



Documentation / August 2014

WARRANTY CERTIFICATE FOR LOKOTRACK ST2.4 S/N 78046

Enclosed are the following documents that are necessary in order to activate the warranty of the above mentioned equipment:

- Commissioning and Warranty Registration (CWR)
- CWR Internal Policy for New Equipment
- Standard Limited Warranty Conditions

Please complete the CWR document and follow the instructions outlined in the CWR Internal Policy for New Equipment.

Best Regards,

For
METSO MINERALS OY



N11469729, C-rev.
Rev. -

**Commissioning and Warranty Registration
For METSO
ST352/ST358/ST458/ST3.5/ST3.8/ST4.8/ST2
.4**

Date 22.11.2012
S/N
Model

Metso Minerals warranty starts on the day of this Commissioning and Warranty Registration has taken place.

Customer Maymead	Phone	Warranty certificate received:	<input type="radio"/> Yes <input type="radio"/> No
Branch name	MetsolD	Instruction manual received:	<input type="radio"/> Yes <input type="radio"/> No
Customer representative	Position	Parts manual received:	<input type="radio"/> Yes <input type="radio"/> No
Address		Delivery date as promised:	<input type="radio"/> Yes <input type="radio"/> No
City, State, Zip, Country Mountain City, Tenn, Tenn,		Have MM met your expectation in terms of product quality	
Metso Minerals LSU / Distributor		Perception (first impression)	<input type="radio"/> Yes <input type="radio"/> No
Contact	Phone	Operating tests	<input type="radio"/> Yes <input type="radio"/> No
Application: <input type="checkbox"/> Rock <input type="checkbox"/> Gravel <input type="checkbox"/> Recycling		Was the sales process you met through acceptable	
Amb. temperature C / F		Pre sales	<input type="radio"/> Yes <input type="radio"/> No
Setting: mm / in		Delivery	<input type="radio"/> Yes <input type="radio"/> No
		Are you generally satisfied with all MM contacts	
		Attitude	<input type="radio"/> Yes <input type="radio"/> No
		Responsiveness	<input type="radio"/> Yes <input type="radio"/> No
		Competence	<input type="radio"/> Yes <input type="radio"/> No

(*) <http://www.cat.com> (engines > engine warranty registration)

A. ST START-UP	
Inspections before starting the engine	
1. Check oil and water level in diesel engine	<input type="radio"/> OK <input type="radio"/> NOTE
2. Check oil level in track gearboxes	<input type="radio"/> OK <input type="radio"/> NOTE
3. Check oil level in feeder vibration unit	<input type="radio"/> OK <input type="radio"/> NOTE
4. Check oil level in hydraulic tank	<input type="radio"/> OK <input type="radio"/> NOTE
5. Check V-belt tension-engine	<input type="radio"/> OK <input type="radio"/> NOTE
After the engine start	
6. Check function of the process & options	<input type="radio"/> OK <input type="radio"/> NOTE
7. Check manual valve functions	<input type="radio"/> OK <input type="radio"/> NOTE
8. Check hydraulic oil max pressure, LS pressure and tank line	<input type="radio"/> OK <input type="radio"/> NOTE
9. Check the safety and E-stop installations & operations	<input type="radio"/> OK <input type="radio"/> NOTE
10. Check conveyor belt tracking-no load	<input type="radio"/> OK <input type="radio"/> NOTE
After material feed	
11. Screen cloth tightening on screen unit	<input type="radio"/> OK <input type="radio"/> NOTE
12. Conveyor belt tracking	<input type="radio"/> OK <input type="radio"/> NOTE

B. FAMILIARISATION TRAINING OF THE OPERATOR	
1. Safety familiarisation	<input type="radio"/> OK <input type="radio"/> NOTE
2. Operating with unit	<input type="radio"/> OK <input type="radio"/> NOTE
3. Daily maintenance of the unit	<input type="radio"/> OK <input type="radio"/> NOTE
4. Name / Company of attending in training	<input type="radio"/> OK <input type="radio"/> NOTE
a.	
b.	
c.	
5. Train on and test radio remote option	<input type="radio"/> OK <input type="radio"/> NOTE
6. Review & train on manual (forced) control	<input type="radio"/> OK <input type="radio"/> NOTE
C. OTHER	
1. Foldable conveyer operation	<input type="radio"/> OK <input type="radio"/> NOTE
2. Screen units operation	<input type="radio"/> OK <input type="radio"/> NOTE

Section A Notes:
Section B Notes:
Section C Notes:
Section D Notes:

Customer	Date	Metso Minerals/Distributor Service Eng	Date	Metso Minerals Service Manager	Date
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METSO MINING AND CONSTRUCTION CRUSHING AND SCREENING PRODUCTS COMMISSIONING AND WARRANTY REGISTRATION (CWR) POLICY FOR NEW EQUIPMENT

1. POLICY. All new Crushing and Screening equipment must be commissioned in accordance to the guidelines provided in the equipment's CWR Form. A paper copy of the appropriate CWR Form will always be delivered along with all other documentation of the equipment, and this Form must be followed and filled-in during commissioning. Should the CWR Form be lost or misplaced, additional copies can be obtained from the manufacturing facilities of the product.

2. WARRANTY ACTIVATION. The Warranty for new equipment will begin immediately after the date of execution of the CWR Form. The executed CWR Form is the equipment's warranty certificate, and it's conditions are as stated in " Standard Limited Warranty Conditions for New Crushing and Screening Equipment, Components, Parts and Services." A copy of the executed CWR Form must be issued to the final buyer (i.e. the end user) of the equipment, and a copy of the CWR Form must be kept by the Metso Minerals Sales and Service Office or by authorized distributor.

3. WARRANTY REGISTRATION (ELECTRONIC). The executed CWR Form (i.e. the Warranty certificate of the new equipment) must be registered electronically within 30 days from the date of commissioning of the equipment. Electronic registration is to be done on-line using Warranty Registration -functionality in extranet.metsominerals.com. Instructions for registering the warranty of the equipment are found from the extranet help section.

The electronic Warranty registration must be done in the English language, and all relevant information should be written electronically.

A paper copy of the executed CWR Form does not need to be sent to the manufacturing facility of the new product. However, a paper copy must be kept by the Metso Minerals Sales and Service Office or by authorized distributor. The manufacturing facility reserves the right to inspect and/or request copies of the executed CWR Forms without prior notice. A paper copy of the executed CWR form must be filed by the Metso Minerals Sales and Service Office or by authorized distributor for at least one (1) year after the warranty period has expired.



OEM Model Information Available at Cat® Dealers

This manufacturer has made their service information available at CAT dealers through the OEM Service Interlink system.

Ask your Cat dealer to view in at

<http://oeminterlink.cat.com/>

THESE ARE METSO MINING AND CONSTRUCTION'S STANDARD LIMITED WARRANTY CONDITIONS FOR NEW CRUSHING AND SCREENING EQUIPMENT, COMPONENTS, PARTS AND SERVICES

1. WARRANTY. Metso Mining and Construction ("Metso") warrants new crushing and screening equipment, and components and spare parts thereto, supplied by Metso under the contract between Metso and its Purchaser ("Contract"), to be free from defects in materials and workmanship in accordance with this Warranty. Subject to Clause 4.2, wear parts and consumables are not warranted. This Warranty covers the first Purchaser or user ("User") and is not transferable without Metso's written consent.

Metso has the right to make a review of the delivered machinery at any time agreed with the User during the warranty period though latest by the expiry date of the warranty.

2. DURATION. Unless otherwise agreed in the Contract, warranty period for new equipment is valid for 12 months or 2000 operating hours, whichever comes first, counted from the date when commercial operation of the equipment starts. The warranty period expires, whether in case of extended storage, delayed Start-up, repairs, replacements, latent defects or otherwise, after 18 months from the original delivery of the equipment to the User (according to the delivery term in the Contract) at the latest.

In case of equipment, the Commissioning and Warranty Registration ("CWR") Form shall be filled in and sent to Metso within 30 days from the CWR Inspection. Subject to applicable mandatory law, this Warranty becomes effective only if Metso receives the properly filled CWR Form.

Unless otherwise agreed in the Contract, warranty period for components and spare parts supplied by Metso is 6 months from the delivery to the User or 1000 operating hours, whichever comes first. The warranty period expires, whether in case of extended storage, delayed installation, repairs, replacements, latent defects or otherwise, after 12 months from the original delivery of the component or spare part to the User at the latest.

If the equipment, components or spare parts are used more intensely than specified by Metso or against good industry practice, above periods of time shall be reduced proportionally as determined by Metso in good faith.

3. REMEDY. Metso shall, at its option, either repair the defect or replace the defective equipment, component or part under this Warranty. Repair work shall be carried out by Metso or its authorized representative at the place decided by Metso.

The User may have the right to carry out the warranty repair or replacement only subject to Metso's prior consent or in case of urgency where no consent and service from Metso is available within reasonable time. In such event, Metso shall reimburse reasonable actual out-of-pocket costs incurred to the User in the necessary repair or replacement of the defective equipment, component or spare part. Costs resulting from preparatory work, auxiliaries or plant environment shall not be reimbursed. No compensation shall be paid by Metso for overtime, Sunday or other holiday work or for any removal or installation costs.

Unless otherwise agreed, transport from site to Metso (or other repair shop or replacement source) and to site in connection with remedying of defects under this Warranty shall be at the risk and expense of the User. The defect in question shall be clearly marked on the part, component or equipment, which must be packed properly and in such a way that Metso can carry out a defect or fault analysis reliably.

NOTE. If the machinery is located in an area where Metso does not have warranty service resources available, or where business travel is discouraged, or if there are other reasons why warranty remedy would require extraordinary arrangements or costs, Metso shall have the right to invoice a specific warranty claim handling charge, as determined by Metso in good faith.

4. EXCLUSIONS. This Warranty does not cover:

4.1 ordinary wear and tear or deterioration of the equipment, components or parts, normal maintenance and service (such as

engine tune-ups, adjustments, settings and inspections), normal ageing, normal replacement items (such as service filters), or any damage resulting therefore;

4.2 wear parts and wear components such as hoses, belts, rubber tyres, blades, linings, discs, batteries, nozzles, oil, fuel, fluids, grease, coolants or other materials or parts, which are considered within the industry as wear parts or consumables, except where defects in materials or workmanship are found, in Metso's judgement, to cause premature breakage or wear;

4.3 components, parts and work, if repair or correction requires only minor effort such as changing of seals, tightening, adjustment or settings;

4.4 any modifications or work if carried out by an unauthorized repairer or without Metso's prior consent;

4.5 carelessness of the operators or service men, incorrect operation, maintenance, service or storage, overloading, or any use, action or omission against Metso's manuals or instructions;

4.6 Force Majeure events or any other circumstances beyond the reasonable control of Metso (such as fire, lightning, flooding, earthquake, landslide, vandalism, labour dispute, war, riot, governmental action, utility shortage or excessive voltage fluctuation), or acts or omissions of the User or a third party;

4.7 parts, other than those approved by Metso, which have been used in earlier repair or maintenance work or are otherwise not of sufficient quality and design;

4.8 defects or faults that have no significance to the operation of the equipment or plant, such as dents or surface scratches;

4.9 defects or faults caused by materials or parts provided or designs or specifications specified by or on behalf of the User; and

4.10 any indirect or consequential damage or loss whatsoever, such as loss of profit, loss of production, down-time, business interruption, loss of business opportunity, capital costs, cost of substitute use, claims by third parties or loss of use.

5. REPORTING. The User shall notify Metso in writing of any defect as soon as it becomes apparent or damage occurs and in no event later than 14 days after this Warranty expires in accordance with Clause 2 above.

6. TITLE TO REPLACED PARTS. Parts, components and equipment replaced under this Warranty shall become the property of Metso upon Metso's request.

7. NO LIABILITY FOR OTHERS' WORK. Metso does not accept any liability for defects, faults or occurrences incurred as a result of any service, maintenance, repair or replacement carried out by others than Metso or its authorized representative.

8. GENUINE METSO PARTS REQUIRED. No claim will be considered and this Warranty will be null and void to the extent any defect, fault or occurrence has been caused as a result of the use of other than GENUINE METSO SPARE AND WEAR PARTS in the equipment or plant in question.

9. SERVICES. Metso warrants that the services provided by Metso under the Contract shall be performed in a workmanlike manner. Unless otherwise agreed, no warranty of any kind is given by Metso as it comes to the outcome of the equipment, plant or system or other outcome of the services. Upon User's notification, Metso shall investigate the claimed defect in the services and shall, in its sole discretion, either carry out a defective part of the services again or reimburse the relevant portion of the price as User's entire and exclusive remedy.

10. APPLICABLE METSO COMPANIES AND PRODUCTS. This Warranty shall apply only to the Metso equipment, components, parts and services and Metso companies specified in the Contract.

THIS WARRANTY IS EXPRESSLY IN LIEU OF ALL OTHER LIABILITIES, WARRANTIES, CONDITIONS AND REMEDIES, WHICH ARE HEREBY EXCLUDED, DISCLAIMED AND WAIVED BY THE PARTIES WITH RESPECT TO METSO'S WARRANTY OBLIGATIONS FOR THE EQUIPMENT, COMPONENTS, PARTS AND SERVICES PROVIDED BY METSO.



**EY-VAATIMUSTENMUKAISUUS-
VAKUUTUS KONEESTA**

(Direktiivi 2006/42/EY, liitteen II malli A - fin)

**EC DECLARATION OF CONFORMITY
FOR MACHINERY**

(Directive 2006/42/EC, Annex II, sub A - eng)

METSO MINERALS OY
Lokomonkatu 3
FIN-33100 TAMPERE
FINLAND

vakuuttaa, että

herewith declares that

Lokotrack ST2.4 S/N 78046

täyttää konedirektiivin (direktiivi 2006/42/EY) ja siihen
liittyvien muutosten sekä ne voimaansaattavien kansallisten
säädösten määräykset;

is in conformity with the provisions of the Machinery
Directive (Directive 2006/42/EC), as amended, and with
national implementing legislation;

ja lisäksi vakuuttaa, että

and furthermore declares that

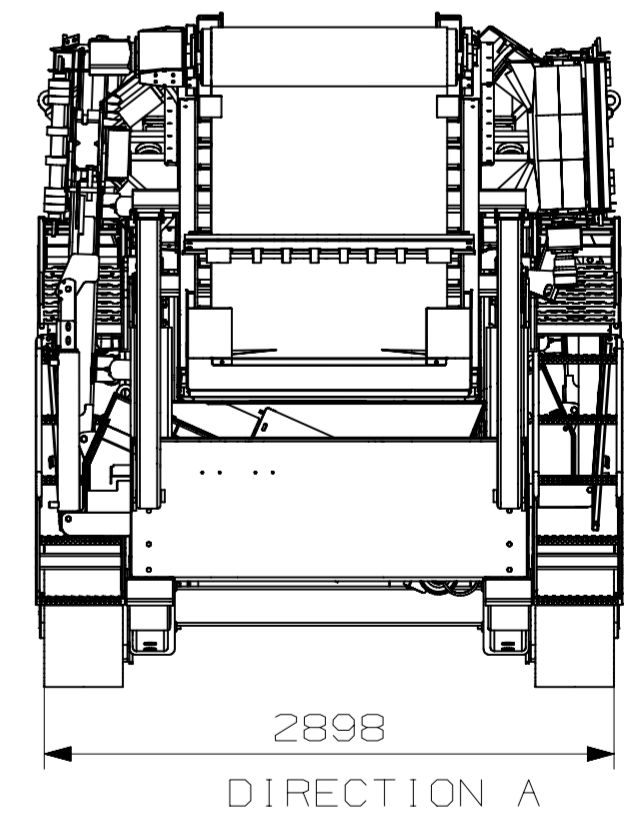
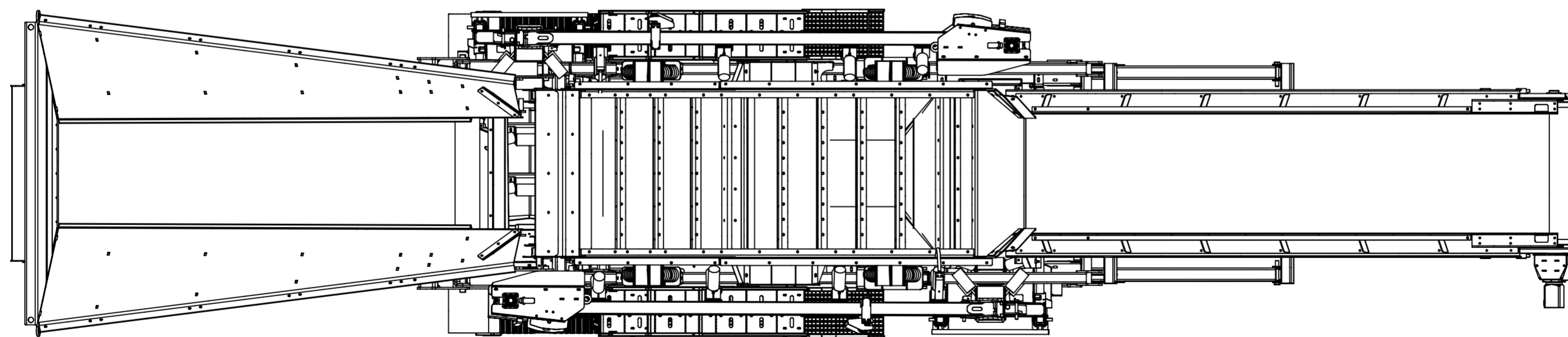
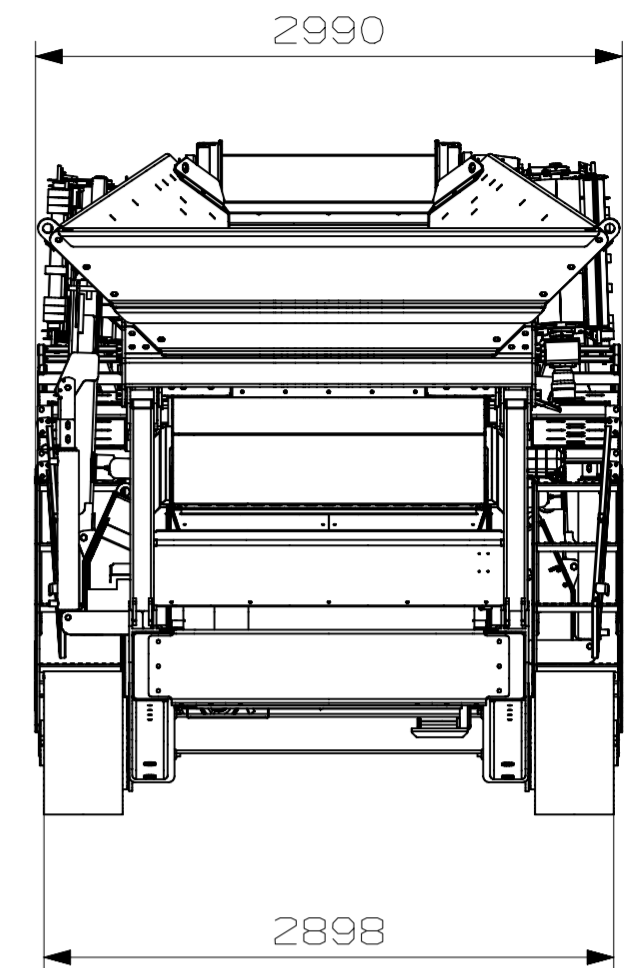
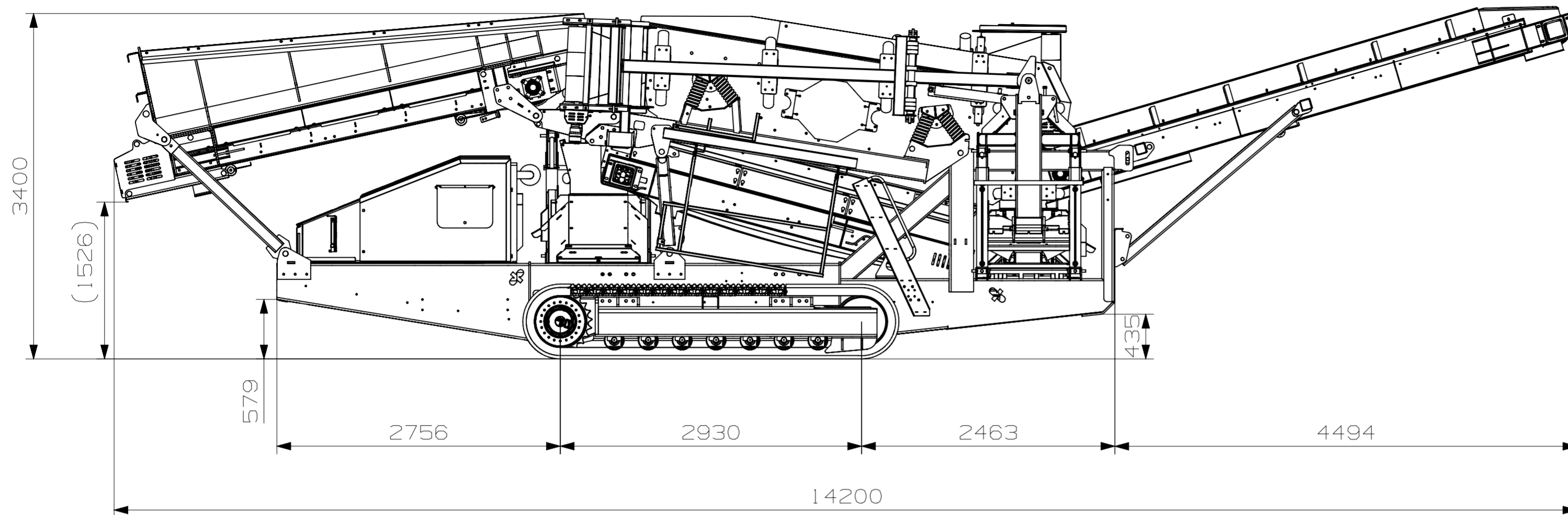
seuraavia yhdenmukaistettuja standardeja (tai niiden
osia/kohtia) on sovellettu:

the following (parts/clauses of) harmonized standards have
been applied:

*EN ISO 12100
EN ISO 13857
EN 349 + A1
EN ISO 4413
EN ISO 13850
EN ISO 13732-1
EN 614-1 + A1
EN 626-1 + A1
EN 1037 + A1
EN 60204-1*

Tampereella / in Tampere, 2014-08-20

Kimmo Anttila
Tuotepäällikkö / Product Manager
Teknisen tiedoston kokoaja / The person authorised to compile the technical file



WEIGHT : WITH BELT FEEDER 23500 kg
 APRON FEEDER 26500 kg

1	VIEW ADDED	-	jar	12-Mar-2014	-
0		-	trepajunni	18-Sep-2012	-
REV	DESCRIPTION OF CHANGE	LOC	BY	DATE	ECN
	weight (kg) 0,05	STANDARDS AND INSTRUCTIONS FOR MANUFACTURING ALL DIMENSIONS IN MM			
	Drawn by: trepa.junni Date: 18-Sep-2012	ASSEMBLY AND DESCRIPTION			Document Group MI
	Checked by: xyo Date: 12-Mar-2014	PRODUCT	DRAWING DESCRIPTION TRANSPORT DRAWING ST2.4		Page 1/1
	Approved by: xyo Date: 12-Mar-2014	DRAWING NUMBER			REV
<small>THE INFORMATION CONTAINED HEREIN IS CONFIDENTIAL AND PROPRIETARY TO METSO AND IS NOT TO BE REPRODUCED, DISCLOSED TO A THIRD PARTY, MODIFIED OR USED WITHOUT PRIOR PERMISSION OF METSO OR ITS DULY AUTHORIZED REPRESENTATIVE. ALL RIGHTS RESERVED.</small>		DWG SIZE A2	PREFIX	ITEM CODE MM0583616	SUFFIX REV 1



Lokotrack ST2.4

s/n 78046

INSTRUCTION MANUAL

- 1 Safety**
- 2 ST2.4**
- 3 JMG**
- 4 CAT**

MANUFACTURER:

Metso Oy

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Finland

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SAFETY INSTRUCTIONS

Safety instructions

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1.1 General

This manual, together with specific instruction manuals for individual equipment, has been prepared by Metso Minerals Crushing and Screening Business Line to increase the knowledge and awareness of all persons involved in the operation, supervision, service and maintenance of crushing and screening equipment with regard to safety and operations. A copy of this manual must be provided to and studied by each person entering the machine areas of the Crushing Plant, or otherwise involved in the operation of the Crushing Plant. It is the responsibility of the Owner to always keep this manual and other written instructions either in the Crushing Plant or its vicinity for Operator reference.

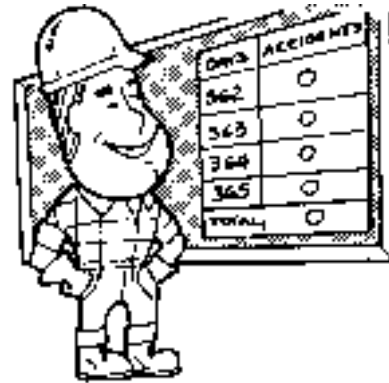
Knowledge of the machines and the potential hazards they present are essential to a safe workplace. Knowledge of and compliance with all state, provincial, and federal safety laws, safety regulations, and Crushing Plant safety procedures, warnings and instructions also are essential to a safe workplace. Failure to do so can result in serious injury or death.

When in doubt - don't! Never bypass instructions or procedures to save time. Never place foreign items, tools, rods, or any part of your body into an operating machine. Never reach over, around or beyond safety devices. Never operate a machine if safety devices are missing or disabled. Never replace an OEM safety device with a non-OEM device.

Never service equipment until all potentially moving parts are secured and power has been locked out and tagged out to prevent unexpected movement.

The Operator is responsible for using care and common sense at all times.

Remember, safety is everyone's business. You are responsible not only for your safety, but for the safety of those around you.



Please read this manual carefully. Know its contents. If you have any questions, contact your Metso Minerals representative without delay for advice. Keep in mind that there are different types of risks, hazards and injury types (see Section 2.3 *Typical risks in Crusher Plant working environment*), which are related to each other. Foresee and prevent such risks and hazards as well as resulting injuries and other consequences from occurring by all available means. Never compromise when the question is about safety!

Metso Minerals, as the machinery manufacturer and supplier, regards safety as of the utmost importance, and deems the following as essential prerequisites to the safe operation of the Crushing Plant:

- That the Owner makes available this manual, before using the machinery, to each person involved with the operation, supervision, service, or maintenance of the Crushing Plant.
- That compliance with and adherence to this manual be mandated and supervised by the Owner.
- That all personnel involved in the operation, supervision, service, or maintenance of the Crushing Plant

become familiar with the contents of this manual prior to such involvement.

- That every person involved in the operation, supervision, service, or maintenance of the Crushing Plant be properly trained and have adequate professional skills as required for the performance of the respective tasks.
- That all visitors to the Crushing Plant be properly informed of applicable safety precautions and risks, and that safety precautions be adequately maintained and in connection with any such visits, including, but not limited to, adherence to this manual.

No changes shall be made in the operation of the machinery supplied by Metso Minerals or the contents of this manual without express written approval of Metso Minerals. All operation, service, maintenance, handling, modifications, or other use of Crushing Plant equipment and/or systems is the responsibility of the Owner. Metso Minerals shall not be liable for any injury, death, damage or cost caused by any act or omission on the part of the Owner, Operator or other personnel, agents, contractors, vendors, or others. All applicable safety rules, regulations, standards, instructions, and procedures must be complied with; as must be those of this manual as well as any other instructions, specifications, and recommendations by Metso Minerals.

This manual is based upon the safety laws, rules and regulations in effect on the date hereof. The owner and operator bear sole responsibility for complying with any amendments, additions or other changes to safety law, rules or regulations arising subsequent to the date on which this manual was drafted.

Although these instructions are intended to be as comprehensive as possible, there may be hazards that cannot be anticipated, hazards associated with a particular work-site or hazards covered by special company safety

programs. The information may also not include all practices that must be observed, such as insurance requirements or governmental regulations.



If you have questions or concerns regarding safety aspects of machinery supplied by Metso Minerals, contact us before using, operating, servicing or repairing the machinery.

IMPORTANT!

Safe operation of the machine requires alertness and safety-consciousness on the part of all operating personnel. It should be operated only by knowledgeable and trained personnel.

1.2 Definitions:

“**Crushing Plant**” means a combination or part of various equipment, components, systems and parts for crushing and/or screening of rock, minerals, recycling or other crushable materials. For the purposes of this manual, the Crushing Plant means also stand-alone crushing or screening equipment as applicable. Throughout this manual, words such as “machine”, “machinery”, “equipment” and “crusher” are used interchangeably to refer to the Crushing Plant and its component parts.

“**Owner**” means the entities or individuals who own or lease the Crushing Plant and/or the entities or individuals who are in charge of operating and/or servicing the Crushing Plant.

“**Operator**” means the individuals who either operate the Crushing Plant or perform actual maintenance, service, repairs, supervision or any other activity on or for it.

“**This manual**” means, as applicable, this general safety instructions, together with any specific instructions for individual equipment, as amended from time to time, provided by or on behalf of Metso Minerals.

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GENERAL SAFETY INSTRUCTIONS FOR A CRUSHING PLANT OR PLANT ENVIRONMENT**2.1 SAFE PRODUCTS AND THE CRUSHING PLANT**

All machines require human involvement. Like any other heavy machinery, a Crushing Plant has inherent dangers that must be identified, understood and taken into account in order to avoid accidents and injuries. Metso Minerals, as machinery manufacturer and supplier, is committed to promoting safety at the Crushing Plant by providing safety devices and features, and by providing training, services, manuals and instructions.

2.2 SAFETY AND YOU

Safety is everyone's responsibility; safety is your responsibility.



Safety is the concern of all personnel. With your actions, you participate in establishing the safety of the working environment.

Metso Minerals products are designed and constructed with safety in mind. The machines incorporate high quality safety features used.

To assure safe operation, all personnel must be alert when operating or working on or around the machine. Be aware of real and potential hazards. Only properly trained personnel should operate, supervise, maintain, or service the machine.

Personnel must carefully study all aspects of the specific machine, including:

- operating instructions
- service, trouble-shooting and maintenance instructions
- automated features and motions of the machine

- specific safety features and instructions

IMPORTANT!

- If unsure of any procedure, check the operation manuals and/or contact your supervisor before proceeding.
 - Follow all lockout and safety procedures before entering the machine.
 - Be constantly aware of the location of each worker on or around the machine.
 - Observe all safety instructions.
 - Do not remove or disable any guard, safety device, sign or warning.
-

2.2.1 Objective

The objective of these instructions is to minimize risks and to avoid or prevent accidents and injuries. Accidents are often caused by carelessness or disregard of important instructions.

Knowledge of the machine operation and continuous safety training are necessary for a safe working environment.

Safety can be summarized in three main themes:

- MACHINE KNOWLEDGE
- SAFE OPERATION AND MAINTENANCE
- GOOD HOUSEKEEPING

2.2.2 Safety Signs, Labels And Symbols

The following symbol is used in this manual and on the machine to call attention to instructions, which will help prevent machine related injuries.

When you see this symbol on your machine or in this manual, be alert to the potential for personal injury.



Figure 2.1 Alert Symbol

This manual uses the alert symbol, with words such as DANGER, WARNING or CAUTION, to alert you and other Crushing Plant personnel of actions or conditions that pose a potential safety hazard, with an attending risk of personal injury (including death) or property damage. The machine also displays safety signs, labels and tags at appropriate points to show safety risks that may exist.



Sign	Description
DANGER	Immediate hazards or unsafe practices that will result in severe personal injury or death.
WARNING	Hazards or unsafe practices that could result in severe personal injury or death
CAUTION	Hazards or unsafe practices that could result in minor personal injury or equipment damage

Figure 2.2 Danger, Warning, Caution Signs And Their Meaning

2.2.3 Some General Safety Instructions

1. Do not remove, cover or disable any installed safety devices, guards, warning signs or tags. They are attached to equipment to warn personnel of possible danger and prevent injury. Use OEM replacements in the event any safety devices, warning signs or tags become damaged or unreadable. Observe all instructions. Keep warnings signs and tags clean, visible and readable. (Warning signs are listed and their locations described in the machine safety instructions.)
2. Make sure that all required walkways, handrails, barriers, safety devices, and guards are in place before starting the machine. Do not use non-OEM walkways, handrails, barriers, safety devices or guards, when such items are available from OEM.
3. Keep the machine itself and the area around the machine clean and clear of obstructions. Be aware of dust, smoke or fog, which may obscure your vision.
4. Wipe up any substance, such as spilled oil, grease, water or ice, which may cause a person to slip or fall. Good housekeeping practices prevent injuries. Be a good housekeeper. Keep the machine environment and walkways clean and free from oil, grease, rags, cables, chains, buckets, rocks and other obstructions. Keep loose parts in a toolbox or return them there promptly.
5. Keep clothing and all parts of the body away from nip points and rotating or moving equipment. Be especially alert to avoid contact with parts that move intermittently.
6. Know the weight limitations of lifting devices and their loads. Never detach a lifting device from a load until the load is stable and secured from unintended movement.
7. Do not climb or stand on equipment other than in areas, which are designed for that purpose. Do not overreach.
8. Emergency-Stop buttons should be tested on a regular schedule for proper operation, as should electrical interlocks and related limit switches. Safety defects should be repaired prior to continuing operation, and thereafter tested and certified for appropriate operation by skilled personnel.
9. Personal protective equipment and safety uniforms, safety shoes, helmets, safety glasses, heavy gloves, ear protection devices etc. should be used at all times. Safety shoes should be used by all personnel entering into the Crushing Plant. Persons with loose clothing, neck ties, necklaces, unprotected long beard or long hair should not go near the machine. Wrist watches and rings can be dangerous. Rings should be removed or covered with tape. Keep your pockets free of loose objects.
10. Keep all non-operating and non-trained personnel clear of the Crushing Plant at all times. Injury or death may result if this is not done.
11. The equipment at the control panel should be handled with care. Do not place objects on the keyboard, color display or other equipment. All equipment can fail if put in contact with liquids, or excessive heat or excessive humidity. Allow good air flow around the equipment at all times. Keep magnets away from computer components, particularly hard drives and PLC cabinets.
12. A knowledgeable and properly trained Operator familiar with this manual, safety requirements, and automatic operation of the machine should be stationed at the controls whenever the machine is operating.

13. Do not consume any alcoholic beverages or other intoxicants before coming to work or while on the job. Do not operate the Crushing Plant after taking any medicines, tranquilizers or other drugs, which can impair the senses.
14. Familiarize yourself with the safety signs on the Crushing Plant. Never remove or damage any safety signs, nameplates or other safety related warnings, symbols or components. Replace them as necessary with OEM equipment.
15. Do not paint over safety signs, name plates or warnings.

2.2.4 Blasting



The use of the Crusher Plant's radio control device is strictly forbidden during blasting operations, as it may cause a premature explosion. Move the mobile Crushing Plant far enough away from dangerous area when blasting. Do not store or transport explosives on mobile crushing plant or screening plants.

WARNING:



Only qualified and properly trained operators and servicemen should operate or service the machine. Everyone else should stay clear of the machine when it is operating, or under service or maintenance!

WARNING:



People using the pacemaker must not go near the magnet!

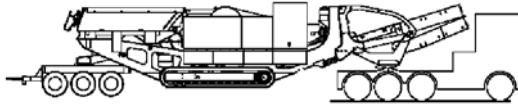
2.2.5 Portable Plants

If the Crushing Plant includes of portable equipment (i.e. crushing and screening equipment mounted on trailers), trailer footing or cribbing is extremely important for safe operation. Your machine must be on as solid and level footing as possible. If the ground is not naturally level, it must be leveled so that the unit will operate safely and effectively. The ground must support the weight of entire unit and keep it from sinking or shifting. Use heavy timber mats as needed. Trailers must be raised so that trailer wheels do not touch the ground.

Place jacks at each corner of the trailer or as near the corner as possible and to other suggested support points at mid-frame. All corner jacks must be at an equal distance from each end. Adjust each jack until the unsupported portion of the trailer beams stops vibrating or until vibrations are reduced to a minimum. Lock jacks and adjustable support legs mechanically with locking pins when applicable.

Periodically recheck trailer footing for stability.

2.2.6 Mobile Equipment Transportation



Use only appropriate transportation and lifting equipment with adequate capacity. Provide a supervisor to direct lifting operations. Follow all disassembly and assembly instructions carefully. Disconnect all external power supplies before moving any part of the equipment. Transport or hoist components and handle any parts in accordance with the instructions and advice provided. Fasten the lifting equipment only to the points meant for lifting. Use only proper means of transport with adequate transporting capacity. Fasten the load carefully. For lifting use only the fastenings shown in instructions. Secure all component parts of the equipment immediately after loading to avoid any accidental shifting. Attach required warning signs to the load.

When moving your trailer, check bridges before crossing. Make sure they will support the weight of the machine. Check clearances under bridges, for overhead lines or any overhead obstruction. Never travel with near capacity loads. Check local laws, especially on weight limitations. When travelling on the highway make sure all headlights, clearance lights and tail lights are on, as applicable. Use proper traffic warning flags and signs.

Remove all shipping brackets before re-starting the Crushing Plant. Carefully assemble all of the parts previously disassembled. Perform any start up in accordance with the instruction manual.

After the system is running, check all gauges and instruments to see that they are working correctly. Check that all controls function normally and properly. Listen for unusual noises. Shut system down immediately if any component of the system does not operate normally.

2.3 TYPICAL RISKS IN CRUSHING PLANT WORKING ENVIRONMENT



Even though every Metso Minerals machine is designed with many safety features, it is impossible to design out all safety risks. There are potential hazards, that must be recognized and avoided. Noise levels may interfere with normal discussion when the machine is operating. By their nature, Crushing Plant and auxiliary equipment can create dust. Crushing itself and some other machine processes may momentarily obstruct the view of some machine parts. In general, high levels of respirable silica and other dust in the air may expose Operator to health risks for lung disease depending upon the length and amount of exposure and type of material being crushed. In addition, there are some risks or hazards which cannot be completely guarded or avoided because of interference with machine operations. Accordingly, working on the Crushing Plant requires constant alertness by all personnel in the area. Accidents happen unexpectedly. Below are some typical hazards and types of accidents that everyone working at, on or around the Crushing Plant should be aware of.

Typical Hazards

- nips, gaps, and pinch points
- poor housekeeping
- elevated or narrow working areas
- lifting and shifting heavy loads
- cranes and mobile cranes

- sharp edges
- high-pressure hydraulic equipment
- electrical equipment
- automatic functions and unexpected start-ups
- toxic and corroding agents
- machine inertia
- hot surfaces and fires
- zinc
- conveyor belts
- dust
- noise and vibration
- improper work methods
- rotating equipment and moving components
- ejection of material from the crusher
- falling material from conveyors, and from loading, unloading and feeding operations
- crushing cavity

These typical hazards are discussed more fully in *Section 2.3.1* of this chapter. Be aware of these hazards. All personnel working on or around the machine should be properly trained in avoiding these hazards.

Typical Injury Types

- crushing
- slipping, tripping and bumping
- falling
- cutting
- entanglement
- burns and electrical shocks
- respiratory organ illnesses
- asphyxiation

2.3.1 Typical Hazards

Nips, Gaps, and Pinch Points



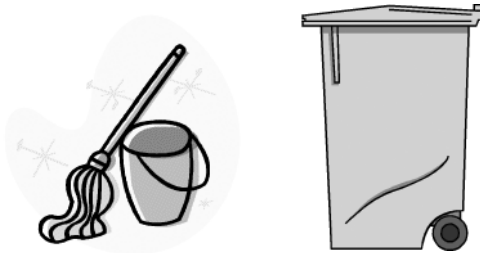
An ingoing nip is formed by drive devices such as belt and pulley, chain and sprocket or gears. Similarly, a pinch point may be formed by rotating or moving equipment.

DANGER:



Nips and gaps are serious hazards in a Crushing Plant. They are usually guarded by nip guards, railings, or location. In all cases, extreme care must be taken to avoid nips, gaps, and pinch points or serious injury or even death may occur.

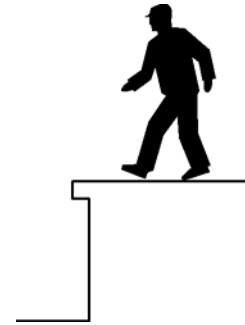
Poor Housekeeping



Promote good housekeeping. Keep machine environment, walkways, platforms etc. clean and dry and free of debris. Oily or wet machine environment, walkways, platforms, steps and hand rails are slippery. In cold weather, watch out for ice and snow. Wet spots, especially near electrical equipment, are dangerous. Return tools to their proper place after use. Even then extreme caution should be used. Follow established Crushing Plant safety procedures. Clean slippery deposits from walkways,

ladders and floors. Tidiness provides a safer working environment by preventing or helping reduce tripping, slipping, fire hazards and electrical shocks.

Elevated or Narrow Working Location



Crushing Plants are tall structures. The walkways and platforms, designed to be used during machine operation, are furnished with railings to help prevent falling.

When working on an elevated surface be aware of machine movements and other activities in the area. Do not run on the walkways. Do not reach over or beyond walkway railings while the machine is running. Do not stand on railings or toe plates.

There may be narrow access routes for maintenance purposes. Do not use these routes while the machine is operating.

Do not enter any close quarters within the Crushing Plant when the machine is operating.

Lifting And Shifting Heavy Loads



- Cranes

Crushing Plants, like any other type of mechanical equipment, require regular periodic maintenance. One of the most flagrant Crushing Plant safety violations is the use of inadequate and unsafe lifting equipment. Although a Crushing Plant is a finely tuned piece of equipment, the internal parts of a Crushing Plant should be assembled and disassembled with crane facilities that have the capability of gently and slowly lifting and lowering the various parts that make up a Crushing Plant.

Do not use chain hoists (chain blocks) to assemble or disassemble a Crushing Plant. These lifting devices lack the stability and robustness required in lifting and positioning heavy components.

Do not use impact hammer boom or any other equipment which are not designed for lifting, for assembly or disassembly purposes.

Affix the load securely to its destination. Never detach a lifting device from a load until the load is stable and secured from unintended movement.

When it comes to safety, don't compromise!

IMPORTANT!

When using a crane, always operate within the rated capacity of the crane. The safe rated capacity includes weight of hook, block and any materials handling devices such as cables, slings, spreader bars, etc. Subtract the weight of all these items from the rated capacity to find the true weight of the load that can be handled safely. Always follow the crane manufacturer's operational and safety instructions.

IMPORTANT!

The weight indicated in machine plates tells the weight of standard configuration. In many cases the actual weight may differ greatly from that indicated in machine plate due to, e.g., options or ancillary equipment. Always verify the weight of the object you are lifting before attempting to lift it.

- Mobile cranes

Safe ratings are based on operating the crane on firm, level ground; outriggers must be properly extended and/or lowered whenever required. Avoid fast swings, hoists or sudden braking; these can cause overloads. Do not handle large, heavy loads in strong winds. When moving your crane, check bridges before crossing, make sure they will support the total weight in question. Check clearances under bridges for overhead electrical lines and any overhead obstruction. Be sure your hitcher is clear before starting lift. Make sure the load is securely attached.

IMPORTANT!

When using a mobile crane, always operate within the rated capacity of the machine to avoid buckling the boom or tipping.

Take the following precautions when lifting heavy loads:

- Follow all established Crushing Plant procedures.
- Follow all instructions and safety procedures recommended by the crane manufacturer.
- Plan the lifting and maintenance procedures in advance. Read and understand specific instructions for proper use of lifting equipment prior to using (e.g instructions of the machine, lifting device and local regulations).
- Clean the working environment beforehand to prevent slipping and tripping hazards.
- Make sure that the crane and other lifting devices such as chains and slings have sufficient capacity and are in good working order.
- Do not attempt to ride or sit on moving loads.
- Be sure that crane operators, riggers and other personnel have been properly trained.
- Rig the load firmly to prevent any unintended movement and assure stable and accurate positioning.
- Make sure nobody is below or on the path of the load and that the transfer routes are clear and proper protective clothing and gear are used.

Sharp Edges



Sharp edges may occur on any metal structures. Equipment damage may uncover or produce unexpected sharp edges. Sharp edges may inflict deep and serious cuts. Wear protective gloves when handling materials, parts, etc. with sharp edges. Repair or guard detected sharp edges immediately.

High-pressure Equipment - Hydraulic or Air



High pressure oil can be dangerous. Relieve all pressure before opening or removing any hydraulic or air pressure lines, valves, fittings, etc. Do not touch pressurized components since the pressure from a pin hole leak is so strong that it can easily penetrate the skin or eyes. Always exercise caution when handling hydraulic devices.

Regularly check the condition of hoses, pipes, valves and various connections. Replace them as necessary.

Before starting any maintenance work, stop all hydraulic pumps, lock out pump motors, and depressurize the system, bringing all components to a zero energy state. Remember to also depressurize the accumulators through

the bleed valve for each accumulator. Do not disconnect any hoses until the actuator has been brought to a zero energy state and properly secured.

Bleed the hydraulic system regularly to remove entrapped air that may interfere with normal expected machine operation or cause a hazard during maintenance.

WARNING!


Poorly tightened or damaged hydraulic components may inject dangerous jets of fluid. Before restarting the machine, be sure that the hydraulic system is ready for operation, and personnel are clear of affected areas.

WARNING!


Machine parts may move unintentionally and cause a risk of injury. Before restarting the machine, make sure that all personnel are clear of affected areas where machine movement may occur.

Electrical Equipment


Be especially cautious when working with or near electrical equipment. An electric shock can be fatal. Crushing Plant electrical outlets must be grounded and have ground fault interruption protection. Tools plugged into the outlets must be double insulated. Never expose electrical equipment to mechanical damage or humidity. Protect all electrical equipment from direct contact with water or high humidity.

Protect electrical devices that move as part of the machine from dirt and mechanical damage. Regularly check the operability of these devices.

DANGER:


There is a risk of an electric shock, if sufficient precautions are not taken. An electric shock can be fatal.

For maintenance work, disconnect all devices from electric and hydraulic power sources and follow Crushing Plant lockout procedures.

The lockout program, locks, tags and the blocking/restraining devices provided are designed for your protection. Your responsibility is to follow the program and use the proper equipment.

Remember:

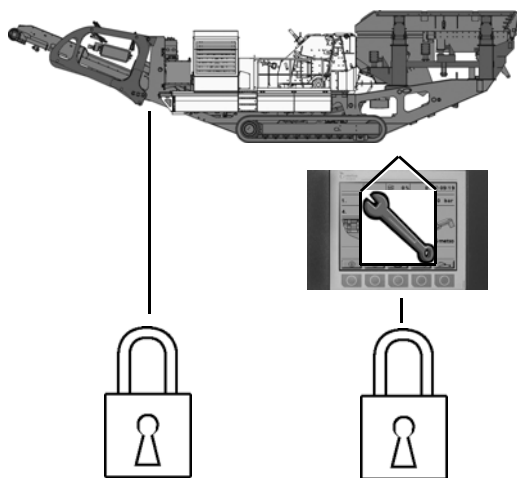
- Follow procedures.
- Stay alert.
- Do not take anything for granted.
- Verify lockout.
- Each person working on the unit must have his own lock with only 1 key.

- Tag must identify the work being done and the person(s) who locked and tagged the control.
- Locks and tags are changed with each shift that comes on.

Work to prevent injury or death. Follow proper procedures at all times!

Maintenance, repair and installation of electrical equipment must be performed only by qualified personnel who are familiar with the machinery and equipment in question.

Automatic Functions and Unexpected Start-ups



Unexpected start-ups during maintenance:

- Lock out and tag machine controls before performing maintenance or repairs to avoid unexpected start-up. Failure to properly lock out the machine can lead to injury or death. Someone may accidentally start the machine from the control room or an unexpected occurrence may activate a control. For example, a power surge may alter the logic of the control system status causing an unexpected machine movement or sequence.

WARNING:



Machine parts may move unintentionally and cause a risk of injury. Absence of safety functions may cause dangerous machine movements.

Do not tamper with limit switches or other safety devices included in the system.

DANGER:



If danger zones are not respected during machine operation or manoeuvres there is a risk of serious injury or death.

Many devices operate automatically, following certain sequences which have been programmed into the logic system (i.e. programmable logic controller, microcontroller, relay system or similar). The danger zone is any area within the confines of moving machine elements, feed material or beneath any objects being lifted. Do not enter these danger zones unless the machine has been properly safeguarded according to the Crushing Plant lockout procedure and manufacturer's instructions.

Welding Equipment



Weld repairs are to be performed only by qualified personnel. Welders and welder's helpers must wear protective clothing and equipment.

Precautions must be taken when torch cutting and/or welding due to the health hazards posed by many metals. Anyone performing these types of procedures should avoid breathing the fumes. Such procedures should be done outdoors or in a well ventilated area with either a separate clean air supply provided to the mechanic or with local exhaust of fumes. Please refer to EU, OSHA, MSHA or other applicable standards as appropriate. One of the most frequently used tools around the Crushing Plant is the cutting torch. Crushing Plants which are equipped with hydraulic components and/or conveyor belts and/or v-belts should have these components depressurized and adequately covered with flame-proof material so that sparks, weld spatter, etc., cannot reach these areas. Ruptured high pressure hydraulic lines will quickly vaporize the hydraulic fluid as it reaches the atmosphere. This vaporized fluid can quickly become a mass of flames, resulting in severe burns for personnel in the immediate area. Adequate precautions should be made to avoid contact with these components. Never perform welding or torch cutting activities in the presence of flammable materials.

WARNING:



Risk of injury. Fire may break out. Never perform welding or torch cutting activities in the presence of flammable materials.

IMPORTANT!

All maintenance personnel who use cutting and/or welding torches should be advised if there are hydraulic components in the immediate area in which they are working.

IMPORTANT!

Contact Metso Minerals or its authorized representative prior to any welding of major Crushing Plant components such as main frame, adjustment ring, bowl, etc. Performing welding on the Crushing Plant components can be detrimental. Before welding, always verify that material is weldable! Failure to do so may result in weldment failure and present a risk of injury and/or property damage.

Toxic, Corroding and Irritating Agents

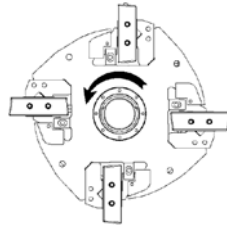


Before handling chemicals, carefully read the safety instructions from the supplier of the respective chemical. Hazardous chemicals may be in use. Wear protective clothing, gloves, boots, glasses, and respirator when necessary.

Refer to the MSDS (Material Safety Data Sheets) and Crushing Plant procedures for handling of these materials.

Avoid prolonged contact with fluids, such as gasoline, diesel fuel, hydraulic oil and cleaning solvents, which may cause skin irritation or other reactions.

Machine Inertia



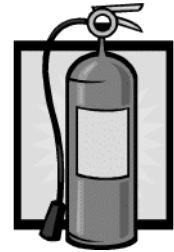
Due to the large inertial forces of the Crushing Plant and Crushing Plant components, the machine can not be stopped abruptly. This is potentially hazardous to personnel. All personnel must stay clear of rotating elements and other moving parts until the machine has come to a complete stop. Regularly inspect the structural elements to maintain safe operation.

Hot Surfaces and Fires



There are hot surfaces on Crushing Plants. Protective gloves and coveralls help protect against burns. Be aware of hydraulic system, hoses, fittings, and pipes. Regularly inspect and observe high temperature lines, and fluid lines for leaks or damage. On mobile equipment be cautious around the engine because of exhaust gases.

When in contact with hot temperatures, or when heated themselves, some hydraulic oils may ignite at around 392°F (200°C). Attention must be paid to the condition of hydraulic hoses and couplings. Remove immediately oil spills from floor, walkways, and pits. Fix all sources of oil leaks and clean up spills.



In case of a fire, the machine must be equipped with a fire extinguisher or fire extinguishing system, and marked according to the regulations. Legislation and regulations about suitable equipment may vary by country. Familiarize yourself with applicable standards. Personnel must also be trained properly to be able to use fire extinguishing equipment.

A trained person with sufficient fire extinguishing equipment must be present during welding maintenance work. Cold water on hot metal surfaces may cause a violent explosion. Monitoring after welding must be arranged as required by laws and regulations. If no other regulations apply, monitoring time is a minimum of one half hour.

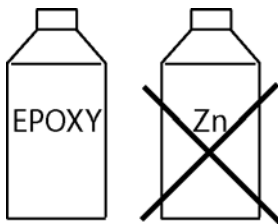
Fire Hazards



- Do not smoke while refueling, or when handling fuel containers.
- Shut off engine when refueling and use extra caution if engine is hot.
- When pouring fuel into the tank, ground the funnel or spout against the filler neck to avoid static electric spark.

- Do not use gasoline or diesel fuel for cleaning parts. Good commercial, nonflammable solvents should be used.
- Do not smoke while using flammable cleaning solvents. Whenever possible, use non-flammable cleaning solvents.
- Do not let greasy, oily rags accumulate in a poorly ventilated area. Store oily rags and other combustible material in a safe place.
- Never use an open flame to check fuel, battery electrolyte or coolant levels, or to look for hydraulic leaks anywhere on the equipment. Use a flashlight. Know where fire extinguishers are kept, how they operate, and for what type of fire. Check regularly, at least monthly, to be sure they are in the working area.
- Do not weld or cause open flame in the presence of flammable materials.
- In the event of a fire, shut down the Crushing Plant, hydraulic power unit and lubrication system if this can be safely done. Warn other people in the area and commence fire fighting activities according to applicable rules. It is the responsibility of the Owner to maintain proper training and instructions in these respects.

Epoxy Versus Zinc



Many Crushing Plants require some type of backing when replacing the crushing members. Epoxy resin backing compounds have almost

completely eliminated the possibility of workers being accidentally burned due to molten zinc either spilling or exploding when it comes in contact with wet surfaces. When epoxy backings are used, care should also be taken when removing the liners with a cutting torch. Do not use molten zinc as backing material. Use epoxy only according to specific instructions from the manufacturer.

Conveyor Belts



WARNING:



Do not use conveyor belts as walkways. Do not climb on them. Always stay clear of any falling or dropping materials or components. Never attempt to stand on, walk on, or step across a conveyor. Never stand below a running conveyor. Do not use loose clothing, neck ties, necklaces or other loose items when near conveyors or other moving or rotating equipment. Emergency pull cords should be used only in case of emergency -do not use them for routine stoppage of conveyor. Never attempt to service the conveyor while it is energized. Keep in mind hazardous nip points.

Crushing Plant Dust



By their nature, Crushing Plant and auxiliary equipment such as chutes, transfer stations, screens, etc. can create dust and, if not contained, the dust can escape into the air. In general, high levels of dust (particularly, respirable silica) in the air can create a hazard of lung disease, depending upon the concentrations of dust, the length of exposure, and the type of material being crushed. Dust protective devices and dust warnings may be required by OSHA, MSHA or local laws.

The Owner and Operator of the Crushing Plant must identify the material being crushed and ascertain whether respirable dust from the application poses a health hazard to personnel in the vicinity of the Crushing Plant. If the material presents such a hazard the Owner and Operator must take all necessary measures to ensure that personnel are protected from the dust. Such measures include, but are not limited to providing dust collection system, using water spray bars at the feed and discharge points, crusher transfer points and screens and providing adequate personal respiratory protection devices to workers.

Crushing with a choke level may also reduce the amount of dust issuing from the Crushing Plant itself. Because the configuration of each rock crushing installation is different, Metso Minerals recommends that the Owner and Operator consult Metso Minerals or a dust consultant about possible alternative means of dust reduction.

IMPORTANT!

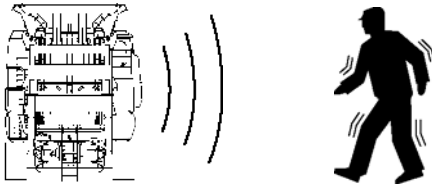
Metso Minerals highly recommends that dust protective devices such as an appropriate respirator be worn by anyone exposed to airborne dust to prevent its inhalation.

WARNING:



Breathing dust may be hazardous to the health of anyone working at, on, or around the Crushing Plant. It can cause serious or fatal respiratory diseases including silicosis! It is the responsibility of the Owner and Operator to determine the necessity and adequacy of protective devices and warnings, to provide them, and to ensure that they are used and followed!

Noise and Vibration



• Crushing Plant Noise

Crushing Plant by its very nature is noisy and the auxiliary equipment found at, on or around the Crushing Plant such as chutes, transfer stations, screens, etc., can at times be noisier than the Crushing Plant itself. Typical Crushing Plant noise level while crushing range from 100 - 110 dB measured at 1 m (3ft) from the Crushing Plant.

Metso Minerals recommends wearing ear protection at, on and around Crushing Plant, particularly when the noise level exceeds 85dB. It is recommended that the Owner develop a signaling communication system in noisy environments to reduce the risk of accidents. Proper machine maintenance and replacement of worn parts can help reduce noise.

The most commonly applied noise reduction procedures are:

- use of isolation techniques
- equipment enclosures
- operator enclosures
- silencers

Allowable noise levels and exposure limits are regulated by various agencies such as ISO, OSHA, MSHA, etc. Refer to applicable safety regulations for permissible noise exposures, and take steps to ensure compliance with those regulations.

• Vibration

Long term exposure of Operator to vibration may result in detrimental health effects. There

is an increased risk of falling on a vibrating platform. Avoid standing on a vibrating Operator's platform or walkway.

Unexpected or excessive vibrations may be a sign of wear and/or maintenance needs. Excessive vibrations associated with a portable crushing or screening plant is frequently caused by improper cribbing.

It is recommended to regularly monitor vibration levels of machine components including, but not limited to:

- bearings
- shafts
- rollers
- structural members (including conveyor frames, walkways, platforms, hoppers, chutes, etc.)

Improper Work Methods



Improper work methods and motions may cause physical injuries. Use suitable tools, cranes or jacks for moving large and heavy objects. Overreaching and improper support for loads may lead to injuries to the back or other parts of the body. If you are unsure of proper work methods, contact your safety director or other person responsible for ensuring the safety at your work place.

When lifting equipment by hand, protect your back by lifting close to your body and using your legs without twisting. Use hoists whenever possible. Stand clear of hoisted loads and lifting cables.

Rotating Equipment and Moving Components



Rotating and moving components provide pinch points, snagging possibilities and other potential hazards. Keep clear of all moving parts until they come to a complete stop. Do not use any body part, tool or other foreign object to attempt to stop, adjust, clear, or clean any area in proximity to moving equipment such as vibrating feeder, conveyor belts, drives or other rotating parts of the crusher. Engaging in such activities can result in severe personal injury, including death.

Crushers, designed to operate within a specific RPM range for maximum efficiency, are

typically checked with a tachometer. Make sure that any access openings have a protective cover in place at all times except when RPM readings are being taken. Never change sheave combinations without first consulting your Metso Minerals representative.

Ejection of Objects from the Crushing Plant



Ejected objects from the Crushing Plant may cause bodily injury. For example rock can be thrown several meters (several yards) into the air out of the crushing cavity during operation. Ejected materials may include rock, tramp metal, metal rods and work implements. Do not look into crushing cavity while crusher is in operation. Never attempt to clear jam on feeder, crushing cavity or conveyors when system is energized.

Falling Material from Conveyors, Loading, Unloading and Feeding Operations



Rocks or other objects may fall from conveyors during loading, unloading and feeding operations. Impact of falling material may cause serious bodily injury. To assure safe operation, all personnel must be alert when operating or working at or around the machine. Wear proper protective clothing (including also helmet) and protective devices. Keep all non-operating and non-trained personnel clear of the Crushing Plant at all times.

Never walk under any equipment included in loading, feeding, crushing, conveying, discharging or stockpiling material.

2.3.2 Typical Injury Types

Crushing

In general, avoid areas where you may be exposed to expected or unexpected machine movements. Crushing injuries typically occur either between two rotating or moving parts, or between a moving component and a stationary object.

Keep all body parts, clothing and tools away from areas where they may get trapped, pinched, or crushed, or otherwise come into contact with moving parts on the Crushing Plant. When moving equipment, be sure the path is clear. Horns and lights, where provided, are for your safety to alert you of moving objects. Pay attention to all such devices.

Slipping, Tripping, and Bumping



Items such as hoses, tools, etc., on walkways and Crushing Plant floors impede movement and create a tripping and slipping hazard. Good housekeeping reduces the risks considerably.

Personnel should wear safety shoes that reduce the risk of slipping and provide protection against falling objects or crushing. Hydraulic oil leaked or spilled on the floor must be cleaned up immediately.

To help avoid injury, be aware of parts positioned close to the floor level or protruding machine components, changes in elevation of platforms, walkways, and narrow access points. It is recommended that safety shoes be worn at all times. Wear safety helmets and other safety equipment as appropriate.

Falling



Use only designated access routes designed for the purpose, for example walkways and platforms. Walkways and platforms are furnished with railings designed to meet applicable standards. However, in some work phases, railings or platforms may have to be temporarily shifted aside. In those cases, special caution signs or temporary barriers must be used when working on the machine. Use personal fall protection gear, temporary barriers, interlocks, or other warning devices where appropriate. Never attempt to operate, service, or repair the Crushing Plant without first ensuring proper protection against falling. Guards that are moved aside must be installed immediately after maintenance work and before the machine is returned to operation. Never climb or stand on areas of the Crushing Plant not specifically designated for that purpose.

WARNING:



Do not operate any equipment until all guard rails and safety devices have been re-installed or returned to their proper operating condition. Failure to do this could result in serious injury or death.

KEEP THE AREA CLEAN!

Cutting



Do not reach in or enter:

- the movement paths of cutting equipment
- between moving machine components
- between moving loads and machine structures

Entanglement



To avoid entanglement, avoid wearing loose clothing that could be caught by rotating shafts, conveyors, and other moving parts and materials. Remove neckties, necklaces, rings, and other jewelry before performing work assignments. Also protect a long beard or hair from entanglement.

Do not touch a rotating roller, sheave, pulley, idler or moving conveyor belts with any body part or work implement, as you may become entangled and pulled into a hazardous area.

Never attempt to service, repair, or troubleshoot any moving part of the Crushing Plant while it is energized or otherwise capable of movement.

WARNING:



Keep safety gates, shrouds, guards, and other protective devices in place and in good working condition at all times. Test emergency stop, electrical interlocks, and related limit switches frequently.

Burns and Electrical Shocks



Protective gloves and coveralls help protect against burns. Be cautious around and near hydraulic system hoses, fittings and pipes. Regularly inspect and repair leaking or damaged high temperature lines and fluid lines.

To avoid electrical shocks:

- Power must be shut off and locked out before any servicing or maintenance work is done. Unplug or disconnect all auxiliary motors and equipment.
- DO NOT drill blindly into beams, electrical cabinets or other enclosures.

Avoid any contact between moisture or other fluid and electrical equipment.

from the path of ejected materials, also during lifting, assembly and disassembly operations.

Removal of tramp iron jammed between the crushing members is extremely dangerous. Follow the instructions in the instruction manual.

Do not look into crushing cavity while crusher is in operation.

Impact from Ejected Materials



There are several hazards related to falling, flying or otherwise ejected materials when the Crushing Plant is being operated or serviced. For example, rock can be thrown several meters (several yards) into air out of crushing cavity during operation. Ejected materials may include rock, tramp metal, metal rods and work implements. Keep the safety grate down during the operation. Wear proper protective clothing (including helmet) and protective devices. Always use properly maintained and approved tools and work methods. Stay clear

2.4 PERSONAL PROTECTIVE EQUIPMENT AND CLOTHING

Personal protective equipment and clothing such as foot protection, helmet, hearing protection, dust protective devices, safety glasses or other personal protective clothing and equipment should be worn at all times. All equipment should be maintained in accordance with applicable standards. Respirators, goggles, protective masks, gloves, boots, and other such equipment shall be cleaned and disinfected before being used by another employee. The Owner and Operator are responsible for ensuring that all eye, head, respiratory, and ear protection conforms to applicable standards.

IMPORTANT!

Always use right size of protective equipment.

IMPORTANT!

It is the responsibility of the Owner and Operator to determine the necessity and adequacy of protective devices and warnings, to provide them, and to ensure that they are used and followed.

2.4.1 Hearing Protection



Noise level in the machinery area may exceed 85 dB, and exposure to the machinery area in such circumstances without adequate hearing protection may lead to hearing loss. Therefore, users must be provided with

appropriate hearing protection of the type and to the extent required by law.

2.4.2 Eye And Face Protection



General requirements should include:

- The Owner should ensure that personnel for the machine area use appropriate eye or face protection when exposed to eye or face hazards such as flying material, molten metal, liquid chemicals, acids or caustic liquids, chemical gases or vapors.
- The Owner should ensure that affected personnel use eye protection that includes side protection from flying objects.
- The Owner should ensure that affected personnel who wear prescription lenses while engaged in operations that involve possible eye hazards wear eye protection that incorporates the prescription in its design, or wear eye protection that can be worn over the prescription lenses without disturbing the proper position of the prescription lenses or the protective lenses.

2.4.3 Respiratory Protection



Respiratory protection is required when the air contains contamination such as harmful dusts, fogs, fumes, mists, gases, smokes, sprays, or vapors. The primary objective is to protect the health of workers.

Respiratory protection must be provided by the Owner when such equipment is necessary to protect the health of personnel. The Owner shall provide the respiratory protection and training programs, which are applicable and suitable for the purpose intended and comply with the latest requirements and recommendations of health authorities and regulatory agencies.

IMPORTANT!

The enormous degree of convenience as well as the high safety factor involved when using plastic backing agents has made the use of molten zinc for Crushing Plant liner backing obsolete. See 2.3.1

IMPORTANT!

The area should be well ventilated. Epoxy fumes can cause nausea or eye or skin irritation.

IMPORTANT!

Breathing dust may be hazardous to the health of anyone working at, on, or around the Crushing Plant.

IMPORTANT!

Metso Minerals highly recommends that adequate dust-protective devices such as a respirator be worn by anyone exposed to airborne dust, particularly silica dust, to prevent its inhalation.

2.4.4 Foot Protection



The Owner shall ensure that affected personnel use protective footwear when working in areas where there is a danger of foot injuries due to falling or rolling objects piercing the sole, and where feet are exposed to electrical or chemical hazards.

2.4.5 Head Protection



The Owner should ensure that affected personnel wear a protective helmet approved by OSHA, MSHA (or by other applicable authority) when working in areas where there is a potential for head injuries from falling objects or walking throughout areas with low head clearance.

The Owner should ensure that a protective helmet designed to reduce electrical shock hazard is worn by personnel when near exposed electrical conductors which could contact the head.

2.4.6 Hand Protection



The Owner should ensure that personnel use properly sized appropriate hand protection when hands are exposed to hazards such as those from skin absorption of harmful substances, cuts or lacerations, abrasions, punctures, chemical burns, thermal and electrical burns, and harmful temperature extremes.

2.4.7 Safety Harnesses



The Owner should ensure that any person working on elevated areas not protected by railings, or on hazardous places must wear suitable safety equipment, including safety harnesses, if there is a risk of falling. Confined spaces may also require safety harnesses.

2.4.8 Work Clothing



The Owner should ensure that personnel wear appropriate clothing to help protect against hazardous material and hot surfaces. Loose clothing can get caught in a nip, shaft, or other moving machine components.

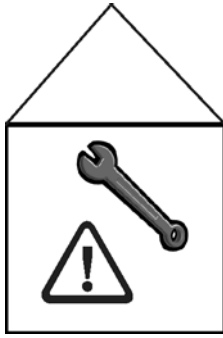
2.4.9 Tools



The Owner should ensure that personnel use appropriate tools for the job. Use tools that are specially designed to break away or are easily released to help avoid certain accident situations such as unexpected movement at a nip point or a rotating shaft. Under no circumstances must tools be allowed to come into contact with moving parts while the Crushing Plant is energized.

When working in humid or damp environments, use hydraulic tools or electrical tools that are suitably grounded, double insulated, or have ground fault interruption circuits.

2.4.10 Safety Locks And Tags



Follow all lock-out tag procedures. Refer to appropriate standards and instructions provided by Metso Minerals.

DANGER:



For maintenance work, disconnect all devices from electric power sources. Bring all hydraulic gravity or spring loaded devices to a zero-energy state. Follow lockout procedures.

The lockout program, locks, tags and the blocking/restraining devices provided are designed for Operator's protection. Operator's responsibility is to follow the program and use the proper equipment.

Remember:

- Follow procedures.
- Stay alert.
- Do not take anything for granted.
- Verify lockout.
- Tag must identify the work being done and the person(s) who locked and tagged the control.
- Locks and tags are changed with each shift that comes on.

Work to eliminate injury and death. Follow proper procedures at all times!

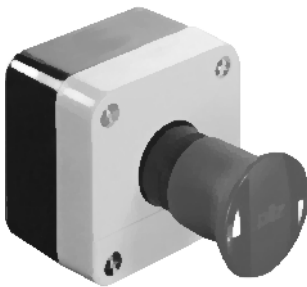
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3.1 PROTECTIVE DEVICES AND ACCESSORIES FOR MACHINE SAFETY

3.1.1 Overview

The machine system has many built-in safety features. Owners and Operators should make themselves familiar with the function and purpose of each feature and make sure all of the features are enabled. Owners and Operators should never attempt to defeat, bypass or disable any safety features. If any of the features are defeated or become disabled, the machine should not be operated until corrective action is taken and all safety features are restored.

3.1.2 Emergency-Stop (E-Stop)



Use the emergency stop when injury may occur or human life is in danger from continued operation of the machine. This provides the quickest, most sure way to stop the machine. Due to the large inertial forces of the Crushing Plant and Crushing Plant parts and components, the machine can not be stopped abruptly.

Large red emergency stop buttons are typically located in control panels near the vicinity of danger points.

Emergency stops can be, and often are, in the form of pull cords that run parallel to conveyors and surround hazards.

WARNING:



On large complex systems, the E-stop may control only those components that are in the immediate area.

The location of local E-stop buttons may vary on different machines; therefore the locations of these buttons must be verified from the operating and maintenance manuals specific to the equipment and/or from proper training.

In emergency stop situations, the objective is to stop the machine as soon as possible to minimize potential injuries while maintaining the structural integrity of the machine.

CAUTION:



Emergency stop not only stops the machine but often it may initiate other protective sequences.

NOTE: It may be necessary to engage reset switches before movement can resume.

3.1.3 Safety Interlocks

A safety interlock is a device that will interrupt the supply of electricity, hydraulic oil or compressed air to an actuator or motor. A machine already in operation may need to stop quickly due to Operator error, safety violations, or an unexpected machine event. For example, a safety gate may be interlocked to stop a machine if the gate is opened while the machine is running.

Interlocks can also be used to prevent sudden unexpected movement of a machine function or component.

During operation, the logic system (i.e. programmable logic controller, microcontroller, relay system or similar device) controls the functions of the machine. Interlocks built into the system employ limit switches and other sensors to help assure proper machine operation.

THEREFORE IT IS IMPORTANT THAT INTERLOCKING ARRANGEMENTS ARE NOT REMOVED, MODIFIED OR BYPASSED, AND THAT THEY ARE CORRECTLY ADJUSTED. LIMIT SWITCHES, AND OTHER SENSORS MUST BE KEPT IN GOOD WORKING ORDER.

Electric Motors



Electric drives and motors may be controlled to stop or reduce speeds, as determined by the safety interlocks at a particular location.

Hydraulic System



Components that help protect the hydraulic system include certain valves, such as hose burst valves, pressure relief valves, counterbalance valves and pilot-controlled throttle valves as well as pressure transducers and drain valves for pressure accumulators. Metso Minerals uses these components where applicable in the hydraulic systems to minimize the potential for hazardous situations to occur.

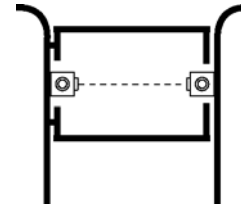
A hose break valve functions to lock up if fluid flow is discharged too rapidly from an actuating cylinder, as happens if a hose breaks and the loads react to gravity.

The pressure relief valve prevents the system pressure from rising beyond system capabilities. It helps protect the entire fluid system and any operators in the vicinity from bursting hoses and components.

The pilot-controlled throttle valve helps prevent uncontrolled actuator movements.

Pressure transducers monitor the system pressure for information or control purposes.

Safety Gates



Some safety gates are designed so that opening or closing of the gates will prevent or stop a specific machine function in that area. Hydraulic, hydraulic or electric limit interlock switches may cut off the drive or actuator power or initiate an emergency stop mode.

For specific operation, see later sections of this manual.

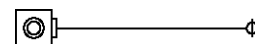
WARNING:



Safety gates must not be opened during normal machine operation. Exceptions to this rule are defined in the operating instructions.

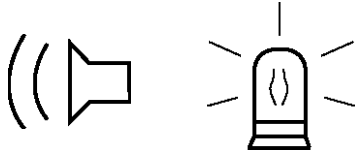
Safety gates may also be opened for maintenance purposes when the machine has been stopped. Follow all lockout procedures.

Cable Switches



Cables or ropes connected to the electrical switches can be used as interlocks also. They may stop machine function in areas where control panels cannot be closely located but where Operators may be working. Know the locations of e-stop pull cords for conveyors.

3.1.4 Additional Warning Devices Horns and Lights



If visual contact between work places is obstructed or if communication is difficult, sound and/or light signaling devices may be used before starting the machine or a machine function. The warning device for start-up should operate so that personnel are given sufficient time to move to a safe distance from the machine. It is the responsibility of the Owner to ensure that the Crushing Plant is always equipped with required horns and lights.

Safety Signs and Labels



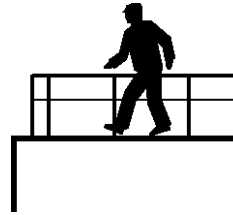
Safety signs have colors to determine the degree of hazard in particular areas. These signs must not be removed. Temporary placement of safety signs and danger tags should also be used on the control panels to warn of maintenance work and lockout situations.

Obey all warning and safety signs on the machine and in the manual.

Safety Warning Colors

Color of safety warnings are typically safety yellow.

3.1.5 Walkways, Service Platforms, Ladders And Railings



The design of walkways, ladders and railings follow standards and regulations for the application. The walkways provide access to the machine. Safe operating procedures must be followed when on walkways. Never stand, walk or climb in or on any area of the Crushing Plant not designated for such activity. If an area of the Crushing Plant must be accessed and cannot be reached by designated walkways, ladders, or platforms, then the Owner and Operator must make all necessary arrangements for safe access to the area, including but not limited to safe lifting devices and fall protection.

CAUTION:



Extreme caution must always be used on machine walkways.

3.2 TRANSPORT

Observe the following precautions before transporting the Crusher Plant:

1. Chock chassis tires securely whenever connecting or disconnecting chassis from tractor or dolly.
2. Check tire pressure. Use a protective cage or a clip-on type air chuck and remote in-line valve and gauge when inflating tires. Never exceed maximum inflation pressures of the tire or rim.
3. Check tightness of wheel lug nuts before transport and check frequently during transport.
4. Check that brake system operates correctly.
5. Observe maximum axle and tire loading capacities.
6. Protect components being transported using appropriate shipping braces and blocking material.
7. Travel may be limited to daylight hours only, depending on your specific plant and applicable state regulations.
8. Follow recommended limits on towing speed.
9. Make sure all lights are on and that they are operating correctly.
10. Use traffic warning flags, signs and lights as required.
11. Before moving the Crushing Plant, check all roadways and bridges on the route for weight limits.
12. Check clearance of bridges, overhead lines and other overhead obstructions.
13. Follow all applicable laws and regulations.

3.3 TOWING

Observe the following precautions before towing the Crusher Plant or its components:

- Check if towing is allowed for each individual equipment.

3.4 AT THE WORK-SITE

3.4.1 Precautions

Observe the following minimum precautions at the work-site:

1. Know the locations of underground and overhead powerlines and other potential hazards.
2. Select the work-site with care. The ground must be firm, level and able to support the weight of the entire plant. Make sure there is enough room for loading ramps, loaders, conveyors, etc. and for safe maneuvering of trucks and loaders.
3. Check that cribbing is secure and that plant has not shifted or settled.
4. Make sure that electrical cables are protected from wear and traffic.
5. Follow pre-operation checks and start-up procedure covered in the individual manual supplied with your specific unit equipment

3.4.2 During operation

Keep watch

Do not rely too much on automated systems. Observe Crushing Plant equipment while the system is running. Pay attention to unauthorized persons approaching the site as well as any unusual behavior of the equipment (uncommon noise, vibration, smell, reduced output, etc.).

Clearing

Crushers Plant equipment can become plugged and stall because of power failures, surges of material or other unplanned events. Clearing Crusher is potentially very hazardous. Shut down the system completely, lock and tag out all applicable controls and follow all instructions in the instruction manual of your specific crusher.

4.1 GENERAL INFORMATION AND SAFETY LOCKOUTS

Detailed instructions for the operation of the machine can be found in following sections of the manual. Because each machine section may incorporate unique functions, some of which may be automated, maintenance personnel should be knowledgeable of the operation of the machine sections in order to perform the maintenance and repair work as safely as possible.

DO NOT COMPROMISE SAFETY DUE TO TIME PRESSURES.

FOLLOW ALL CRUSHING PLANT SAFETY AND FIRE PREVENTION PROCEDURES.

Before starting any repair, maintenance or troubleshooting work on the machine, ensure the following:

- If you have not been trained to perform the required repairs, maintenance or troubleshooting, or you are unsure how to safely perform the activity - **STOP!** Never attempt to repair, maintain or troubleshoot any aspect of the Crushing Plant unless you are thoroughly trained for the activity and understand how to perform the activity in a safe manner.
 - Be sure to coordinate all repair and maintenance work with other Crushing Plant operations.
 - Use lockout and warning signs to inform others that maintenance and repair work are in progress. These signs should only be removed (after all work has been completed) by the person who has placed them there.
 - Transmit all knowledge of the maintenance work to the succeeding shift.
 - Know the whereabouts of all personnel in, on, at and around the machine.
- Never service any machine or component without first referencing its maintenance manual.
 - Before handling chemicals, refer to the MSDS (Material Safety Data Sheets) and Crushing Plant procedures for handling of these materials.

4.2 MECHANICAL SAFETY DURING MAINTENANCE AND REPAIR



4.2.1 General



DANGER:
FOLLOW ALL ESTABLISHED LOCKOUT PROCEDURES. REFER TO THE APPROPRIATE STANDARDS.

For repair, maintenance or troubleshooting work, disconnect all devices from electric, pneumatic and hydraulic power sources and follow lockout procedures.

The lockout instructions, locks, tags and the blocking/restraining devices provided are designed for your protection. Your responsibility is to follow the instructions and use the proper equipment.

Remember:

- Follow procedures
- Stay alert
- Do not take anything for granted
- Verify lockout
- Tag must identify the work being done and the person(s) who locked and tagged the control.
- Locks and tags are changed with each shift that comes on.

Work to eliminate injury and death.
Follow proper procedures at all times!

IMPORTANT!

Be sure all mechanical components are brought to a zero energy state including all spring driven devices, cylinders, accumulators, drive shafts, pulleys, rollers, gears, etc., prior to entering the machine and performing the work. Never attempt to perform repair, maintenance, or troubleshooting work on or in proximity to energized mechanical components.

IMPORTANT!

Block up and support parts as necessary to prevent any unexpected motion when performing maintenance.

4.2.2 Fire Safety During Maintenance And Repair



Observe all regulations on fire safety. Sources for fires include, but are not limited to the following:

- sparks from grinding
- flames and molten metal from welding or torching
- electrical arcing
- spontaneous combustion
- smoking.

Before starting any work take the following steps to prevent a fire hazard:

- Properly dispose of rags with combustible material to avoid spontaneous combustion.
- Move flammable materials 10 m (33 ft) or more away from any fire hazard.
- Clean up all debris.
- Clean up all oil spills and leaks.
- Remove any source of flammable gases, liquids or solids.
- Use proper electrical grounding techniques for welding.
- Provide adequate fire extinguishing equipment; inspect such fire equipment regularly.
- Arrange for qualified personnel to guard against fire while welding, cutting, or heating operations are being performed, as well as a sufficient period of time after the work is completed.

- Protect yourself and others from sparks with proper personal protective equipment and clothing.

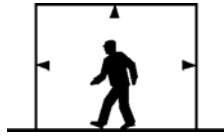
4.2.3 Preventive Maintenance

Preventive maintenance will both increase safety and be economically beneficial. It is more safe and economical to replace a worn part during a scheduled shut-down than to repair a broken device in the middle of a production cycle. A machine or device that is not in proper condition, and that has been left without regular maintenance and inspections, is a safety risk for its user. For instance, without lubrication a bearing may fail, bringing a production line down. Furthermore, the hot bearing may present a fire hazard or cause skin burns.

Some preventive maintenance suggestions for a machine include:

- observing the maintenance and lubrication instructions of the machine and equipment suppliers
- keeping the machine and surrounding area clean and orderly
- monitoring the vibration levels of the machine and to help predict bearing failures
- monitoring the power consumption of motors to help detect early failures
- repairing all leaks as soon as possible to prevent more serious conditions that eventually may occur
- monitoring the condition of pipes and tubes enclosed in ducts; repairing possible leaks

4.2.4 Confined Spaces



A confined space means a space that:

1. is large enough and so configured that a person can enter and perform assigned work; and
2. has limited or restricted means for entry or exit (for example, the crushing cavity, tanks, vessels, silos, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry.); and
3. is not designed for continuous employee occupancy.

Certain confined spaces may require an entry permit program to allow entry. Be sure that all applicable procedures are followed. If you have questions contact your Crushing Plant supervisor for more information.

DANGER:



Confined spaces may contain high concentrations of gases which may cause injury or death. Follow all established safety procedures.

4.3 ELECTRICAL SAFETY DURING MAINTENANCE AND REPAIR



4.3.1 General

DANGER:



Follow all established lockout procedures.

For maintenance work, disconnect all devices from electric, pneumatic and hydraulic power sources and follow lockout procedures.

The lockout instructions, locks, tags and the blocking/restraining devices provided are designed for your protection. Your responsibility is to follow the program and use the proper equipment.

Remember:

- Follow procedures
- Stay alert
- Do not take anything for granted
- Verify lockout
- Tag must identify the work being done and the person(s) who locked and tagged the control.
- Locks and tags are changed with each shift that comes on.

Work to eliminate injury and death. Follow proper procedures at all times!

Be sure all electrical components are brought to a zero energy state including capacitors and similar electrical devices.

Before maintenance work:

- Be sure all control power supplies are turned off, disconnected, and lock out procedures have been followed.
- Confirm that **ALL** power sources are disconnected. Some electrical devices may be supplied by more than one power source.
- Be aware that multiple voltage levels may exist in some junction boxes.
- Ensure that during lockout procedures, locks and signs are appropriately attached, and subsequently removed only by the person who installed them after all work is completed. Follow Crushing Plant lockout instructions for placement and removal.
- For testing and troubleshooting, clear all personnel from the machine just as though the machine were being returned to production mode. Reactivate the necessary power supplies and perform the tests. Then again disconnect all power supplies and follow lockout instructions before further maintenance work is performed.
- Be sure electrical supply voltage is disconnected before drilling into any structural frame members. Electrical cables may be inside.
- Verify that electric motors are disconnected before starting any maintenance work, thereby preventing the supply of electricity to the motor. Generally the disconnects are located in the drive control room. Each person performing maintenance work should install their lock and sign the lockout tag.

4.3.2 Electrical Fault Situations

Electrical faults may be caused by component failures such as loose or damaged wiring.

Diagnostics are provided through pilot lights, alarms, and help messages.

IMPORTANT!

Electrical connections can and do loosen due to vibration in transit and thermal expansion of the wires and lugs in operation. This is especially true after initial delivery, break in and after major relocation. Loose connections increase current draw, which can result in false trips, intermittent circuits, and burned-out components. As part of the start-up, check and retighten as necessary all electrical connections in the electrical enclosure. Repeat after the first forty to fifty hours of operation. This work must be performed by properly trained personnel.

IMPORTANT!

Improper phasing will damage backstops in conveyor drive reducers and may damage hydraulic system components.

4.3.3 Program Changes

WARNING:


Changes to Metso Minerals' supplied control program should be made only by Metso Minerals personnel. Faulty program code may cause the machine to behave unexpectedly. Any changes to interlock circuitry must be made with extreme caution and be reviewed and approved in writing by Metso Minerals before implementation.

An electric outlet may be supplied in the logic center and control cabinet for programming purposes only. Do not connect any electrical tools to this outlet. The tool may cause electrical disturbances in the machine control system. This could alter the machine control program and cause unpredictable machine operation.

NOTE: Do not use the logic center or control cabinet's outlet for anything other than a programming device!

4.4 HYDRAULIC SAFETY DURING MAINTENANCE AND REPAIR



DANGER:


Follow all established lockout procedures.

For maintenance work, disconnect all devices from electric, pneumatic and hydraulic power sources and follow lockout procedures.

The lockout instructions, locks, tags and the blocking/restraining devices provided are designed for your protection. Your responsibility is to follow the program and use the proper equipment.

Remember:

- Follow procedures
- Stay alert
- Do not take anything for granted
- Verify lockout
- Tag must identify the work being done and the person(s) who locked and tagged the control.
- Locks and tags are changed with each shift that comes on.

Work to eliminate injury and death. Follow proper procedures at all times!

Before proceeding with any repair, maintenance or diagnostic procedures on the hydraulic system, bring all components to a zero energy state, including cylinders,

accumulators, spring loaded hydraulic devices, circuitry between valves and actuators, etc.

- Mineral and other oils and additives can cause skin irritation. Inhaled oil mist can also cause internal irritation, headache or nausea. Avoid repeated exposure to these materials. Use appropriate personal protective equipment.
- Purge entrapped air from the hydraulic system. Entrapped air in the hydraulic system can cause erratic and unexpected movements.
- Oil mist in the work area or oil leaking onto floors and walkways will cause a serious risk of slipping. Clean up all spills and repair leaks immediately.
- Hydraulic oil temperature may be extremely high;

WARNING:



Elevated temperatures levels can be hazardous and may cause severe burns. Wait until machine cools down before doing maintenance or repair.

-
- A mixture of air and oil mist may explode at higher temperatures. Hydraulic oil spilled on hot machine surfaces may start a fire.
 - Pressurized hydraulic hoses should not be handled with bare hands since high-pressure leaks may easily penetrate the skin. Hydraulic fluid pressure in the hoses may exceed 3000 PSI/210 bar/21MPa.

WARNING:



Pressure remains behind the hose burst and lock valves.

WARNING:



Risk of personal injury due to high pressure fluid jets. Do not check for pressurized leaks with bare hands. Use cardboard or other appropriate techniques.

Hydraulic hoses are subject to wear and tear. Pressurized hoses tend to straighten up, bend or twist due to reaction forces. Replace all weakened or deteriorated hoses promptly. Keep hoses properly clamped and secured to help prevent being whipped by broken hoses.

- Avoid letting dirt and other impurities into the system while doing maintenance work. Use lint free cloths for cleaning the hydraulic components system.
- When changing a cylinder, or other hydraulic device, plug all open ports and hose ends. Catch spilled oil in a suitable storage device and avoid introducing dirt into the system. Dispose of all waste fluids as presented by law.
- Tighten disconnected pipe and hose couplings immediately after reinstallation. Before finishing the work, check all parts and connections that have been serviced or repaired.
- Before starting up the pumps, make sure that maintenance work is completely finished in all work areas. When starting up the pumps, stay at a

distance from the areas which were repaired.

- Before opening the main valves, make sure that there is no one working between any parts of the machine, since pressurization of the system may cause machine motion.
- Once the system is in the pressurized state, test repaired system for proper operation before putting system back into production.

Check the system for possible leaks after repair. Leaking fittings must not be tightened when under pressure. To seal threaded fittings, use appropriate sealing rings or a sealing compound suitable for hydraulics.

4.5 GENERAL MAINTENANCE WORK

The following are some of the do's and don'ts to be followed as part of normal Crushing Plant procedures

- Do not perform any maintenance on moving machinery. This includes such items as adding lubricating oil or greasing parts while the crusher is in operation.
- Never clear a jam on or in the feeder, crushing cavity or conveyors when system is energized.
- Do not put hands or feet on the release cylinders, which protect the crusher from tramp iron overloads while the crusher is in operation.
- Do check the manufacturer's recommendations for periodic maintenance procedures. These maintenance procedures are designed to not only avoid damage to the equipment but also to avoid harm to the Operator.
- Do avoid spillage around the crusher. Operator should make it a habit to keep the area immediately adjacent to the crusher free from spillage, which could cause people to trip and fall.
- Never look into the crushing cavity while crusher is in operation.
- When using a crane or other lifting device to raise or lower a load keep all personnel clear of the area.
- Never detach a lifting device from its load until the load is securely affixed at its designation, or steps have been implemented to prevent the load from unintended shifting or falling.
- Never walk, stand, crawl or lay under any load hanging from a crane or other lifting device.

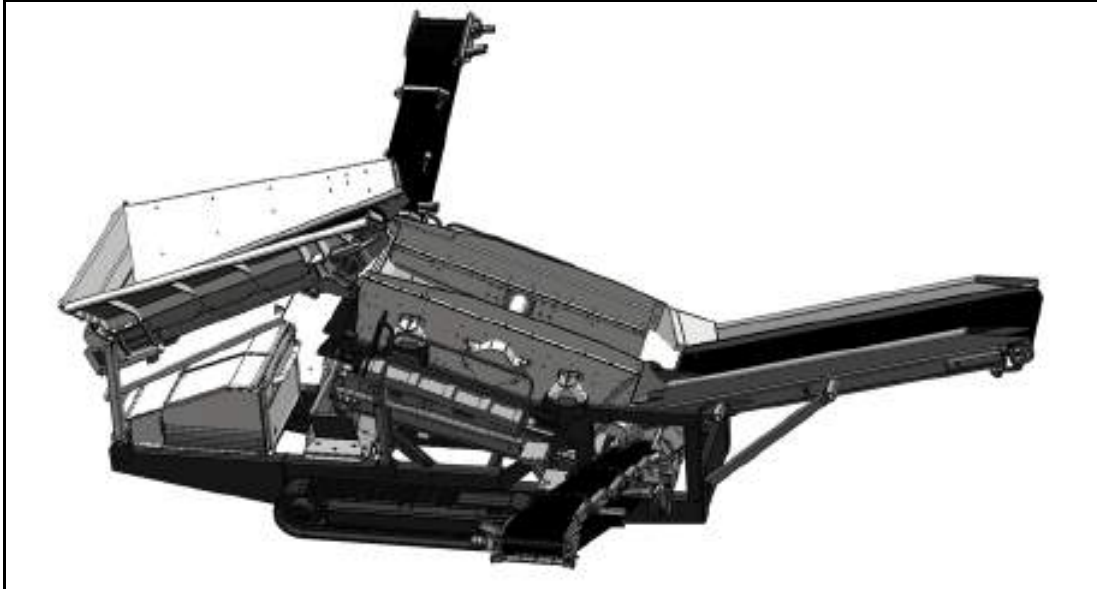


***LOKOTRACK ST2.4
INSTRUCTION MANUAL
MM0372748-EN***

REV 3

<https://tractormanualz.com/>

This Instruction Manual is valid for Lokotrack ST2.4 mobile screening unit manufactured by Metso beginning from the year of 2012 and the serial number of 77076. Lokotrack ST2.4 is a track-mounted, self-propelled diesel engine powered screening unit, with capacity up to 400 metric tons per hour (mtpH).



Because of the continuous development of the product, the manufacturer reserves a right to alter the technical specifications written in this manual, without any advance information. In case of conflicts between different language versions, the English version of this manual is the original and prevails.

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SYMBOL IDENTIFICATION

ADDITIONAL INFORMATION

RECYCLING

This instruction manual is intended to assist owners and users of Metso products in the proper use of the equipment.

It includes important references to safe, proper and economical operation of the equipment. Following these instructions will help to avoid possible danger, reduce repair costs and breakdowns and to increase the reliability and life of the equipment.

This manual must be complemented by those instructions necessary because of existing national mandatory rules relating to accident prevention and environmental protection.

A copy of this manual must be kept at the equipment's location and made available to the operators as required.

In addition to this manual and accident prevention regulations mandatory in the country of use and at the equipment's place of operation, generally recognized rules for safe and professional operation must be observed.

This instruction manual must be read and used by each person who works with the equipment, typically:

- operations, including installation, startup, operation, application engineering, materials handling, site labour, environmental engineering and safety departments.
- maintenance, including inspection and repair.
- transport, materials handling and rigging.

Note that this instruction manual contains information and instructions on alternative and optional equipment. Normally the machines have only some of them. Before maintaining and servicing, find out which alternative and optional equipment your machine has.

See separate instruction manuals for more detailed instructions when servicing the main components.

There may be optional equipment which have separate instruction manuals. Those manuals must be read and used by each person who works with the equipment.

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Please refer to the general Safety Instructions in Part A of this Instruction Manual folder.

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3.1 GENERAL

Lokotrack ST2.4 is a track-mounted, self-propelled diesel engine powered screening unit.

Even though the application is robust constructed, it's powerful undercarriage system makes the unit highly maneuverable.

The directions right and left are defined from the direction of travel of the material from the feeder side perspective.

**WARNING!**

This equipment must not be used in explosive duties or premises. It is highly forbidden to screen explosive or flammable materials.

NOTE! The ST2.4 screening unit must not be used for any other purpose than those intended by the manufacturer. In particular, you must not:

- Transport or haul persons or loads
- Pull or push the equipment with another machine
- Use the hydraulic hammer as lifting gear

The Lokotrack ST2.4 has been designed for safe operation when used by professional staff in the operating situations included in this instruction manual. All other service and repair procedures must be performed by specially trained personnel or authorized Metso service staff.

3.2 MAIN DIMENSIONS WITH STANDARD ACCESSORIES

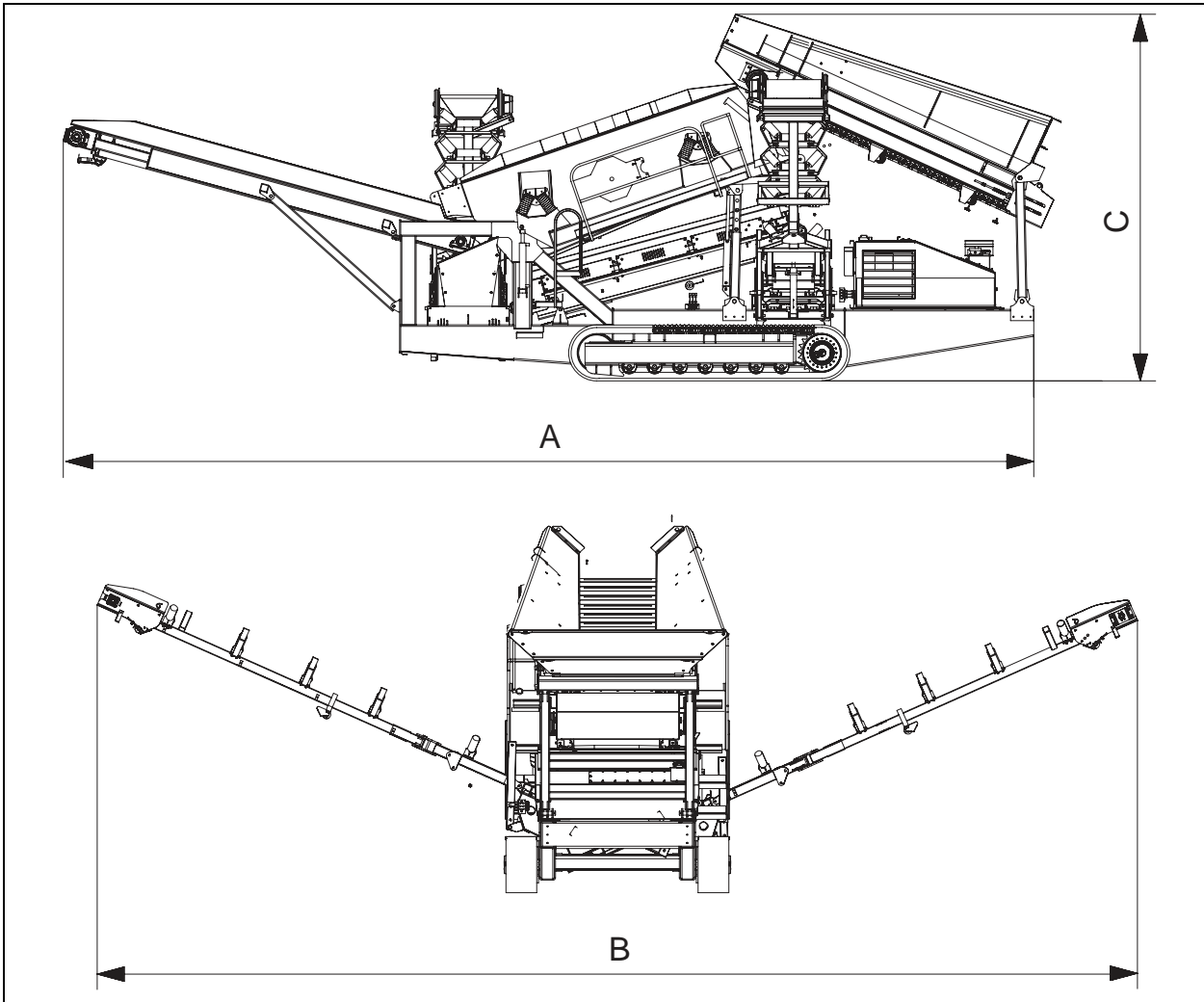


Figure 3.1 ST2.4 in operating position

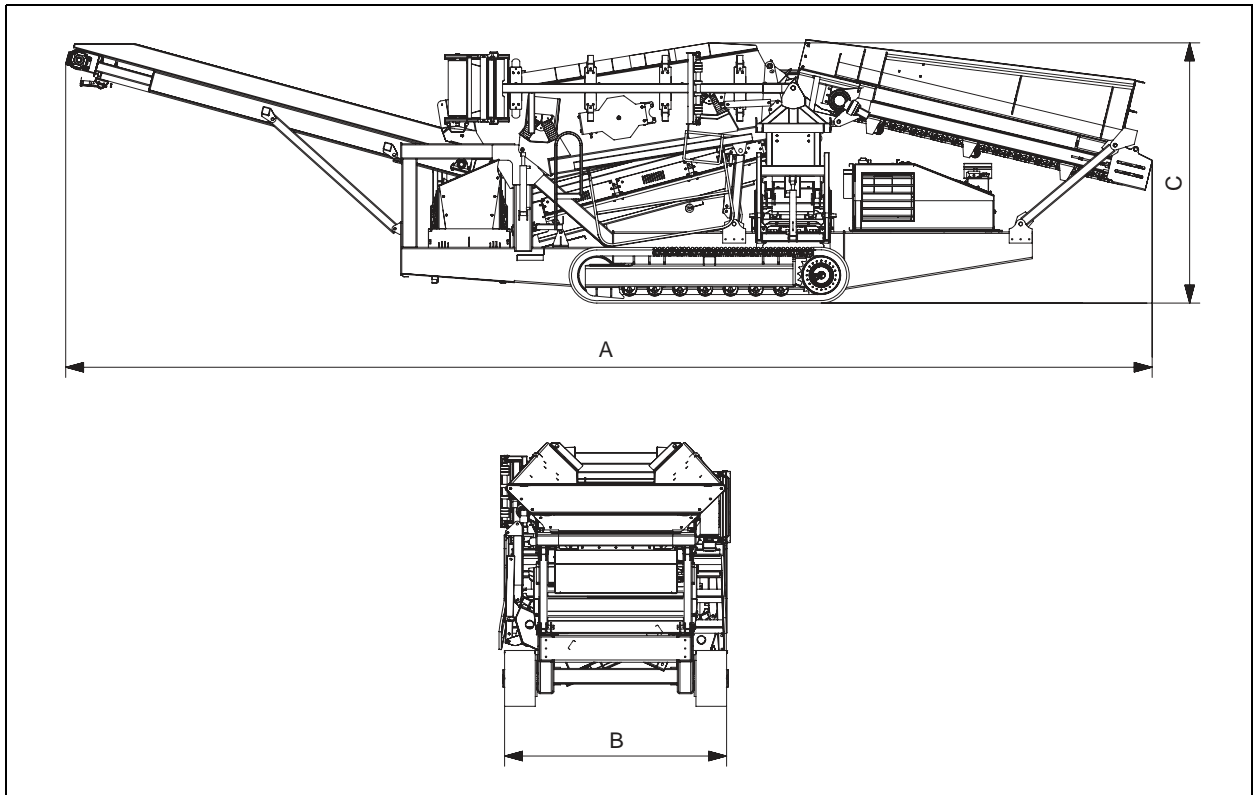


Figure 3.2 ST2.4 in transport position

Table 3-1 Main dimensions

	Operation	Transport
Length A	12 700 mm (41' - 8")	14 200 mm (46' - 7")
Width B	13 600 mm (44' - 7")	2 990 mm (9' - 10")
Height C	4 800 mm (15' - 9")	3 400 mm (11' - 2")
Weight	With belt: 23 500 kg (51 810 lbs) With apron: 26 500 kg (58 420 lbs)	With belt: 23 500 kg (51 810 lbs) With apron: 26 500 kg (58 420 lbs)

3.3 SPECIFICATIONS

3.3.1 GENERAL

- Screening capacity 400 t/h.
- Maximum Feed cubical: Fitted with belt feeder 400 mm and fitted with lamella feeder 500 mm

3.3.2 SCREEN

- Top deck 3640 mm x 1520 mm, open area 5,5 m²
- Bottom deck 3320 mm x 1520 mm
- Speed 900 rpm. Stroke 10 mm, depending medias
- Screen working angle: adjustable 11 to 18.5 degree
- Discharge end lifting up cylinders for easy maintenance

3.3.3 FEED HOPPER

- Capacity 4.5 m³
- Fixed hopper walls

3.3.4 FEED CONVEYOR

- 1200 mm wide belt
- Manually controlled variable speed 0-0,4 m/s
- Impact beams

3.3.5 COLLECTION / TRANSFER CONVEYOR BENEATH SCREEN

- 1200 mm wide
- Manually controlled variable speed 0-1,7 m/s
- Bolted sidewalls

3.3.6 FINES SIDE CONVEYOR (UNDERSIZE)

- 650 mm wide - 8000 mm long
- Belt speed 2,0 m/s
- 3 Ply Chevron belt
- Angle fixed 24 degrees .Discharge Height 3850 mm (measured drum crown)

3.3.7 MIDSIZE SIDECONVEYOR

- 650 mm wide - 8000 mm long
- Manually controlled variable speed 0-2,0 m/s
- 3 Ply Chevron belt
- Angle fixed 24 degrees. Discharge Height 3660 mm (measured drum crown)

3.3.8 OVERSIZE CONVEYOR

- 1200 mm wide.
- Belt speed 0-1,2 m/s
- Angle fixed 18 degree. Discharge Height 3300 mm (measured drum crown)
- Impact beam zone on load point

3.3.9 ENGINE MODULE TIER 3

- Engine CAT C4.4 74.9 kW (100HP)
- Fixed displacement pumps 4 pc. 33.1/33.1/33.1 and 30.5 ccm³
- Fuel tank 270 L

3.3.10 TRACKS

- Width 400 mm (1' – 4")
- Traveling speed 0,87 km/h

3.3.11 MAIN OPTIONS

- Lamella feeder
- Many media options for screen.
- Engine block heater
- Radio track drive control
- Magnetic separator for oversize conveyor.
- Light mast

3.3.12 SCREEN TOP DECK MEDIA OPTIONS (MM)

- Grizzlies 75, 100, 125, 150
- Finger grizzly 50, 75, 100, 125, 150
- Screen mesh (Side tensioned) 30 - 100
- Rubber mesh (Side tensioned)
- Punch plate (Side tensioned) 50, 75, 100

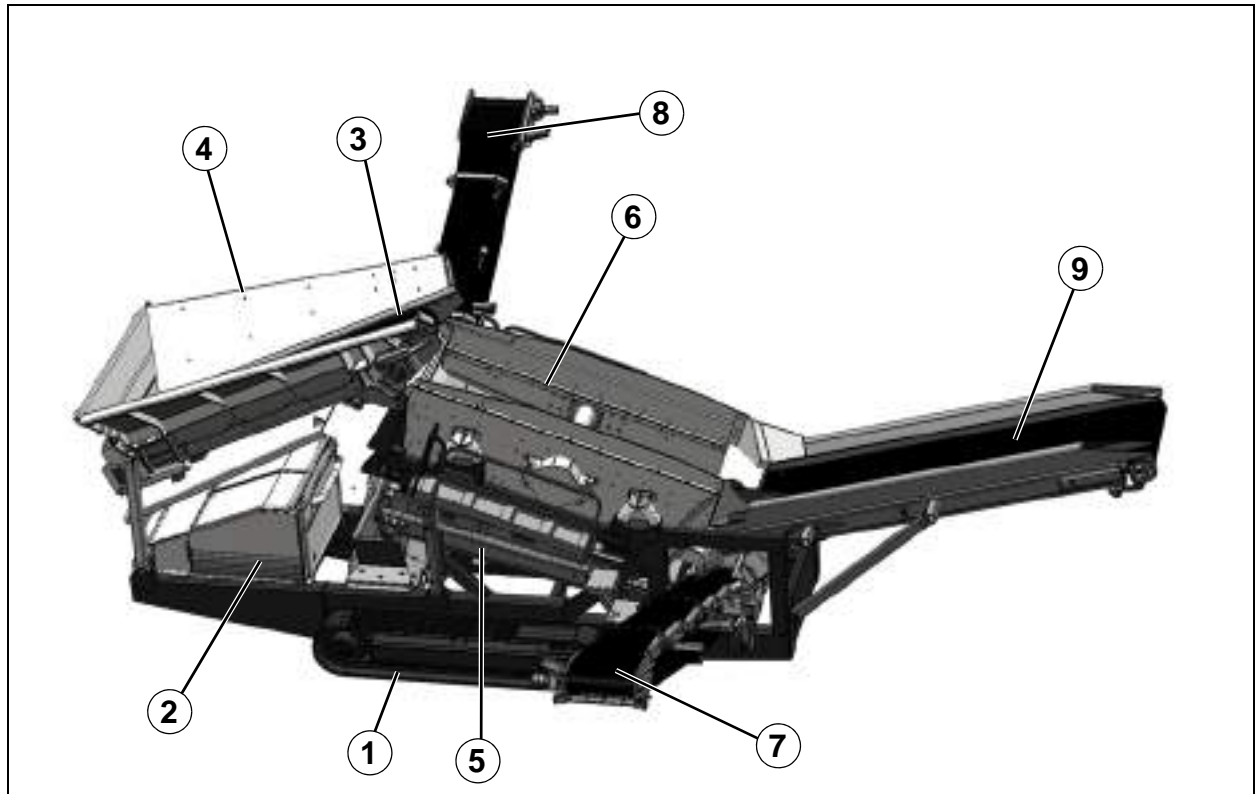
3.3.13 BOTTOM DECK OPTIONS (MM)

- Screen mesh (End tensioned) 10 - 60
- Rubber mesh (End tensioned)

3.3.14 LAMELLA FEEDER , OPTION

- 1300 mm wide lamella
- Manually controlled variable speed
- Lamella Hopper has same loading and capacity values as belt feeder hopper

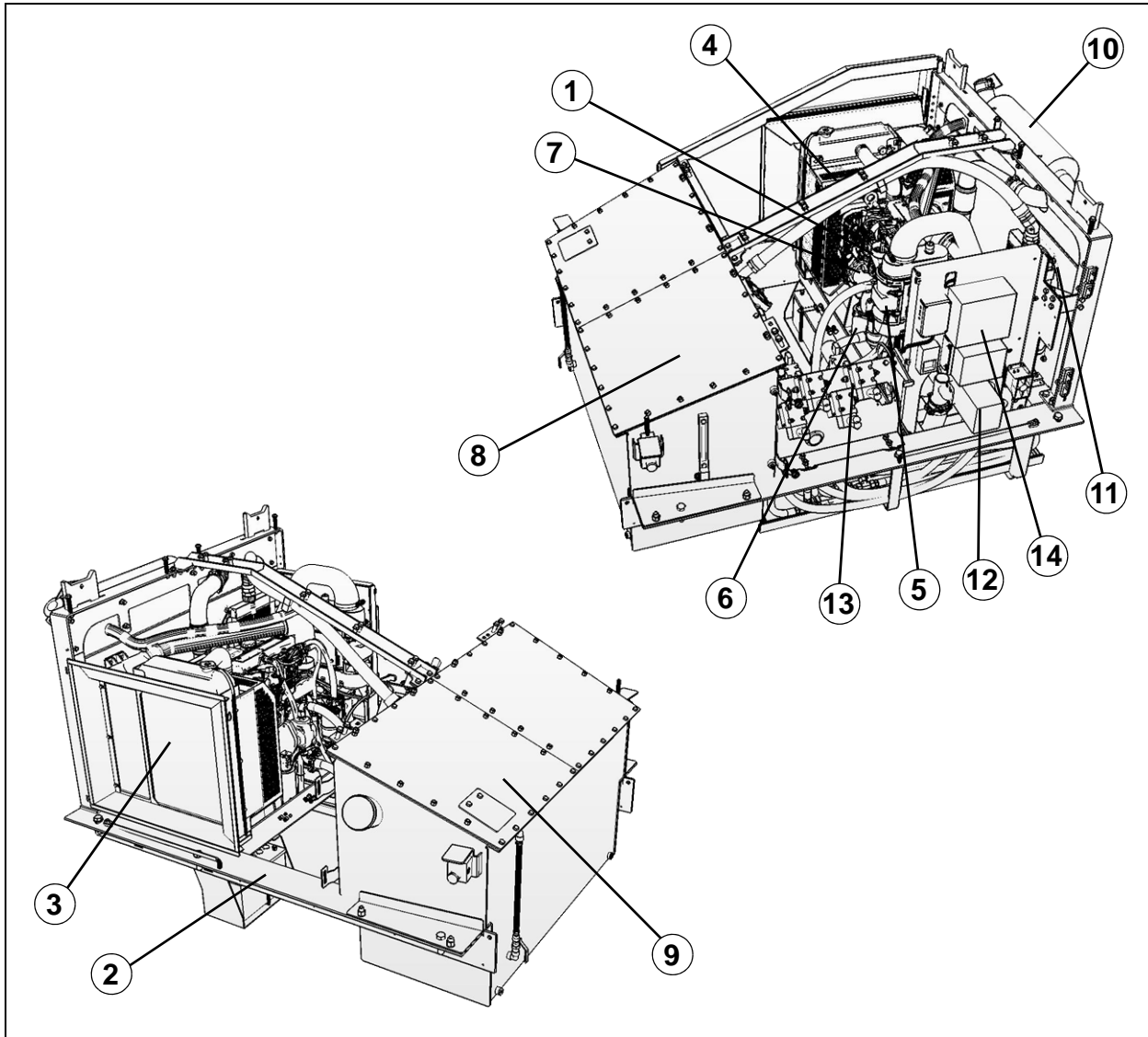
4.1 MAIN ASSEMBLY



Callout	Description	Callout	Description
1	Tracks	6	Screen
2	Power pack	7	Side conveyor (midsize)
3	Feed conveyor	8	Side conveyor (undersize)
4	Feed hopper	9	Oversize conveyor
5	Underscreen conveyor		

Figure 4.1 Main assembly

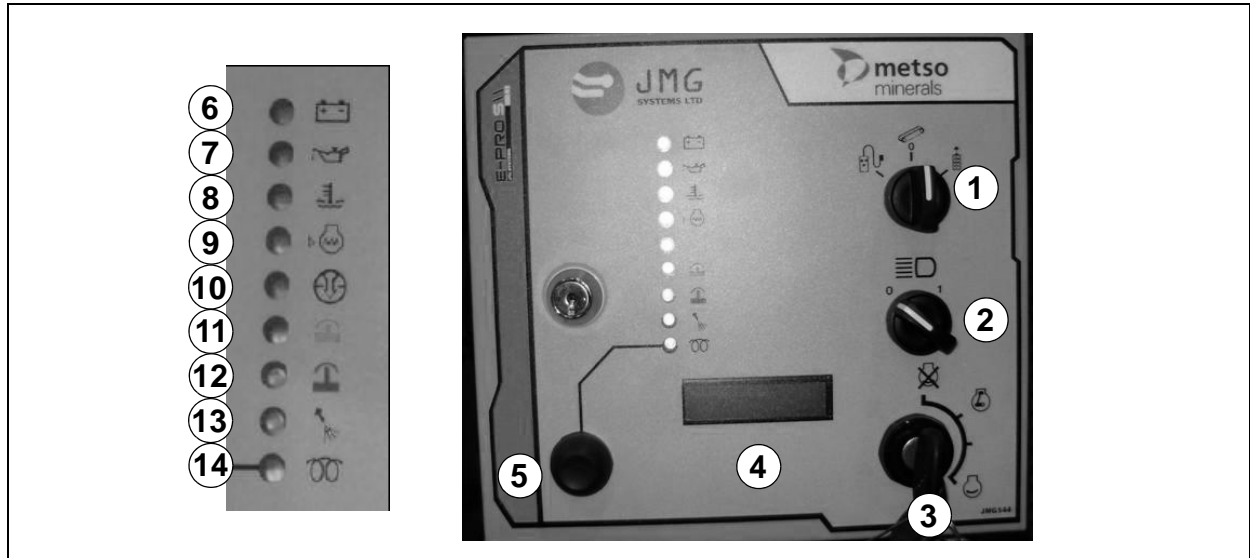
4.2 POWER PACK



Callout	Description	Callout	Description
1	Diesel engine	8	Hydraulic oil tank
2	Powerpack frame	9	Fuel tank
3	Cooler	10	Silencer
4	Fan	11	Hydraulic oil cooler
5	Intake air filter	12	Hydraulic pumps
6	Engine oil filter	13	Hydraulic valves
7	Fine fuel filter	14	Main control center

Figure 4.2 Caterpillar C4.4 diesel engine

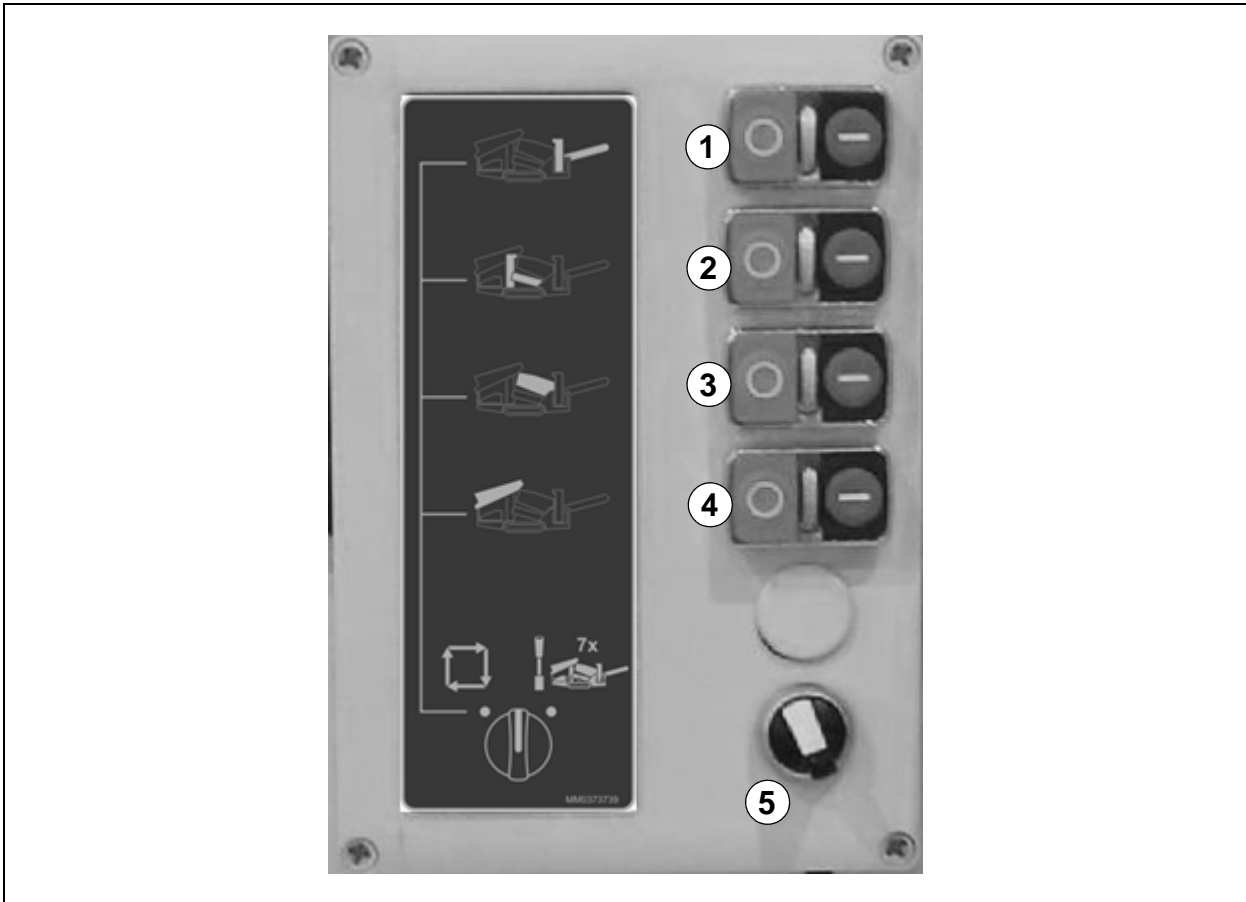
4.3 MAIN CONTROL CENTER



Callout	Description	Callout	Description
1	Tracks ON/OFF	8	Temperature warning lamp
2	Drive lights ON/OFF	9	Coolant level (not in use, visual inspection)
3	Ignition switch	10	Air filter warning lamp (not in use, visual inspection)
4	Display screen	11	Emergency stop activated
5	Pre-Heat switch	12	Emergency stop healthy
6	Battery charging warning light	13	Fuel ON light
7	Oil pressure warning light	14	Pre-Heat light

Figure 4.3 Main control center

4.4 THE LOCATION OF THE CONTROLS OF HYDRAULIC FUNCTIONS

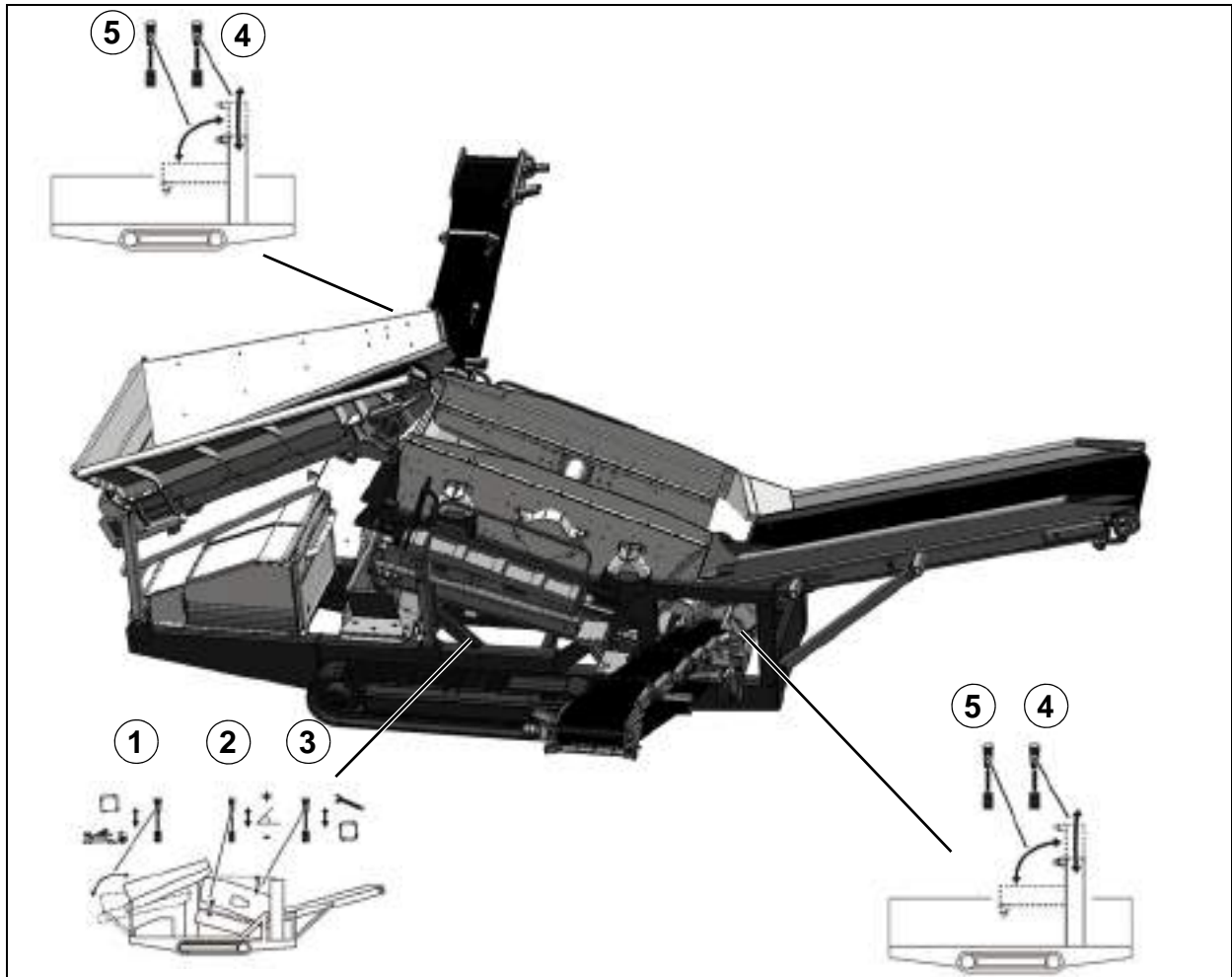


Callout	Description
1	Oversize conveyor and Side conveyor (midsize)
2	Underscreen conveyor and Side conveyor (undersize)
3	Screen
4	Feed conveyor
5	Process activation / Hydraulic control levers activation

Figure 4.4 Controls of hydraulic functions

4.5 HYDRAULIC CONTROL LEVERS

The unit's hydraulic control levers are located in three separate places. The locations of the control levers are shown in the picture below. The hydraulic control levers are used to operate all the hydraulic cylinders in the ST2.4.



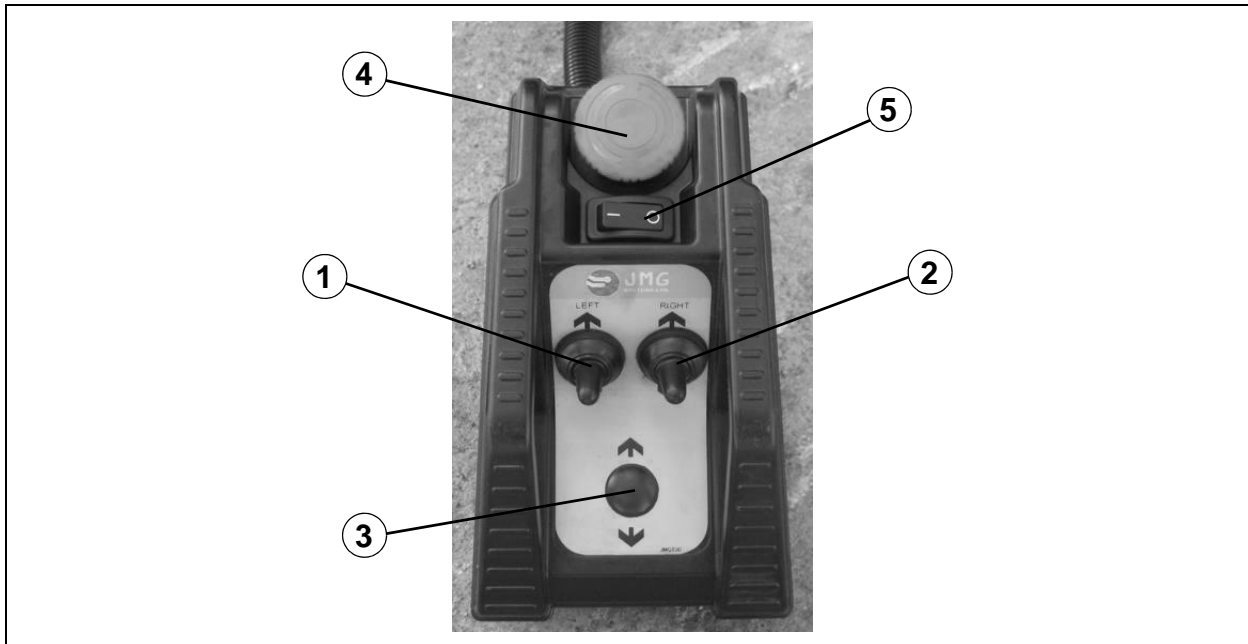
Callout	Description
1	Feeder work position, feeder transport position
2	Screen angle (lowest position in transport position)
3	Screen work position, screen maintenance position
4	Side conveyor raise/lower
5	Side conveyor fold/unfold

Figure 4.5 Hydraulic control levers

4.6 DRIVING CONTROLS

The machine cannot be moved when the screening process is on.

NOTE! The machine cannot be moved when the screening process is on.



Callout	Description	Callout	Description
1	Drive control, left track *	4	Remote stop button
2	Drive control, right track *	5	Drive control box ON/OFF
3	Drive control, both tracks		

Figure 4.6 Drive control box

* The directions right and left are defined from the direction of travel of the material from the feeder side perspective.

4.7 RADIO



Reference	Description	Reference	Description
1	Radio controller shut down	4	Engine kill
2	Left track forward	5	Right track forward
3	Left track reverse	6	Right track reverse

Figure 4.7 Radio control

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5.1 BEFORE STARTING

Follow this procedure every time before you start the engine (Figure 5.1). See the meaning of the symbols in appendix A.

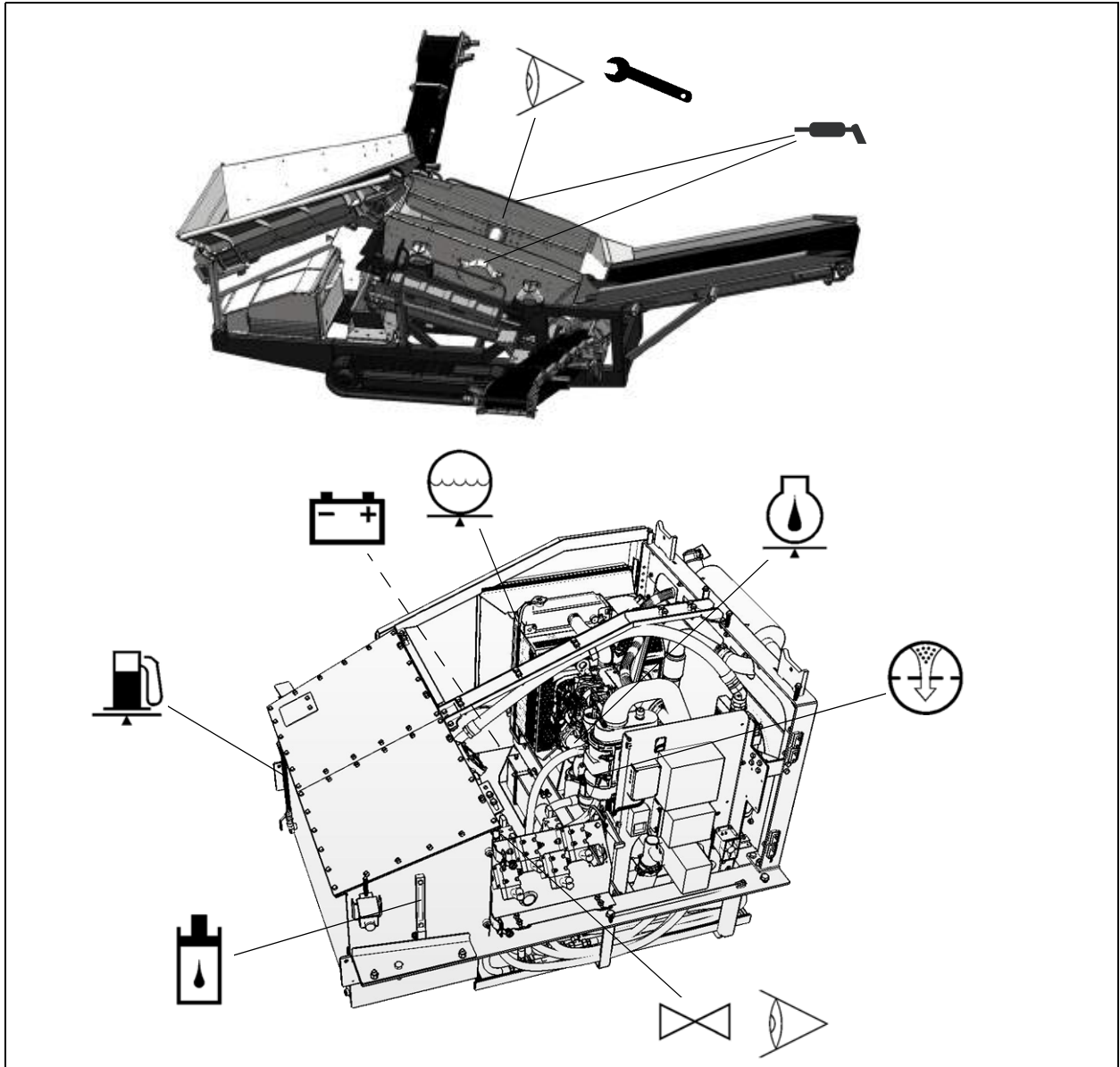


Figure 5.1 Measures to be taken before starting the engine

1. Check the condition of the engine air filter and the sealing of the housing (Figure 5.2).

The clogging indicator of the air filter warns, if the filter is clogged and the filter element must be replaced. When replacing the element, take extra precautions not to let any dust enter the intake channel.



Figure 5.2 Intake air filter of the engine

NOTE! Check that the clamps on the pipe of the intake air filter are properly tightened. If the tightening is loosen or insufficient, the engine takes air past the intake filter, which might damage the engine.

2. Check that the oil level of the engine is between the ADD and FULL marks on the dipstick (Figure 5.3). Add oil, if necessary.

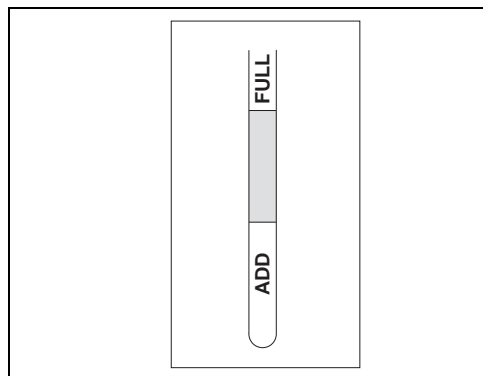


Figure 5.3 Engine oil dipstick

3. Check that the coolant level is approximately 50 mm (2 in) below the sealing face of the refiller cap. Open the cap carefully if the engine is warm (Figure 5.4).



Figure 5.4 Coolant level



WARNING!

Do not open the cooler cap when the engine is hot.

4. Check the fuel level. Refill if necessary. Make sure that no dust or dirt enters into the fuel tank through refill opening.

Clean the suction tube carefully before placing it into the fuel drum.

5. Check that the hydraulic shut-off valve is opened. (Figure 5.5).

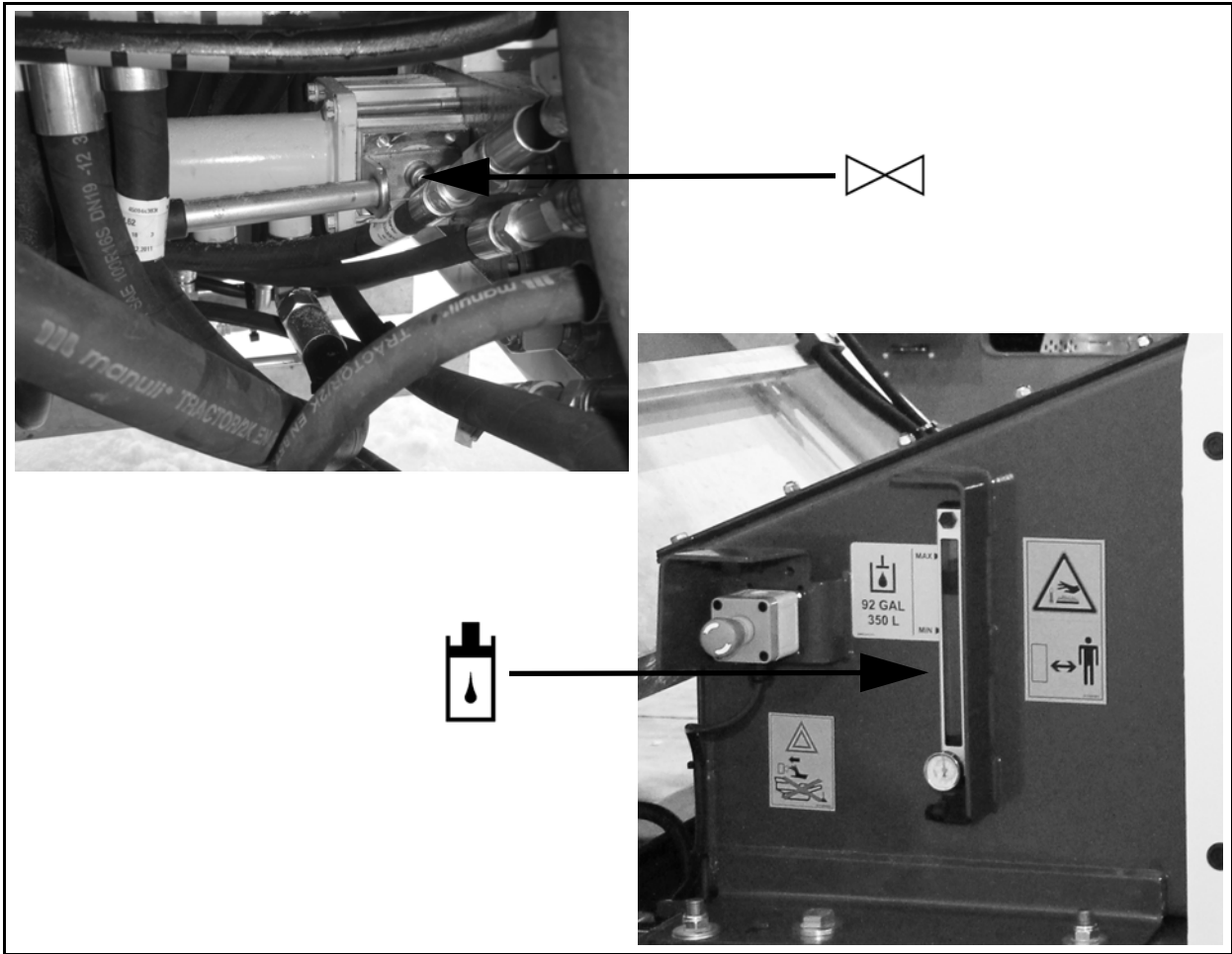


Figure 5.5 Make sure that the shut-off valve of the hydraulic tank is fully open

6. Check the hydraulic oil level from the sight glass. Add hydraulic oil, if necessary (Figure 5.5).

NOTE! Make sure that there are no leaks in the hydraulic system.

7. Check that the emergency stop buttons has not been pushed. If any of the buttons are in the down position, the engine cannot be started.

5.2 STARTING THE DIESEL ENGINE

NOTE! Never use startup spray or similar to help the engine start, because it might cause a destructive explosion in the induction manifold.



WARNING!

Never use startup spray or similar to help the engine start, because it might cause a destructive explosion in the induction manifold.

Start the diesel engine as follows

1. Make sure that the safety and emergency circuit is operational i.e all red emergency push buttons are pulled out, hydraulic oil level is normal and hydraulic suction valve is fully open.
2. Make sure that the level of the engine oil is normal.
3. Turn the key switch(B) on the main control center to the ON-position.
4. Press the glowing button (A) 5 - 60 s (depending on ambient temperature), turn and hold the key switch (B) until the engine has started.

NOTE! Take into account the 30 second delay and alarm when starting the engine!

5. Allow engine to warm up for approximately 5 minutes.

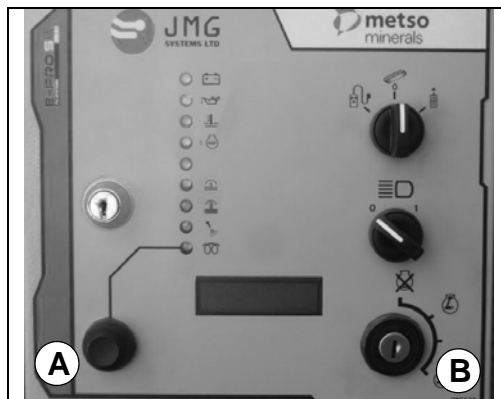


Figure 5.6 Starting the engine

5.3 STOPPING THE DIESEL ENGINE

NOTE! Do not shut down the engine before the process has stopped completely.

1. Stop the diesel engine by turning the key switch to “OFF” position (B, Figure 5.6).

NOTE! Before stopping the diesel engine, allow the engine to idle (cool down) for approximately 5 minutes.

5.4 REFUELING

NOTE!

- Shut down the engine or set it to idle while refueling.
- Use only clean diesel fuel or engine fuel oil. Check the quality requirements for fuel from the instruction manual of the Caterpillar C4.4 engine.
- In cold operating conditions, note the low temperature properties of the fuel.
- The fuel must be stored so that it cannot be contaminated by water or impurities.
- Replace the fuel filter frequently enough (see the servicing instructions). A clogged or damaged filter may reduce the engine capacity or damage the injection pump or injector nozzles.



WARNING!

Diesel fuel and engine fuel oil are flammable fuels. Do not smoke, light an open fire or generate sparks when fuel is being handled nearby.

5.4.1 REFUELING THROUGH THE FILLER CAP

When adding fuel through the filler cap (Indicated with an arrow in the Figure 5.7), be careful not to let any dirt enter the fuel tank through the opened cap. Clean around the cap before opening it.

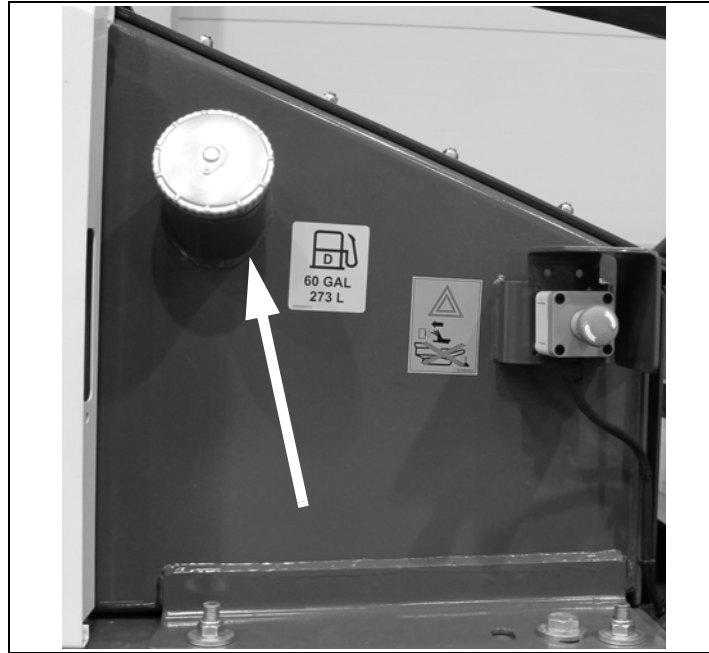


Figure 5.7 Fuel filler cap

5.5 ADJUSTING DIESEL ENGINE RPM SPEED

1. When the engine is started the engine rpm rises to idle speed (approximately 800 rpm). The engine speed can be adjusted manually from the RPM-lever.



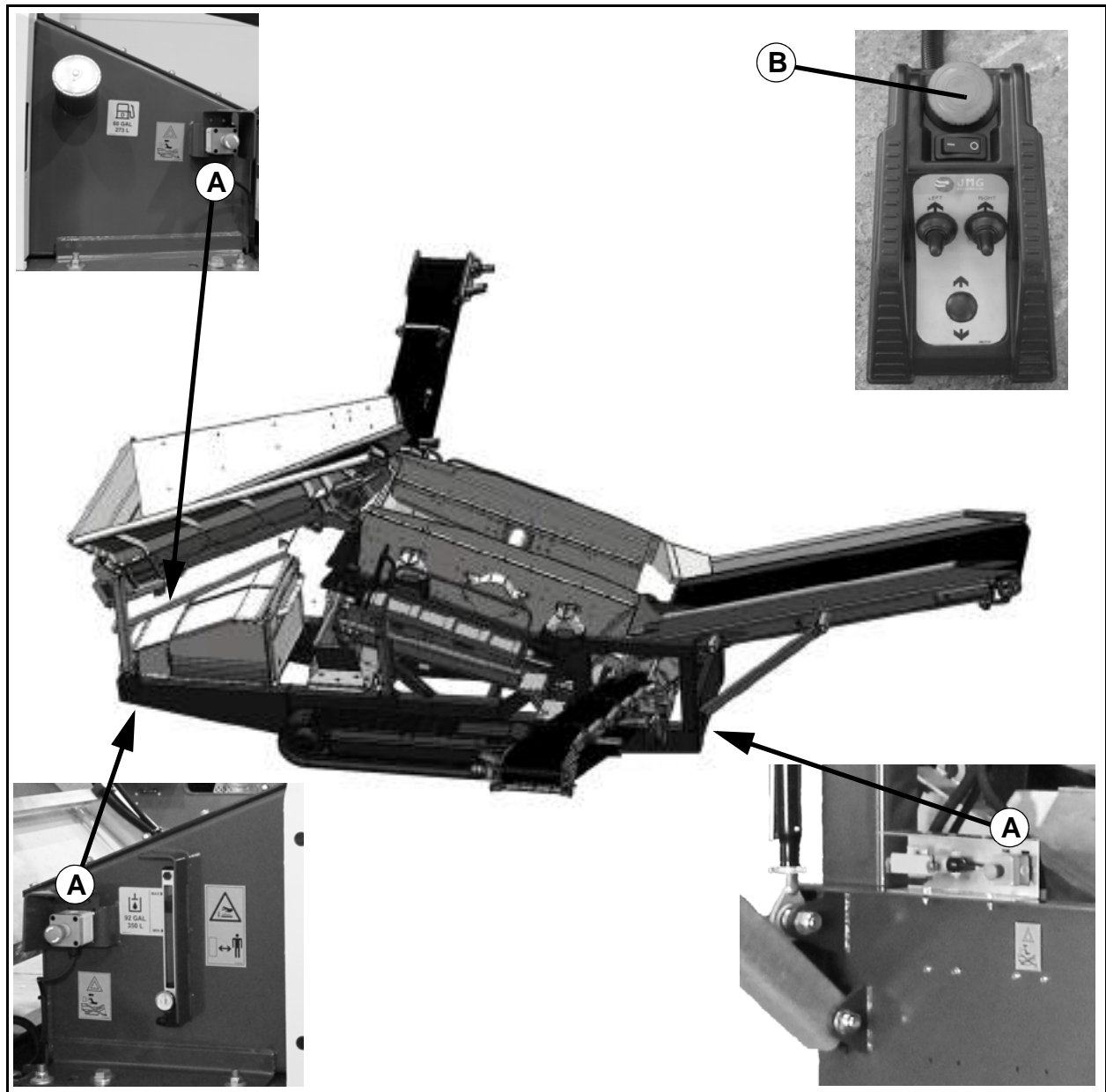
Figure 5.8 RPM-lever

5.6 ENGINE AND SCREEN

For instructions of actions during running-in and start-up of the engine and the screen refer to the Instruction Manuals of these device.

5.7 EMERGENCY STOP

In case of emergency, press emergency stop button to stop the machine. The locations of the buttons are shown in Figure 5.9. The remote stop button in the remote works only when the remote is connected.



EMERGENCY STOP BUTTON	FUNCTION
A	Stops the machine
B	Remote stop button, stops the machine

Figure 5.9 Location of the Emergency stop -buttons.

5.8 SCREENING PROCESS

5.8.1 PREPARING THE EQUIPMENT FOR USE

Proceed as follows (Figure 5.10)

NOTE! Always when preparing ST2.4 for use, turn the side conveyors open first.

1. Activate the hand valves by turning the selector switch (5; figure 4.4) in the control panel to the right.
2. Turn the side conveyors (1 and 2) into the operating position. See paragraph 5.8.1.1. At first undo the transport lockings.
3. Turn the service platform handrails (3) to the upright position and install lockings. See paragraph 5.8.1.2.
4. Drive the screen (4) into the operating position. See paragraph 5.8.1.3.
5. Drive the feed conveyor (5) to the operating position. See paragraph 5.8.1.5.
6. Lift the light pole up (optional).
7. Make sure that the machine is operated only in safe manner. Operate the machine only, when it is in good mechanical condition. Make sure that the machine is standing properly and will not overturn.



WARNING!

Do not enter the service platform when the handrail has been folded down to the transport position.

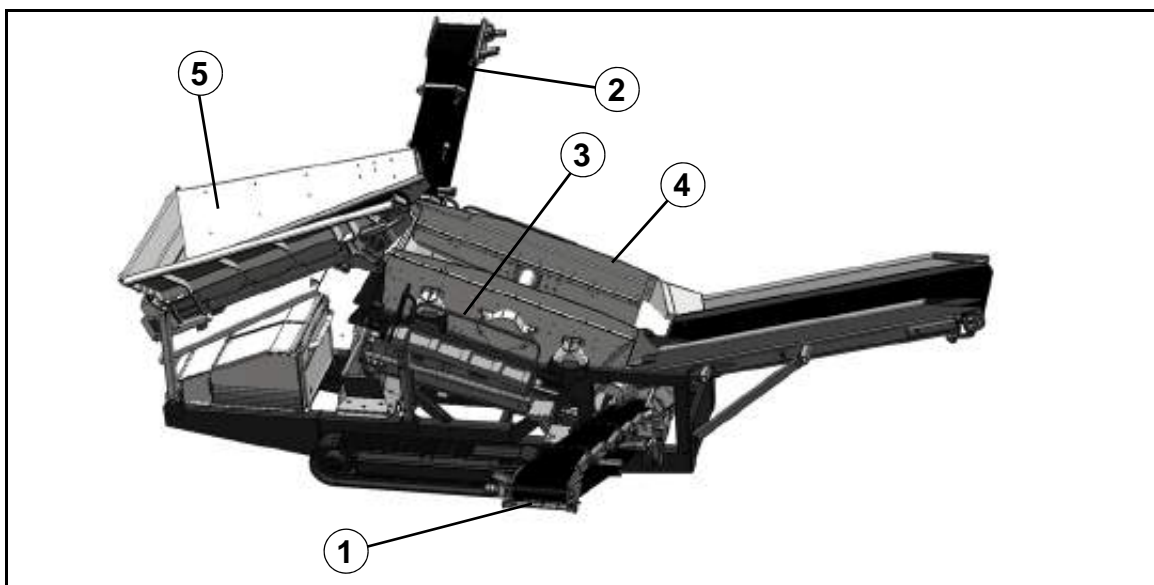


Figure 5.10 Preparing the equipment for use

NOTE! The operation of the machine must only be allowed, when all necessary protective and safety devices, e.g. guards, emergency stop devices, silencers, aspirators etc. are in place and in operating condition.



WARNING!

Before starting the machine, make sure that there are no persons in the area whose safety may be endangered! Walk around the machine and make sure that there is nobody on, by or below the machine. Warn everybody in the vicinity before starting.

5.8.1.1 Maneuvering the side conveyors



WARNING!

Risk of serious injury or death!

Air enters the cylinder circuit when a cylinder, hose, or other component is replaced or damaged.

After such operation before maneuvering the conveyors, ensure that the folding cylinder circuits have been bled. Any air trapped in the cylinder circuit will cause the conveyor or a part from it to drop.

Bleed the cylinder circuit by disconnecting the cylinder rod ends from their mountings and running the cylinders back and forth until all air is positively removed from the circuit (at least three times).

Ensure that nobody is in the restricted area (Figure 7.1) of when the conveyors are maneuvered.



WARNING!

Stay away from the folding conveyor!

NOTE! Folding the side conveyors without care will cause damage to the conveyors.



WARNING!

Make sure all personnel are clear of the machine.



WARNING!

Only trained and competent personnel should operate/maintain/service the ST2.4. If operating procedures are unclear, contact your local Metso distributor for assistance prior to operating.

When unfolding the side conveyors attention must be given to obstacles and the conveyor belt clearances.

NOTE! Stop all the process operations before attempting adjustments. Remove process material before adjustment procedures.

Function: Side conveyor fold hydraulics allows the side conveyors to be folded for transport, tracking and storage.

Description: Hand valves for the side conveyors are located on the left side of conveyor frame.

UNFOLD:

The following assumes that the machine is positioned upon a level site, with engine running. All transportation-term securing straps must be removed.

1. Turn the selector switch 5 (Figure 4.4) to the right to activate hydraulic control levers.
2. Open the mechanical locking from above the lifting cylinders. Lift the weight off from the locking with the hydraulic cylinder (Figure 5.13). Turn the transportation support to the side and lock it open.
3. Turn the transportation support to upper position. Lock it open.

NOTE! Support needs to be fully open before movement.



Figure 5.11

4. Open the securing pin from the transportation support.

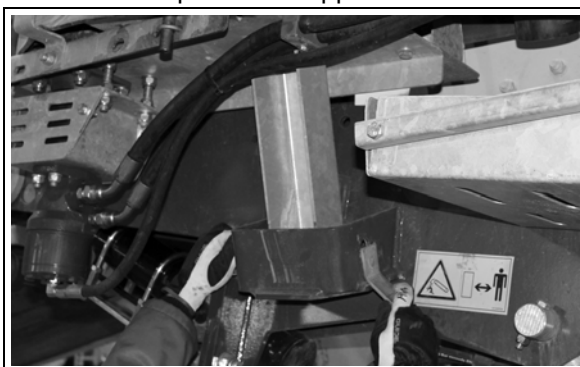


Figure 5.12

5. If lockings were too tight to remove, move the conveyor slightly with the FOLD/UNFOLD (1) and RAISE/LOWER (2) control levers and try again.

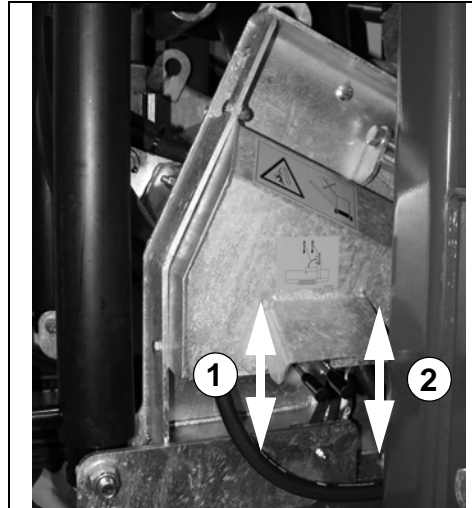


Figure 5.13

6. First lower the conveyor slightly away from the screen. Then raise the conveyor with UNFOLD control lever approximately 400 mm from the transportation support.
7. Lower the conveyor with LOWER control lever until the lifting cylinder has approx. 100 mm stroke left.



Figure 5.14

8. Unfold the the conveyor completely with UNFOLD control lever. Pay attention to the straightening of the conveyor belt. If needed stop the movement and adjust the belt.

9. Lower the conveyor with LOWER control lever to the end of the cylinder stroke.
10. Close the mechanical locking (Figure 5.15).
11. Repeat the steps 1 - 10 for the other side conveyor

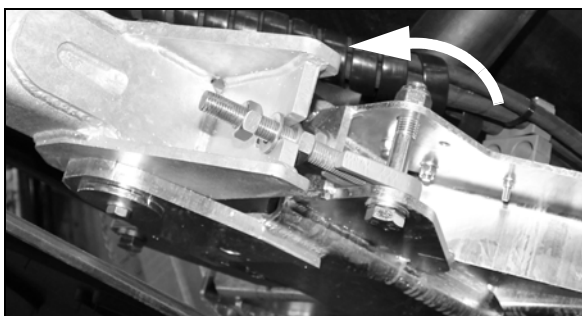
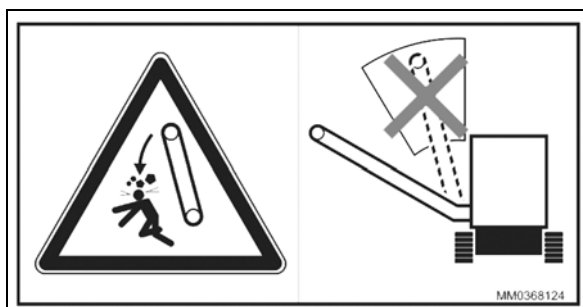


Figure 5.15

**WARNING!**

Do not lift the conveyor straight up (vertical). Always use both FOLD and RAISE functions in turn.

FOLD:

Make sure that the service platforms are empty and the hand rails are folded down before moving the side conveyors. The screen and the feeder must be in the lowest transport position.

1. Turn the selector switch 5 (figure 4.4) to the right to activate hydraulic control levers.
2. Open the mechanical locking (Figure 5.16)

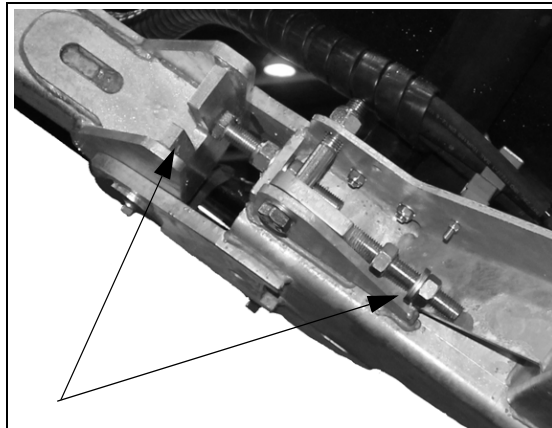


Figure 5.16

3. Raise the conveyor with RAISE control lever so that the lifting cylinder has extended approx. 100mm (Figure 5.13).
4. Fold the the conveyor by three quarters down towards the frame with FOLD control lever. Pay attention to the conveyor belt. If needed stop the movement and adjust the belt.
5. Raise the conveyor with RAISE control lever near the frame. Fold the conveyor down and carefully approach the transportation support with both FOLD and RAISE levers.
6. When the conveyor frame is on the support raise the conveyor with RAISE control lever and turn the hydraulic cylinder transportation support on its place. Lock the transportation support with a securing pin.
7. Use the hand lever gently to release the weight of the conveyor to the mechanical support.
8. Repeat the steps 1 - 8 for the other side conveyor.



5.8.1.2 Service platforms

NOTE! Stop all the process operations before attempting adjustments.

SERVICE PLATFORMS TO THE OPERATING POSITION:

1. Open the transport lockings (1).
2. Lift up the long side rail (2). Lock the rail from both ends (1) to the service platform.

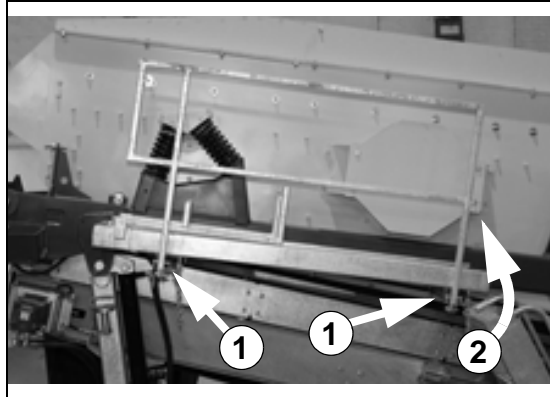


Figure 5.17

3. Lift up the short end rail (3). Lock the short rail to the long rail.

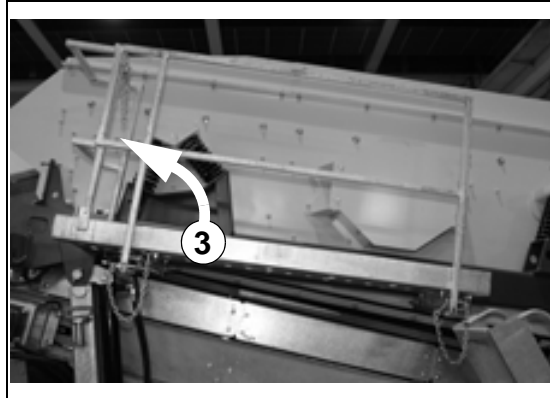


Figure 5.18

4. Repeat the steps 1-3 for the other service platform.

SERVICE PLATFORMS TO THE TRANSPORT POSITION:

1. Open the locking of the end rail.
2. Open the locking of the longer side rail and turn it down.
3. Lock the side rail for the transportation.
4. Lower the end rail on to the service platform.
5. Repeat the steps 1-4 for the other service platform.

5.8.1.3 Adjusting the screen angle

NOTE! Stop all the process operations before attempting adjustments. Remove process material before adjustment procedures.

NOTE! Do not raise the screen angle if the side conveyors are on the transport position

Function: Screen angle hydraulics allows the screen box to be adjusted to change the screen media efficiency for existing conditions dependent on the application. Also allows positions for transport, tracking and storage.

Description: Hand valves for the screen angle is located on the right side of the frame.

RAISE:

1. Turn the selector switch 5 (figure 4.4) to the right to activate hydraulic control levers.
2. Use the angle control lever to adjust the screen angle (feed side up or down).

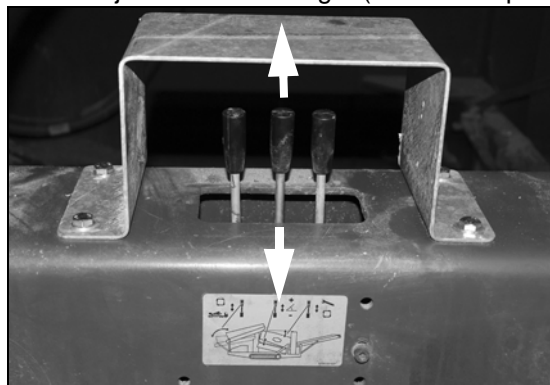


Figure 5.19

3. Install the locking pins and lower the screen so that the weight is on the pins and not on the cylinders.

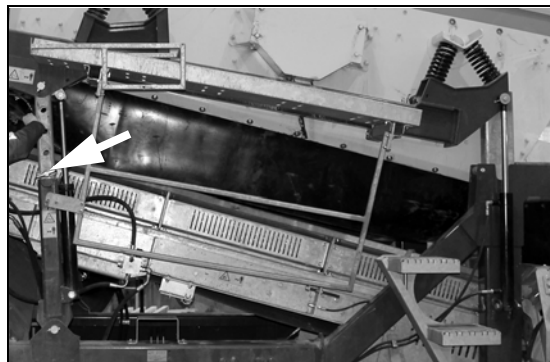


Figure 5.20

NOTE! Insure both trestles are adjusted equally, failure to do so will damage the screen box assembly.

5.8.1.4 Screen service position

NOTE! Stop all the process operations before attempting adjustments. Remove process material before adjustment procedures.

NOTE! Do not raise the screen angle if the side conveyors are on the transport position.

SCREEN SERVICE POSITION:

1. Turn the selector switch 5 (figure 4.4) to the right to activate hydraulic control levers.
2. Raise the screen with service position RAISE control lever to the service position.

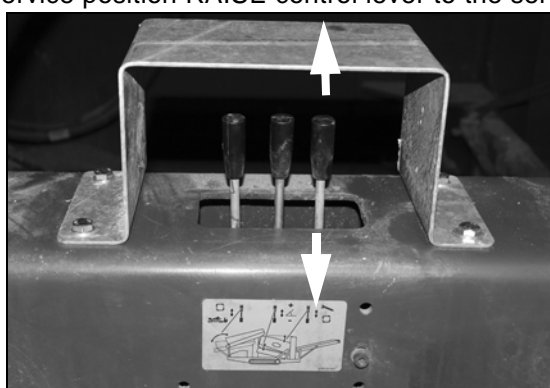


Figure 5.21

3. Install the locking pins and lower the screen to rest on the pins.



SCREEN OPERATING POSITION:

1. Turn the selector switch 5 (figure 4.4) to the right to activate hydraulic control levers.
2. Remove the service position locking pins. First lift the screen lightly.
3. Lower the screen with service position LOWER control lever to the operating position.

**WARNING!**

Make sure all personnel are clear of the machine.

**WARNING!**

Only trained and competent personnel should operate/maintain/service the ST2.4. If operating procedures are unclear, contact your local Metso distributor for assistance prior to operating.

5.8.1.5 Maneuvering the feed conveyor

NOTE! Stop all the process operations before attempting adjustments. Remove process material before adjustment procedures.

**WARNING!**

Make sure all personnel are clear of the machine.

**WARNING!**

Only trained and competent personnel should operate/maintain/service the ST2.4. If operating procedures are unclear, contact your local Metso distributor for assistance prior to operating.

NOTE: Stop all the process operations before attempting adjustments. Remove process material before adjustment procedures.

Function: Feed conveyor hydraulics are used to lift/lower the feed conveyor for transport, operations or moving.

Description: Hand valves for the feed conveyor are located on the right side of the frame.

FEED CONVEYOR TO THE OPERATING POSITION:

1. Turn the selector switch 5 (figure 4.4) to the right to activate hydraulic control levers.
2. Use the feed conveyor control lever RAISE to raise the feed conveyor on top of the screen. When movement stops it is hydraulically locked and there is no need for mechanical locking pins.

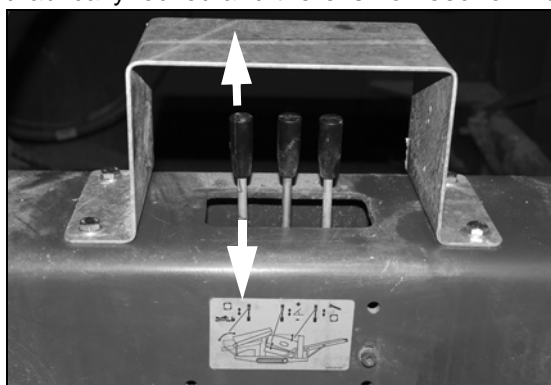


Figure 5.22

FEED CONVEYOR TO THE TRANSPORT POSITION:

1. Turn the selector switch 5 (figure 4.4) to the right to activate hydraulic control levers.
2. Use the feed conveyor control lever LOWER to lower the feed conveyor away from the screen. When movement stops it is hydraulically locked and there is no need for mechanical locking pins.

5.8.2 STARTING THE SCREENING PROCESS

NOTE! Ensure that all inspection and service hatches are on their places, closed and locked.



WARNING!

Never go to the vicinity of the feeder or screen when the machine is running.



WARNING!

Do not climb on top of the machine when it is operating!

NOTE! Before starting always make sure that the screening plant is empty.



WARNING!

When the screening process has begun, the RPM speed of the diesel engine cannot be adjusted by the operator until the screening process is stopped again.

Proceed as follows:

- Start the engine. Refer to chapter 5.2.
- Increase the engine rpm to the maximum (2100 rpm).
- Turn the selector switch 5 to the left.
- Start the oversize and side conveyor (midsize) from the button 1.
- Start the underscreen and side conveyor (undersize) from the button 2.
- Start the screen from the button 3.
- Start the feed conveyor from the button 4.

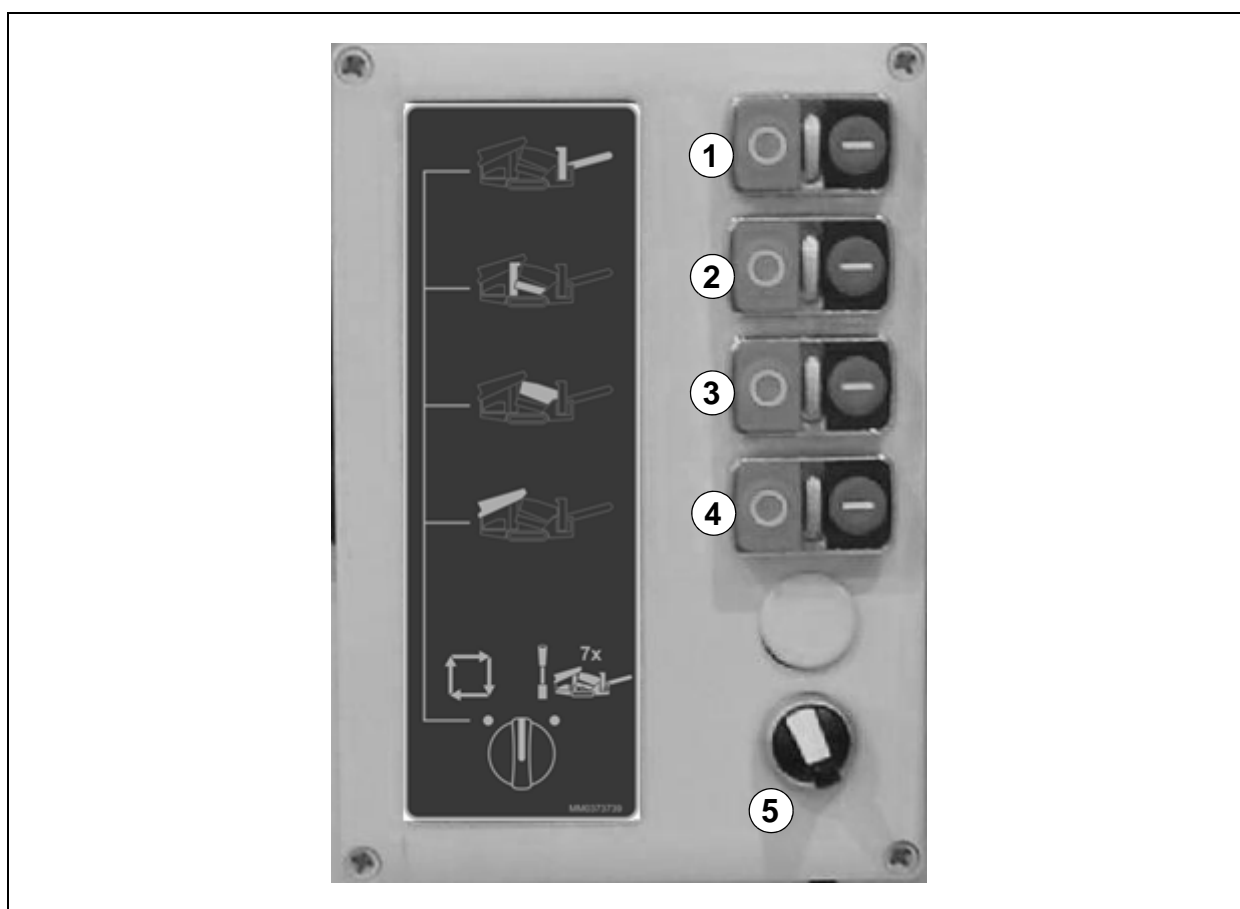


Figure 5.23

5.8.3 STOPPING THE SCREENING PROCESS

Proceed as follows:

- Stop the feed conveyor from the button 4.
- Stop the screen from the button 3.
- Stop the underscreen and side conveyor (undersize) from the button 2.
- Stop the oversize and side conveyor (midsize) from the button 1.
- Decrease the engine rpm to the idle (800 rpm)
- Switch the work lights off, if necessary (optional)
- Stop the engine after 5 minutes at idle to cool the engine.

See the Screen instruction manual for details in screening.

NOTE! In case of emergency press “Emergency stop”-button to stop the ST2.4.

Don't try to screen too large material. Even single large rocks reduces capacity, and imposes unnecessary loads on the screen.

6.1 GENERAL

Because of the size and weight of the equipment, special attention must be paid when moving the ST2.4. Always make sure that nobody is on top of or near the ST2.4.



WARNING!

Ensure that there is nobody in the range of hydraulic devices when operating.



WARNING!

Make sure that the lighting is appropriate at the site or near the ST2.4.

MAXIMUM INCLINATIONS	
Sideways	5 °
Lengthwise	15 °



WARNING!

Make sure that there is nobody on top of or near the ST2.4.

NOTE: Before driving make sure that:

- the driving route is smooth enough.
- differences in altitude and road inclination do not prevent driving.

**WARNING!**

In case the surface is slippery or icy, make sure that the sanding is sufficient enough to prevent the unpredictable movement of the ST2.4.

NOTE: The hydraulic oil temperature must be observed during longer moves. The temperature may be a maximum of 90 °C. Oil that is too hot might damage the sealings.

NOTE: Longer moves (more than 100 m) must be driven with the feeder end of the machine first, when the driving gear comes after the track. In that case, the lower end of the track remains tight, because the ground supports the track and it does not bend down. This helps to prevent the chain from jumping over the driving wheel teeth.

6.2 MOVING ON THE SITE

NOTE: Before moving on the site, make sure that the process has stopped, and that no material has been left in the screening unit.

NOTE: Keep the side conveyor angle as low as possible. Do not drive if conveyors are lifted over 45 degree angle.

Internal moves on the work site can usually be performed by track drive.

1. Make sure that the load bearing capacity of the ground is at least 30 000 kg/m².
2. Start the engine as instructed in section 5.2.
3. Connect the drive control box to one of the alternative cable connectors (Figure 6.2). Switch on the drive control box preselection (A) if using the cable remote. If the machine is equipped with an optional radio remote control box, switch on the radio control preselection (B) from the main control board (Figure below), when driving with the radio control.

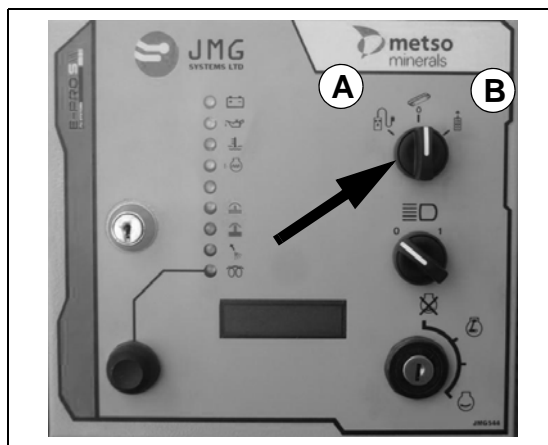


Figure 6.1

4. Adjust the engine speed with the lever in the power pack to the desired speed of 800 - 2100 1/min.
5. Drive the machine to the desired area using the manual levers on the remote control box.

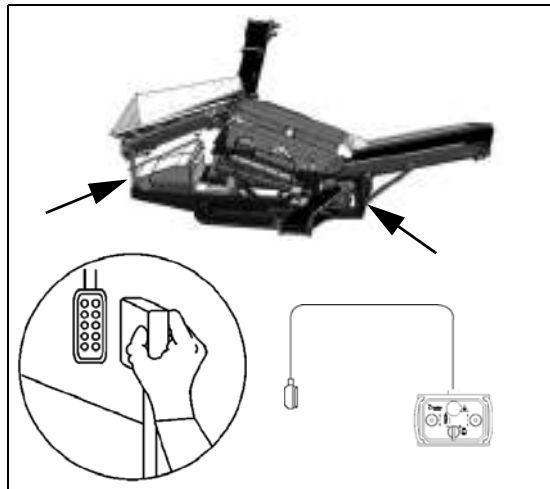


Figure 6.2 Connecting the drive control box

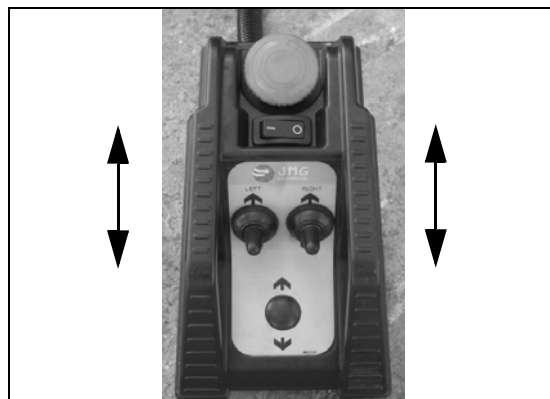


Figure 6.3 Driving the equipment with the help of the manual levers on the drive control box



WARNING!

The drive control box must be disconnected from the unit immediately after driving. The drive control box is allowed to be lifted and held only from its handles. Do not pull the box from the cable or drag or move it otherwise.

6. The driving speed can be changed by adjusting the engine speed.
7. On a new crushing site, drive the tracks back and forth in order make the ground more compact.
8. If you do not proceed with screening after moving the machine, shut down the engine as instructed in section 5.3.

Some hints to make turning the ST2.4 easier:

- ST2.4 turns easier when driven forward with the minimum power required.
- ST2.4 turns easier on hard than soft ground.
- If the ST2.4 cannot be turned when driving uphill, drive a short way downhill and turn the unit at the same time.
- By driving the center of one of the track onto a small rise, rock, or similar, it becomes easier to turn towards the lifted side.
- Always select an appropriate surface for turning the ST2.4. Only attempt to turn the ST2.4 in a location where the turning is easiest.
- When turning on soft ground, change the direction gradually.
- Avoid turning the unit completely at one time, so that material does not accumulate on the sides of the tracks.

NOTE: Avoid turning the machine in situations when the traction force is on the upper section of the chain track. The chain track may loosen as the tension spring inside the track frame can not hold the pressure any longer, which might cause the drive sprocket to jump over the track.

6.3 TRANSPORT FROM SITE TO SITE

When the Lokotrack ST2.4 is transported on public road, special care shall be paid to have necessary permissions from authorities for special transport. Check the local regulations, as they vary in each country.

The feeder, side conveyors, light mast, stairs etc. must be placed in transport position.

6.3.1 TRANSPORT EQUIPMENT NEEDED

- a trailer truck for transporting the ST2.4

NOTE: PRIOR TO TRANSPORT MAKE SURE THAT:

- The components that exceed the free transport height and width have been removed
- The load is appropriately fastened
- All the latches of the hatches and the engine cover are locked

6.3.2 ACTIONS BEFORE TRANSPORT

Proceed as follows:

1. Lower the light pole (optional).
2. Lower the screen.
3. Lower the feed conveyor.
4. Turn the hand rails into transport position.
5. Turn the side conveyors into the transport position. See paragraph 5.8.1.1
6. Stop the engine (refer to paragraph 5.3).

NOTE: Always when preparing the ST2.4 for transport, move the side conveyors last.



WARNING!

Do not enter the service platform when the handrail has been folded down to the transport position.

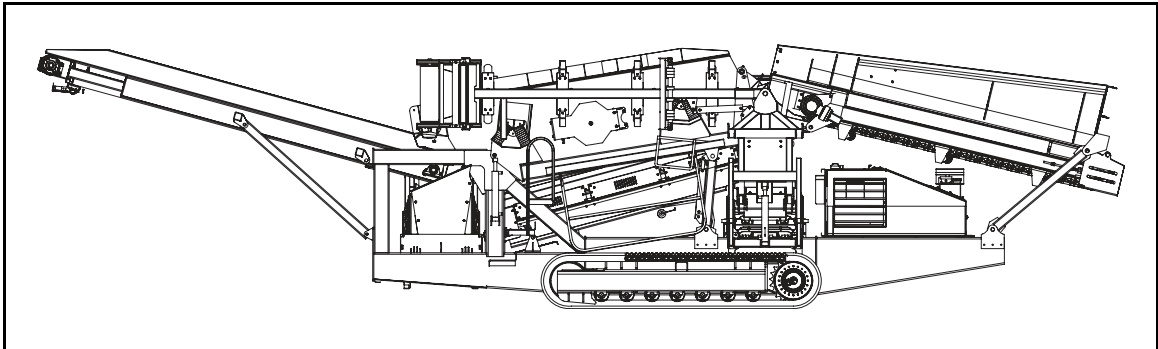


Figure 6.4 ST2.4 in transport position

6.4 DRIVING ONTO/OFF A TRAILER TRUCK

The ST2.4 must be driven onto and off the truck trailer with extreme precaution. Slow down the driving speed from the engine speed lever on the power pack.

**WARNING!**

Drive the unit onto/off the truck trailer with great care.
Make sure that there is nobody in the danger area.

When driving the unit onto/off the truck trailer, always make sure that no component of the ST2.4 hits the truck tractor. Also make sure, that the load is not on top of the truck tractor's cabin and does not cause any danger to the trailer truck's driver especially if the conveyor end is in front.

The ramp must have as low a gradient as possible (rise max.1:10), when the unit is driven onto the truck trailer. Refer to the picture below, but remember that the picture is for reference only, and not necessary from your machine.

**WARNING!**

Make sure that the ramp is properly positioned and in perfect technical order.

Shut down the engine as instructed in section 5.3.

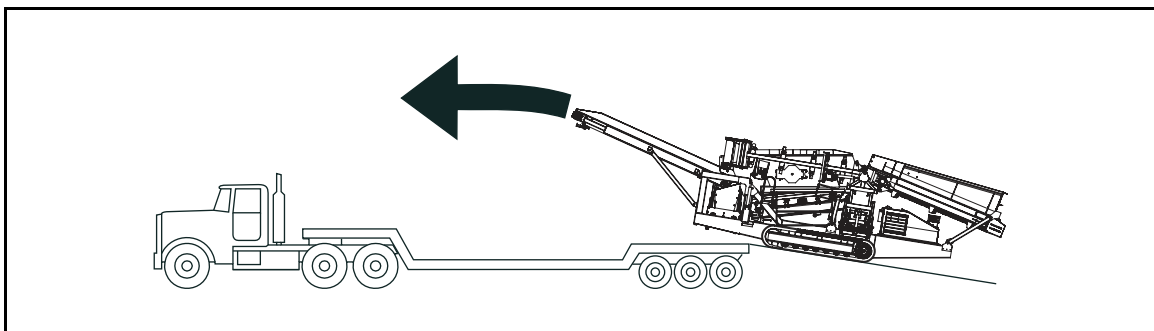


Figure 6.5 Driving the unit onto a truck trailer

NOTE: The actual weight of the unit can be calculated by adding the weight of the optional equipment to the weight of the basic unit. Check the actual weight of the unit from the transport drawing.

NOTE: The weights are for reference only. Actual weights may vary due to manufacturing tolerances.

Make sure that the load is properly fastened. Refer to the figure 6.6.



Figure 6.6 Fastening points of the unit

Make sure that the truck trailer is wide enough for the Lokotrack, and most of the track's width is on the truck trailer on both sides.

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7.1 BEFORE OPERATION

Before starting the process, prepare the working site for screening and perform the necessary inspections described in the chapter 5 and next paragraphs.



WARNING!

Before starting the screening process and during the screening, make sure that the restricted area is clear of people.

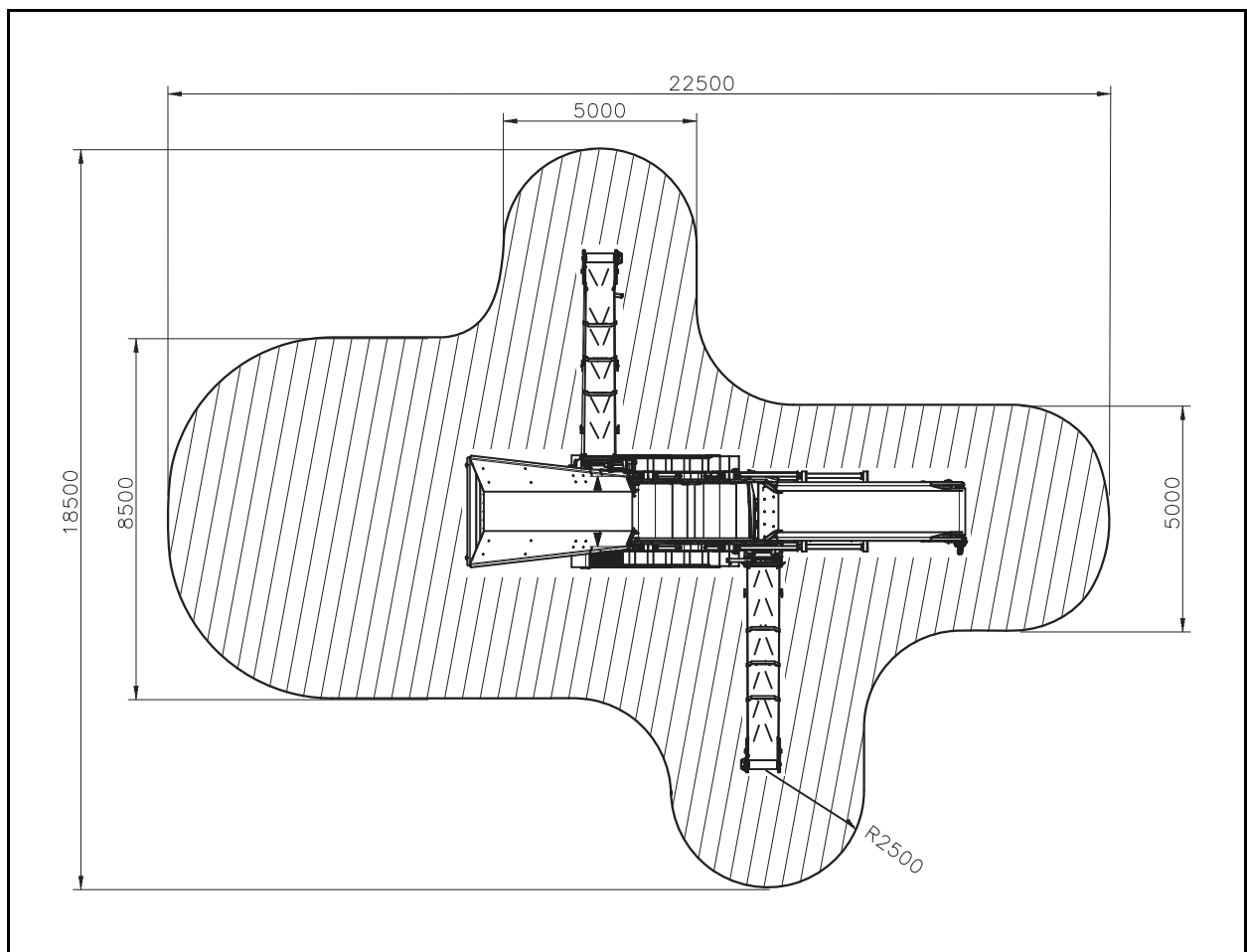


Figure 7.1 Restricted area

7.2 SCREENING SITE

The unit should be located near the material pile to make loading easy and quick. Shape the feed material pile with a wheel loader or excavator so that it is distributed over a small area and piled high enough for easy loading (Figure 7.2).

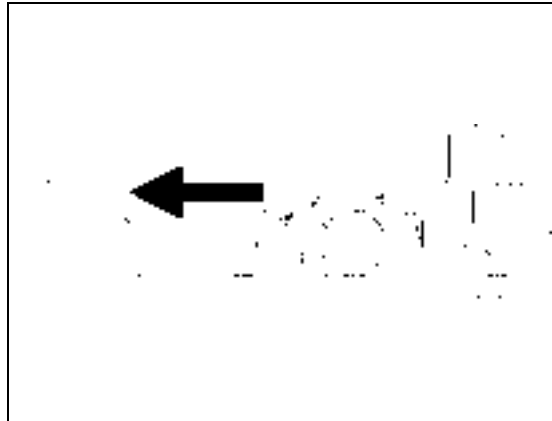


Figure 7.2 Shape the material pile

The location of the discharge pile must be chosen so that it doesn't cause any danger to workers or passers-by. Make sure that there is enough space for the discharge pile, the discharge machinery (wheel loader or excavator) and the lorry (Figure 7.3).

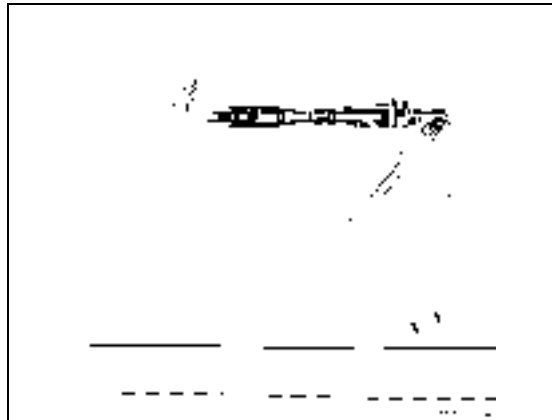


Figure 7.3 General measures taken on the site

The place where the screening unit is to be located must be even. The machine must not be allowed to sway. The surface below the screening unit must be levelled and evened out. Spread some fine-grained material on the ground, distributing it evenly (Figure 7.4). Next, harden the underlying ground by driving the unit back and forth over the site (Figure 7.5).

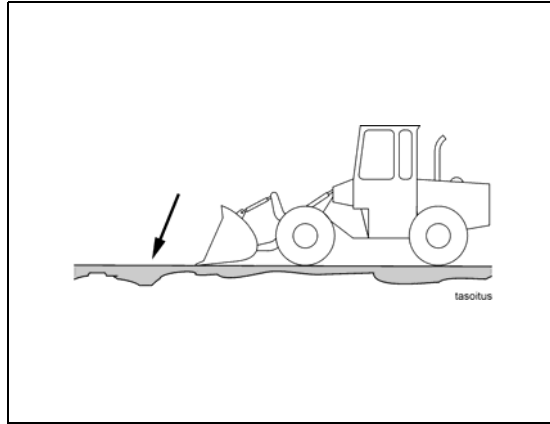


Figure 7.4 Material spreading

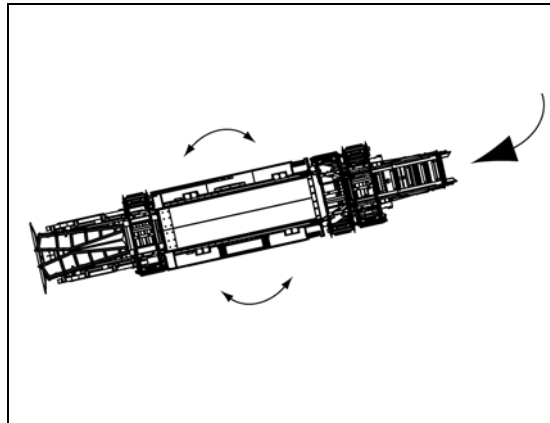


Figure 7.5 Strengthening the ground

During the screening process, make sure that the unit is in horizontal position. The maximum inclination allowance is 1 degree in lateral and longitudinal direction (Figure 7.6 and Figure 7.7).

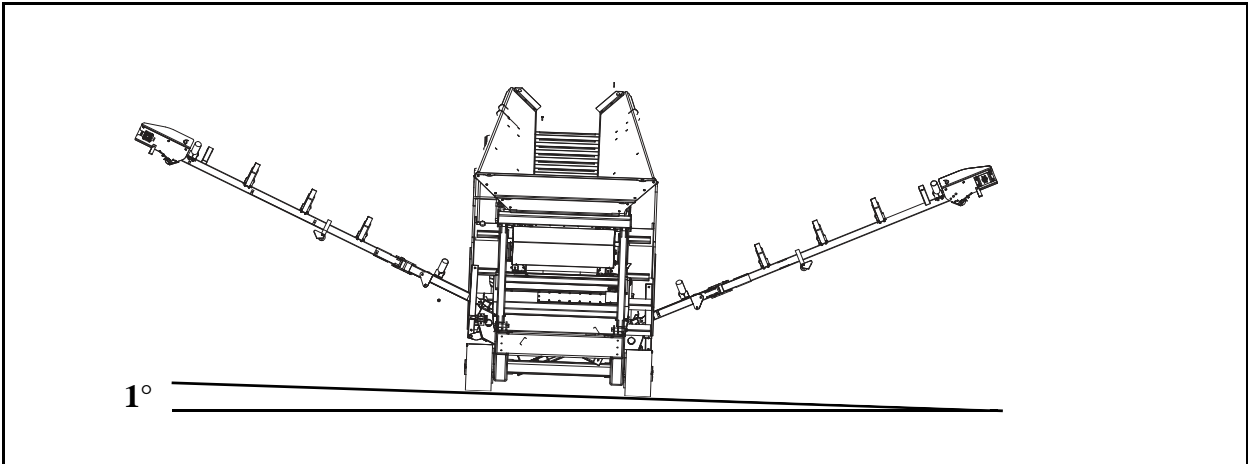


Figure 7.6 The maximum lateral inclination

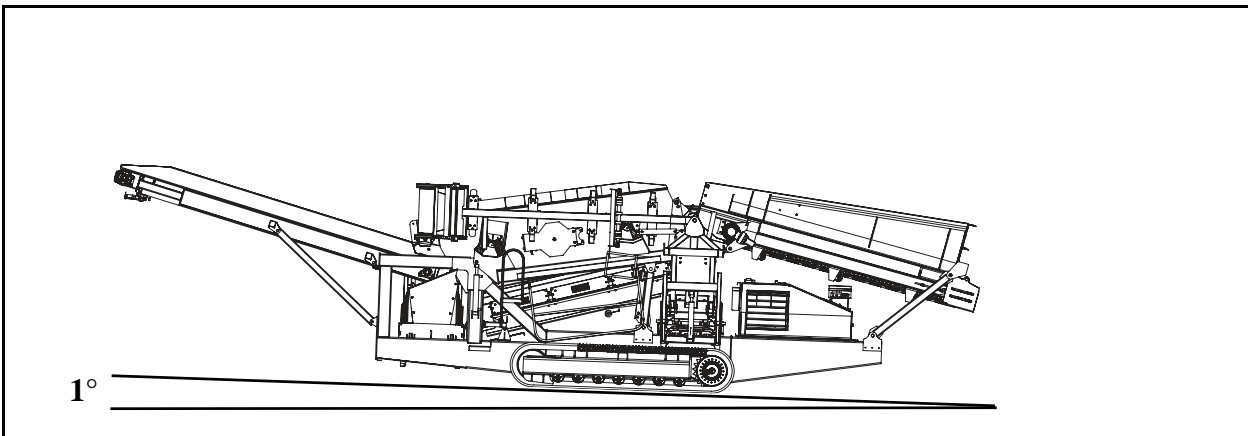


Figure 7.7 The maximum longitudinal inclination

7.3 FEEDING MEASURES

The unit can be loaded with the primary crusher or with the help of an excavator / a wheel loader.

- Loading using a primary crusher

Unit can be loaded with the primary crusher from the side or the rear. Unit must be located so that the material flow enters to the center of the lifting belt about 1,0 m (3 1/3 ft) from the tail pulley.

The rear wall of feed hopper can be lowered if needed.

Observe the material flow to the crusher and adjust the feed material so that the flow is not restricted due to feed size.

- Loading using an excavator

The unit can be loaded from the side or the rear.

Find a suitable loading site and move the excavator bucket to its loading position. Then drive the unit into a suitable position below the excavator bucket.

The operator of the excavator must have full visibility to the feed hopper.

Slide the bucket full when there is room on the lifting conveyor feed hopper. Do not overfill the lifting conveyor feed hopper.

- Loading using a wheel loader

This unit is designed to be loaded with wheel loader with maximum size of 27 metric tons for example CAT966.

If required, use the feed material to make a loading ramp to ease access to the feeder.

Drive the unit as close to the pile as possible to make loading quick and easy.

NOTE: An overfilled feed hopper can prevent or slow down the starting of the feed conveyor and reduce the throughput.

7.4 DISCHARGE MEASURES

Check the height and volume of the discharge pile. Do not let the pile grow so high that it reaches the conveyor. The distance between the pile and the conveyor must always be at least 200 mm (8") (Figure 7.8).

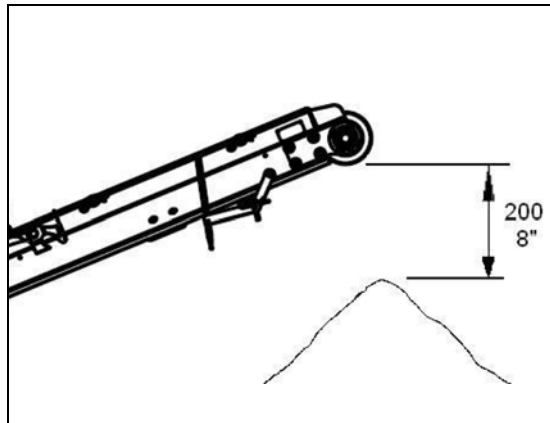


Figure 7.8 Distance from the pile

NOTE: When discharging with the help of the wheel loader, be careful not to damage the conveyor. Discharge from the side, do not push the material under the unit.

7.5 STANDARD DISCHARGE ARRANGEMENT

Lokotrack ST2.4 has three discharge conveyors:

- Two side conveyors for the undersize and midsize from the 1st and 2nd decks.
- One oversize conveyor in the rear for the oversize material from above the screen

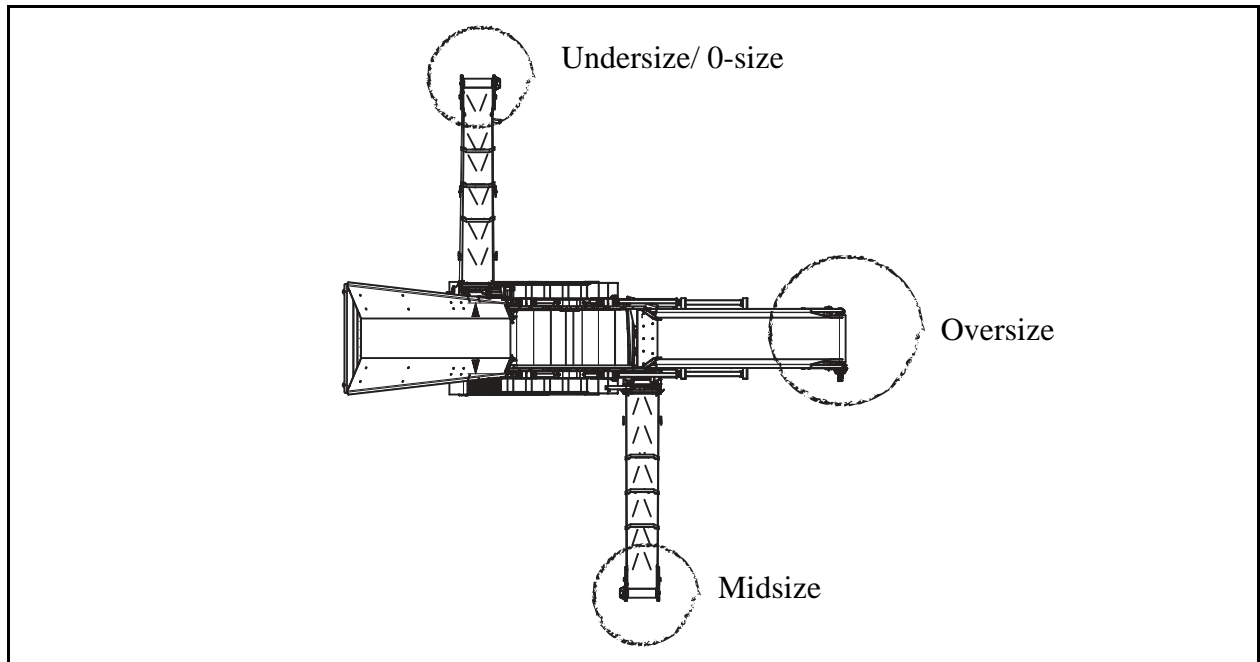


Figure 7.9 Discharge operation

NOTE: Secure that the unit stands on an even surface of crushed material, levelled for example with a wheel loader. Check with a spirit level.

7.6 ADJUSTING THE SCREENING PROCESS

Observe all the conveyors during screening.

Different feed materials will screen differently depending on the size and coarseness of the feed material but also the size of the screens. The speed of the feed conveyor determines the volume feeded in to the screen.

Before adjusting the speed of process let the machine empty from the process material.

When starting the process adjust the speed of the feed conveyor (A) to approximately half of the maximum speed. The speed can be adjusted with a control valve which is located at the hydraulic valve block.

The speed of the side conveyor (midsize) (B) can be adjusted from the control valve near the conveyor. Use as slow speed as possible to avoid the process material to roll back.

Default setting for oversize conveyor speed adjustment (C) is 50% of the maximum.

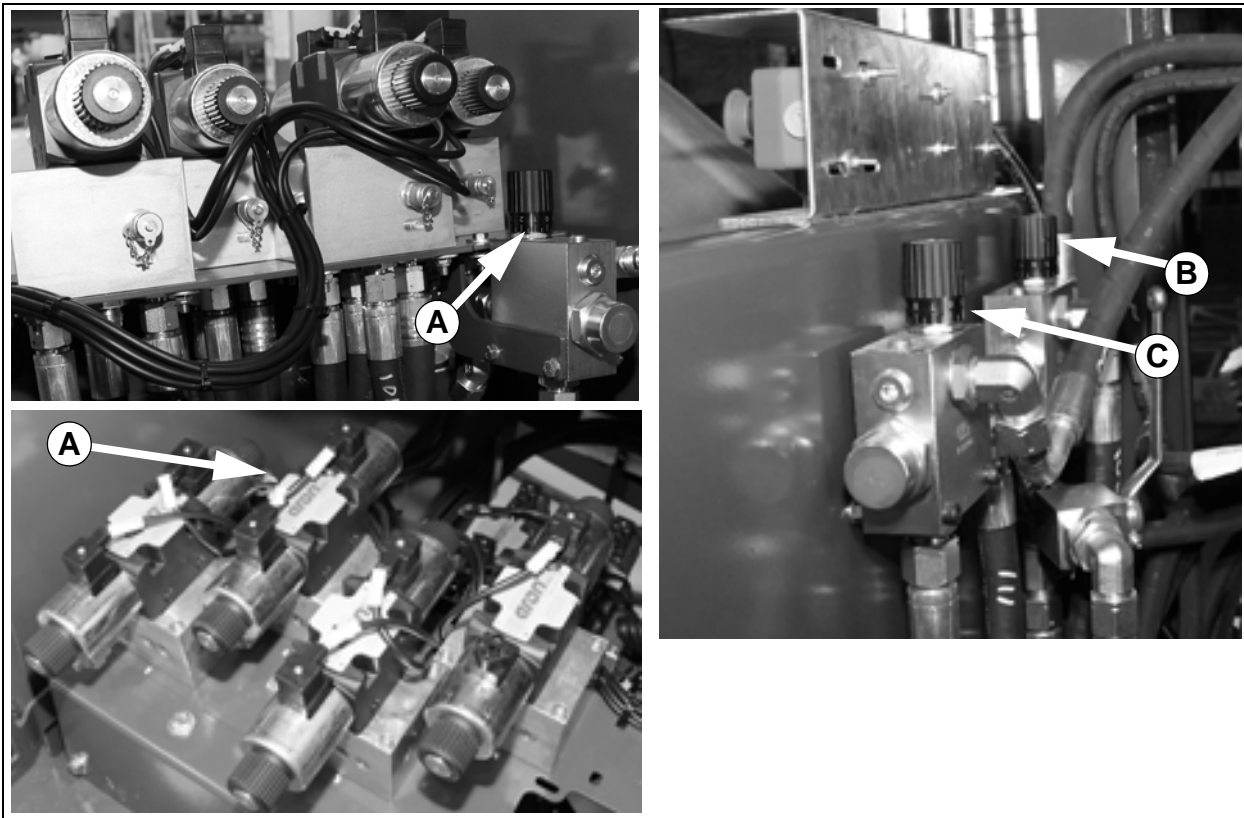


Figure 7.10



WARNING!

The speed of the conveyor can not be adjusted while there is feed material in the feed hopper! Do not feed the hopper while adjustments are made!

7.6.1 ADJUSTING MATERIAL DROP HEIGHT BETWEEN THE SCREEN NOSE AND OVERSIZE CONVEYOR

- The screen angle is adjustable (Chapter 5.8.1.3).
When the angle is low, the drop height between the screen nose and oversize conveyor is greatest.
- The oversize conveyor's angle can be changed by adjusting the two adjusting rods. Open the locking and twist the adjusting rod to raise or lower the conveyor.



Figure 7.11 Adjusting rod

NOTE: With a great screen angle the screen nose is close to the conveyor

NOTE: When using the highest 19 degrees screen angle, the adjusting rods adjustment must be low

NOTE: Stop all the process operations before attempting adjustments. Remove process material before adjustment procedures.

7.7 CLEARING OF THE JAMMED CONVEYORS

NOTE: Never try to clear the blockage with an excavator.

If the conveyor stops, follow these instructions:

- Stop the process immediately
- The engine RPM must be adjusted manually

Clear the jammed conveyor manually as well as possible. When most of the material is removed start the conveyor.

7.7.1 Clearing the lower conveyor and 0-side conveyor

Open the valve lever (1) by turning it to the vertical position, so that only the 0-side conveyor is running.

When the side conveyor is empty, close the valve lever (2) by turning it to the horizontal position.

Now both of the conveyors are running.

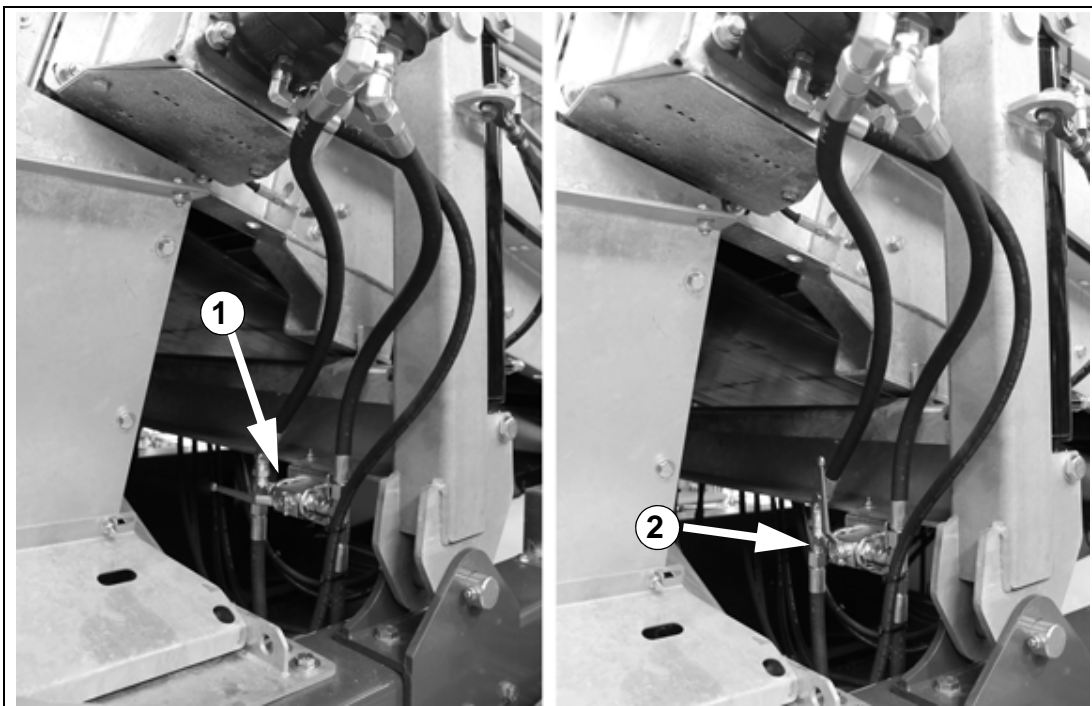


Figure 7.12 Valve lever open and closed



WARNING!

Watch out for the discharge material!

7.8 REPLACEMENT OF THE SCREEN MESHES

When installing the meshes, bring them to the screen from the discharge end of the screen.

Handling the meshes:

Screen meshes are heavy and awkward to handle. Wherever possible, always use suitable mechanical lifting equipment with a valid test certificate.

Always adhere to the occupational health and safety regulations when lifting manually or mechanically.

Watch out for your hands and fingers when handling screen meshes. Wire ends can be extremely sharp and there are many pinching points. Work gloves are recommended when handling screen meshes.

Eye protection should be worn when working under the screens.

Never use fuel, gas or other cutting equipment on the ST2.4. If replacement screen meshes require trimming because they have been supplied oversized, never cut them when they are inside or on the machine.

Some screens will need slight trimming of the support strips. Approximately 20 mm will need to be trimmed from each end of the cross support strips, so that the harp wire will sit flat onto the steel sealing strip bolted to the screen side plate.

Some harp wires are supplied with steel or plastic cross support strips, depending on the supplier.

7.8.1 PREPARATION FOR SCREEN MESH MEDIA CHANGE

1. Start and run the engine at idling speed to carry out the following steps.
2. Unfold both side conveyors and to the operation position.
3. Remove all debris from the screen. If walkways are not fitted, then care must be taken when trying to access the screen from the sides. It is recommended that you work from a ladder that is suitably secured.
4. If the meshes are badly covered with sticky material it is recommended that the screen box be run empty for at least 3 minutes. After this, switch off the unit and remove the key. Inspect the meshes and if they are still badly covered then tap the meshes with a hammer to loosen the sticky material. Repeat these procedures until you are satisfied that all the material is removed. Shut down the screening.
5. Raise the screen to the service position and install the locking pins.
6. Switch off the engine and remove the ignition key. Keep the ignition key in your pocket at all times when working on the unit. For extra safety, it is advised that all emergency stops are depressed while working on the screen.
7. Metso recommends that prior to the removal of the meshes from the screen, the replacement mesh, the replacement capping rubbers, and the cable ties are already on site.
8. Prior to replacement, thoroughly clean the side plates of the screen box.
9. Remove all debris at the points where the screen mesh hooks into the cross beams.
10. Always inspect the condition of the screen tension bolts, screen protection rubbers, and clamp plates during mesh replacement. Replace damaged or worn parts accordingly.
11. Replace all damaged capping rubbers and cable ties.
12. Replace any damaged bolts/nuts/washers etc.
13. Replace/repair any damaged or worn screen sealing strips.
14. When the screen meshes are removed, inspect all screen cross members, fixings and general screen structure for damage or wear. Repair/replace accordingly.

7.8.2 BOTTOM DECK MESH REMOVAL



WARNING!

Eye protection must be worn when working under the screen

NOTE: Bottom deck has two meshes. The mesh on the discharge end is longer.



Figure 7.13 Meshes

1. Secure the machine to insure that it cannot be started while maintenance is being performed.
2. Loosen the tensioners from both ends of the screen until the screen meshes are loose.



Figure 7.14 Tensioning bolts

3. Unhook the screen mesh from the tensioners.
4. Unhook the screen mesh from the center anchor beam slot. Unhook the upper shorter mesh first. Push the mesh up 50 mm.

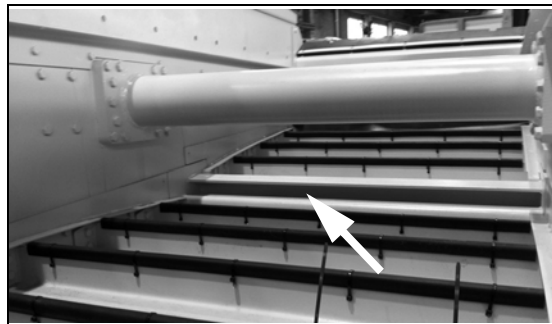


Figure 7.15 Center anchor beam

5. Unhook the discharge end mesh from the center anchor beam slot.
6. Pull the shorter mesh on top of the longer and pull both of the screens out from the discharge end on top of the oversize conveyor. Lift the meshes away from the machine.
7. Check the condition of all sealing strips and screen support rubbers, and replace or repair if necessary.

7.8.3 BOTTOM DECK MESH INSTALLATION AND TENSIONING

NOTE: Bottom deck has two meshes. The mesh on the discharge end is longer.

1. Secure the machine to insure that it cannot be started while maintenance is being performed.
2. Use proper lifting method and lift both meshes on top of the oversize conveyor. Longer mesh on the bottom.
3. Insert both meshes from the discharge end and move them until the longer mesh is on top of the center anchor beam.
4. Place the hook of the longer mesh in to the lower anchor beam slot.
5. Move the shorter mesh up and insert the discharge end hook in to the upper anchor beam slot.
6. Insert the hook of the upper screen in to the tensioner slot. Force and leverage may be necessary.
7. Tighten the tensioning bolts from the feed end lightly. Inspect that the rubber sealing strips are in place.
8. Insert the hook of the longer mesh in to the tensioner slot. Force and leverage may be necessary.
9. Tighten the tensioning bolts from the discharge end lightly. Inspect that the rubber sealing strips are in place. Tighten the tensioning bolts.
10. Tighten the feed end tensioning bolts.

NOTE: It is recommended that upon completion of the screen mesh replacement, the screen is run empty for approximately 10 minutes and the mesh is re-tensioned. This should be repeated after one hour and four hour normal operation. Make sure that the screen is tightly over the protection rubbers.

7.9 SCREEN TOP DECK MEDIA

Check the tension of the grizzly bars regularly by hitting the bars with mallet. Loose bars will sound different from the tight ones. Tighten the loose grizzly bars.

For new finger grizzly tighten the grizzly bars after 10 and 40 hours of use. After that tighten the grizzly bars after 250 hours of use.

Raise the screen up to the service position. Remove the first mesh to make more room for working.

Tighten the grizzly bar by tightening the nut (A) and hammering the grizzly bar (B) simultaneously.

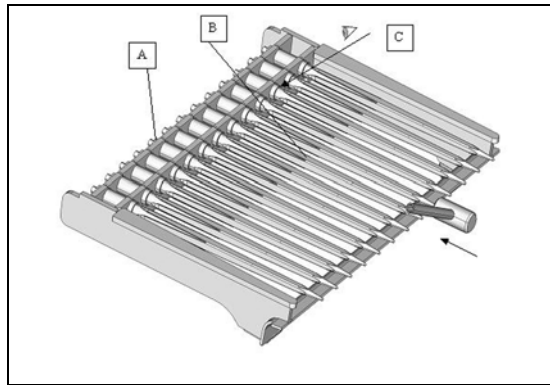


Figure 7.16

NOTE: Loose grizzly bar will cause damage to the mounting sleeve (C).

Properly maintaining the ST2.4 is your best insurance for operating at peak efficiency through long periods of use. Maintenance consists of routine servicing of the engine, conveyor bearings/seals and screens.

**WARNING!**

READ SAFETY SECTION BEFORE PROCEEDING WITH ANY SERVICE, MAINTENANCE, REPAIR, MODIFICATION, INSTALLATION, COMMISSIONING OR INSPECTION WORK ON THE ST2.4.

SAFETY FIRST!

ONLY COMPETENT AND TRAINED PERSONNEL SHOULD CARRY OUT ANY WORK ON THE ST2.4.

**CAUTION!**

When carrying out any form of maintenance or repair always ensure that the engine is stopped, the conveyor safety switch is locked and the ignition key is removed and stored in a secure place.

**WARNING!**

Before performing any maintenance operations make sure that there is no pressure in the hydraulic system!

**WARNING!**

Let the engine cool down before performing any maintenance operations.

8.1 PERIODIC MAINTENANCE

Carry out periodic maintenance according to given operating hours rather than given period. Carry out all maintenance procedures at least once per year even if the hour limit is not reached.

NOTE! Grease lubrication specification NLGI EP 2

	Daily	Weekly 50 h	250 h	1000 h	2000 h	When needed
DIESEL ENGINE						
Check engine oil level	X					
Check engine coolant level	X					
Check engine V-belts	X					
Change engine oil			X			
Change engine oil filter			X			
Drain water from primary fuel filter		X				
Change the primary fuel filter element (water separator)			X			
Change the fine fuel filter			X			
Check the air filter indicator	X					
Change the air filter cartridge if necessary (at 250 h at the latest)		X				
Change the fuel tank breather (filter)				X		
Clean the crankcase breather filter (coarse filter)						X
See the engine operating manual for other maintenance						X
SCREEN						
Check the tightening of screen meshes an finger grizzly	X					
Retighten the screen meshes		X				
Grease the bearings 40g/bearing		X				
Retighten the top deck finger grizzly			X			
For more information, see the screen manual						X
CONVEYORS						
Lubricate the bearings of head and tail pulleys. (15-20 g/bearing)		X				
Check the belt tracking and tension of the belt	X					
Check scrapers, plough and brush condition		X				
Check safety devices, instruments condition		X				
FEEDER/ HOPPER						
Lubricate the bearings of head and tail pulleys (20 g/bearing)			X			
Check the belt tracking and tension of the belt	X					
Check the condition of the scrapers and plough		X				
Check the belt feeder gear box oil level		X				
Change the belt feeder gear box oil				X		
Check the feed hopper sealing rubber condition	X					
Check the feed hopper wear liner condition		X				

	Daily	Weekly 50 h	250 h	1000 h	2000 h	When needed
HYDRAULICS						
Check all components for leaks		X				
Check rigid pipes and flexible hoses		X				
Change hydraulic oil. Check if oil can be reused. Refill with new oil if necessary					X	
Clean the hydraulic tank					X	
Check the breather of the hydraulic tank		X				
Change the hydraulic tank breather filter				X		
Replace the filter cartridges and check canister gaskets					X	
BATTERY						
Check fluid level		X				
Check the cleanliness of the battery terminals		X				
TRACKS						
Check tension of track chains		X				
Check tightness of track bolts (for tightening torque refer to the track manual)						X

8.2 MAINTENANCE DURING RUNNING-IN PERIOD

8-16 h

- Grease the screen vibrator's bearings.
- Check the stroke of the screen (in every corner and at the vibrator) (*).
- Check the tightening of the screen meshes. Retighten the bolts.
- Check the conveyor belts centering. Adjust if necessary.
- Listen for abnormal sounds. Locate the cause and repair.
- Check screen side bolts. If black circle appears around the bolt head, then tighten the bolt.
- Tighten the bolts of the screen vibrator main bearings.

40-50 h

- Check the tightening of the screen meshes.
- Grease the bearings of the drive drums and tail pulleys of the conveyors.
- Check the tightening of the reduction gear fastening bolts.

100 h

- Change the engine oil (Note the warranty policy of the CAT engine!)
- Replace the engine oil filters.
- Check the valve clearances of the diesel engine (This procedure must be done by authorized CAT service).
- Replace the filters of the hydraulic oil.
- Replace the belt feeder gear box oil.

200 h

- Change the oil of the track drive gear.
- Change the hydraulic oil filters of the unit.
- Check the track shoe fastening bolts. If necessary tighten the bolts.

(*) The stroke must not differ more than 1,5 mm between each corner.

Further instructions are included in chapter 9 *Service instructions*.

For more information, consult Metso Minerals service department.

8.3 DAILY MAINTENANCE

Keep the working site clean. Clean the spillage material from the machine and around the machine when needed or at least once per week.

8.3.1 CONVEYORS

- Check that all of the conveyor rolls are running.
- Check the conveyor belt tension (Figure 8.1) and centering. Adjust if necessary.
- Check that there is no crushed material in locations where it might prevent the conveyor from running properly.



WARNING!

Do not touch the rolls, belt or drum when the conveyor is running.

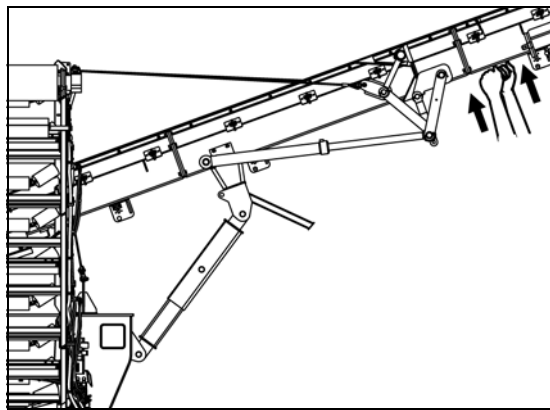


Figure 8.1 Check the conveyor belt tension

8.3.2 DIESEL ENGINE

- If the engine is used continuously, check oil and coolant levels every 8 hours.
- The clogging indicator of the air filter warns if the filter is clogged. If the clogging indicator goes off, the filter element must be replaced. The safety element of the filter must be replaced when every third replacement takes place.
- Observe the engine running temperature, oil pressure and speed. If the values differ from the recommendations, determine the cause and repair the fault.

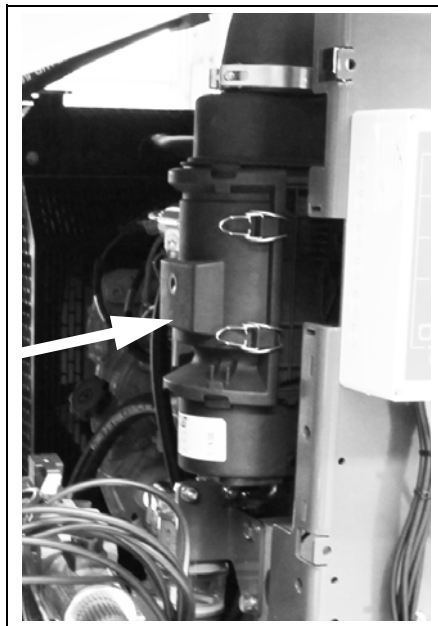


Figure 8.2 Intake air filter of the engine

8.3.3 HYDRAULICS

- Check hydraulic oil level from the sight glass. Add hydraulic oil, if necessary.
- Check the hydraulic oil temperature. If temperature is above 90°C stop the process and let the oil cool. Find out what causes the system to overheat and repair the fault.

8.3.4 CONTACTORS, SWITCHES, ETC.

- Check that the connectors are properly connected.
- Check that the control center doors are properly closed.
- Check the condition of the cables. Replace or repair worn or damaged cables.

8.3.5 FRAME

- Visually check that there are no cracks in the frame beams or in the weld joints.
- Repair any cracks immediately.

8.3.6 SCREEN

- Check that the screen meshes are undamaged and tightened right.
- Before starting, remove jammed material from the top deck if necessary.
- Run the screen empty and listen for abnormal sounds. If you hear anything abnormal, locate the fault and fix it before operating.
- Check the tightness of the finger grizzly bars. Use mallet to hit the grizzly bars. Loose grizzly bars will sound different from the tight ones. Retighten if necessary. See chapter 7.9.

8.3.7 TRACK SYSTEM

Check the track tensions. Adjust, if necessary. The correct track deflection is shown in the Figure 8.3.

Measure at the midpoint between the upper track supports.

Track tension can be increased by pumping more grease into the control cylinder with a grease gun (use the special connector). The tension is loosened by removing grease from the control cylinder and by moving the equipment, if needed.

Check that the track shoes and their tightening screws are undamaged, and that the screws remain tightened.

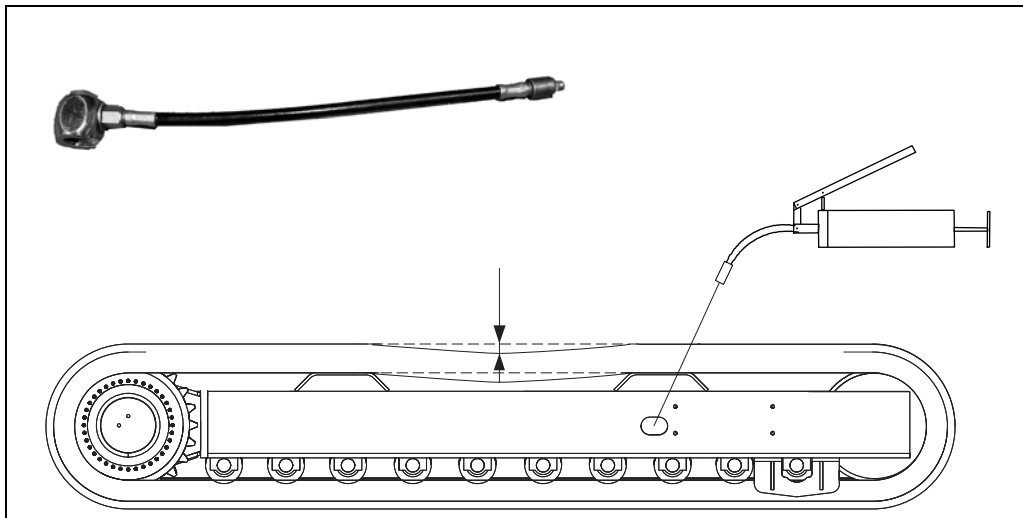


Figure 8.3 Check the track tension. The correct deflection (X) is 25 mm.

8.4 LUBRICANT RECOMMENDATIONS

8.4.1 GENERAL

This section contains information and instructions on several alternative and optional equipment. Normally the unit has only some of them. Before maintaining and servicing, find out which alternative and optional equipment your ST2.4 has.

8.4.2 SCREEN

Vibrators are lubricated with grease.

Recommended grease:

The mineral grease must have an base oil with NLGI2 grade. The base oil viscosity must be lie between 130 cst and 230 cst at 40°C.

The mineral grease must have a lithium soap. Greases based on a calcium soap must not be used for incompatibility reasons with grease based on lithium soap.

Example: MOBILUX EP2.

8.4.3 TRACK GEAR

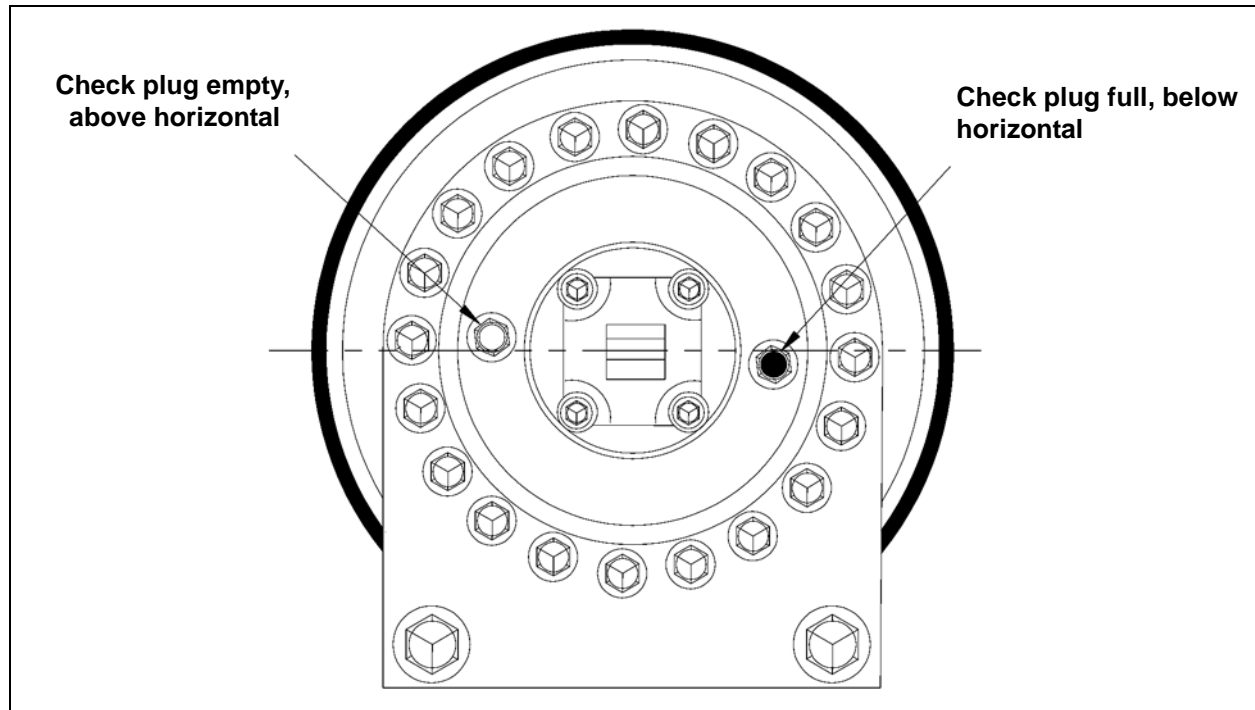
- Oil designation to DIN 51517, part 3: CLP 220.
- ISO viscosity to DIN 51519: ISO - VG 220.
- Kinematic viscosity at 40°C (104°F): Min. 198 mm²/s (cSt). Max. 242 mm²/s (cSt).
- FZG test A /8,3/90 to DIN 51354, p. 2: Min. breakdown load stage 12.

Recommended oil brands are e.g.:

- BP - Enersyn HTX 220
- Shell - Omala oil 220
- CASTROL - Alphasyn T 220, Alpha ZN 220
- MOBIL - Mobilgear 630, SHC 220
- TEXACO - Syngear 220
- TEBOIL - Tebo pressure oil 220

8.4.4 BELT FEEDER GEAR BOX

Position the feeder gear box so that the check plugs are slightly off horizontally parallel.



If the oil level is correct, as shown, no oil is required.

If oil is not showing in the lower check plug when the gear box is in the position shown, remove the upper check plug and slowly fill the gearbox with the appropriate oil until the lower check plug is full.

Do not overfill!

Oil level should never exceed check plugs when they are horizontally parallel. The correct level would be half the check plug filled when the two check plugs are horizontally parallel.

The oil to be used in the gearbox is VG150.

Capacity: 1.3 litres.

The first oil change is after 100 hours, and after every 1,000 hours to six months depending on the duty. Change the oil when warm.

8.4.5 ENGINE

Quality requirements for lubricating oil

- Caterpillar class ECF-2, General class API CH-4

Factory oil is 15W-40.

Choose the viscosity of the lubricating oil in accordance with the outside temperature.

Viscosity class	Temperature range	
SAE 0W/40	−40...+40 °C	−40...+104 F
SAE 5W/30	−30...+30 °C	−22...+86 F
SAE 5W40	−30...+40 °C	−22...+104 F
SAE 10W/30	−20...+40 °C	−4...+104 F
SAE 15W/40	−15...+50 °C	+5...+122 F

Oil and grease brands have been listed in the lubricant section of the Caterpillar manual.

Most of the traditional heavy-duty coolants and antifreeze additives utilize glycol and water in a 50%/50% ratio.

The factories use cooling water and monoethylene glycol in a 50%/50% ratio, in compliance with the standard BS 6580:1992. The temperature limit for antifreeze is −35 °C (−31 F).

NOTE! Do not use a mixture containing more than 50 % glycol, since it weakens the thermal exchange capacity of the solution.

NOTE! Wrong solution weakens the freezing point and/or thermal exchange capacity and/or corrosion protection.

NOTE! Further information is provided in the cooling system section of the Caterpillar manual.

NOTE! Check the coolant quantity from the filling quantities section.

8.4.6 HYDRAULICS

Basic requirements for the hydraulic oil quality:

- viscosity index should be min. 150
- min. viscosity 16 cSt at operating temperature
- max. viscosity 1000 cSt at starting temperature

Unless otherwise mentioned, the **factory fill oil** is a special hydraulic oil of ISO VG 46 class. The max. allowable operating temperature with this oil type is about +80°C (176°F) and min. allowable starting temperature is about -20°C(-4°F), which makes it **suitable for use all year round** in most operating conditions.

Attached some examples of oil brands meeting these requirements:

- BP Energol SHF 46
- Esso Unavis N 46
- Shell Tellus Oil T 46
- Teboil Tebo Hydraulic Oil 46
- Mobil DTE 15

If the operating temperatures are constantly close to the ISO VG 46 limit temperatures use ISO VG 36 in cold and ISO VG 68 in hot.

In winter time e.g. in cold climate conditions, when the operating temperature of the oil stays below +60°C (140°F), the use of a special hydraulic oil of ISO VG 32 class is recommended. The max. allowable operating temperature with this oil type is about +65°C (149°F) and min. allowable starting temperature is about -30°C (86°F).

Attached some examples of oil brands meeting these requirements:

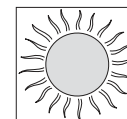
- BP Energol SHF 32
- Esso Unavis N 32
- Mobil DTE 13
- Shell Tellus Oil T 32
- Teboil Tebo Hydraulic Oil 32 S



In summer time e.g. in hot climate conditions, when the ambient temperature exceeds +35°C(95°F), the use of a special hydraulic oil of ISO VG 68 class is recommended. The max. allowable operating temperature with this oil type is about +90°C(194°F) and min. allowable starting temperature is about -10°C (14°F).

Attached some examples of oil brands meeting these requirements:

- BP Energol SHF 68
- Mobil DTE 16
- Teboil Tebo Hydraulic Oil 68



8.4.7 GREASE

The grease must be NLGI EP 2 Type. Grease containing Molybdenum additives is NOT allowed.

8.5 FILLING VOLUMES

	Lokotrack ST2.4
Hydraulics	350 l / 92.5 gal
Final drive	Refer to track manual
Fuel tank	270 l / 72 gal
Feeder belt gear box	1.3 l / 0.26 gal

	DIESEL ENGINE
	CATERPILLAR C4.4
Engine oil	9.5 l / 2.38 gal
Coolant	7 l / 1.85 gal

9.1 GENERAL

The equipment must be serviced and repaired by professional personnel that is adequately acquainted with the equipment.

The safety manual instructions, the startup and shut-down instructions in the instruction manual and all possible servicing instructions must be followed in all proceedings concerning the operations of the equipment and its safety devices, as well as inspecting, servicing and repairing the equipment.

**WARNING!**

- Always shut down the engine during servicing, unless otherwise instructed by the signs or the instruction manual.
- Reserve a large security zone around the equipment for maintenance!

When the ST2.4 has been shut down for servicing or repair, make sure that it cannot restart unintentionally. Remove the ignition key. Attach a warning sign to a visible place, and switch the safety switch of the conveyors to the “0” position

**WARNING!**

- Do not smoke or light an open fire when refueling or when the fuel system is opened.
 - Diesel fuel is a flammable liquid. It must not be used as a cleaning agent. Use approved solvents instead.
 - Check that the electric wires are free of abrasion damage, which might cause a short circuit and fire.
-

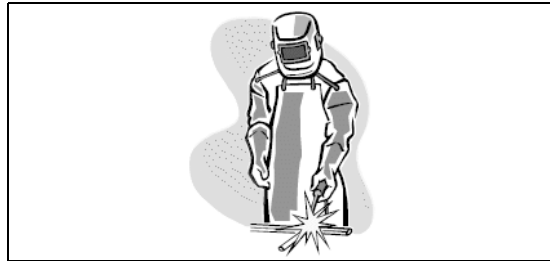
NOTE: If you detect any signs of fire, proceed as follows, if possible:

- Drive the machine away from the dangerous zone.
- Shut down the engine with the ignition switch.
- Shut down the current with the main switch.
- Start extinguishing the fire and call the fire department, if needed.

**WARNING!**

- When checking a possible leak, use paper or a suitable rigid plate. Do not use your hand.
 - If you start the engine when the ST2.4 is inside, make sure that the ventilation is adequate for removing the exhaust gas.
 - Keep in mind that some solvents may cause a rash and some are highly flammable. Avoid inhaling the solvent vapors.
 - Keep the servicing site clean. Oil and water make the floor slippery and they are a risk when servicing electrical system or using electric tools. Clothes stained by oil or grease catch fire easily.
 - Always keep the ST2.4 and its equipment free of dirt and oil. Apart from reducing the risk of fire, it facilitates the detection of damaged or loosened parts.
 - Check that the hydraulic hoses are free of abrasion damage.
-

9.1.1 WELDING

**WARNING!**

Welding and grinding must only be conducted in parts of the machine that has been cleaned for that particular purpose. Never weld or grind parts that contain flammable fluids (tanks, fluid pressure pipes or similar). Take special precautions when welding or grinding near such parts.

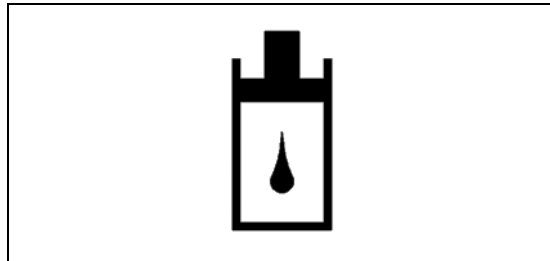
When arc welding:

- Shut down the engine.
- Turn the on-off switch to the “0” position.
- Remove the earth cable of the batteries.
- Connect the earth cable of the welding power source to the part to be welded, if possible, and make sure that the current does not flow through bearings, joints or electrical devices.

**WARNING!**

The fire extinguisher must be easily accessible at all times!

9.2 HYDRAULIC SYSTEM



General instructions on servicing hydraulic equipment:

- Observe absolute cleanliness.
- Avoid using open containers.
- Use lint-free cleaning cloths.
- Check the hydraulic oil level.
- Observe the hydraulic oil temperature.
- Observe the operating temperature and noise of the hydraulic pumps and engines. If you detect abnormalities, determine the cause.
- Observe the hydraulic components, pipes, hoses and joints. Repair potential leaks immediately.
- Keep the coolers clean.
- Check the fastening of the pumps and tighten periodically
- The hydraulic oil change interval can be extended if sufficient quality has been verified with a generally accepted inspection method. However, filters and the breather must be replaced according to the intervals given in the maintenance table.

9.2.1 CHANGING THE HYDRAULIC OIL

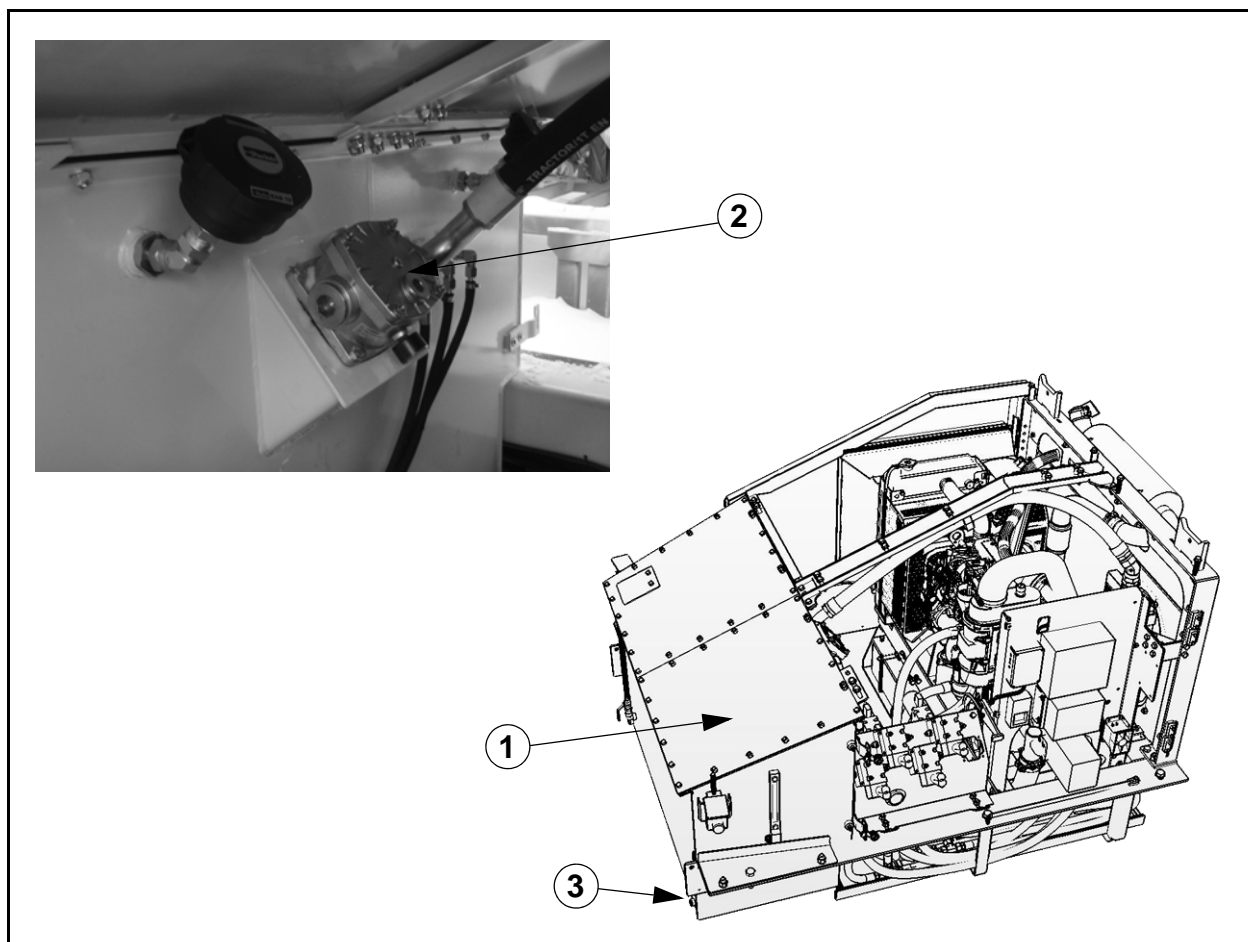
Oil quantities and qualities are provided in the section 8.

Hydraulic oil must be changed every 2,000...2,200 hours or once a year.

1. Start the engine and drive all the hydraulic cylinders to the closed position (pistons retracted).
2. Shut down the engine and make sure that the hydraulic system is pressure-free.
3. Collect the used oil in a suitable receiver. Pump the oil from the tank through the filler opening or empty it by opening the drain valve/plug (Figure 9.1). Dispose of the used oil following the local instructions, laws and regulations, and pay attention to environmental protection.
4. Replace the filters, see paragraph 9.1.
5. Refill the tank with new oil through the filler opening until the oil level reaches the midpoint of the sight glass (with the cylinder pistons retracted).
6. Run the machine for a while and check the hydraulic oil level again.

If the operating conditions are favorable, oil can be used for longer than 2,000 hours. In that case, the appropriate oil quality must be verified using a generally accepted method of analysis.

NOTE: It is advisable to fill the hydraulic oil tank through the return filter



Reference	Description
1	Hydraulic oil tank
2	Return filters
3	Drain valve

Figure 9.1 Hydraulic oil tank

9.2.2 RETURN FILTER CHANGE

The filter is mounted into the hydraulic tank. The filter is a replaceable element, under a cover.



Figure 9.2 Return filter

Proceed as follows:

1. Stop the engine and let the machine cool down. Make sure that the hydraulic system is pressure-free.
2. Drain the hydraulic oil tank (or, if you don't change the hydraulic oil at the same time, close the hydraulic shut-off valves).
3. Undo the cover of the return filter. Open the four nuts (13 mm wrench) and remove the cover (Figure 9.3).

NOTE: Be careful when removing the cover, as there is a spring under the cover.

NOTE: The following figures are for reference only, and not necessary from your machine.



Figure 9.3 Undo the cover.

4. Pull the filter assembly out from the filter housing (Figure 9.4).



Figure 9.4 Remove the filter

5. Open the filter assembly by opening the 36 mm lock nut. Remove the filter element (Figure 9.5).



Figure 9.5 Open the filter assembly

6. Clean the magnets before installing a new filter element (Figure 9.6). Use 20 - 25 Nm torque when securing the filter element. Insert the filter assembly on its place and close the cover.



Figure 9.6 Clean the magnets

- Observe the O-ring condition and lubricate it before installation. Use 15 Nm torque for the cover mounting nuts (Figure 9.7).

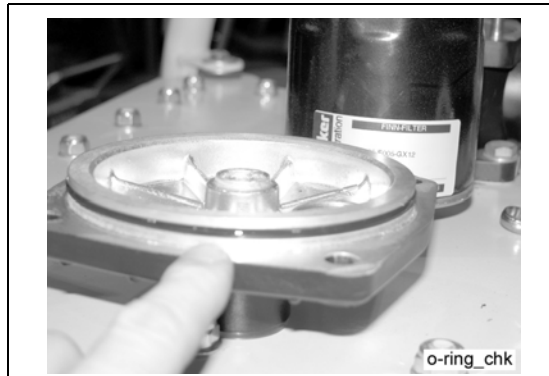


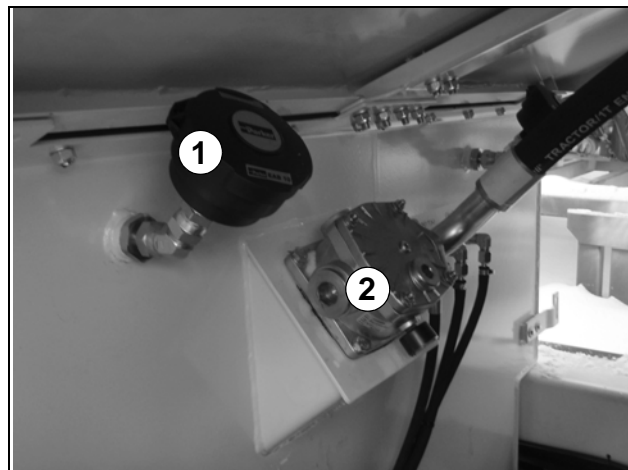
Figure 9.7 Observe the O-ring condition

NOTE: Hydraulic oil filters must be replaced in conjunction with the hydraulic oil change every 2,000...2,200 hours, once a year or when the filter clogging indicator gives an alarm.

If the pressure filter must be replaced due to alarm, the return filter must be replaced at the same time.

9.2.3 BREATHER

Change the breathers every 500 hours. See Figure 9.8.



Reference	Description
1	Hydraulic oil tank breather
2	Return filter

Figure 9.8 Hydraulic oil tank/fuel tank

9.3 DIESEL ENGINE

See the appended instruction manual of the Caterpillar engine for further engine maintenance instructions.

9.3.1 ENGINE OIL

Oil quantities and qualities are provided in the section 8.

9.3.1.1 Checking the oil level

The oil level is checked from the dipstick (1) on the side of the engine. The level must be checked daily. The oil level must be between the marks ADD and FULL

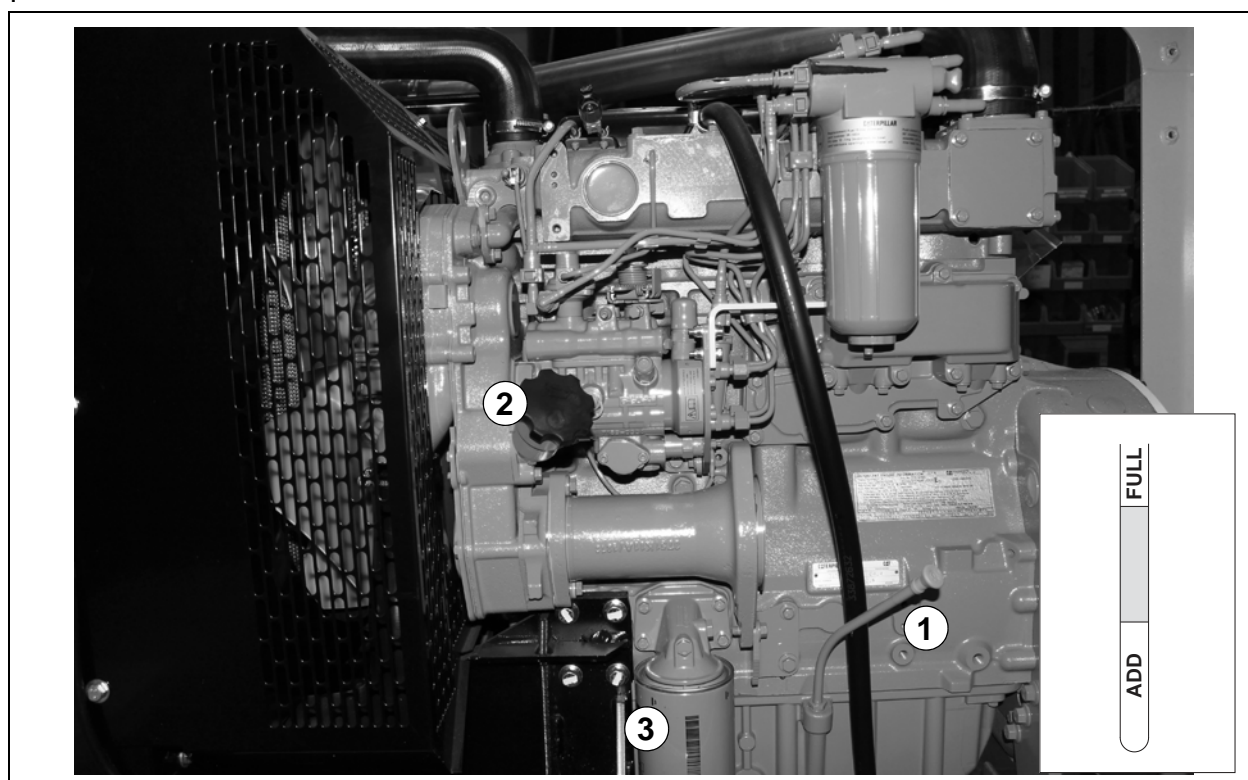


Figure 9.9 Checking the oil level

9.3.1.2 Changing the oil

Change the engine oil every 200-250 operating hours. Oil must be drained immediately after driving, when the engine is hot. Add new oil from the filler opening (2).

9.3.1.3 Replacing the engine oil filter

The filter must be replaced in conjunction with every oil change:

1. Before removing the filter (3), clean it carefully from the outside (Figure 9.9).
2. Remove the filter.
3. Use oil to lubricate the rubber seal of the new filter. Screw the filter element in place by hand until the seal touches the sealing face. Then tighten the filter again 1/2 - 3/4 turns. Be careful not to overtighten the filter.
4. Add new oil to the engine. Start the engine and check that there are no oil leaks.

9.3.2 ENGINE COOLANT

Change the engine coolant when needed.

9.3.3 AIR FILTER

NOTE: A clogged air filter reduces the engine capacity, increases fuel consumption and harmful exhaust gases.

NOTE: In very dusty conditions, observe the condition of the filter more often than usual.

The operating life of the engine air filter depends significantly on the operating conditions. In extremely dusty conditions, you may need to replace the filter element as often as several times a week. If the conditions are less dusty, the filter element may remain operational for a significantly longer period.

If the engine air filter is clogged, the filter element (1) must be replaced. The safety element of the filter (2) must be replaced when every third replacement takes place. When opening the filter, check the cleanliness of the seals and their mating surfaces.

The pre-cleaning system at the end of the cleaner case must be inspected regularly. Visually check that the vanes in the tubes and the protective screen on hood assembly are free of dust. Use the compressed air to remove the dust. Do not aim the airstream directly into tubes. Check the condition of the exhaust ejector scavenge hose. Replace if necessary.

NOTE: When checking and replacing the elements, take extra precautions not to let any dust enter the intake channel.

The clogging indicator is located in the filter housing.

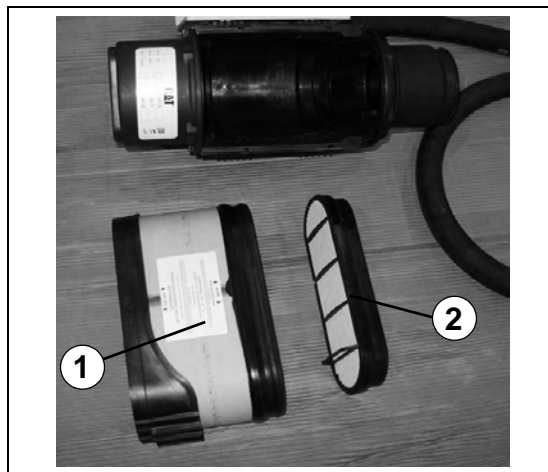


Figure 9.10 Engine intake air filter

The condition of the air filter must be observed every 8h of operation.

NOTE: The following figures are for reference only, and not necessary from your machine.



Figure 9.11 Remove the cover

When replacing the air filter, proceed as follows

1. Undo the filter housing latches to remove the cover.
2. Draw the primary cartridge out from its place. If needed draw the safety cartridge out from its place.
3. Install the new cartridges on their place.

NOTE: Always check that the replacement filter size is correct. If the replacement filter is shorter than the original one, it might cause a serious engine damage

4. Close the air filter housing cover correctly on its place and make sure that all latches are properly closed.

9.3.4 FUEL SYSTEM

9.3.4.1 Draining the fuel water separator

1. Open the drain valve (1). The drain valve is a self-bleeding valve. Collect the draining water in a suitable container. Dispose of the drained water in accordance with the local laws and regulations.
2. Close the drain valve.

9.3.4.2 Replacing the pre-fuel filter

The primary fuel filter must be replaced every 200-250 operating hours, or monthly.

1. Shut down the engine.
2. Close the feed valve of the fuel tank.
3. Clean the pre-filter unit (2) from the outside.
4. Open the drain valve (1) of the pre-filter and drain the fuel from the filter cover into a suitable container. Close the drain valve.
5. Remove the water separator bowl (3) of the filter, and wash it with a suitable solvent detergent.

6. Remove the pre- filter element.
7. Clean the sealing face of the filter base. Make sure that the base is clear of old seal residues.
8. Install the new filter element by twisting it until the sealing touches the base. Then tighten the filter again by 3/4 of a turn. Be careful not to overtighten the filter.
9. Install a clean water separator bowl to the new fuel filter.
10. Open the fuel valve.
11. Start the engine and check that there are no leaks.

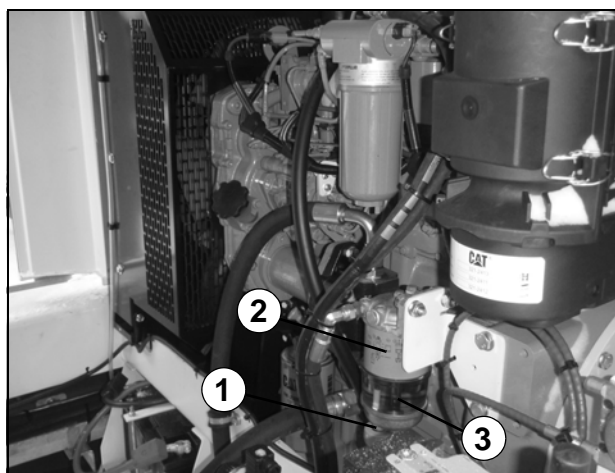


Figure 9.12 Replacing the pre-fuel filter

9.3.4.3 Replacing the fine fuel filter

The fine filter must be replaced every 1000-1200 operating hours or every 6 months.

1. Close the feed valve of the fuel tank.
2. Clean the filter unit (1) from the outside.
3. Open the bleed plug (2) slightly in order to bleed the residual pressure from the system.
4. Remove the used fine filter element.
5. Clean the sealing face of the filter base. Make sure that the base is clear of old seal residues.
6. Apply clean fuel to the seal of the new filter.
7. Install the new filter element by twisting it until the seal touches the base. Then tighten the filter again by 3/4 of a turn. Be careful not to overtighten the filter.
8. Open the feed valve of the fuel tank and pre-fill the fuel system.

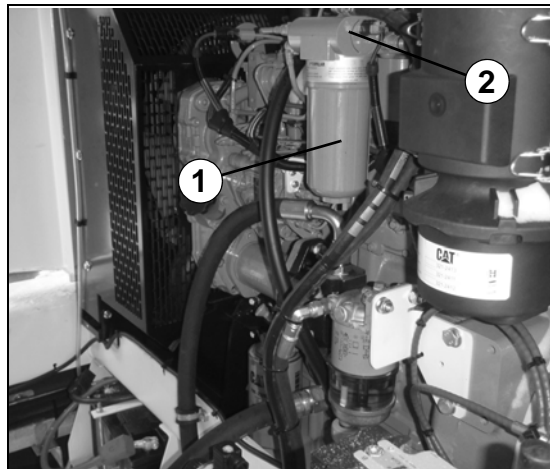


Figure 9.13 Replacing the fine fuel filter

NOTE: Removing air by using the fittings of the fuel pipes or any other parts of the rail system is strictly prohibited! Refer to the instruction manual of the engine.

9.4 BATTERIES



WARNING!

You must not use open fire when checking the electrolyte level, for the gas that is generated during charging is highly flammable.

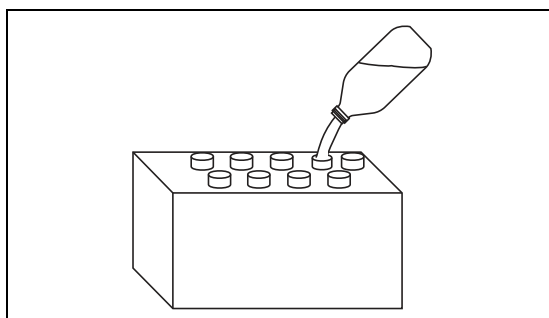
Electrolyte consists of diluted sulfuric acid, which is extremely corrosive. Therefore you must handle the batteries with care in order to avoid spilling the electrolyte on your skin or clothes.

Batteries that function properly are a prerequisite for the operation of electrical devices. That is why they must be kept fully charged. The battery terminals must be cleaned frequently enough and lubricated with a suitable protective agent. The cable shoes must be kept well tightened and the liquid level must be monitored. Add distilled water, if necessary.

9.4.1 CHECKING THE ELECTROLYTE LEVEL

The electrolyte levels of the batteries must be checked every 100 operating hours (Figure 10.3). The electrolyte surface must be approximately 10 mm above the plates. Add clean distilled water if necessary. By observing the water consumption you can determine whether the battery charging voltage is within the right limits. If no water is consumed, it implies that the charging limit is too low and that there is continuous undercharge of the batteries. If water is consumed excessively, the alternator is charging with overvoltage, which decreases the operating life of the batteries and lamps.

Figure 9.14 The fluid levels of the batteries must be checked every 100 operating hours.



9.4.2 CHECKING THE CHARGE LEVEL

The charge level must be checked periodically with a hydrometer. Measuring must not take place immediately after water has been added, because water does not mix with the electrolyte until the batteries have been slightly charged. The specific weight of the electrolyte in a fully charged battery is approximately 1.28, and 1.20 if the state of charge is 50 %. These values apply only at the temperature of +20 °C.

The batteries must always be kept fully charged. A continuous undercharge condition causes the plates to sulphate, which decreases the charging capacity and power of the battery.

In addition, note that a battery freezes at the temperature of -25 °C if the state of charge is 50 %, and a depleted battery freezes at the temperature of -10 °C.

9.4.3 CLEANING THE BATTERIES, TERMINALS AND CABLE SHOES

You must clean these parts at least once a year. Battery terminals and cable shoes should be cleaned with special tools suitable for the job, which helps to keep their shape and contact area sufficiently wide. After the cleaning, battery terminals and cable clips must be protected from oxidation with a thin layer of Vaseline. Also check the fastening of the grounding wire to the frame, the fastening of the starting motor cables and the fastening of the generator and the voltage regulator wires. Clean and tighten any loosened connectors. Keep the outer surface of the batteries clean and dry.

NOTE: Danger of explosion. Never connect the battery terminals together.

9.5 OTHER ELECTRICAL DEVICES

9.5.1 CHARGING CIRCUIT

The wire connections must be checked and tightened at regular intervals.

The generator and regulator only need periodical checking.

In terms of an alternator, you must follow these instructions carefully:

- The battery cables or any other charging circuit connections must not be removed when the engine is running.
- The engine must not be used when the charging circuit wires are disconnected.
- When charging the batteries externally, disconnect the ground cable; verify the correct polarity before connecting the batteries, additional batteries and the charger.
- When repairing electrical devices, disconnect the coupling cables of the batteries.
- You must not use the charging system with batteries disconnected from the circuit or with loose generator or battery connections.
- It is absolutely forbidden to polarize the alternator.
- Do not short any part of the circuit or do any measuring with equipment of small inner resistance.

When starting with the help of additional batteries, ensure that

- The battery voltages are similar.
- The terminals with the same name are connected to one another.

9.5.2 STARTING CIRCUIT

Normally the starting circuit does not require much servicing. The engine must be kept clean and the wire connections tightened. The most important factors for the operation of the starting circuit are the condition and the charge level of the batteries.

9.6 CONVEYORS

Lubricate the bearings of the drive drums and tail pulleys every 40-50 hours or weekly.

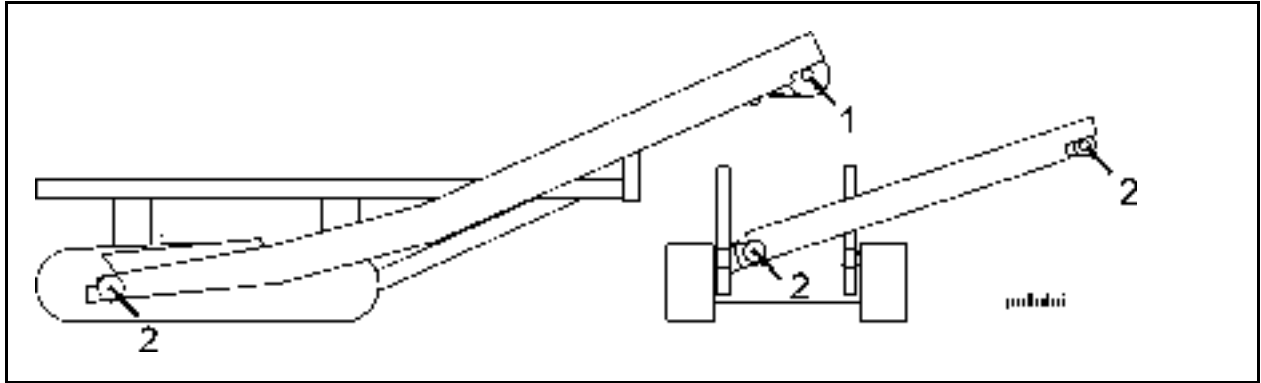


Figure 9.15 Lubricate the drive drum and tail pulley bearings

9.7 TRACKS

9.7.1 TRACK GEARS OF THE TRACKS

Check the track gear oil level every 1,000 hours or a minimum of twice a year. When the drain plug (1) is in the down position 'at 6 o'clock', the oil level must be on the level of the check plug (2).

Change the track gear oil every 2,000 hours or a minimum of once a year. The drain plug (1) must be in the down position. Open the drain plug and let the oil flow into the receiver. Clean and close the drain plug. Add new oil through the check plug (2), until the oil level reaches the level of the plug. Close the check plug. Check that there is no oil leaking from the plugs or the rotary oil seal.

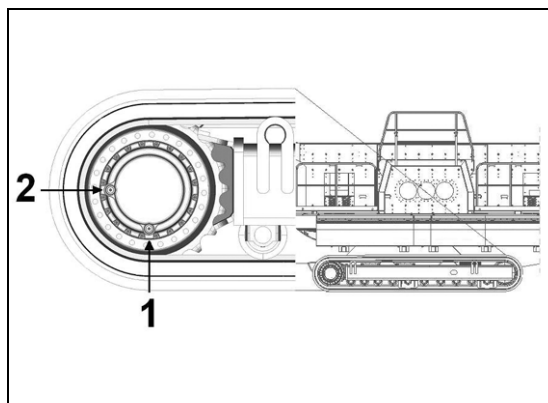


Figure 9.16 Check the oils in the track gears of the tracks.

9.7.2 TRACK SHOE TIGHTENING SCREWS

The tension of the track shoe tightening screws must be checked carefully using a torque wrench right at the beginning of operation (the torques are displayed in table 9.1).

Check the tension of the fastening screws for the first time after 8-16 operating hours, and the second time after 200 operating hours.

After that, check the tension every 200 operating hours.

If the track shoes are bent or appear to be almost broken, they may be too wide for the ground in question.

If the track shoes are bent or broken, the track system may get overloaded. This can damage the track shoes beyond repair.

The track shoes do not require any other service.

Table 9-1 Tightening torques of the track shoes

LT	Tightening torque Dry (Nm)	Tightening torque Lubricated (Nm)
ST2.4	747-877	622-731

9.8 SCREEN

The screen has two main bearings. Each bearings has 5+5 bolts. Retighten the bolts (A) after the first 16 hours of operation.

If you have to replace the vibrator drive belt check the spare part manual for proper replacement part. When replacing the belt, first mark the old tension before loosening the belt. Retension the new belt to match the old marks with the adjustment bolts (B).

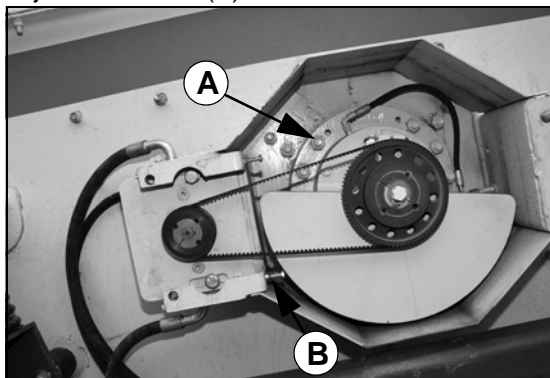


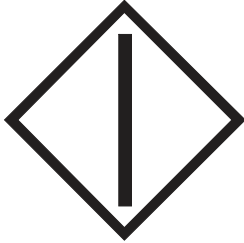
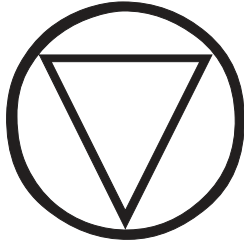
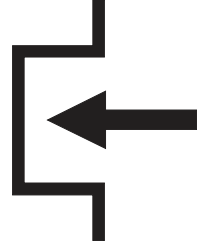
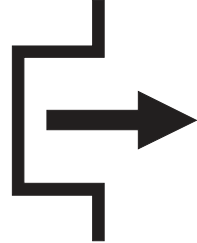
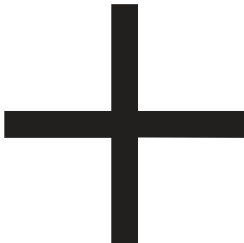



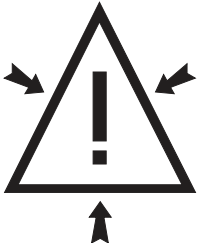
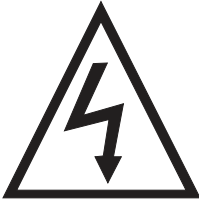

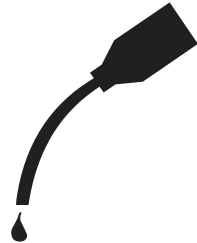



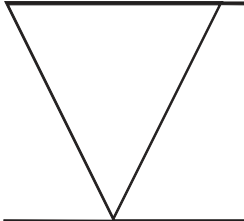
Figure 9.17

Maintenance procedures:


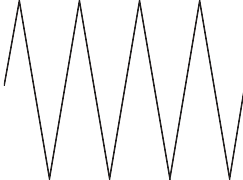
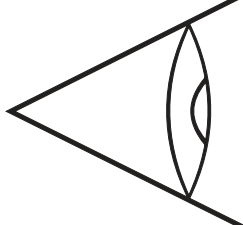

- Grease the vibrator bearings weekly
- Check the tightness of screen meshes daily
- Before starting the operation, remove jammed material from the top deck if necessary.
- Run the screen empty and listen for abnormal sounds. If you hear anything abnormal, locate the fault and fix it before operating.
- Check screen side bolts. If black circle appears around the bolt head, then tighten the bolt.
- Check the tightness of the finger grizzly bars. Use mallet to hit the grizzly bars. Loose grizzly bars will sound different from the tight ones. Retighten if necessary. See chapter 7.9.

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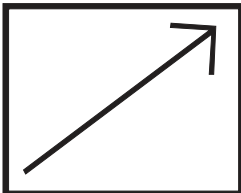
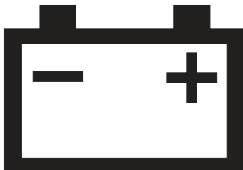
SYMBOL IDENTIFICATION

1.General symbols			
			
1. On/Start	2. Off/Stop	3. Connecting	4. Disconnecting
			
5. Increase	6. Decrease	7. Stepless adjustable movement	8. Warning
			
9. Warning: pressurized	10. Warning: electric danger	11. Grease lubrication point	12. Oil lubrication point
			
13. Running hours	14. Lifting point	15. Horn	16. Level

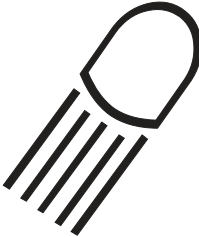

1. General symbols

			
17. Belt conveyor	18. Feeding	20. Check	21. Max. temperature

2. Electric symbols

	
1. Remote control	2. Battery charging indicator

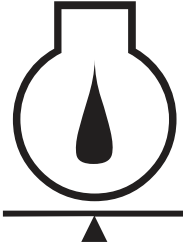



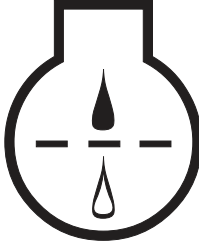
3. Lights

	
1. Work light	2. Driving lights

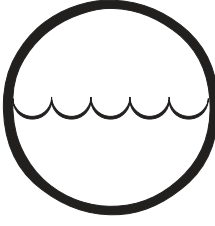
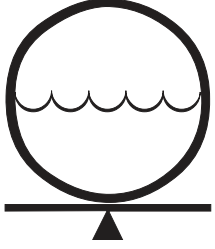
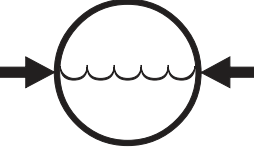
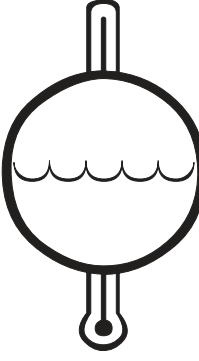
4. Engine			
1. Engine emergency stop	2. Stopping of engine	3. Engine running speed	4. Combustion engine
5. Starting of engine			

5. Fuel			
1. Fuel volume	2. Fuel pressure	3. Fuel filter	4. Fuel shut-off
5. Fuel refill			

6. Engine oil

			
1. Oil level	2. Oil refill	3. Oil pressure	4. Oil temperature
			
5. Oil filter			

7. Cooler system

			
1. Coolant refill	2. Coolant level indicator	3. Coolant pressure	4. Coolant temperature

8. Transmission oil

1. Oil refill	2. Oil level indicator	3. Oil pressure	4. Oil temperature
5. Oil filter	6. Testing point: oil pressure		

9. Hydraulic oil

1. Hydraulic oil refill	2. Hydraulic oil level	3. Hydraulic oil pressure	4. Hydraulic oil temperature

9. Hydraulic oil

<p>5. Hydraulic oil filter</p>	<p>6. Pressure testing</p>	<p>7. Shut-off valve</p>	

10. Air

<p>1. Air intake</p>	<p>2. Air pressure</p>	<p>3. Air filter</p>	

11. Symbols not included in the ISO standard

<p>1. Tensioning of power transmission belt</p>	<p>2. Tightening of nuts and bolts</p>	<p>3. Remove / install transport locking</p>	

ADDITIONAL INFORMATION

GUARDS AND PROTECTION DEVICES

- Belt drives are guarded.
- Conveyor head and tail drum nip points are guarded.
- Conveyors are equipped with emergency stop cables and safety switches or valves.
- Emergency stop buttons are provided on the remote control box and service platform and in the electrical centre and cabin.

EMERGENCY STOP

If a dangerous situation occurs, pull the nearest emergency stop cable or push an emergency stop button. After pulling an emergency stop cable, the trip switch will remain engaged and a signal light will show. To reset, push the button in the switch. To reset an emergency stop button, pull the red button to its outer position. Before restarting the machine ensure the area is clear around the unit and that no one will be endangered by your action. Start the machine according to the instruction manual.

DISPOSAL OF WASTE

Waste materials, such as oil, battery acids and cleaning fluids etc. must be removed carefully using suitable containers to prevent any hazard to people, animals or environment. The hazardous material must be removed to a suitable waste collection plant for disposal or recycling.

FIRE

The Manufacturer has not provided this machine with a fire extinguisher, and recommends that the user equips the machine with an extinguisher of a type approved by his local authorities. Inflammable materials used in the construction and use of this machine include: diesel and lubricating oils, conveyor belting and skirts, electrical cables and fittings, etc.

STORAGE OF THE MACHINES

The machine must be stored in a dry and covered area.

DISPOSAL OF THE MACHINE

Whenever a machine is taken out of use, being dismantled or disposed of, all hazardous materials, such as oils, battery acids, fuels etc. must be carefully removed first to eliminate any danger to life and the environment. The hazardous materials must be removed to a suitable waste collection plant for disposal or recycling. Dispose of the machine so that there is no danger to life or the environment.

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RECYCLING

If the machine is used for recycling, pay attention to the following:

1. Preprocessing of the feed material

Break the feed material small enough and cut the feed material with reinforcement bars to the max length of 1 m (3 ft). Too long bars may damage the conveyor belt.

2. Feeding the material

Remove the metal objects from the feed, before loading material to the feeder, if possible. At least remove the loose metal. The metal objects larger than the crusher setting must not enter the crusher. Observe the feed material.



CAUTION!

Never go to the vicinity of the feeder or crusher when the machine is running.

3. Block removal

Be very careful when clearing the blocking. Stop the machine and use safe working methods to remove blockage.

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Factory test run in Metso Minerals (Tampere) Oy

**This document is only valid for products manufactured in Tampere, Finland.
The machine has been test-run – i.e., its operation has been checked and adjusted to meet the requirements of the product specifications.**

During the test run, diesel fuel was used. This fuel may have in many countries a low-duty/tax or even duty/tax-free status and which may be categorised as red fuel in your country. There is this fuel left in the fuel tank and it may be subject to restrictions for use in certain countries.



JMG
SYSTEMS LTD.

***CONTROL PANEL
OPERATION***



***For Metso ST3.5, ST2.4, ST2.8 & ST272 Fitted With
CAT 4.4 76KW Engine***

JMG SYSTEMS Ltd.
68A Derry Road, Omagh, Co. Tyrone, N.Ireland

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In the interest of continuous plant reliability, it is essential that the equipment is maintained with meticulous care and attention. This operation and parts manual has been produced to assist the user to obtain maximum effectiveness from the equipment and to trace and remedy faults, should they arise.

Consider this manual a permanent part of your machine. Keep a copy of this manual at the operational site.

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Issue No. 6

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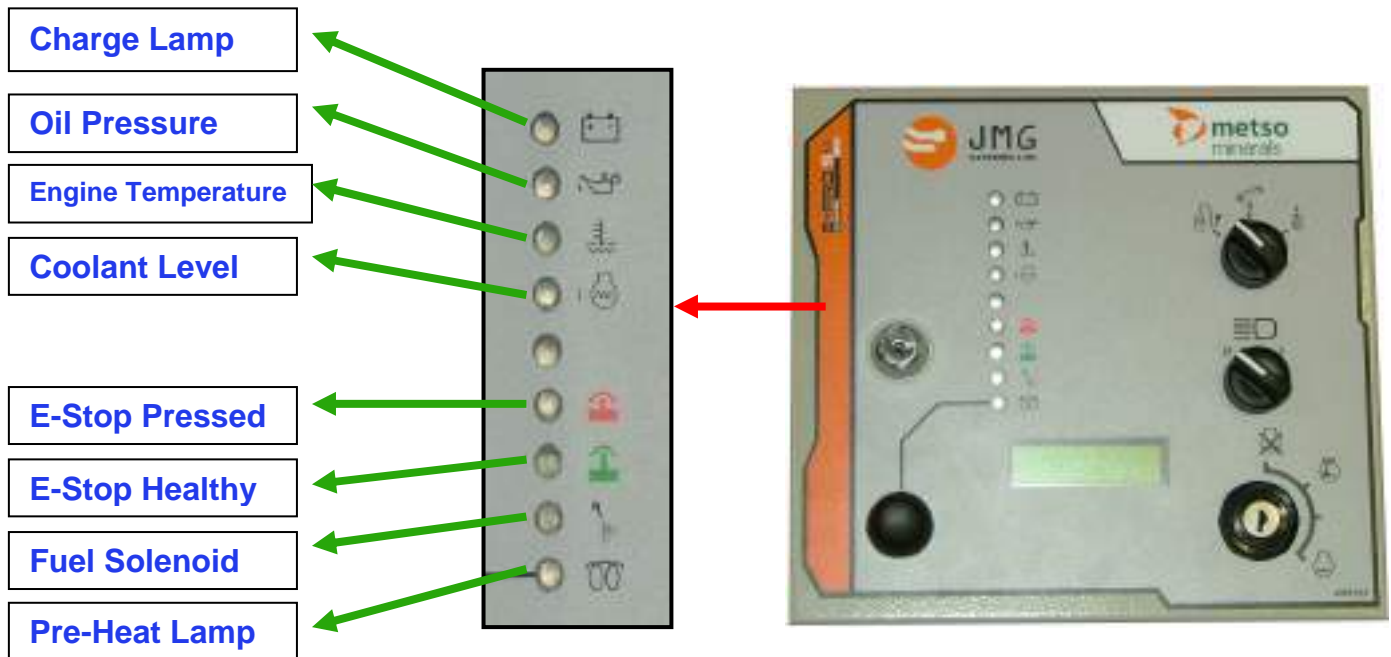
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OPERATION

1.1 Main Control Panel LEDs

LED Functions



Battery Charging Warning Light.

This light should illuminate when the key switch is turned to the "on" position (B). As soon as the Engine starts charging, it should go out. If it fails to illuminate when the key is turned on or if it illuminates when the engine is running, it indicates that there is a fault in the charging circuit. Stop the engine and have the circuit checked



Oil Pressure Warning Light.

This light should illuminate when the key switch is turned to the "on" position (B). As soon as the Engine starts it should go out. If a fault occurs in the oil pressure system the light will illuminate and the Engine will shut down after 2 seconds.



Temperature Warning Lamp

Lights if overheating is detected in the coolant system. Engine shuts down 2 seconds after the fault has been detected.



Coolant Level Warning Lamp

This will light if the Coolant Level becomes too low. Warning light will illuminate for 5 seconds and engine will shut down.

FOR ENGINE START UP PROCEDURE REFER TO FIGURE.1 ON PAGE 7.



Machine Stop Activated

This light will flash when a Machine Stop has been pressed. This will immediately shut down the Engine. If the light is flashing after shut down this indicates that one or more of the Machine Stops has been pressed.



E-Stop Healthy

This light should illuminate when the key is turned to the on position (B) and will remain on at all times. If it goes out then a Machine Stop has been pressed and the Engine will shut down immediately. The Engine will not start if this light is not illuminated.



Fuel On Light

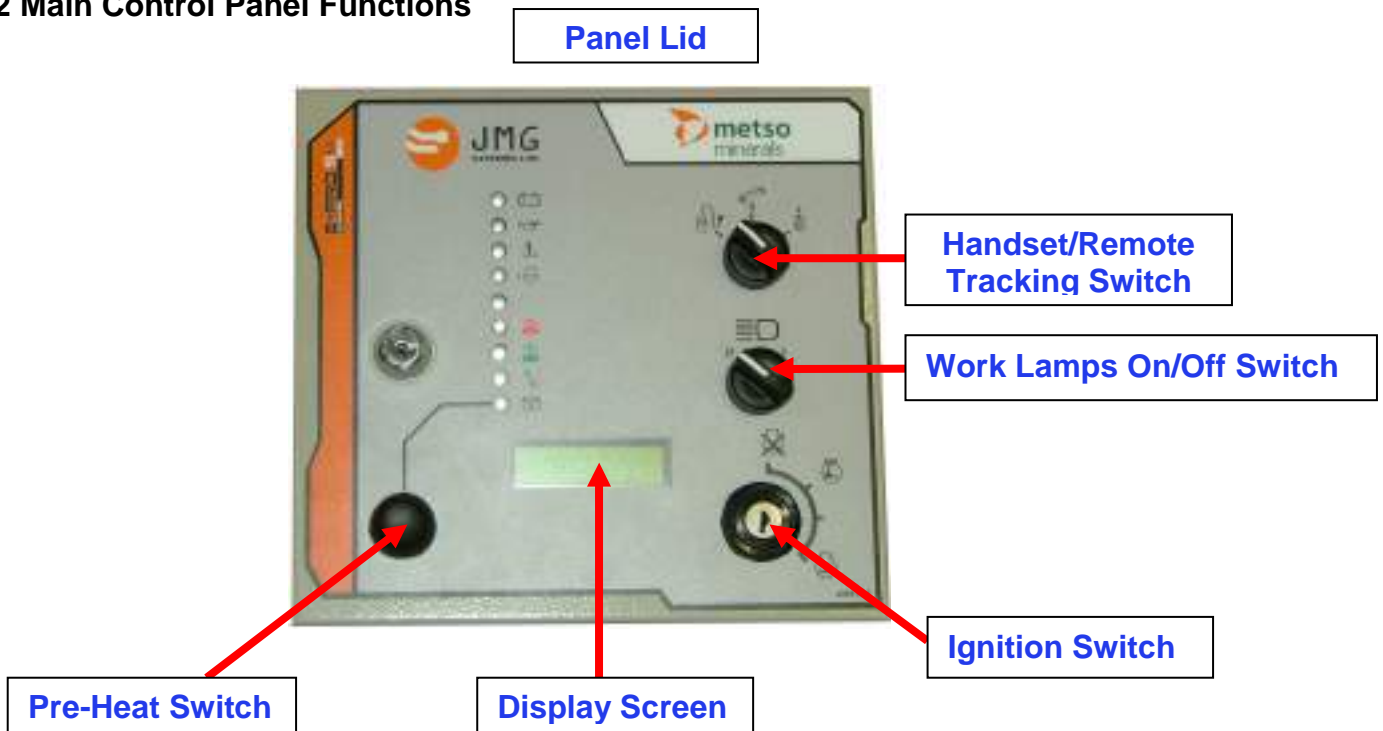
This light will illuminate when the ignition key is turned to position (C) to indicate that the fuel solenoid circuit has been energized. The Engine will not start if this light is not on. While the engine is running this light will remain on.



Pre-Heat Light

This light illuminates when the Pre-Heat switch is pressed on the panel lid.

1.2 Main Control Panel Functions



FOR ENGINE START UP PROCEDURE REFER TO FIGURE.1 ON PAGE 7.

Pre-Heat Switch : To enable the Pre-Heat function push the switch and hold. This will illuminate the pre-heat lamp. Refer to manufactures manual on how long this function should be held.

Display Screen : This display allows you to read the current RPM of the machine. It also displays the amount of operation hours on the machine.

Ignition Switch : Ignition switch has 4 positions. The first position is off (A). Second position is ignition on (B). The third position is engine crank (C). This allows you to start engine. Once engine starts release key immediately to the second position.

Handset/Remote Tracking Switch : Switch used to select manual or remote tracking.

Work Lamps On/Off Switch : Turn the switch to the on position so that the work lamps can be enabled.

1.3 Engine Start up Procedure

Before operating this Machine you must read the Safety instructions in the machine Operations Manual.

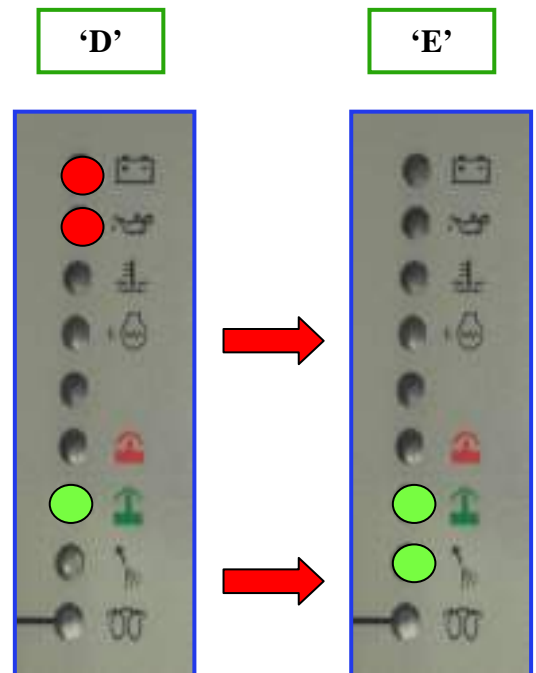
ENGINE START UP PROCEDURE.

i) To start the engine first turn the ignition key to Position 'B'. When in this position note that the charge, oil pressure and E-stop healthy LEDs will all appear (shown at D). If any of these lamps don't appear this indicates a problem. Don't attempt to start machine unless these LEDs appear. If these appear this means that you can continue with the start-up process.

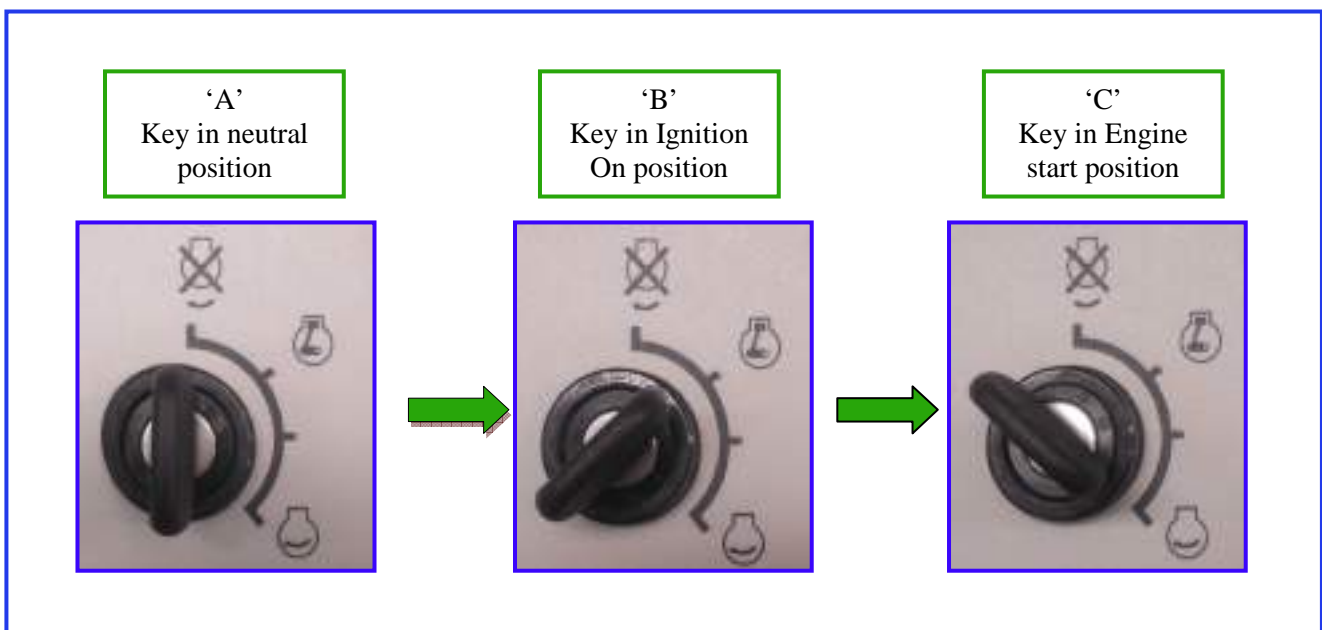
ii) Turn the ignition key to the start-up position (C). The fuel solenoid indicator will appear. Once turned to this position there is a 7 second delay until the starter engages. During this delay a siren will sound to indicate that the Machine is about to start. Once machine is started the Engine run and fuel solenoid indicators will be on (E).

iii) Once engine has started release ignition key back to Position B. At this stage the charge and oil pressure LEDs should no longer appear. If any fault indicator appears while machine is running this will turn off the fuel solenoid which in turns shuts down the engine. Fault should be rectified before machine is re-started.

iv) To switch off the Engine turn the key to position (A).



(Figure.1)



1.4 Tracking Procedure Manual Handset



A	Left Hand Track Forward/Reverse Control
B	Right Hand Track Forward/Reverse Control
C	Left Hand & Right Hand Track Forward/Reverse Control
D	Machine Stop

Tracking

- (i) Ensure that the Manual Handset is connected to the Machine, and that the Machine Stop (**D**) is not pressed.
- (ii) Start the Engine as per the Engine start up procedure in section 1.3.
- (iii) Switch the Handset/Remote Selector Switch, located on the Main Panel, to the "Handset" position. To allow tracking functions.

Note: At this point the Tracking Safety Siren should sound. There is a ten second delay on the handset before the Tracks will operate. Ensure that the Machine is clear of any obstacles before operating the Tracks.

- (iv) The Machine can now be tracked using the controls (**A**), (**B**) and (**C**) on the Dog-lead Handset, as shown above.

1.5 Tracking Procedure Radio Remote



1	Transmitter Off Button
2	Tracking Enabled On/Off
3	Left Hand Track Forward
4	Right Hand Track Forward
5	Left Hand Track Reverse
6	Right Hand Track Reverse
7	Machine Stop
8	Spare Function

Remote Tracking

(i) Ensure that the Radio Remote Receiver Unit is connected directly to the main control panel.

(ii) Start the Engine as per the Engine start up procedure in section 1.3.

(iii) Switch the Handset/Remote Selector Switch, located on the Main Panel, to the "Remote" position. To allow remote to be operated

(iv) Press the tracking enabled function (Button 2) and there will be a ten second delay before the tracks can be operated

Note: At this point the Tracking Safety Siren should sound. After ten seconds the tracks can be operated. Ensure that the Machine is clear of any obstacles before operating the Tracks.

(v) The Machine can now be tracked using the controls (3), (4), (5) and (6) on the Radio Remote, as shown above.

(vi) By pressing button 7 (machine stop) this will immediately shut down the machine.

1.6 Tipping Grid Operation



SAFETY

2.1 Safety Introduction

**BEFORE OPERATING THIS
MACHINE YOU MUST READ ALL
SAFETY INSTRUCTIONS PROVIDED**

All personnel who operate this machine must be fully trained to correctly and safely operate this machine.

Before operating this machine the operator must:

- i) Have received specific and adequate training in the task to be carried out.
- ii) Have read and understood the Operation Manual and the Safety signs on the machine.
- iii) Know the location and function of controls and safety features such as Remote Machine Stop buttons and isolator switches.
- iv) Be aware of all moving parts on the Machine.

Electrical Safety

While this equipment is rated at only 12 volts safety should not be taken lightly. This equipment can cause serious burns and injuries if connected wrongly or if tampered with. Remember batteries can explode.

- (i). Never work on the electrical system of any equipment unless you are thoroughly familiar with the systems details.
- (ii). Work on the electrical system must only be carried out by a qualified electrician.
- (iii). Special care should be taken when disconnecting, replacing and/or charging the batteries. Ensure that the batteries are re-connected correctly. Contact across the terminals can cause sparks or explosions.
- (iv). The electrical equipment of the Machine should be inspected at regular intervals. Damaged cables or loose connections must be repaired immediately. Use only the manufacturer's replacement parts with the specified current rating, especially fuses. Isolate the batteries when welding on the Machine.

Safety before and during operation

- i) Read and understand your Operation Manual before you start the Machine. Study the DANGER, WARNING, CAUTION and IMPORTANT safety signs on your Machine.
- ii) Before starting walk completely around the Machine. Make sure no one is under it, on it or close to it. Let all other operators and bystanders know you are starting up and do not start until everyone is clear of the Machine.
- iii) Ensure that all control levers are in the neutral position

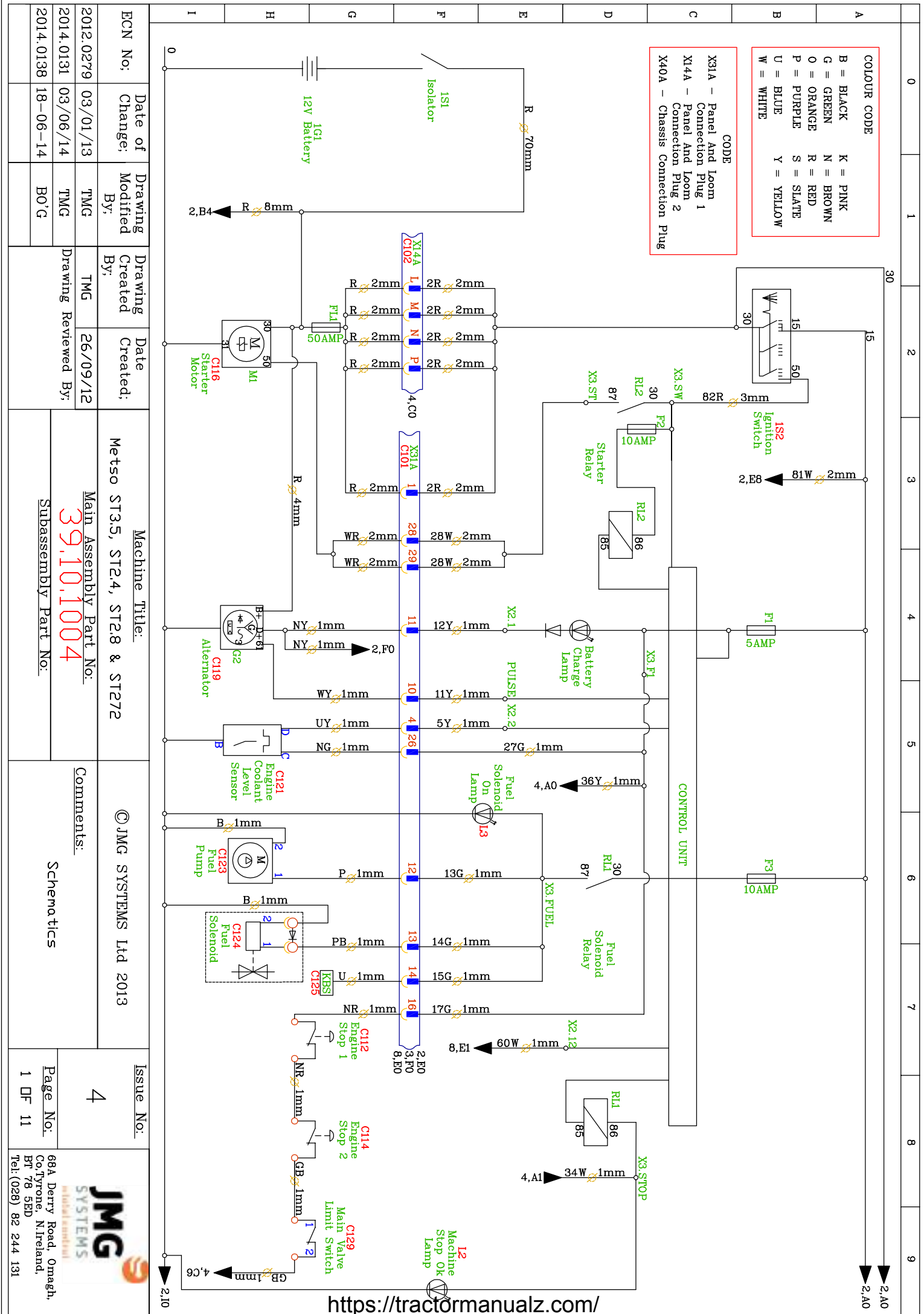
2.2 Safety Considerations

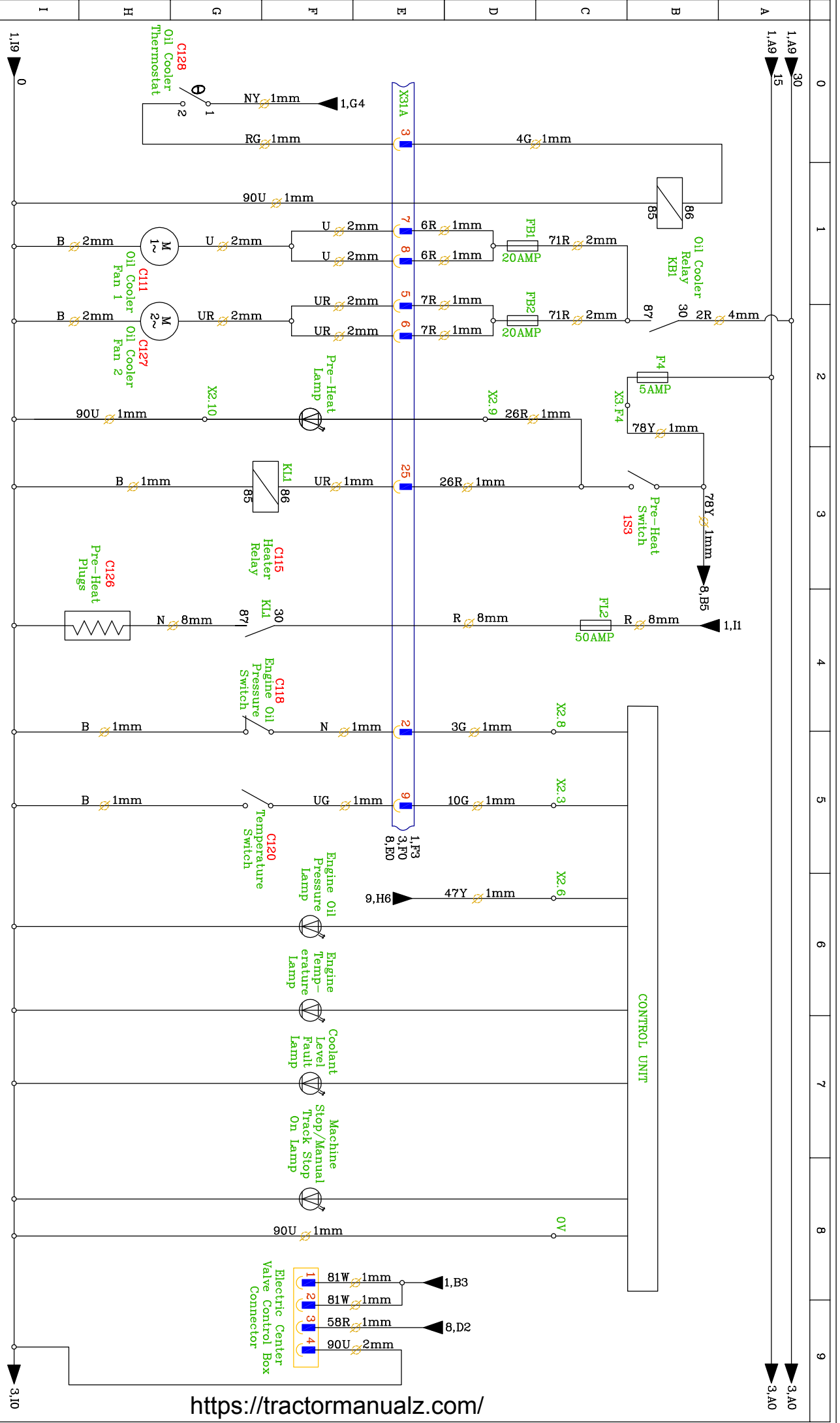
In cases where electric welding is required on the machine observe the following.

1. Stop the machine and switch off the ignition switch.
2. Isolate the system by disconnecting the battery negative terminal.
3. Do not use electrical components to earth the welder.
4. Connect the welder earth clamp to the machine as close to the part to be welded as possible.

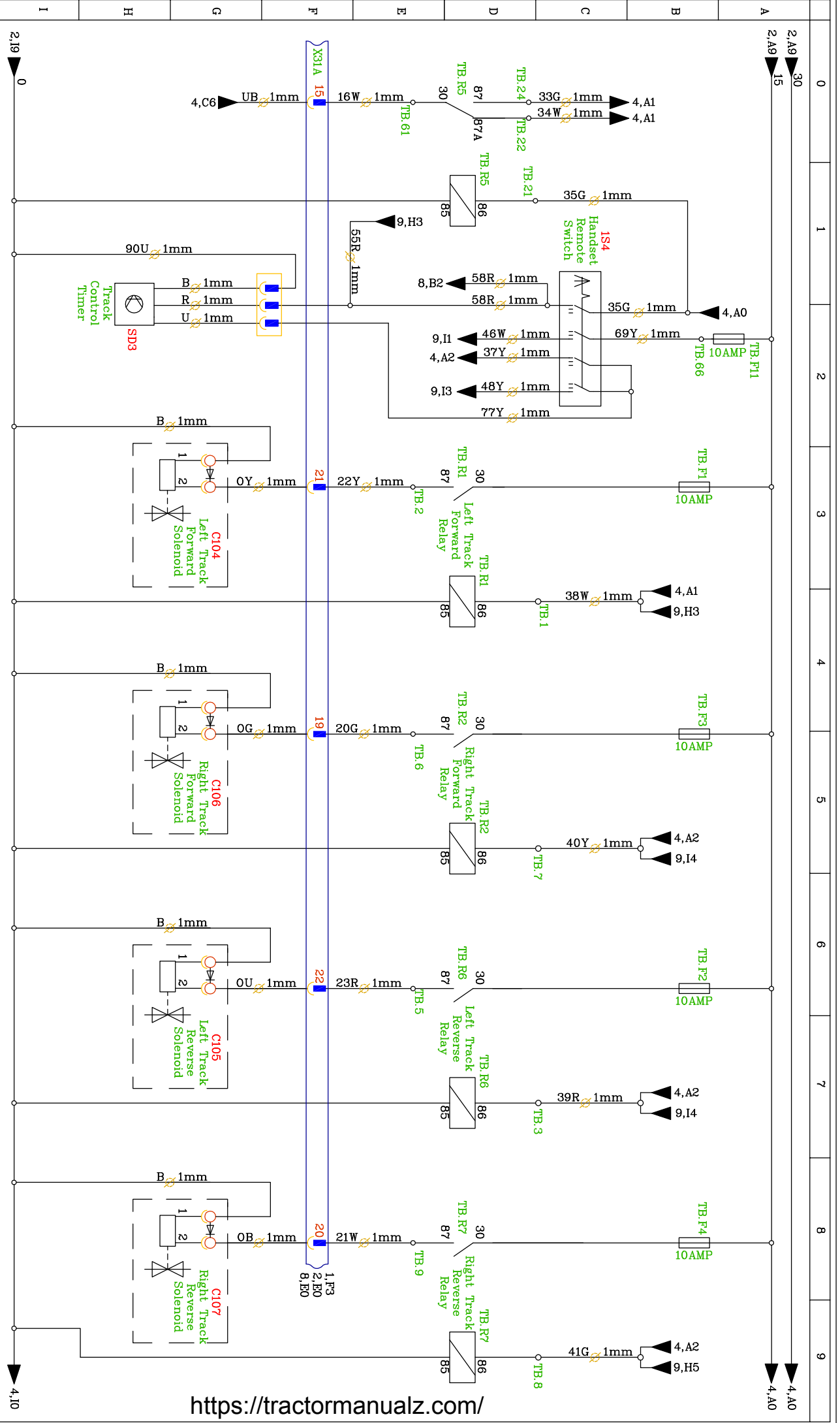


WIRING DIAGRAM

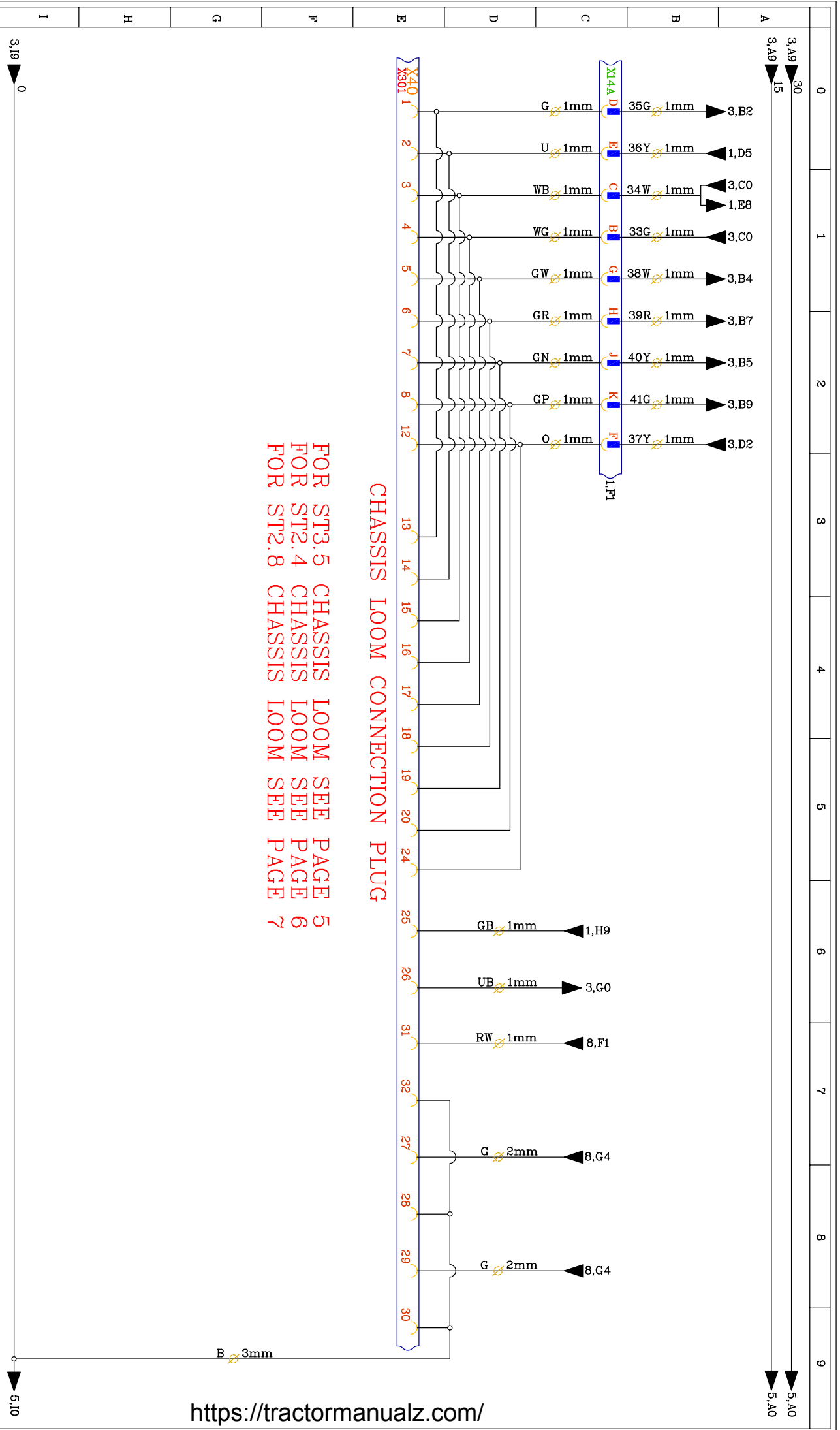




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2014.0131	03/06/14	TMG	TMG		Main Assembly Part No: 39.10.1004		Schematics		Page No: 2 DF 11	68A Derry Road, Omagh, Co. Tyrone, N. Ireland, BT 78 5ED Tel: (028) 82 244 131
2014.0138	18-06-14	BO'G			Subassembly Part No:					



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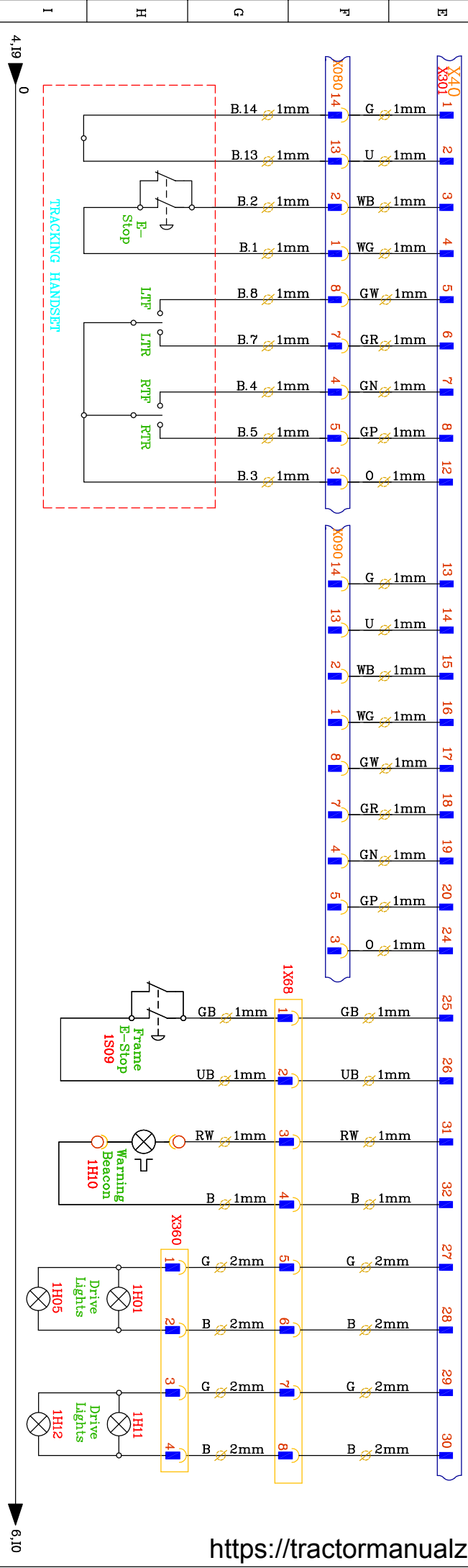
CHASSIS LOOM CONNECTION PLUG

FOR ST3.5 CHASSIS LOOM SEE PAGE 5
 FOR ST2.4 CHASSIS LOOM SEE PAGE 6
 FOR ST2.8 CHASSIS LOOM SEE PAGE 7

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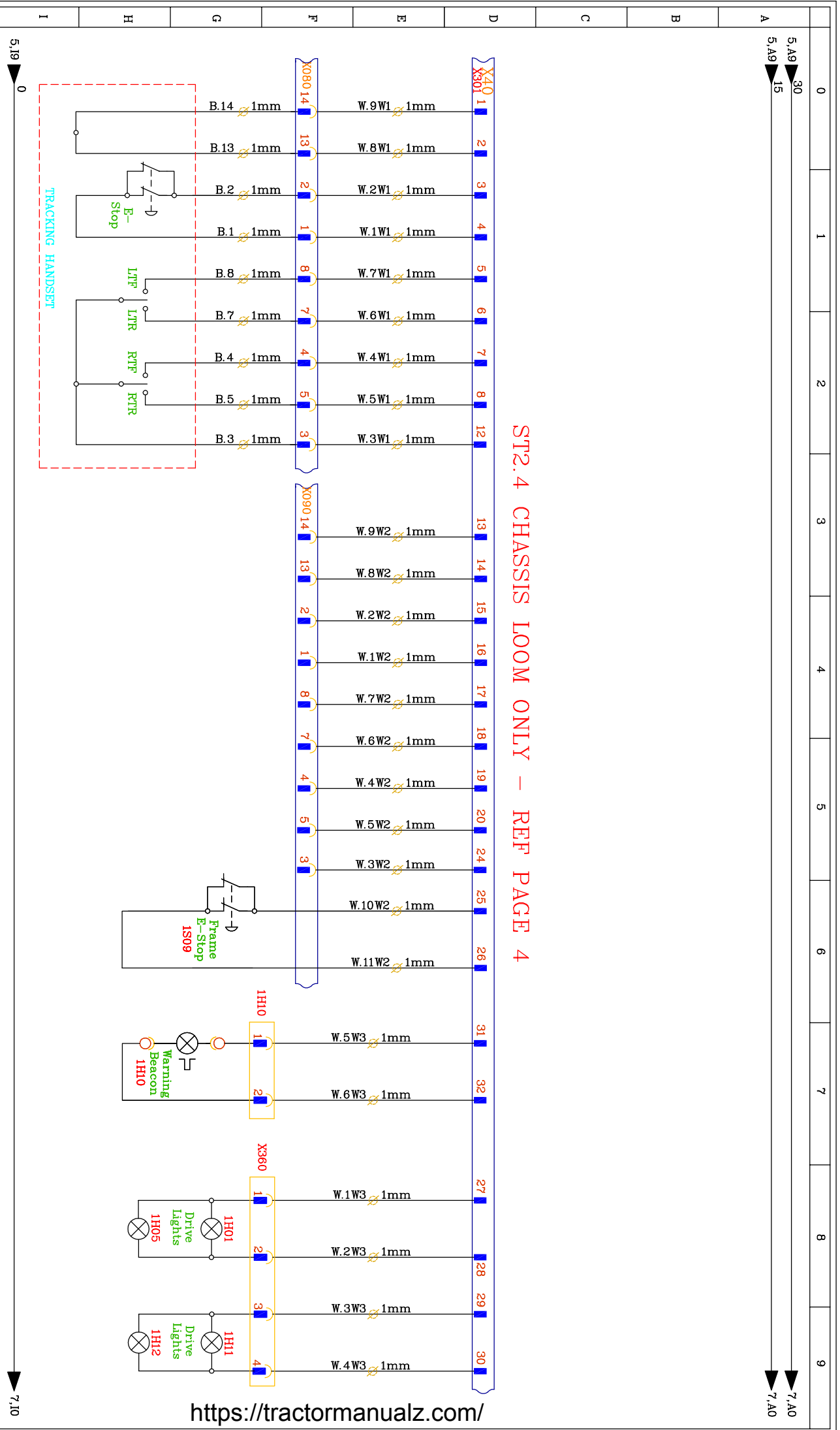
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ST3.5 CHASSIS LOOM ONLY - REF PAGE 4



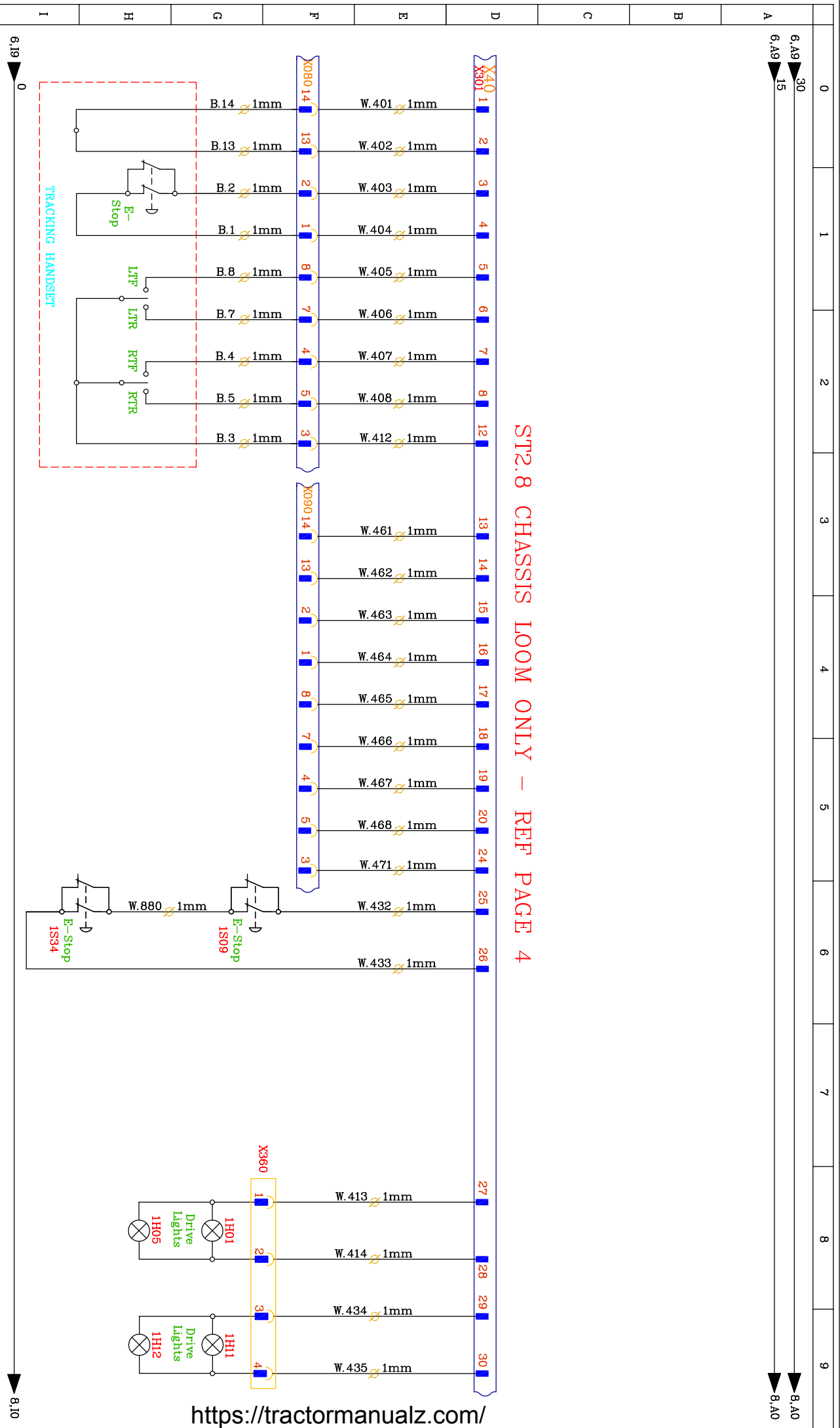
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ST2.4 CHASSIS LOOM ONLY - REF PAGE 4

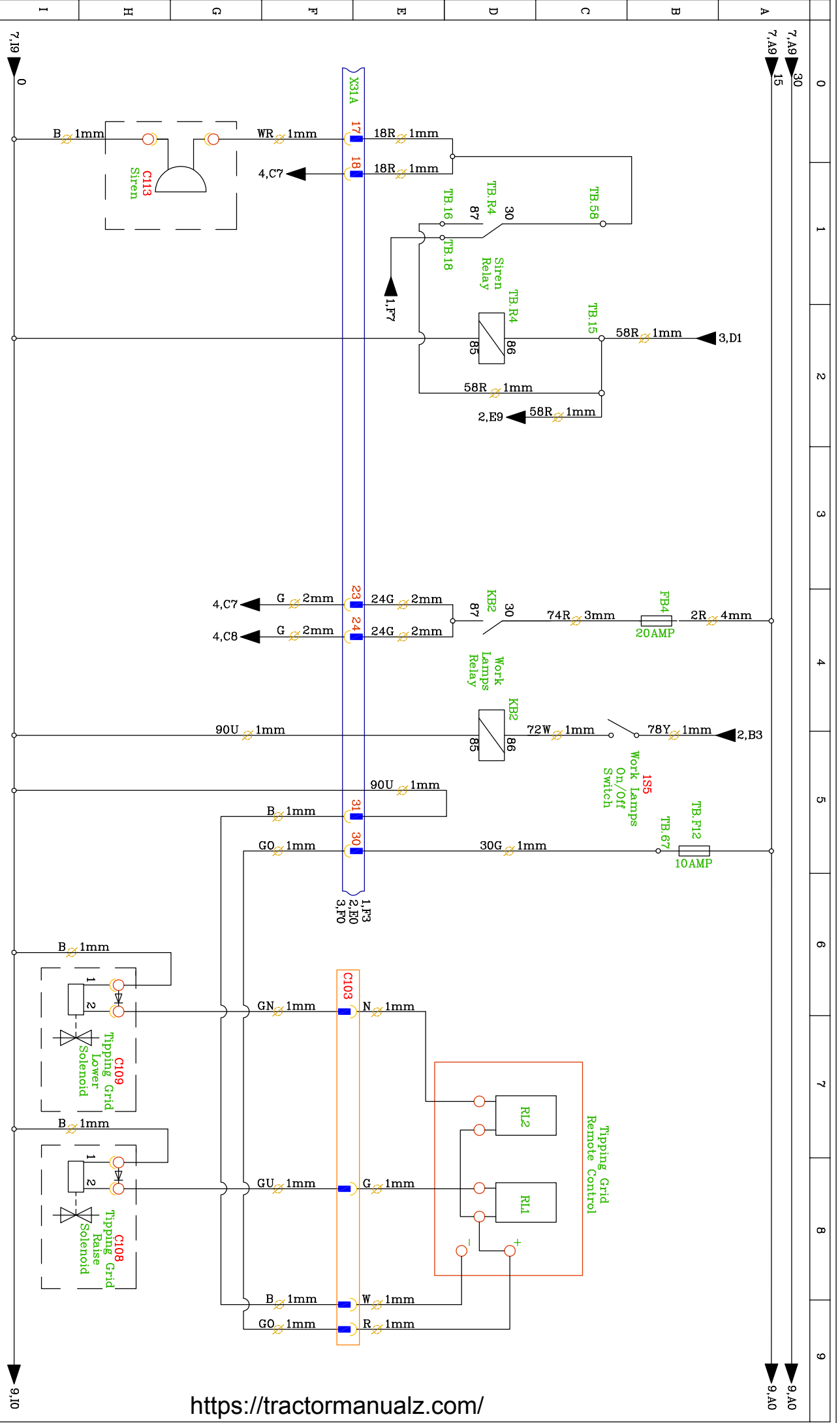


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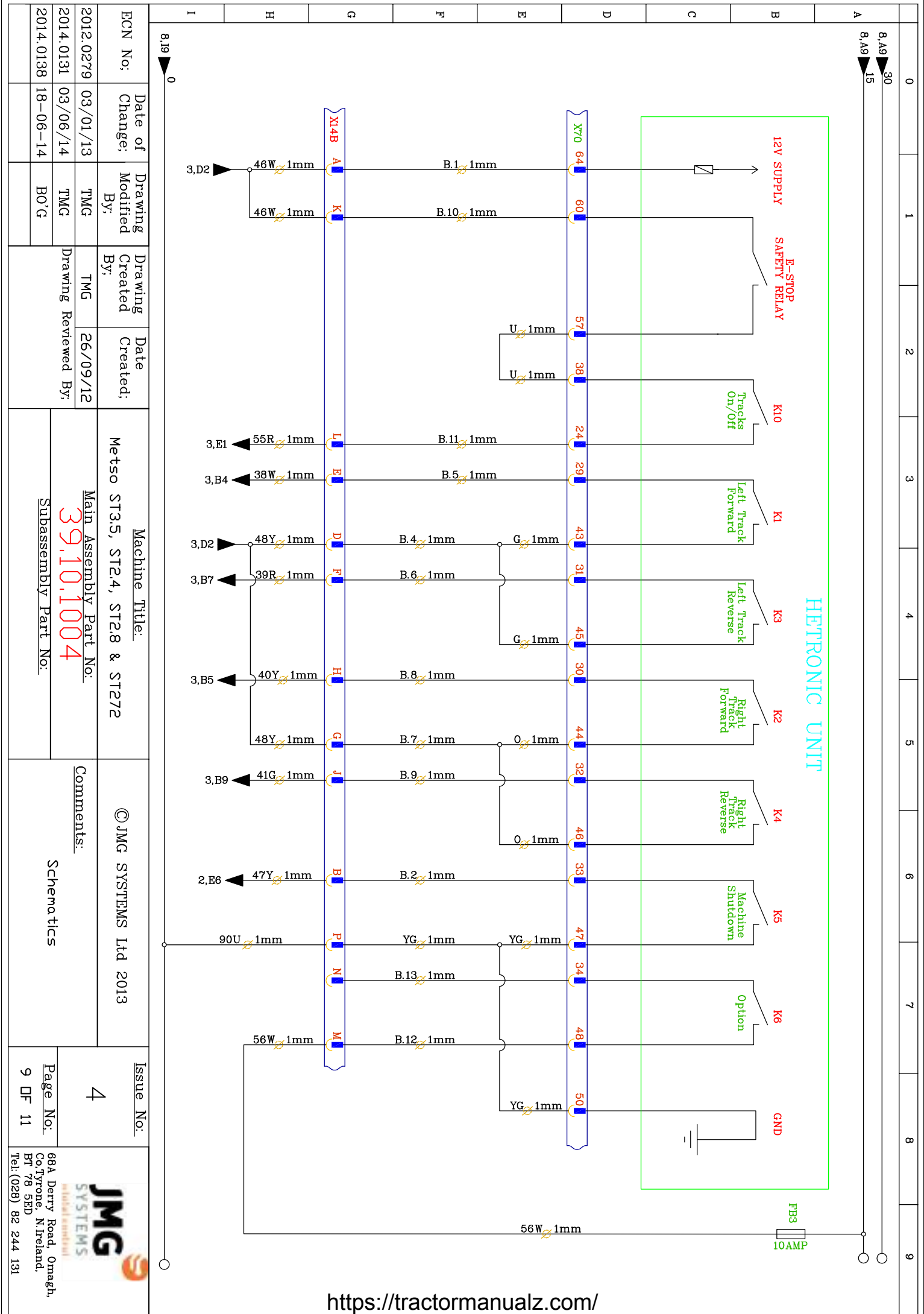
ST2.8 CHASSIS LOOM ONLY - REF PAGE 4

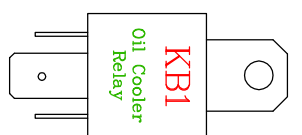
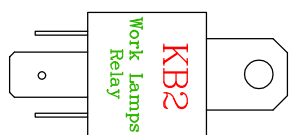
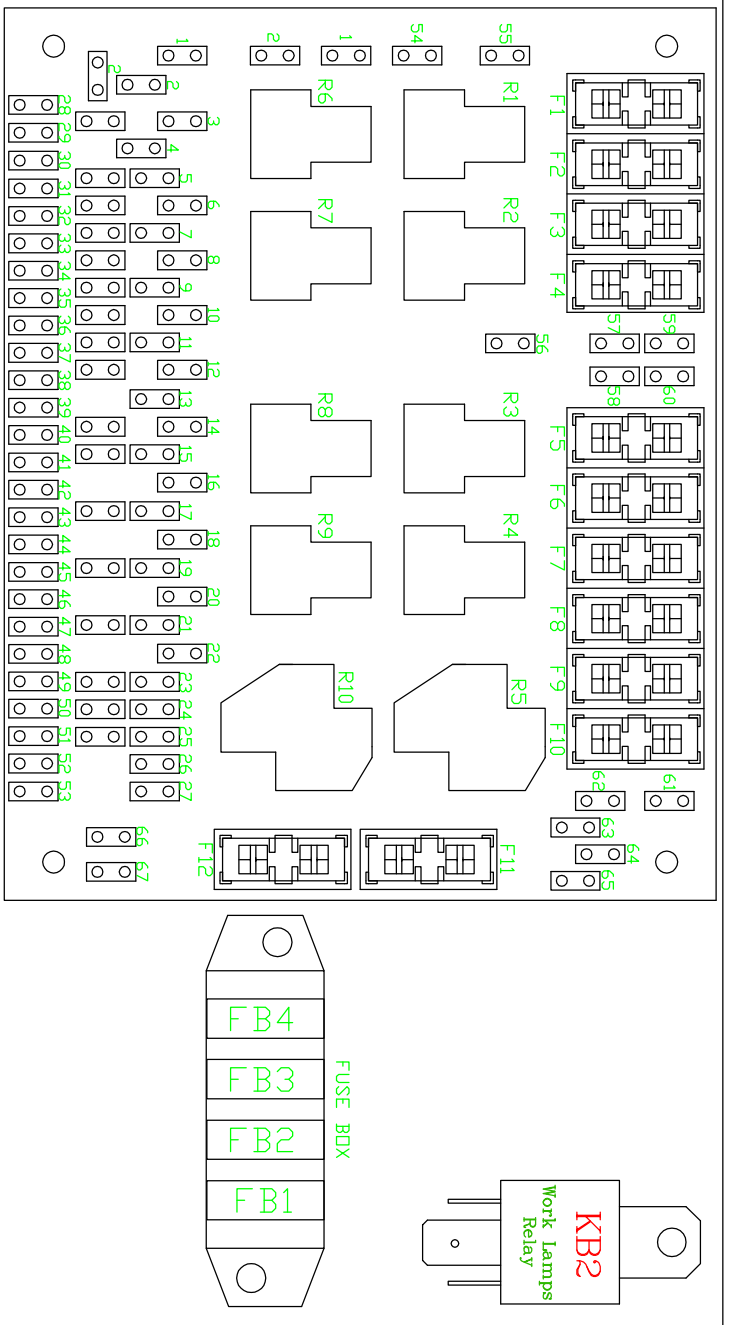


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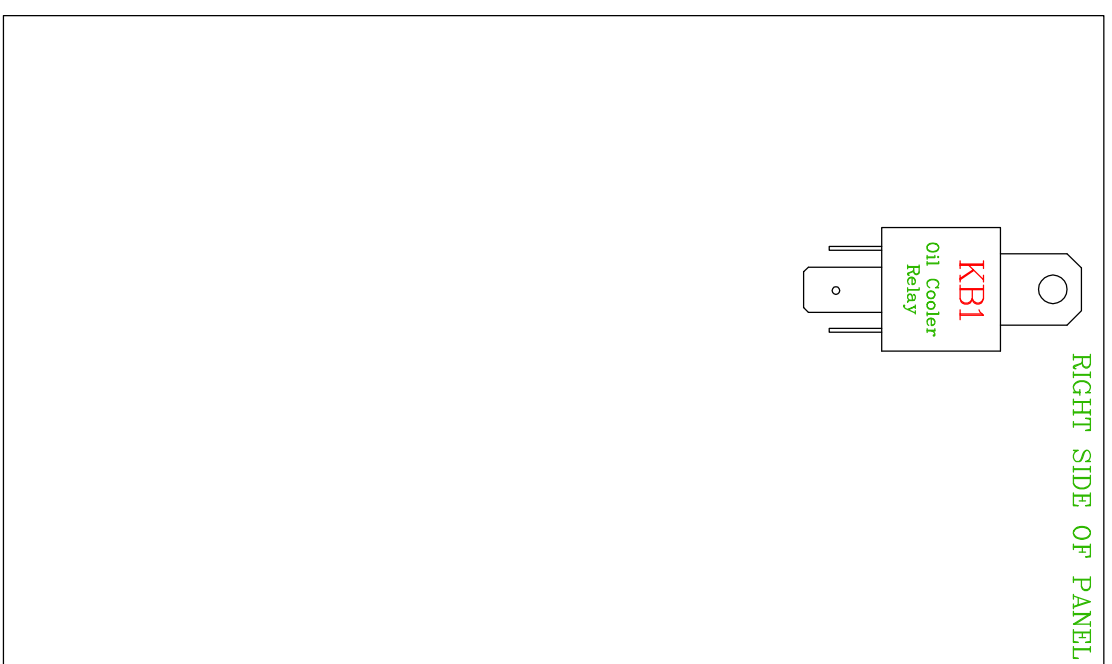
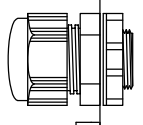
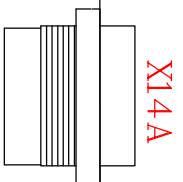
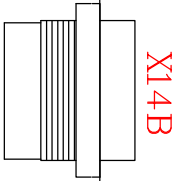


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2014.0131	03/06/14	TMG	TMG		Main Assembly Part No: 39.10.1004		Schematics		Page No: 8 DF 11	
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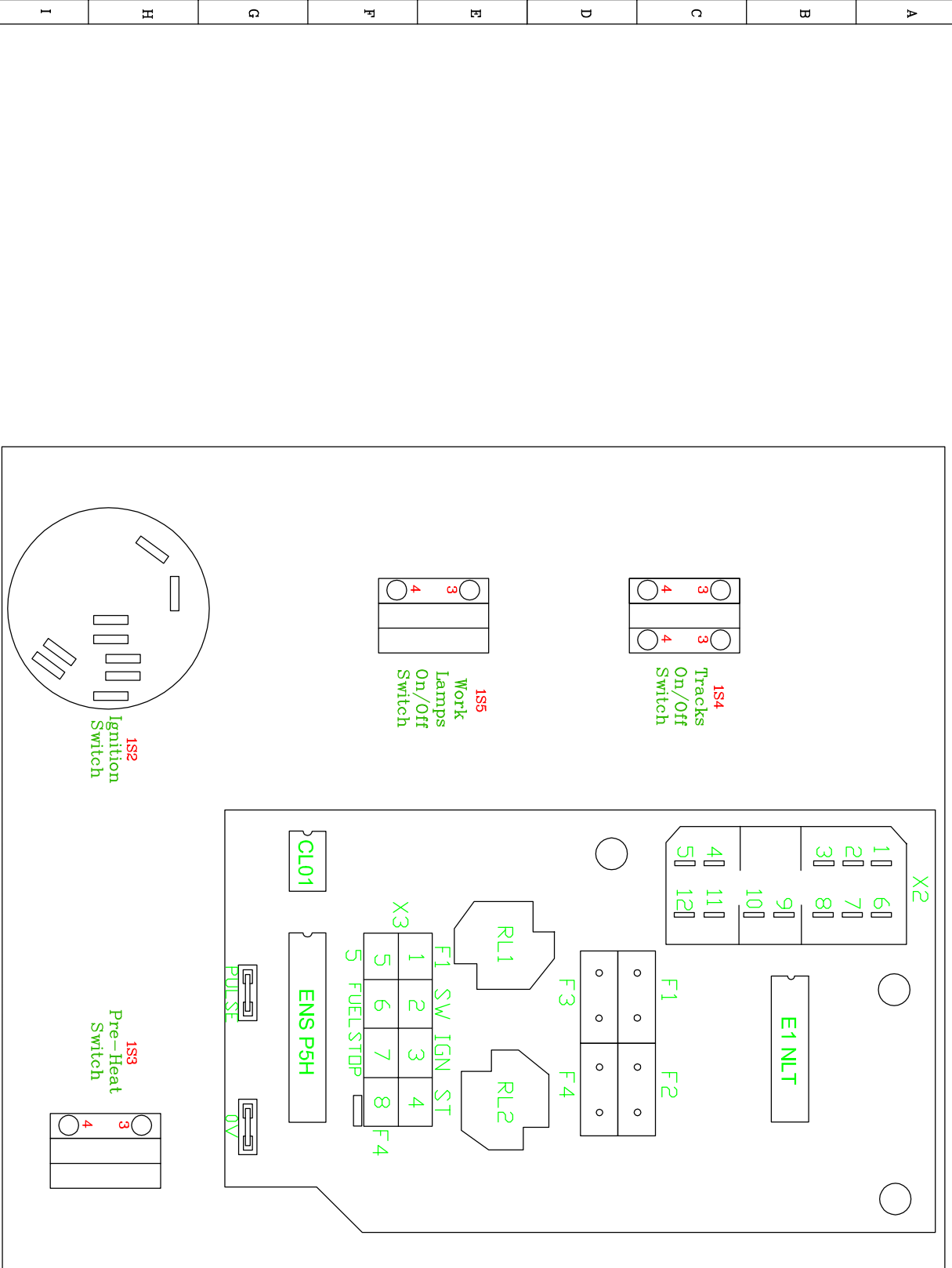




RIGHT SIDE OF PANEL



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Machine Title:
Metso ST35, ST24, ST28 & ST272

Main Assembly Part No:
39.10.1004

Subassembly Part No:

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Comments:
Schematics

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4

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Operation and Maintenance Manual

C4.4 (Mech) Industrial Engine

4461-Up (Engine)

Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the "Safety Alert Symbol" and followed by a "Signal Word" such as "DANGER", "WARNING" or "CAUTION". The Safety Alert "WARNING" label is shown below.



The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

Operations that may cause product damage are identified by "NOTICE" labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. If a tool, procedure, work method or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that the product will not be damaged or be made unsafe by the operation, lubrication, maintenance or repair procedures that you choose.

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Caterpillar dealers have the most current information available.



When replacement parts are required for this product Caterpillar recommends using Caterpillar replacement parts or parts with equivalent specifications including, but not limited to, physical dimensions, type, strength and material.

Failure to heed this warning can lead to premature failures, product damage, personal injury or death.

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Foreword

Literature Information

This manual contains safety, operation instructions, lubrication and maintenance information. This manual should be stored in or near the engine area in a literature holder or literature storage area. Read, study and keep it with the literature and engine information.

English is the primary language for all Caterpillar publications. The English used facilitates translation and consistency in electronic media delivery.

Some photographs or illustrations in this manual show details or attachments that may be different from your engine. Guards and covers may have been removed for illustrative purposes. Continuing improvement and advancement of product design may have caused changes to your engine which are not included in this manual. Whenever a question arises regarding your engine, or this manual, please consult with your Caterpillar dealer for the latest available information.

Safety

This safety section lists basic safety precautions. In addition, this section identifies hazardous, warning situations. Read and understand the basic precautions listed in the safety section before operating or performing lubrication, maintenance and repair on this product.

Operation

Operating techniques outlined in this manual are basic. They assist with developing the skills and techniques required to operate the engine more efficiently and economically. Skill and techniques develop as the operator gains knowledge of the engine and its capabilities.

The operation section is a reference for operators. Photographs and illustrations guide the operator through procedures of inspecting, starting, operating and stopping the engine. This section also includes a discussion of electronic diagnostic information.

Maintenance

The maintenance section is a guide to engine care. The illustrated, step-by-step instructions are grouped by fuel consumption, service hours and/or calendar time maintenance intervals. Items in the maintenance schedule are referenced to detailed instructions that follow.

Use fuel consumption or service hours to determine intervals. Calendar intervals shown (daily, annually, etc.) may be used instead of service meter intervals if they provide more convenient schedules and approximate the indicated service meter reading.

Recommended service should be performed at the appropriate intervals as indicated in the Maintenance Interval Schedule. The actual operating environment of the engine also governs the Maintenance Interval Schedule. Therefore, under extremely severe, dusty, wet or freezing cold operating conditions, more frequent lubrication and maintenance than is specified in the Maintenance Interval Schedule may be necessary.

The maintenance schedule items are organized for a preventive maintenance management program. If the preventive maintenance program is followed, a periodic tune-up is not required. The implementation of a preventive maintenance management program should minimize operating costs through cost avoidances resulting from reductions in unscheduled downtime and failures.

Maintenance Intervals

Perform maintenance on items at multiples of the original requirement. Each level and/or individual items in each level should be shifted ahead or back depending upon your specific maintenance practices, operation and application. We recommend that the maintenance schedules be reproduced and displayed near the engine as a convenient reminder. We also recommend that a maintenance record be maintained as part of the engine's permanent record.

See the section in the Operation and Maintenance Manual, "Maintenance Records" for information regarding documents that are generally accepted as proof of maintenance or repair. Your authorized Caterpillar dealer can assist you in adjusting your maintenance schedule to meet the needs of your operating environment.

Overhaul

Major engine overhaul details are not covered in the Operation and Maintenance Manual except for the interval and the maintenance items in that interval. Major repairs are best left to trained personnel or an authorized Caterpillar dealer. Your Caterpillar dealer offers a variety of options regarding overhaul programs. If you experience a major engine failure, there are also numerous after failure overhaul options available from your Caterpillar dealer. Consult with your dealer for information regarding these options.

California Proposition 65 Warning

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

Battery posts, terminals and related accessories contain lead and lead compounds. **Wash hands after handling.**

Safety Section

The Universal Warning label (2) is located on the rear end of the valve mechanism cover. Refer to illustration 2.

i02690461

Safety Messages

SMCS Code: 1000; 7405

There may be several specific warning signs on your engine. The exact location and a description of the warning signs are reviewed in this section. Please become familiar with all warning signs.

Ensure that all of the warning signs are legible. Clean the warning signs or replace the warning signs if the words cannot be read or if the illustrations are not visible. Use a cloth, water, and soap to clean the warning signs. Do not use solvents, gasoline, or other harsh chemicals. Solvents, gasoline, or harsh chemicals could loosen the adhesive that secures the warning signs. The warning signs that are loosened could drop off of the engine.

Replace any warning sign that is damaged or missing. If a warning sign is attached to a part of the engine that is replaced, install a new warning sign on the replacement part. Your Caterpillar dealer or your distributor can provide new warning signs.

(1) Universal Warning



Do not operate or work on this equipment unless you have read and understand the instructions and warnings in the Operation and Maintenance Manuals. Failure to follow the instructions or heed the warnings could result in serious injury or death.

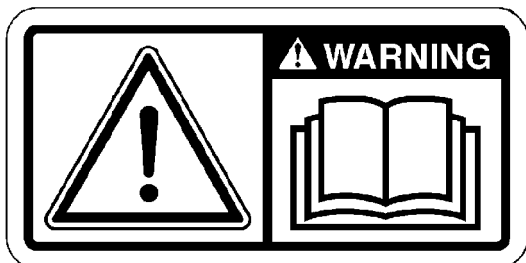


Illustration 1
Typical example

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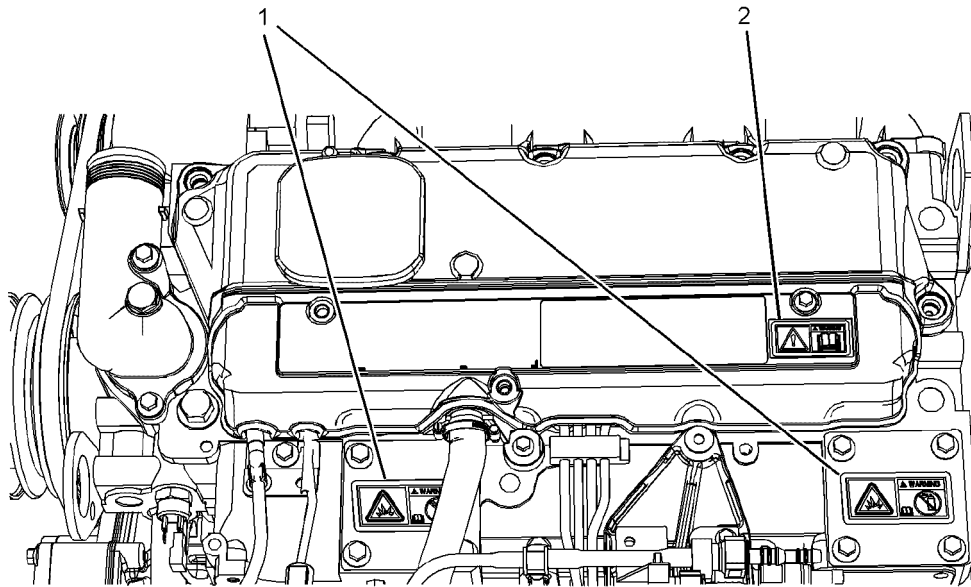


Illustration 2

g01353108

(1) Ether Warning Label

(2) Universal warning

(2) Ether

i02705981



Do not use aerosol types of starting aids such as ether. Such use could result in an explosion and personal injury.

General Hazard Information

SMCS Code: 1000; 7405



Illustration 3

g01154809

Typical example

The ether warning label (1) is located on the inlet manifold cover. Refer to illustration 2.

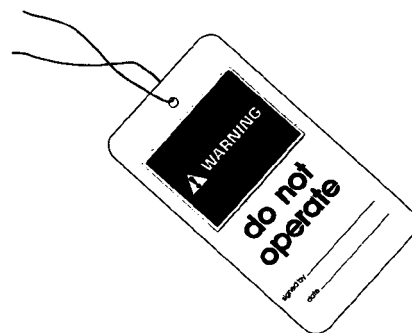


Illustration 4

g00104545

Attach a "Do Not Operate" warning tag or a similar warning tag to the start switch or to the controls before the engine is serviced or before the engine is repaired. These warning tags (Special Instruction, SEHS7332) are available from your Caterpillar dealer. Attach the warning tags to the engine and to each operator control station. When it is appropriate, disconnect the starting controls.

Do not allow unauthorized personnel on the engine, or around the engine when the engine is being serviced.

Engine exhaust contains products of combustion which may be harmful to your health. Always start the engine and operate the engine in a well ventilated area. If the engine is in an enclosed area, vent the engine exhaust to the outside.

Cautiously remove the following parts. To help prevent spraying or splashing of pressurized fluids, hold a rag over the part that is being removed.

- Filler caps
- Grease fittings
- Pressure taps
- Breathers
- Drain plugs

Use caution when cover plates are removed. Gradually loosen, but do not remove the last two bolts or nuts that are located at opposite ends of the cover plate or the device. Before removing the last two bolts or nuts, pry the cover loose in order to relieve any spring pressure or other pressure.

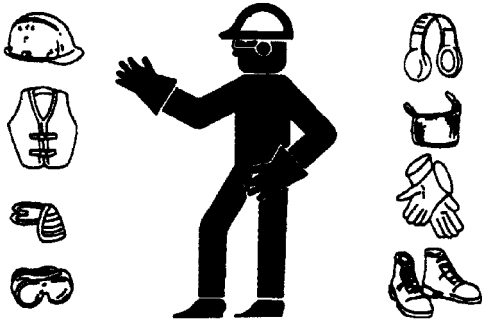


Illustration 5

g00702020

- Wear a hard hat, protective glasses, and other protective equipment, as required.
- When work is performed around an engine that is operating, wear protective devices for ears in order to help prevent damage to hearing.
- Do not wear loose clothing or jewelry that can snag on controls or on other parts of the engine.
- Ensure that all protective guards and all covers are secured in place on the engine.
- Never put maintenance fluids into glass containers. Glass containers can break.

- Use all cleaning solutions with care.
- Report all necessary repairs.

Unless other instructions are provided, perform the maintenance under the following conditions:

- The engine is stopped. Ensure that the engine cannot be started.
- Disconnect the batteries when maintenance is performed or when the electrical system is serviced. Disconnect the battery ground leads. Tape the leads in order to help prevent sparks.
- Do not attempt any repairs that are not understood. Use the proper tools. Replace any equipment that is damaged or repair the equipment.

Pressurized Air and Water

Pressurized air and/or water can cause debris and/or hot water to be blown out. This could result in personal injury.

When pressurized air and/or pressurized water is used for cleaning, wear protective clothing, protective shoes, and eye protection. Eye protection includes goggles or a protective face shield.

The maximum air pressure for cleaning purposes must be below 205 kPa (30 psi). The maximum water pressure for cleaning purposes must be below 275 kPa (40 psi).

Fluid Penetration

Pressure can be trapped in the hydraulic circuit long after the engine has been stopped. The pressure can cause hydraulic fluid or items such as pipe plugs to escape rapidly if the pressure is not relieved correctly.

Do not remove any hydraulic components or parts until pressure has been relieved or personal injury may occur. Do not disassemble any hydraulic components or parts until pressure has been relieved or personal injury may occur. Refer to the OEM information for any procedures that are required to relieve the hydraulic pressure.

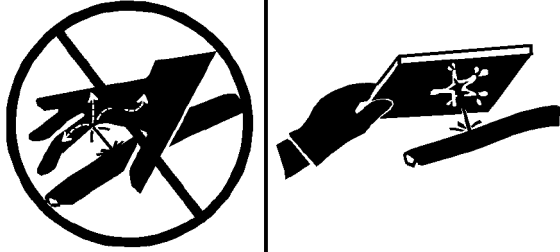


Illustration 6

g00687600

Always use a board or cardboard when you check for a leak. Leaking fluid that is under pressure can penetrate body tissue. Fluid penetration can cause serious injury and possible death. A pin hole leak can cause severe injury. If fluid is injected into your skin, you must get treatment immediately. Seek treatment from a doctor that is familiar with this type of injury.

Containing Fluid Spillage

Care must be taken in order to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the engine. Prepare to collect the fluid with suitable containers before opening any compartment or disassembling any component that contains fluids.

Refer to Special Publication, NENG2500, "Dealer Service Tool Catalog" for the following items:

- Tools that are suitable for collecting fluids and equipment that is suitable for collecting fluids
- Tools that are suitable for containing fluids and equipment that is suitable for containing fluids

Obey all local regulations for the disposal of liquids.

Asbestos Information

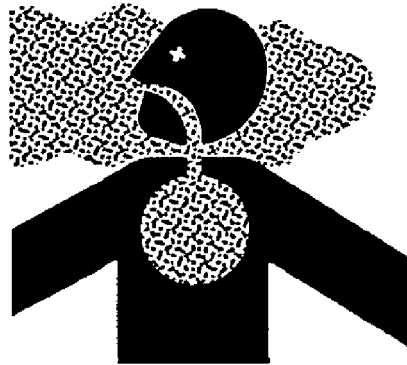


Illustration 7

g00702022

Caterpillar equipment and replacement parts that are shipped from Caterpillar are asbestos free. Caterpillar recommends the use of only genuine Caterpillar replacement parts. Use the following guidelines when you handle any replacement parts that contain asbestos or when you handle asbestos debris.

Use caution. Avoid inhaling dust that might be generated when you handle components that contain asbestos fibers. Inhaling this dust can be hazardous to your health. The components that may contain asbestos fibers are brake pads, brake bands, lining material, clutch plates, and some gaskets. The asbestos that is used in these components is usually bound in a resin or sealed in some way. Normal handling is not hazardous unless airborne dust that contains asbestos is generated.

If dust that may contain asbestos is present, there are several guidelines that should be followed:

- Never use compressed air for cleaning.
- Avoid brushing materials that contain asbestos.
- Avoid grinding materials that contain asbestos.
- Use a wet method in order to clean up asbestos materials.
- A vacuum cleaner that is equipped with a high efficiency particulate air filter (HEPA) can also be used.
- Use exhaust ventilation on permanent machining jobs.
- Wear an approved respirator if there is no other way to control the dust.

- Comply with applicable rules and regulations for the work place. In the United States, use Occupational Safety and Health Administration (OSHA) requirements. These OSHA requirements can be found in "29 CFR 1910.1001".
- Obey environmental regulations for the disposal of asbestos.
- Stay away from areas that might have asbestos particles in the air.

Dispose of Waste Properly

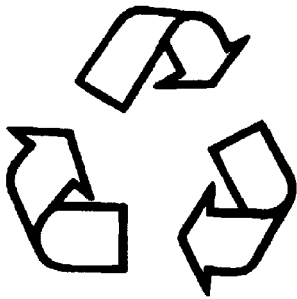


Illustration 8

g00706404

Improperly disposing of waste can threaten the environment. Potentially harmful fluids should be disposed of according to local regulations.

Always use leakproof containers when you drain fluids. Do not pour waste onto the ground, down a drain, or into any source of water.

i01480768

Burn Prevention

SMCS Code: 1000; 7405

Do not touch any part of an operating engine. Allow the engine to cool before any maintenance is performed on the engine. Relieve all pressure in the air system, in the hydraulic system, in the lubrication system, in the fuel system, or in the cooling system before any lines, fittings or related items are disconnected.

Coolant

When the engine is at operating temperature, the engine coolant is hot. The coolant is also under pressure. The radiator and all lines to the heaters or to the engine contain hot coolant.

Any contact with hot coolant or with steam can cause severe burns. Allow cooling system components to cool before the cooling system is drained.

Check the coolant level after the engine has stopped and the engine has been allowed to cool.

Ensure that the filler cap is cool before removing the filler cap. The filler cap must be cool enough to touch with a bare hand. Remove the filler cap slowly in order to relieve pressure.

Cooling system conditioner contains alkali. Alkali can cause personal injury. Do not allow alkali to contact the skin, the eyes, or the mouth.

Oils

Hot oil and hot lubricating components can cause personal injury. Do not allow hot oil to contact the skin. Also, do not allow hot components to contact the skin.

Batteries

Electrolyte is an acid. Electrolyte can cause personal injury. Do not allow electrolyte to contact the skin or the eyes. Always wear protective glasses for servicing batteries. Wash hands after touching the batteries and connectors. Use of gloves is recommended.

i01372254

Fire Prevention and Explosion Prevention

SMCS Code: 1000; 7405



Illustration 9

g00704000

All fuels, most lubricants, and some coolant mixtures are flammable.

Flammable fluids that are leaking or spilled onto hot surfaces or onto electrical components can cause a fire. Fire may cause personal injury and property damage.

A flash fire may result if the covers for the engine crankcase are removed within fifteen minutes after an emergency shutdown.

Determine whether the engine will be operated in an environment that allows combustible gases to be drawn into the air inlet system. These gases could cause the engine to overspeed. Personal injury, property damage, or engine damage could result.

If the application involves the presence of combustible gases, consult your Caterpillar dealer for additional information about suitable protection devices.

Remove all flammable materials such as fuel, oil, and debris from the engine. Do not allow any flammable materials to accumulate on the engine.

Store fuels and lubricants in properly marked containers away from unauthorized persons. Store oily rags and any flammable materials in protective containers. Do not smoke in areas that are used for storing flammable materials.

Do not expose the engine to any flame.

Exhaust shields (if equipped) protect hot exhaust components from oil or fuel spray in case of a line, a tube, or a seal failure. Exhaust shields must be installed correctly.

Do not weld on lines or tanks that contain flammable fluids. Do not flame cut lines or tanks that contain flammable fluid. Clean any such lines or tanks thoroughly with a nonflammable solvent prior to welding or flame cutting.

Wiring must be kept in good condition. All electrical wires must be properly routed and securely attached. Check all electrical wires daily. Repair any wires that are loose or frayed before you operate the engine. Clean all electrical connections and tighten all electrical connections.

Eliminate all wiring that is unattached or unnecessary. Do not use any wires or cables that are smaller than the recommended gauge. Do not bypass any fuses and/or circuit breakers.

Arcing or sparking could cause a fire. Secure connections, recommended wiring, and properly maintained battery cables will help to prevent arcing or sparking.

Inspect all lines and hoses for wear or for deterioration. The hoses must be properly routed. The lines and hoses must have adequate support and secure clamps. Tighten all connections to the recommended torque. Leaks can cause fires.

Oil filters and fuel filters must be properly installed. The filter housings must be tightened to the proper torque.



Illustration 10

g00704059

Use caution when you are refueling an engine. Do not smoke while you are refueling an engine. Do not refuel an engine near open flames or sparks. Always stop the engine before refueling.



Illustration 11

g00704135

Gases from a battery can explode. Keep any open flames or sparks away from the top of a battery. Do not smoke in battery charging areas.

Never check the battery charge by placing a metal object across the terminal posts. Use a voltmeter or a hydrometer.

Improper jumper cable connections can cause an explosion that can result in injury. Refer to the Operation Section of this manual for specific instructions.

Do not charge a frozen battery. This may cause an explosion.

The batteries must be kept clean. The covers (if equipped) must be kept on the cells. Use the recommended cables, connections, and battery box covers when the engine is operated.

Fire Extinguisher

Make sure that a fire extinguisher is available. Be familiar with the operation of the fire extinguisher. Inspect the fire extinguisher and service the fire extinguisher regularly. Obey the recommendations on the instruction plate.

Ether

Ether is flammable and poisonous.

Use ether in well ventilated areas. Do not smoke while you are replacing an ether cylinder or while you are using an ether spray.

Do not store ether cylinders in living areas or in the engine compartment. Do not store ether cylinders in direct sunlight or in temperatures above 49 °C (120 °F). Keep ether cylinders away from open flames or sparks.

Dispose of used ether cylinders properly. Do not puncture an ether cylinder. Keep ether cylinders away from unauthorized personnel.

Do not spray ether into an engine if the engine is equipped with a thermal starting aid for cold weather starting.

Lines, Tubes and Hoses

Do not bend high pressure lines. Do not strike high pressure lines. Do not install any lines that are bent or damaged.

Repair any lines that are loose or damaged. Leaks can cause fires. Consult your Caterpillar dealer for repair or for replacement parts.

Check lines, tubes and hoses carefully. Do not use your bare hand to check for leaks. Use a board or cardboard to check for leaks. Tighten all connections to the recommended torque.

Replace the parts if any of the following conditions are present:

- End fittings are damaged or leaking.
- Outer coverings are chafed or cut.
- Wires are exposed.
- Outer coverings are ballooning.
- Flexible part of the hoses are kinked.
- Outer covers have embedded armoring.
- End fittings are displaced.

Make sure that all clamps, guards, and heat shields are installed correctly. During engine operation, this will help to prevent vibration, rubbing against other parts, and excessive heat.

i01359666

Crushing Prevention and Cutting Prevention

SMCS Code: 1000; 7405

Support the component properly when work beneath the component is performed.

Unless other maintenance instructions are provided, never attempt adjustments while the engine is running.

Stay clear of all rotating parts and of all moving parts. Leave the guards in place until maintenance is performed. After the maintenance is performed, reinstall the guards.

Keep objects away from moving fan blades. The fan blades will throw objects or cut objects.

When objects are struck, wear protective glasses in order to avoid injury to the eyes.

Chips or other debris may fly off objects when objects are struck. Before objects are struck, ensure that no one will be injured by flying debris.

i01372247

Mounting and Dismounting

SMCS Code: 1000; 7405

Inspect the steps, the handholds, and the work area before mounting the engine. Keep these items clean and keep these items in good repair.

Mount the engine and dismount the engine only at locations that have steps and/or handholds. Do not climb on the engine, and do not jump off the engine.

Face the engine in order to mount the engine or dismount the engine. Maintain a three-point contact with the steps and handholds. Use two feet and one hand or use one foot and two hands. Do not use any controls as handholds.

Do not stand on components which cannot support your weight. Use an adequate ladder or use a work platform. Secure the climbing equipment so that the equipment will not move.

Do not carry tools or supplies when you mount the engine or when you dismount the engine. Use a hand line to raise and lower tools or supplies.

i02704618

Before Starting Engine

SMCS Code: 1000

NOTICE

For initial start-up of a new or rebuilt engine, and for start-up of an engine that has been serviced, make provision to shut the engine off should an overspeed occur. This may be accomplished by shutting off the air and/or fuel supply to the engine.

Overspeed shutdown should occur automatically. If automatic shutdown does not occur, press the emergency stop button in order to cut the fuel and/or air to the engine.

Inspect the engine for potential hazards.

Before starting the engine, ensure that no one is on, underneath, or close to the engine. Ensure that the area is free of personnel.

If equipped, ensure that the lighting system for the engine is suitable for the conditions. Ensure that all lights work properly, if equipped.

All protective guards and all protective covers must be installed if the engine must be started in order to perform service procedures. To help prevent an accident that is caused by parts in rotation, work around the parts carefully.

Do not bypass the automatic shutoff circuits. Do not disable the automatic shutoff circuits. The circuits are provided in order to help prevent personal injury. The circuits are also provided in order to help prevent engine damage.

See the Service Manual for repairs and for adjustments.

i02707603

Engine Starting

SMCS Code: 1000

WARNING

Do not use aerosol types of starting aids such as ether. Such use could result in an explosion and personal injury.

If a warning tag is attached to the engine start switch or to the controls DO NOT start the engine or move the controls. Consult with the person that attached the warning tag before the engine is started.

All protective guards and all protective covers must be installed if the engine must be started in order to perform service procedures. To help prevent an accident that is caused by parts in rotation, work around the parts carefully.

Start the engine from the operator's compartment or from the engine start switch.

Always start the engine according to the procedure that is described in the Operation and Maintenance Manual, "Engine Starting" topic in the Operation Section. Knowing the correct procedure will help to prevent major damage to the engine components. Knowing the procedure will also help to prevent personal injury.

To ensure that the jacket water heater (if equipped) and/or the lube oil heater (if equipped) is working correctly, check the water temperature gauge and/or the oil temperature gauge during the heater operation.

Engine exhaust contains products of combustion which can be harmful to your health. Always start the engine and operate the engine in a well ventilated area. If the engine is started in an enclosed area, vent the engine exhaust to the outside.

Note: The engine is equipped with a device for cold starting. If the engine will be operated in very cold conditions, then an extra cold starting aid may be required. Normally, the engine will be equipped with the correct type of starting aid for your region of operation.

These engines are equipped with a glow plug starting aid in each individual cylinder that heats the intake air in order to improve starting.

i02707233

Engine Stopping

SMCS Code: 1000

Stop the engine according to the procedure in the Operation and Maintenance Manual, "Engine Stopping (Operation Section)" in order to avoid overheating of the engine and accelerated wear of the engine components.

Use the Emergency Stop Button (if equipped) ONLY in an emergency situation. Do not use the Emergency Stop Button for normal engine stopping. After an emergency stop, DO NOT start the engine until the problem that caused the emergency stop has been corrected.

Stop the engine if an overspeed condition occurs during the initial start-up of a new engine or an engine that has been overhauled. This may be accomplished by shutting off the fuel supply to the engine and/or shutting off the air supply to the engine.

i02176668

Electrical System

SMCS Code: 1000; 1400

Never disconnect any charging unit circuit or battery circuit cable from the battery when the charging unit is operating. A spark can cause the combustible gases that are produced by some batteries to ignite.

To help prevent sparks from igniting combustible gases that are produced by some batteries, the negative "-" jump start cable should be connected last from the external power source to the negative "-" terminal of the starting motor. If the starting motor is not equipped with a negative "-" terminal, connect the jump start cable to the engine block.

Check the electrical wires daily for wires that are loose or frayed. Tighten all loose electrical wires before the engine is started. Repair all frayed electrical wires before the engine is started. See the Operation and Maintenance Manual for specific starting instructions.

Grounding Practices

Correct grounding for the engine electrical system is necessary for optimum engine performance and reliability. Incorrect grounding will result in uncontrolled electrical circuit paths and in unreliable electrical circuit paths.

Uncontrolled electrical circuit paths can result in damage to main bearings, to crankshaft bearing journal surfaces, and to aluminum components.

Engines that are installed without engine-to-frame ground straps can be damaged by electrical discharge.

To ensure that the engine and the engine electrical systems function correctly, an engine-to-frame ground strap with a direct path to the battery must be used. This path may be provided by way of a direct engine ground to the frame.

All grounds should be tight and free of corrosion. The engine alternator must be grounded to the negative "-" battery terminal with a wire that is adequate to handle the full charging current of the alternator.



Product Information Section

Model Views

i02707217

Model View Illustrations

SMCS Code: 1000

Engine Model Views

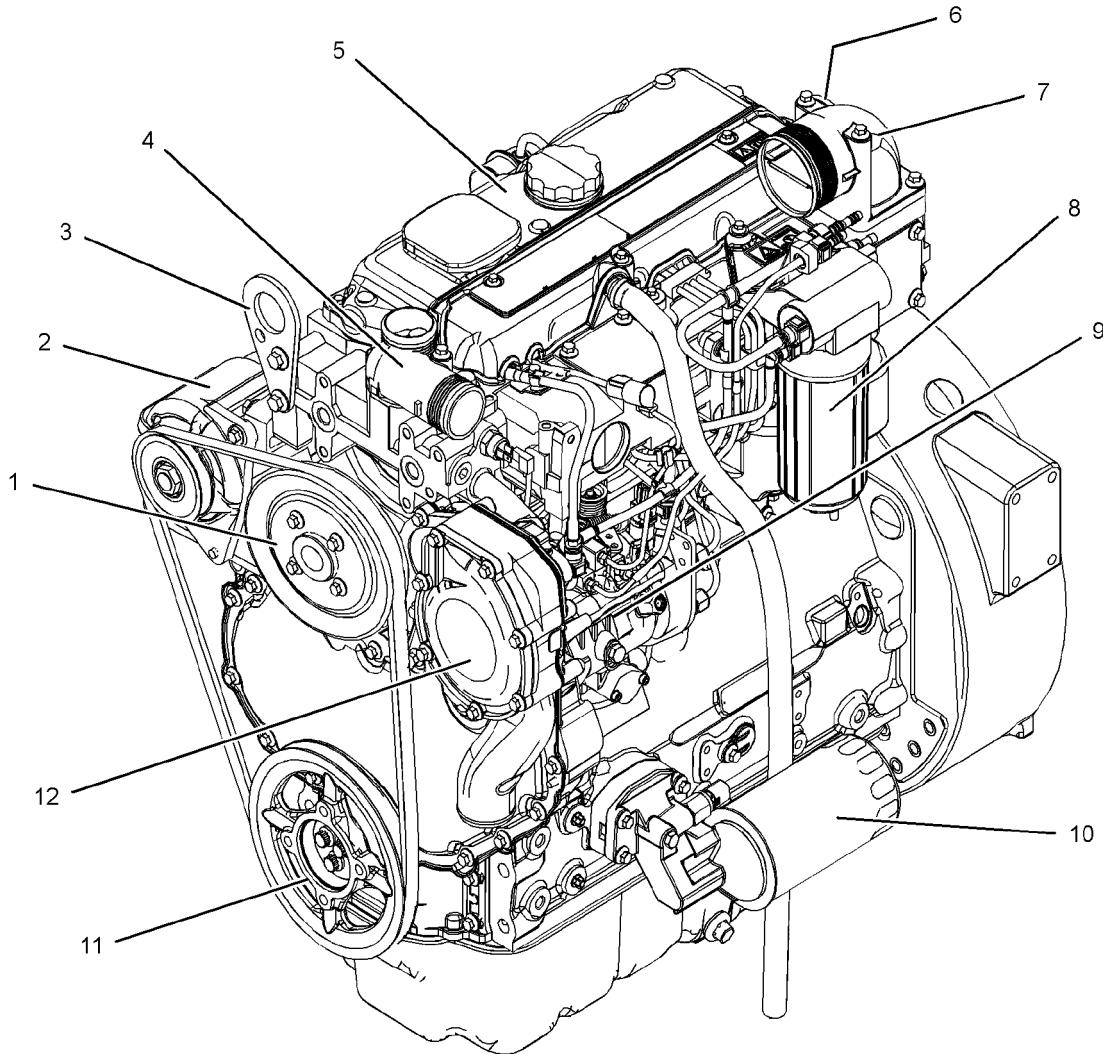


Illustration 12

g01351713

Typical example

- (1) Pulley
- (2) Alternator
- (3) Front Lifting Eye
- (4) Water Outlet

- (5) Valve Mechanism Cover
- (6) Rear Lifting Eye
- (7) Air Intake
- (8) Secondary Fuel Filter

- (9) Fuel Injection Pump
- (10) Oil Filter
- (11) Crankshaft Pulley
- (12) Water Pump

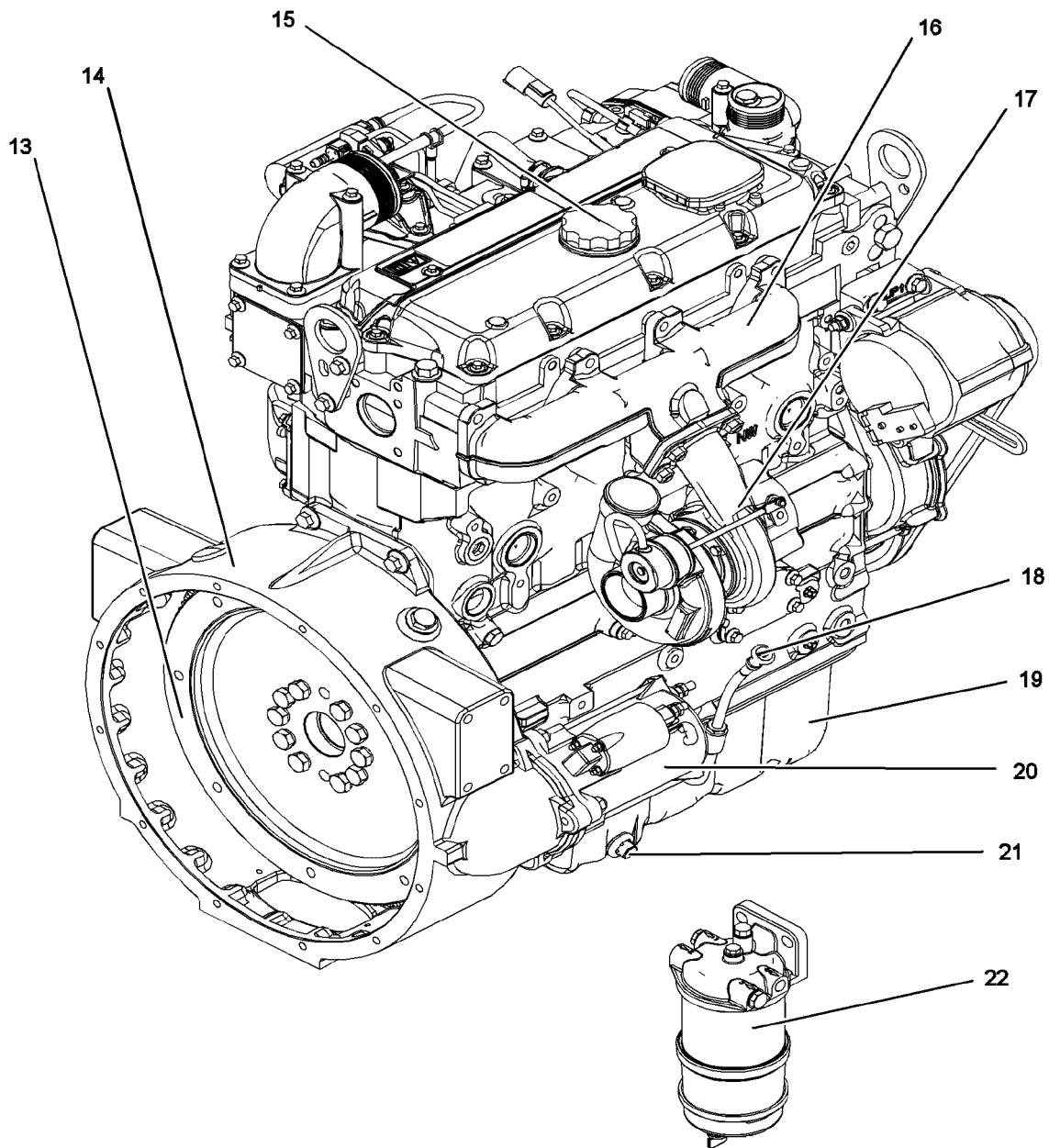


Illustration 13

g01352705

(13) Flywheel
 (14) Flywheel Housing
 (15) Oil Filler Cap
 (16) Exhaust Manifold

(17) Turbocharger
 (18) Oil Gauge
 (19) Oil Pan
 (20) Starting motor

(21) Oil Drain Plug
 (22) Primary Fuel Filter

Engine Description

SMCS Code: 1000

The Caterpillar C4.4 engines are available in the following types of aspiration:

i02708021

- Naturally aspirated
- Turbocharged
- Turbocharged aftercooled

Engine Specifications

Note: The front end of the engine is opposite the flywheel end of the engine. The left and the right sides of the engine are determined from the flywheel end. The number 1 cylinder is the front cylinder.

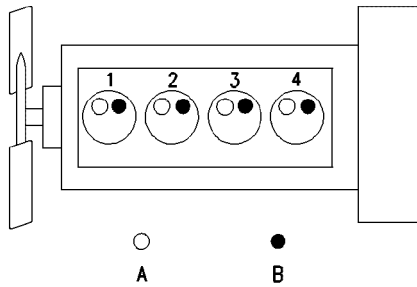


Illustration 14

g00984281

A typical example of the layout of the valves

- (A) Inlet valves
(B) Exhaust valves

Table 1

C-4.4 Industrial Engine Specifications	
Number of Cylinders	4 In-Line
Bore	105 mm (4.134 inch)
Stroke	127 mm (5.0 inch)
Aspiration	Naturally aspirated Turbocharged Turbocharged aftercooled
Compression Ratio	NA 19.3:1 T, TA 18.2:1
Displacement	4.4 L (268 in ³)
Firing Order	1 3 4 2
Rotation (flywheel end)	Counterclockwise
Valve Lash Setting (Inlet)	0.20 mm (0.008 inch)
Valve Lash Setting (Exhaust)	0.45 mm (0.018 inch)

Engine Cooling and Lubrication

The cooling system consists of the following components:

- Gear-driven centrifugal water pump
- Water temperature regulator which regulates the engine coolant temperature
- Gear-driven oil pump (gear type)
- Oil cooler

The engine lubricating oil is supplied by a gear type pump. The engine lubricating oil is cooled and the engine lubricating oil is filtered. Bypass valves provide unrestricted flow of lubrication oil to the engine parts when oil viscosity is high. Bypass valves can also provide unrestricted flow of lubrication oil to the engine parts if the oil cooler should become plugged or if the oil filter element should become plugged.

Engine efficiency, efficiency of emission controls, and engine performance depend on adherence to proper operation and maintenance recommendations. Engine performance and efficiency also depend on the use of recommended fuels, lubrication oils, and coolants. Refer to the Operation and Maintenance Manual, "Maintenance Interval Schedule" for more information on maintenance items.

Engine Service Life

Engine efficiency and maximum utilization of engine performance depend on the adherence to proper operation and maintenance recommendations. In addition, use recommended fuels, coolants and lubricants. Use the Operation and Maintenance Manual as a guide for required engine maintenance.

Expected engine life is generally predicted by the average power that is demanded. The average power that is demanded is based on fuel consumption of the engine over a period of time. Reduced hours of operation at full throttle and/or operating at reduced throttle settings result in a lower average power demand. Reduced hours of operation will increase the length of operating time before an engine overhaul is required.

Product Identification Information

Plate Locations and Film Locations

i02711140

SMCS Code: 1000

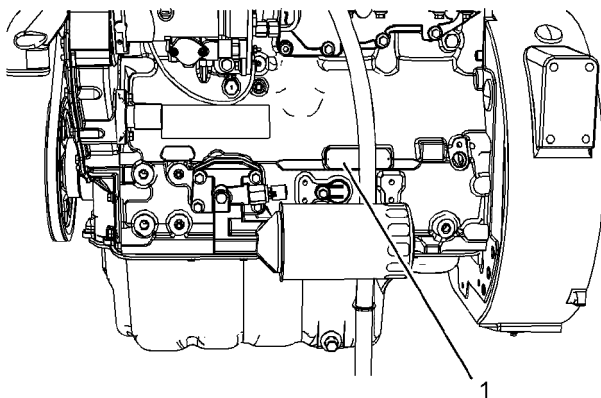
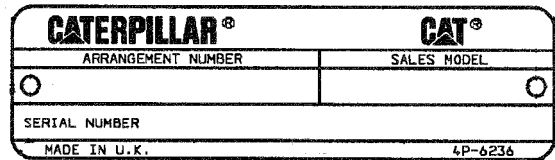


Illustration 15
Location of the serial number plate

g01360892

Serial Number Plate (1)

The engine serial number plate is located on the left side of the cylinder block to the rear of the engine.

Caterpillar dealers need all of these numbers in order to determine the components that were included with the engine. This permits accurate identification of replacement part numbers.

Illustration 16
Serial number plate

g01258789

i02708605

Reference Numbers

SMCS Code: 1000

Information for the following items may be needed to order parts. Locate the information for your engine. Record the information in the appropriate space. Make a copy of this list for a record. Keep the information for future reference.

Record for Reference

- Engine Model _____
- Engine Serial number _____
- Engine Low Idle rpm _____
- Engine Full Load rpm _____
- Primary Fuel Filter _____
- Water Separator Element _____
- Secondary Fuel Filter Element _____
- Lubrication Oil Filter Element _____
- Auxiliary Oil Filter Element _____
- Total Lubrication System Capacity _____
- Total Cooling System Capacity _____
- Air Cleaner Element _____
- Fan Drive Belt _____
- Alternator Belt _____

i02711190

Emissions Certification Film

SMCS Code: 1000; 7405

IMPORTANT ENGINE INFORMATION		CAT [®]
Engine Family: #####12#### #####: #####12##### Engine Type: ##4#/ ##4# EPA Family: #####12#####		(E ₁₁) 120R-###6## ell*97/68## #####16##### ##4#: #####15#####
Advertised kw: ##5## @ RPM:##4# Fuel Rate at adv. kW: ##5## mm3/stk Init. Timing: #####l#### Disp:##4#	MLIT ###7##	
Settings are to be made with engine at normal operating temperature with transmission in neutral. This engine conforms to ##4# U.S. EPA non - road and California off - road Regulations for large C.I. engines and is certified to operate on commercially available diesel fuel.		
Emission Control System: #####16#####	Valve Lash Cold (inch): Exhaust ##5## Inlet ##5##	#####l#### LABEL
Hanger No. #3#	Position ##4#	Label No. 3181A081

Illustration 17
 Typical example

g01360989

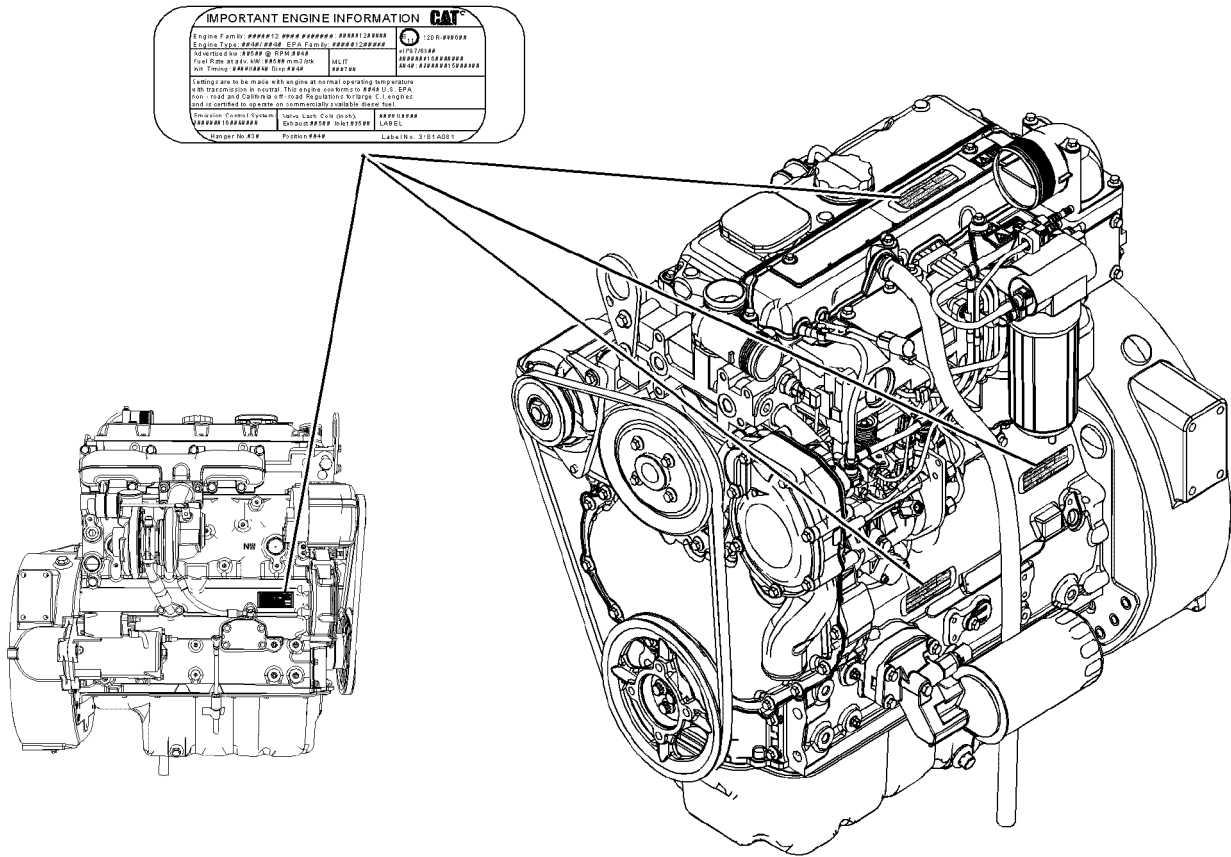


Illustration 18
Typical locations of the Emission Certification Film

g01361347

Operation Section

i02068367

Lifting and Storage

i02708018

Product Lifting

SMCS Code: 1000; 1404; 7002

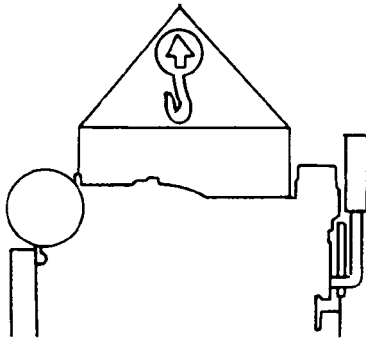


Illustration 19

g00103219

NOTICE

Never bend the eyebolts and the brackets. Only load the eyebolts and the brackets under tension. Remember that the capacity of an eyebolt is less as the angle between the supporting members and the object becomes less than 90 degrees.

When it is necessary to remove a component at an angle, only use a link bracket that is properly rated for the weight.

Use a hoist to remove heavy components. Use an adjustable lifting beam to lift the engine. All supporting members (chains and cables) should be parallel to each other. The chains and cables should be perpendicular to the top of the object that is being lifted.

Some removals require lifting the fixtures in order to obtain proper balance and safety.

To remove the engine ONLY, use the lifting eyes that are on the engine.

Lifting eyes are designed and installed for the specific engine arrangement. Alterations to the lifting eyes and/or the engine make the lifting eyes and the lifting fixtures obsolete. If alterations are made, ensure that proper lifting devices are provided. Consult your Caterpillar dealer for information regarding fixtures for proper engine lifting.

Product Storage

SMCS Code: 1000; 1404; 7002

If the engine will not be started for several weeks, the lubricating oil will drain from the cylinder walls and from the piston rings. Rust can form on the cylinder liner surface. Rust on the cylinder liner surface will cause increased engine wear and a reduction in engine service life.

To help prevent excessive engine wear, use the following guidelines:

- Complete all of the lubrication recommendations that are listed in this Operation and Maintenance Manual, "Maintenance Interval Schedule" (Maintenance Section).
- If freezing temperatures are expected, check the cooling system for adequate protection against freezing. See this Operation and Maintenance Manual, "Refill Capacities and Recommendations" (Maintenance Section).

If an engine is out of operation and if use of the engine is not planned, special precautions should be made. If the engine will be stored for more than one month, a complete protection procedure is recommended.

For more detailed information on engine storage, see Special Instruction, SEHS9031, "Storage Procedure For Caterpillar Products".

Your Caterpillar dealer can assist in preparing the engine for extended storage periods.

Gauges and Indicators

i02704606

Gauges and Indicators

SMCS Code: 1900; 7450

Your engine may not have the same gauges or all of the gauges that are described. For more information about the gauge package, see the OEM information.

Gauges provide indications of engine performance. Ensure that the gauges are in good working order. Determine the normal operating range by observing the gauges over a period of time.

Noticeable changes in gauge readings indicate potential gauge or engine problems. Problems may also be indicated by gauge readings that change even if the readings are within specifications. Determine and correct the cause of any significant change in the readings. Consult your Caterpillar dealer for assistance.

NOTICE

If no oil pressure is indicated, STOP the engine. If maximum coolant temperature is exceeded, STOP the engine. Engine damage can result.



Engine Oil Pressure – The oil pressure should be greatest after a cold engine is started. The typical engine oil pressure with SAE10W30 is 207 to 413 kPa (30 to 60 psi) at rated rpm.

A lower oil pressure is normal at low idle. If the load is stable and the gauge reading changes, perform the following procedure:

1. Remove the load.
2. Reduce engine speed to low idle.
3. Check and maintain the oil level.



Jacket Water Coolant Temperature – Typical temperature range is 71 to 96°C (160 to 205°F). The maximum allowable temperature with the pressurized cooling system at 48 kPa (7 psi) is 103°C (217°F). Higher temperatures may occur under certain conditions. The water temperature reading may vary according to load. The reading should never exceed the boiling point for the pressurized system that is being used.

If the engine is operating above the normal range and steam becomes apparent, perform the following procedure:

1. Reduce the load and the engine rpm.
2. Inspect the cooling system for leaks.
3. Determine if the engine must be shut down immediately or if the engine can be cooled by reducing the load.



Tachometer – This gauge indicates engine speed (rpm). When the throttle control lever is moved to the full throttle position without load, the engine is running at high idle. The engine is running at the full load rpm when the throttle control lever is at the full throttle position with maximum rated load.

NOTICE

To help prevent engine damage, never exceed the high idle rpm. Overspeeding can result in serious damage to the engine. The engine can be operated at high idle without damage, but should never be allowed to exceed high idle rpm.

Note: The high idle rpm and the full load rpm are stamped on the Information Plate.



Ammeter – This gauge indicates the amount of charge or discharge in the battery charging circuit. Operation of the indicator should be to the right side of "0"(zero).



Fuel Level – This gauge indicates the fuel level in the fuel tank. The electrically operated fuel level gauge only operates when the "START/STOP" switch is "ON".



Service Hour Meter – This gauge indicates operating time of the engine.

Features and Controls

i02704608

Engine Shutoffs and Engine Alarms

SMCS Code: 1900; 7400; 7418

Shutoffs

Shutoffs and alarms are electrically operated or mechanically operated. The operation of all electric shutoffs and alarms utilize components which actuate switches in a sensing unit.

Shutoffs are set at critical levels for the following items: operating temperature, operating pressure, operating level, and operating rpm. The particular shutoff may need to be reset before the engine will start.

NOTICE

Always determine the cause of the engine shutdown. Make necessary repairs before attempting to restart the engine.

Be familiar with the following items:

- Types and locations of shutoff
- Conditions which cause each shutoff to function
- The resetting procedure that is required to restart the engine

Alarms

Alarms consist of a switch and a contactor. The switches are wired to the contactors. The contactors activate alarm circuits in an annunciator panel. Your engine may be equipped with the following switches:

Engine oil pressure – The engine oil pressure switch indicates when oil pressure drops below rated system pressure.

Coolant level – The low coolant level switch indicates when the coolant level is low.

Coolant temperature – The coolant temperature switch indicates high jacket water coolant temperature.

Note: The sensing element of the coolant temperature switch must be submerged in coolant in order to operate.

Engines may be equipped with alarms in order to alert the operator when undesirable operating conditions occur.

NOTICE

When an alarm is activated, corrective measures must be taken before the situation becomes an emergency in order to avoid possible engine damage.

If corrective measures are not taken within a reasonable time, engine damage could result. The alarm will continue until the condition is corrected. The alarm may need to be reset.

A switch may be installed in the alarm while the engine is stopped for repairs. Before the engine is started, ensure that the switch is moved to the ON position and that the warning lights are flashing. The engine will not be protected if the switch is left in the OFF position.

Testing the Shutoff and Alarm System

Most control panels are equipped with a lamp test switch. Turn the switch to the ON position in order to check the indicator lights for proper operation. Replace worn bulbs immediately.

NOTICE

During testing, abnormal operating conditions must be simulated. Perform the tests correctly in order to help prevent possible engine damage.

Refer to the Service Manual for more information on testing procedures or consult your Caterpillar dealer.

i02704607

Fuel Shutoff

SMCS Code: 1259; 1704

The fuel shutoff solenoid is located on the fuel injection pump.

When the fuel shutoff solenoid is activated, the solenoid moves to the “Open” position.

When the fuel shutoff solenoid is deactivated, the solenoid moves to the “Closed” position.

Engine Starting

i02704617

Before Starting Engine

SMCS Code: 1000; 1400; 1450

Perform the required daily maintenance and other periodic maintenance before the engine is started. Inspect the engine compartment. This inspection can help prevent major repairs at a later date. Refer to the Operation and Maintenance Manual, "Maintenance Interval Schedule" for more information.

- For the maximum service life of the engine, make a thorough inspection before the engine is started. Look for the following items: oil leaks, coolant leaks, loose bolts, and trash buildup. Remove trash buildup and arrange for repairs, as needed.
- Inspect the cooling system hoses for cracks and for loose clamps.
- Inspect the alternator and accessory drive belts for cracks, breaks, and other damage.
- Inspect the wiring for loose connections and for worn wires or frayed wires.
- Check the fuel supply. Drain water from the water separator (if equipped). Open the fuel supply valve (if equipped).

NOTICE

All valves in the fuel return line must be open before and during engine operation to help prevent high fuel pressure. High fuel pressure may cause filter housing failure or other damage.

If the engine has not been started for several weeks, fuel may have drained from the fuel system. Air may have entered the filter housing. Also, when fuel filters have been changed, some air pockets will be trapped in the engine. In these instances, prime the fuel system. Refer to the Operation and Maintenance Manual, "Fuel System - Prime" for more information on priming the fuel system.

WARNING

Engine exhaust contains products of combustion which may be harmful to your health. Always start and operate the engine in a well ventilated area and, if in an enclosed area, vent the exhaust to the outside.

- Do not start the engine or move any of the controls if there is a "DO NOT OPERATE" warning tag or similar warning tag attached to the start switch or to the controls.
- Ensure that the areas around the rotating parts are clear.
- All of the guards must be put in place. Check for damaged guards or for missing guards. Repair any damaged guards. Replace damaged guards and/or missing guards.
- Disconnect any battery chargers that are not protected against the high current drain that is created when the electric starting motor (if equipped) is engaged. Check electrical cables and check the battery for poor connections and for corrosion.
- Reset all of the shutoffs or alarm components (if equipped).
- Check the engine lubrication oil level. Maintain the oil level between the "MIN" mark and the "MAX" mark on the oil level gauge.
- Check the coolant level. Observe the coolant level in the coolant recovery tank (if equipped). Maintain the coolant level to the "FULL" mark on the coolant recovery tank.
- If the engine is not equipped with a coolant recovery tank maintain the coolant level within 13 mm (0.5 inch) of the bottom of the filler pipe. If the engine is equipped with a sight glass, maintain the coolant level in the sight glass.
- Observe the air cleaner service indicator (if equipped). Service the air cleaner when the yellow diaphragm enters the red zone, or when the red piston locks in the visible position.
- Ensure that any driven equipment has been disengaged. Minimize electrical loads or remove any electrical loads.

i02710653

Starting the Engine

SMCS Code: 1000; 1450

WARNING

Do not use aerosol types of starting aids such as ether. Such use could result in an explosion and personal injury.

Refer to the OMM for your type of controls. Use the following procedure to start the engine.

1. If equipped, move the throttle lever to the full throttle position before you start the engine.

NOTICE

Do not crank the engine for more than 30 seconds. Allow the electric starting motor to cool for two minutes before cranking the engine again.

2. Turn the engine start switch to the START position. Hold the engine start switch in the START position and crank the engine.
3. When the engine starts, release the engine start switch.
4. If equipped, slowly move the throttle lever to the low idle position and allow the engine to idle. Refer to the Operation and Maintenance Manual, "After Starting Engine" topic.
5. If the engine does not start, release the engine start switch and allow the electric starting motor to cool. Then, repeat steps 2 through step 4.
6. Turn the engine start switch to the OFF position in order to stop the engine.

i02710719

Cold Weather Starting

SMCS Code: 1000; 1250; 1450; 1453; 1456; 1900

WARNING

Do not use aerosol types of starting aids such as ether. Such use could result in an explosion and personal injury.

Startability will be improved at temperatures below -18°C (0°F) from the use of a jacket water heater or extra battery capacity.

When Group 2 diesel fuel is used, the following items provide a means of minimizing starting problems and fuel problems in cold weather: engine oil pan heaters, jacket water heaters, fuel heaters, and fuel line insulation.

Use the procedure that follows for cold weather starting.

1. If equipped, move the throttle lever to the full throttle position before you start the engine.
2. If equipped, turn the engine start switch to the HEAT position. Hold the engine start switch in the HEAT position for 6 seconds until the glow plug indicator light illuminates. This will activate the glow plugs and aid in the starting of the engine.

NOTICE

Do not crank the engine for more than 30 seconds. Allow the electric starting motor to cool for two minutes before cranking the engine again.

3. While the glow plug indicator light is illuminated, turn the engine start switch to the START position and crank the engine.
- Note:** If the glow plug indicator light illuminates rapidly for 2 to 3 seconds, or if the glow plug indicator light fails to illuminate, a malfunction exists in the cold start system. Do not use ether or other starting fluids to start the engine.
4. When the engine starts, release the engine start switch key.
 5. If the engine does not start, release the engine start switch and allow the starting motor to cool. Then, repeat steps 2 through step 4.
 6. If the engine is equipped with a throttle allow the engine to idle for three to five minutes, or allow the engine to idle until the water temperature indicator begins to rise. The engine should run at low idle smoothly until speed is gradually increased to high idle. Allow the white smoke to disperse before proceeding with normal operation.
 7. Operate the engine at low load until all systems reach operating temperature. Check the gauges during the warm-up period.
 8. Turn the engine start switch to the OFF position in order to stop the engine.

i02344933

Starting with Jump Start Cables

SMCS Code: 1000; 1401; 1402; 1900

WARNING

Improper jump start cable connections can cause an explosion resulting in personal injury.

Prevent sparks near the batteries. Sparks could cause vapors to explode. Do not allow jump start cable ends to contact each other or the engine.

If the installation is not equipped with a backup battery system, it may be necessary to start the engine from an external electrical source.

For information on troubleshooting the charging system, refer to Special Instruction, REHS0354, "Charging System Troubleshooting".

Many batteries which are considered unusable are still rechargeable. After jump starting, the alternator may not be able to fully recharge batteries that are severely discharged. The batteries must be charged to the proper voltage with a battery charger. For information on testing and charging, refer to the Special Instruction, SEHS7633, "Battery Test Procedure".

NOTICE

Using a battery source with the same voltage as the electric starting motor. Use ONLY equal voltage for jump starting. The use of higher voltage will damage the electrical system.

Do not reverse the battery cables. The alternator can be damaged. Attach ground cable last and remove first.

When using an external electrical source to start the engine, turn the generator set control switch to the "OFF" position. Turn all electrical accessories OFF before attaching the jump start cables.

Ensure that the main power switch is in the OFF position before attaching the jump start cables to the engine being started.

1. Turn the start switch on the stalled engine to the OFF position. Turn off all the engine's accessories.

2. Connect one positive end of the jump start cable to the positive cable terminal of the discharged battery. Connect the other positive end of the jump start cable to the positive cable terminal of the electrical source.
3. Connect one negative end of the jump start cable to the negative cable terminal of the electrical source. Connect the other negative end of the jump start cable to the engine block or to the chassis ground. This procedure helps to prevent potential sparks from igniting the combustible gases that are produced by some batteries.
4. Start the engine.
5. Immediately after the engine is started, disconnect the jump start cables in reverse order.

After jump starting, the alternator may not be able to fully recharge batteries that are severely discharged. The batteries must be replaced or charged to the proper voltage with a battery charger after the engine is stopped. Many batteries which are considered unusable are still rechargeable. Refer to Operation and Maintenance Manual, "Battery - Replace" and Testing and Adjusting Manual, "Battery - Test".

Refer to the Electrical Schematic for your engine. Consult your Caterpillar dealer for more information.

i02710753

After Starting Engine

SMCS Code: 1000

Note: In temperatures from 0 to 60°C (32 to 140°F), the warm-up time is approximately three minutes. In temperatures below 0°C (32°F), additional warm-up time may be required.

When the engine idles during warm-up, observe the following conditions:

- Check for any fluid or for any air leaks at idle rpm and at one-half full rpm (no load on the engine) before operating the engine under load. This is not possible in some applications.
- Operate the engine at low idle until all systems achieve operating temperatures. Check all gauges during the warm-up period.

Note: Gauge readings should be observed and the data should be recorded frequently while the engine is operating. Comparing the data over time will help to determine normal readings for each gauge. Comparing data over time will also help detect abnormal operating developments. Significant changes in the readings should be investigated.

Engine Operation

i01646335

Engine Operation

i02708025

SMCS Code: 1000

Proper operation and maintenance are key factors in obtaining the maximum life and economy of the engine. If the directions in the Operation and Maintenance Manual are followed, costs can be minimized and engine service life can be maximized.

The time that is needed for the engine to reach normal operating temperature can be less than the time taken for a walk-around inspection of the engine.

The engine can be operated at the rated rpm after the engine is started and after the engine reaches operating temperature. The engine will reach normal operating temperature sooner during a low engine speed (rpm) and during a low power demand. This procedure is more effective than idling the engine at no load. The engine should reach operating temperature in a few minutes.

Gauge readings should be observed and the data should be recorded frequently while the engine is operating. Comparing the data over time will help to determine normal readings for each gauge. Comparing data over time will also help detect abnormal operating developments. Significant changes in the readings should be investigated.

i02707215

Engine Warm-up

SMCS Code: 1000

1. Run the engine at low idle for three to five minutes, or run the engine at low idle until the jacket water coolant temperature starts to rise.

More time may be necessary when the temperature is below -18°C (0°F).

2. Check all of the gauges during the warm-up period.
3. Perform a walk-around inspection. Check the engine for fluid leaks and air leaks.
4. Increase the rpm to the rated rpm. Check for fluid leaks and air leaks. The engine may be operated at full rated rpm and at full load when the temperature of the water jacket reaches 60°C (140°F).

Engaging the Driven Equipment

SMCS Code: 1000

1. Operate the engine at one-half of the rated rpm, when possible.
2. Engage the driven equipment without a load on the equipment, when possible.

Interrupted starts put excessive stress on the drive train. Interrupted starts also waste fuel. To get the driven equipment in motion, engage the clutch smoothly with no load on the equipment. This method should produce a start that is smooth and easy. The engine rpm should not increase and the clutch should not slip.

3. Ensure that the ranges of the gauges are normal when the engine is operating at one-half of the rated rpm. Ensure that all gauges operate properly.
4. Increase the engine rpm to the rated rpm. Always increase the engine rpm to the rated rpm before the load is applied.
5. Apply the load. Begin operating the engine at low load. Check the gauges and equipment for proper operation. After normal oil pressure is reached and the temperature gauge begins to move, the engine may be operated at full load. Check the gauges and equipment frequently when the engine is operated under load.

Extended operation at low idle or at reduced load may cause increased oil consumption and carbon buildup in the cylinders. This carbon buildup results in a loss of power and/or poor performance.

i02707216

Fuel Conservation Practices

SMCS Code: 1000; 1250

The efficiency of the engine can affect the fuel economy. Caterpillar's design and technology in manufacturing provides maximum fuel efficiency in all applications. Follow the recommended procedures in order to attain optimum performance for the life of the engine.

- Avoid spilling fuel.

Fuel expands when the fuel is warmed up. The fuel may overflow from the fuel tank. Inspect fuel lines for leaks. Repair the fuel lines, as needed.

- Be aware of the properties of the different fuels. Use only the recommended fuels. Refer to the Operations and Maintenance Manual, "Fuel Recommendations" for further information.
- Avoid unnecessary idling.

Shut off the engine rather than idle for long periods of time.

- Observe the service indicator frequently. Keep the air cleaner elements clean.
- Ensure that the turbocharger is operating correctly so that the proper air/fuel ratio is maintained. Clean exhaust indicates proper functioning.
- Maintain a good electrical system.

One faulty battery cell will overwork the alternator. This will consume excess power and excess fuel.

- Ensure that the belts are properly adjusted. The belts should be in good condition. Refer to the Specifications manual for further information.
- Ensure that all of the connections of the hoses are tight. The connections should not leak.
- Ensure that the driven equipment is in good working order.
- Cold engines consume excess fuel. Utilize heat from the jacket water system and the exhaust system, when possible. Keep cooling system components clean and keep cooling system components in good repair. Never operate the engine without water temperature regulators. All of these items will help maintain operating temperatures.

Engine Stopping

i02704619

Stopping the Engine

i02710650

SMCS Code: 1000; 7000

NOTICE

Stopping the engine immediately after it has been working under load can result in overheating and accelerated wear of the engine components.

If the engine has been operating at high rpm and/or high loads, run at low idle for at least three minutes to reduce and stabilize internal engine temperature before stopping the engine.

Avoiding hot engine shutdowns will maximize turbocharger shaft and bearing life.

Prior to stopping an engine that is being operated at low loads, operate the engine at low idle for 30 seconds before stopping. If the engine has been operating at highway speeds and/or at high loads, operate the engine at low idle for at least three minutes. This procedure will cause the internal engine temperature to be reduced and stabilized.

Ensure that the engine stopping procedure is understood. Stop the engine according to the shutoff system on the engine or refer to the instructions that are provided by the OEM.

- To stop the engine, turn the keyswitch to the OFF position.

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Emergency Stopping

SMCS Code: 1000; 7418

NOTICE

Emergency shutoff controls are for EMERGENCY use ONLY. DO NOT use emergency shutoff devices or controls for normal stopping procedure.

The OEM may have equipped the application with an emergency stop button. For more information about the emergency stop button, refer to the OEM information.

Ensure that any components for the external system that support the engine operation are secured after the engine is stopped.

After Stopping Engine

SMCS Code: 1000

Note: Before you check the engine oil, do not operate the engine for at least 10 minutes in order to allow the engine oil to return to the oil pan.

- Check the crankcase oil level. Maintain the oil level between the “MIN” mark and the “MAX” mark on the oil level dipstick.
 - If necessary, perform minor adjustments. Repair any leaks and tighten any loose bolts.
 - Note the required service interval. Perform the maintenance that is in the Operation and Maintenance Manual, “Maintenance Interval Schedule”.
 - Fill the fuel tank in order to help prevent accumulation of moisture in the fuel. Do not overfill the fuel tank.
-

NOTICE

Only use antifreeze/coolant mixtures recommended in the Refill Capacities and Recommendations topic that is in this Operation and Maintenance Manual. Failure to do so can cause engine damage.

- Allow the engine to cool. Check the coolant level.
- If freezing temperatures are expected, check the coolant for the correct antifreeze protection. The cooling system must be protected against freezing to the lowest expected outside temperature. Add the correct coolant/water mixture, if necessary.
- Perform all required periodic maintenance on all driven equipment. This maintenance is outlined in the instructions from the OEM.

Cold Weather Operation

i02708046

Radiator Restrictions

SMCS Code: 1353; 1396

Caterpillar discourages the use of air flow restriction devices that are mounted in front of radiators. Air flow restriction can cause the following conditions:

- High exhaust temperatures
- Power loss
- Excessive fan usage
- Reduction in fuel economy

If an air flow restriction device must be used, the device should have a permanent opening directly in line with the fan hub. The device must have a minimum opening dimension of at least 770 cm² (120 in²).

A centered opening that is directly in line with the fan hub is specified in order to prevent an interrupted air flow on the fan blades. Interrupted air flow on the fan blades could cause a fan failure.

Caterpillar recommends a warning device for the inlet manifold temperature and/or the installation of an inlet air temperature gauge. The warning device for the inlet manifold temperature should be set at 75 °C (167 °F). The inlet manifold air temperature should not exceed 75 °C (167 °F). Temperatures that exceed this limit can cause power loss and potential engine damage.

i02704604

Fuel and the Effect from Cold Weather

SMCS Code: 1000; 1250

Note: Only use grades of fuel that are recommended by Caterpillar. Refer to this Operation and Maintenance Manual, "Fluid Recommendations".

The following fuels can be used in this series of engine.

- Group 1
- Group 2
- Group 3

- Special Fuels

Caterpillar prefer only Group 1 and Group 2 fuels for use in this series of engines.

Group 1 fuels are the preferred Group of Fuels for general use by Caterpillar. Group 1 fuels maximize engine life and engine performance. Group 1 fuels are usually less available than Group 2 fuels. Frequently, Group 1 fuels are not available in colder climates during the winter.

Note: Group 2 fuels must have a maximum wear scar of 650 micrometers (HFRR to ISO 12156-1).

Group 2 fuels are considered acceptable for issues of warranty. This group of fuels may reduce the life of the engine, the engine's maximum power, and the engine's fuel efficiency.

When Group 2 diesel fuels are used the following components provide a means of minimizing problems in cold weather:

- Glow plugs (if equipped)
- Engine coolant heaters, which may be an OEM option
- Fuel heaters, which may be an OEM option
- Fuel line insulation, which may be an OEM option

There are three major differences between Group 1 fuels and Group 2 fuels. Group 1 fuels have the following different characteristics to Group 2 fuels.

- A lower cloud point
- A lower pour point
- A higher energy per unit volume of fuel

Note: Group 3 fuels reduce the life of the engine. The use of Group 3 fuels is not covered by the Caterpillar warranty.

Group 3 fuels include Low Temperature Fuels and Aviation Kerosene Fuels.

Special fuels include Biofuel.

The cloud point is a temperature that allows wax crystals to form in the fuel. These crystals can cause the fuel filters to plug.

The pour point is the temperature when diesel fuel will thicken. The diesel fuel becomes more resistant to flow through fuel lines, fuel filters, and fuel pumps.

Be aware of these facts when diesel fuel is purchased. Consider the average ambient air temperature for the engine's application. Engines that are fueled in one climate may not operate well if the engines are moved to another climate. Problems can result due to changes in temperature.

Before troubleshooting for low power or for poor performance in the winter, check the fuel for waxing.

Low temperature fuels may be available for engine operation at temperatures below 0 °C (32 °F). These fuels limit the formation of wax in the fuel at low temperatures.

For more information on cold weather operation, refer to the Operation and Maintenance Manual, "Cold Weather Operation and Fuel Related Components in Cold Weather".

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Fuel Related Components in Cold Weather

SMCS Code: 1000; 1250

Fuel Tanks

Condensation can form in partially filled fuel tanks. Top off the fuel tanks after you operate the engine.

Fuel tanks should contain some provision for draining water and sediment from the bottom of the tanks. Some fuel tanks use supply pipes that allow water and sediment to settle below the end of the fuel supply pipe.

Some fuel tanks use supply lines that take fuel directly from the bottom of the tank. If the engine is equipped with this system, regular maintenance of the fuel system filter is important.

Drain the water and sediment from any fuel storage tank at the following intervals: weekly, oil changes, and refueling of the fuel tank. This will help prevent water and/or sediment from being pumped from the fuel storage tank and into the engine fuel tank.

Fuel Filters

It is possible that a primary fuel filter is installed between the fuel tank and the engine fuel inlet. After you change the fuel filter, always prime the fuel system in order to remove air bubbles from the fuel system. Refer to the Operation and Maintenance Manual in the Maintenance Section for more information on priming the fuel system.

The micron rating and the location of a primary fuel filter is important in cold weather operation. The primary fuel filter and the fuel supply line are the most common components that are affected by cold fuel.

Fuel Heaters

Fuel heaters help to prevent fuel filters from plugging in cold weather due to waxing. A fuel heater should be installed in the fuel system before the primary fuel filter.

The following fuel heaters are recommended for Caterpillar engines:

- 7C-3557 Fuel Heater Group
- 7C-3558 Heater Kit

For further information on fuel heaters, consult your Caterpillar dealer.

Disconnect the fuel heater in warm weather.

Note: Fuel heaters that are controlled by the water temperature regulator or self-regulating fuel heaters should be used with this engine. Fuel heaters that are not controlled by the water temperature regulator can heat the fuel in excess of 65°C (149°F). A loss of engine power can occur if the fuel supply temperature exceeds 37°C (100°F).

Note: Heat exchanger type fuel heaters should have a bypass provision in order to prevent overheating of the fuel in warm weather operation.

Maintenance Section

Refill Capacities

i02501519

Refill Capacities and Recommendations

SMCS Code: 1348; 1395; 7560

Engine Oil

NOTICE

These recommendations are subject to change without notice. Contact your local Caterpillar dealer for the most up to date recommendations.

API Oils

The Engine Oil Licensing and Certification System by the American Petroleum Institute (API) is recognized by Caterpillar. For detailed information about this system, see the latest edition of the "API publication No. 1509". Engine oils that bear the API symbol are authorized by API.

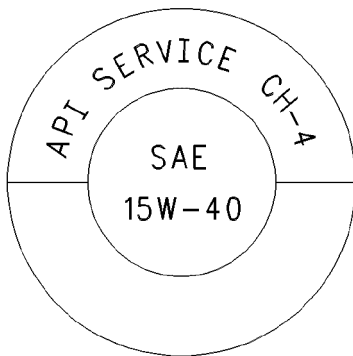


Illustration 20

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Typical API symbol

Diesel engine oils CC, CD, CD-2, and CE have not been API authorized classifications since 1 January 1996.

Table 2

API Classifications	
Current	Obsolete
CH-4 ⁽¹⁾ CI-4	CE, CC, CD
-	CD-2 ⁽²⁾

⁽¹⁾ API CH-4 and CI-4 oils are acceptable if the requirements of Caterpillar's ECF-1 (Engine Crankcase Fluid specification-1) are met. CH-4 and CI-4 oils that have not met the requirements of Caterpillar's ECF-1 Specification may cause reduced engine life.

⁽²⁾ The oil CD-2 is for a two-cycle diesel engine. Caterpillar does not sell engines that utilize CD-2 oil.

Note: When oil meets more than one API classification, the applicable footnote is determined by the highest API classification that is met.

Example – An oil meets both the API CH-4 and the API CF oil classifications. In this case, the API CH-4 applies.

Cat DEO (Diesel Engine Oil)

Caterpillar Oils have been developed and tested in order to provide the full performance and service life that has been designed and built into Caterpillar Engines. Caterpillar Oils are currently used to fill diesel engines at the factory. These oils are offered by Caterpillar dealers for continued use when the engine oil is changed. Consult your Caterpillar dealer for more information on these oils.

Due to significant variations in the quality and in the performance of commercially available oils, Caterpillar makes the following recommendations:

- **Cat DEO (Diesel Engine Oil) (10W-30)**
- **Cat DEO (Diesel Engine Oil) (15W-40)**

Caterpillar multigrade DEO is formulated with the correct amounts of detergents, dispersants, and alkalinity in order to provide superior performance in Caterpillar Diesel Engines.

Caterpillar multigrade DEO is available in various viscosity grades that include SAE 10W-30 and SAE 15W-40. To choose the correct viscosity grade for the ambient temperature, see Table 3. Multigrade oils provide the correct viscosity for a broad range of operating temperatures.

Multigrade oils are effective in maintaining low oil consumption and low levels of piston deposits.

Caterpillar multigrade DEO can be used in other diesel engines and in gasoline engines. See the engine manufacturer's guide for the recommended specifications. Compare the specifications to the specifications of Caterpillar multigrade DEO. The current industry standards for Caterpillar DEO are listed on the product label and on the data sheets for the product.

Consult your Caterpillar dealer for part numbers and for available sizes of containers.

Note: Caterpillar SAE 15W-40 multigrade DEO exceeds the performance requirements for the following API classifications: CI-4, CH-4, CG-4, CF-4, and CF. The Caterpillar multigrade DEO exceeds the requirements of the Caterpillar specification that is ECF-1 (Engine Crankcase Fluid-1). The Caterpillar SAE 15W-40 multigrade DEO passes the following proprietary tests: sticking of the piston ring, oil control tests, wear tests, and soot tests. Proprietary tests help ensure that Caterpillar multigrade oil provides superior performance in Caterpillar Diesel Engines. In addition, Caterpillar multigrade oil exceeds many of the performance requirements of other manufacturers of diesel engines. Therefore, this oil is an excellent choice for many mixed fleets. **True high performance oil is produced with a combination of the following factors: industry standard tests, proprietary tests, field tests, and prior experience with similar formulations. The design and the development of Caterpillar lubricants that are both high performance and high quality are based on these factors.**

Note: Non-Caterpillar commercial oils are second choice oils.

Commercial Oils

Note: If Caterpillar Multigrade DEO is not used, use only commercial oils that meet the following classifications.

- API CH-4 multigrade oils and API CI-4 multigrade oils are acceptable if the requirements of Caterpillar's ECF-1 (Engine Crankcase Fluid specification-1) are met. CH-4 oils and CI-4 oils that have not met the requirements of Caterpillar's ECF-1 Specification may cause reduced engine life.
- API CF-4 multigrade oils are not recommended for this series of diesel engines. For all other smaller commercial diesel engines, the oil drain interval should not exceed 50 percent of the standard oil drain interval for your engine.

NOTICE

In selecting oil for any engine application, both the oil viscosity and oil performance classification/specification as specified by the engine manufacturer must be defined and satisfied. Using only one of these parameters will not sufficiently define oil for an engine application.

In order to make the proper choice of a commercial oil, refer to the following explanations:

API CI-4 – API CI-4 oils were developed in order to meet the requirements of high performance diesel engines that use cooled Exhaust Gas Recirculation (EGR). API CI-4 oils are acceptable if the requirements of Caterpillar's ECF-1 (Engine Crankcase Fluid specification-1) are met.

API CH-4 – API CH-4 oils were developed in order to protect low emissions diesel engines that use a 0.05 percent level of fuel sulfur. However, API CH-4 oils may be used with higher sulfur fuels. API CH-4 oils are acceptable if the requirements of Caterpillar's ECF-1 (Engine Crankcase Fluid specification-1) are met.

Note: CH-4 oils and CI-4 oils that have not met the requirements of Caterpillar's ECF-1 Specification may cause reduced engine life.

NOTICE

Failure to follow these oil recommendations can cause shortened engine service life due to deposits and/or excessive wear.

Note: Refer to Special Publication, SEBU6251, "Caterpillar Commercial Diesel Engine Fluids Recommendations" for additional information that relates to lubrication for your engine.

Lubricant Viscosity Recommendations

The proper SAE viscosity grade of oil is determined by the minimum ambient temperature during cold engine start-up, and the maximum ambient temperature during engine operation.

Refer to Table 3 (minimum temperature) in order to determine the required oil viscosity for starting a cold engine.

Refer to Table 3 (maximum temperature) in order to select the oil viscosity for engine operation at the highest ambient temperature that is anticipated.

Note: Generally, use the highest oil viscosity that is available to meet the requirement for the temperature at start-up.

If ambient temperature conditions at engine start-up require the use of multigrade SAE 0W oil, SAE 0W-40 viscosity grade is preferred over SAE 0W-20 or SAE 0W-30.

Table 3

Engine Oil Viscosities for Ambient Temperatures		
Viscosity Grade	Ambient Temperature	
	Minimum	Maximum
SAE 0W-20	-40 °C (-40 °F)	10 °C (50 °F)
SAE 0W-30	-40 °C (-40 °F)	30 °C (86 °F)
SAE 0W-40	-40 °C (-40 °F)	40 °C (104 °F)
SAE 5W-30	-30 °C (-22 °F)	30 °C (86 °F)
SAE 5W-40	-30 °C (-22 °F)	50 °C (122 °F)
SAE 10W-30	-18 °C (0 °F)	40 °C (104 °F)
SAE 10W-40	-18 °C (0 °F)	50 °C (122 °F)
SAE 15W-40	-9.5 °C (15 °F)	50 °C (122 °F)

Note: Supplemental heat is recommended below the minimum recommended ambient temperature.

S-O-S Oil Analysis

Caterpillar has developed a tool for maintenance management that evaluates oil degradation and the tool also detects the early signs of wear on internal components. The Caterpillar tool for oil analysis is called S-O-S Oil Analysis and the tool is part of the S-O-S Services program. S-O-S Oil Analysis divides oil analysis into three categories:

- Wear Analysis
- Oil condition
- Additional tests

The wear analysis monitors metal particles, some oil additives, and some contaminants.

Oil condition uses infrared (IR) analysis to evaluate the chemistry of the oil. Infrared analysis is also used to detect certain types of contamination.

Additional tests are used to measure contamination levels from water, fuel, or coolant. Oil viscosity and corrosion protection can be evaluated, as needed.

Refer to Special Publication, SEBU6251, "Caterpillar Commercial Diesel Engine Fluids Recommendations" or contact your local Caterpillar dealer for additional information concerning the S-O-S Oil Analysis program.

Refill Capacities for the Lubrication System

The refill capacities for the engine crankcase reflect the approximate capacity of the crankcase or sump plus standard oil filters. Auxiliary oil filter systems will require additional oil. Refer to the OEM specifications for the capacity of the auxiliary oil filter.

Table 4

Engine Refill Capacities		
Compartment or System	Minimum	Maximum
Crankcase Oil Sump ⁽¹⁾	5 L (5.2834 qt)	7 L (7.3968 qt)

⁽¹⁾ These values are the approximate capacities for the crankcase oil sump (aluminum) which includes the standard factory installed oil filters. Engines with auxiliary oil filters will require additional oil. Refer to the OEM specifications for the capacity of the auxiliary oil filter.

Lubricating Grease

Caterpillar provides a range of moderate greases to extremely high performance greases in order to service the entire line of Caterpillar products that operate throughout the wide variety of climates. From this variety of Caterpillar grease products, you will find at least one of the Caterpillar greases that will satisfy the performance requirements for any machine or equipment application.

Before selecting a grease for any application, the performance requirements must be determined. Consult the grease recommendations that are made by the OEM for the equipment when the equipment is operated in the expected conditions. Then, consult with your Caterpillar dealer for a list of greases and the following related characteristics.

- Performance specifications
- Available sizes of containers
- Part numbers

Always choose a grease that satisfies the recommendations that are specified by the equipment manufacturer for the application.

Note: If it is necessary to choose a single grease to use for all of the equipment at one site, always choose a grease that satisfies the requirements of the most demanding application.

Do not use the cost per pound as the only factor when you choose a grease. Use the grease that yields the lowest total cost of operation. The cost analysis should include the following factors:

- Parts
- Labor
- Downtime
- Cost of the grease

Greases that barely meet the minimum performance requirements can be expected to barely produce the minimum life of the parts.

Note: Take care when you change the type of grease. Take care when you change to a different supplier of grease. Some greases are not chemically compatible. Some brands of grease can not be interchanged. **If you are in doubt about the compatibility of the old grease and the new grease, purge all of the old grease from the joint.** Consult your supplier in order to determine if the greases are compatible.

Note: All Caterpillar brand of greases are compatible with each other.

Note: Refer to Special Publication, SEBU6251, "Caterpillar Commercial Diesel Engine Fluids Recommendations" for additional information that relates to lubrication for your engine.

General Fuel Information

Diesel fuels that meet the Caterpillar Specification for Distillate Diesel Fuel are recommended. These fuels will help to provide maximum engine service life and performance. In North America, diesel fuel that is identified as No. 1-D or No. 2-D in "ASTM D975" generally meet the specifications. Diesel fuels from other sources could exhibit detrimental properties that are not defined or controlled by this specification.

NOTICE

Operating with fuels that do not meet Caterpillar's recommendations can cause the following effects: starting difficulty, poor combustion, deposits in the fuel injectors, reduced service life of the fuel system, deposits in the combustion chamber, and reduced service life of the engine.

Note: Refer to Special Publication, SEBU6251, "Caterpillar Commercial Diesel Engine Fluids Recommendations" for the Caterpillar Specification for distillate fuel and for additional information that relates to fuel for your engine.

Refill Capacities for the Fuel System

Refer to the Operation and Maintenance Manual that is provided by the OEM for capacities of the fuel system.

General Coolant Information

NOTICE

These recommendations are subject to change without notice. Contact your local Caterpillar dealer for the most up to date fluids recommendations.

NOTICE

Never add coolant to an overheated engine. Engine damage could result. Allow the engine to cool first.

NOTICE

If the engine is to be stored in, or shipped to an area with below freezing temperatures, the cooling system must be either protected to the lowest outside temperature or drained completely to prevent damage.

NOTICE

Frequently check the specific gravity of the coolant for proper freeze protection or for anti-boil protection.

Clean the cooling system for the following reasons:

- Contamination of the cooling system
- Overheating of the engine
- Foaming of the coolant

Note: Air pockets can form in the cooling system if the cooling system is filled at a rate that is greater than 5 L (1.3 US gal) per minute.

After you drain the cooling system and after you refill the cooling system, operate the engine. Operate the engine without the filler cap until the coolant reaches normal operating temperature and the coolant level stabilizes. Ensure that the coolant is maintained to the proper level.

NOTICE

Never operate an engine without water temperature regulators in the cooling system. Water temperature regulators help to maintain the engine coolant at the proper operating temperature. Cooling system problems can develop without water temperature regulators.

Refer to Special Instruction, SEBD0518, "Know Your Cooling System" and Special Instruction, SEBD0970, "Coolant and Your Engine" for more detailed information.

Many engine failures are related to the cooling system. The following problems are related to cooling system failures: overheating, leakage of the water pump, plugged radiators or heat exchangers, and pitting of the cylinder liners.

These failures can be avoided with proper cooling system maintenance. Cooling system maintenance is as important as maintenance of the fuel system and the lubrication system. Quality of the coolant is as important as the quality of the fuel and the lubricating oil.

Coolant is normally composed of three elements: water, additives, and glycol.

Water

NOTICE

Never use water alone without Supplemental Coolant Additives (SCA) or without inhibited coolant. Water alone is corrosive at engine operating temperatures. Water alone does not provide adequate protection against boiling or freezing.

Water is used in the cooling system in order to transfer heat.

Distilled water or deionized water is recommended for use in engine cooling systems.

DO NOT use the following types of water in cooling systems: hard water, softened water that has been conditioned with salt, and sea water.

If distilled water or deionized water is not available, use water with the properties that are listed in Table 5.

Table 5

Caterpillar Minimum Acceptable Water Requirements		
Property	Maximum Limit	ASTM Test
Chloride (Cl)	40 mg/L (2.4 grains/US gal)	"D512", "D4327"
Sulfate (SO ₄)	100 mg/L (5.9 grains/US gal)	"D516"
Total Hardness	170 mg/L (10 grains/US gal)	"D1126"
Total Solids	340 mg/L (20 grain/US gal)	"D1888"
Acidity	pH of 5.5 to 9.0	"D1293"

For a water analysis, consult one of the following sources:

- Caterpillar dealer
- Local water utility company

- Agricultural agent
- Independent laboratory

Additives

Additives help to protect the metal surfaces of the cooling system. A lack of coolant additives or insufficient amounts of additives enable the following conditions to occur:

- Corrosion
- Formation of mineral deposits
- Rust
- Scale
- Pitting and erosion from cavitation of the cylinder liner
- Foaming of the coolant

Many additives are depleted during engine operation. These additives must be replaced periodically. This can be done by adding Supplemental Coolant Additives (SCA) to Diesel Engine Antifreeze/Coolant (DEAC) or by adding ELC Extender to Extended Life Coolant (ELC).

Additives must be added at the proper concentration. Overconcentration of additives can cause the inhibitors to drop out-of-solution. The deposits can enable the following problems to occur:

- Formation of gel compounds
- Reduction of heat transfer
- Leakage of the water pump seal
- Plugging of radiators, coolers, and small passages

Glycol

Glycol in the coolant helps to provide protection against the following conditions:

- Boiling
- Freezing
- Cavitation of the water pump and the cylinder liner

For optimum performance, Caterpillar recommends a 1:1 mixture of a water/glycol solution.

Note: Use a mixture that will provide protection against the lowest ambient temperature.

Note: 100 percent pure glycol will freeze at a temperature of $-23\text{ }^{\circ}\text{C}$ ($-9\text{ }^{\circ}\text{F}$).

Most conventional heavy-duty antifreezes use ethylene glycol. Propylene glycol may also be used. In a 1:1 mixture with water, ethylene and propylene glycol provide similar protection against freezing and boiling. See Tables 6 and 7.

Table 6

Ethylene Glycol		
Concentration	Freeze Protection	Boil Protection
50 Percent	$-36\text{ }^{\circ}\text{C}$ ($-33\text{ }^{\circ}\text{F}$)	$106\text{ }^{\circ}\text{C}$ ($223\text{ }^{\circ}\text{F}$)
60 Percent	$-51\text{ }^{\circ}\text{C}$ ($-60\text{ }^{\circ}\text{F}$)	$111\text{ }^{\circ}\text{C}$ ($232\text{ }^{\circ}\text{F}$)

NOTICE

Do not use propylene glycol in concentrations that exceed 50 percent glycol because of propylene glycol's reduced heat transfer capability. Use ethylene glycol in conditions that require additional protection against boiling or freezing.

Table 7

Propylene Glycol		
Concentration	Freeze Protection	Anti-Boil Protection
50 Percent	$-29\text{ }^{\circ}\text{C}$ ($-20\text{ }^{\circ}\text{F}$)	$106\text{ }^{\circ}\text{C}$ ($223\text{ }^{\circ}\text{F}$)

To check the concentration of glycol, use the 1U-7298 Coolant/Battery Tester (Degrees Celsius) or use the 1U-7297 Coolant/Battery Tester (Degrees Fahrenheit). The testers give readings that are immediate and accurate. The testers can be used with ethylene or propylene glycol.

Coolant Recommendations

NOTICE

Do not use a commercial coolant/antifreeze that only meets the ASTM D3306 specification. This type of coolant/antifreeze is made for light duty automotive applications.

The following two coolants are used in Caterpillar diesel engines:

Preferred – Caterpillar Extended Life Coolant (ELC) or a commercial extended life coolant that meets the Caterpillar EC-1 specification

Acceptable – Caterpillar Diesel Engine Antifreeze (DEAC) or a commercial heavy-duty antifreeze that meets “ASTM D4985”, or “ASTM D6210” specifications

Caterpillar recommends a 1:1 mixture of water and glycol. This mixture of water and glycol will provide optimum heavy-duty performance as a antifreeze.

Note: Caterpillar DEAC does not require a treatment with an SCA at the initial fill. A commercial heavy-duty antifreeze that meets “ASTM D4985” or “ASTM D6210” specifications MAY require a treatment with an SCA at the initial fill. These coolants WILL require a treatment with an SCA on a maintenance basis.

Refer to Special Publication, SEBU6251, “Caterpillar Commercial Diesel Engine Fluids Recommendations” for additional information that relates to coolant.

S-O-S Coolant Analysis

Table 8

Recommended Interval		
Type of Coolant	Level 1	Level 2
DEAC	Every 250 Hours	Yearly ⁽¹⁾
ELC	Not Required	Yearly

⁽¹⁾ The Level 2 Coolant Analysis should be performed sooner if a problem is identified by a Level 1 Coolant Analysis.

S-O-S Coolant Analysis (Level 1)

A coolant analysis (Level 1) is a test of the properties of the coolant.

The following properties of the coolant are tested:

- Glycol concentration for freeze protection and boil protection
- Ability to protect from erosion and corrosion
- pH
- Conductivity
- Visual analysis
- Odor analysis

The results are reported, and appropriate recommendations are made.

Refer to the Maintenance Interval Schedule in this Operation and Maintenance Manual, “Cooling System Coolant Sample (Level 1) - Obtain” for a sampling location and the maintenance interval for collecting the coolant samples.

S-O-S Coolant Analysis (Level 2)

A coolant analysis (Level 2) is a comprehensive chemical evaluation of the coolant. This analysis is also a check of the overall condition of the inside of the cooling system.

The S·O·S Coolant Analysis has the following features:

- Full coolant analysis (Level 1)
- Identification of the source of metal corrosion and of contaminants
- Water hardness
- Identification of buildup of the impurities that cause corrosion
- Identification of buildup of the impurities that cause scaling

The results are reported, and appropriate recommendations are made.

Refer to the Maintenance Interval Schedule in this Operation and Maintenance Manual, "Cooling System Coolant Sample (Level 2) - Obtain" for a sampling location and the maintenance interval for collecting the coolant samples.

Testing the engine coolant is important to ensure that the engine is protected from internal cavitation and from corrosion. The analysis also tests the ability of the coolant to protect the engine from boiling and from freezing. The S·O·S Coolant Analysis can be done at your Caterpillar dealer. Caterpillar S·O·S Coolant Analysis is the best way to monitor the condition of your coolant and your cooling system. S·O·S Coolant Analysis is a program that is based on periodic samples.

Refer to Special Publication, SEBU6251, "Caterpillar Commercial Diesel Engine Fluids Recommendations" for additional information.

Refill Capacity of the Cooling System

To maintain the cooling system, the Total Cooling System capacity must be known. The approximate capacity for the "Engine Only" cooling system is listed. External System capacities will vary among applications. Refer to the OEM specifications for the External System capacity. This capacity information will be needed in order to determine the amount of antifreeze that is required for the Total Cooling System.

Table 9

Engine Refill Capacities	
Compartment or System	Liters
Engine Only	7 L (7.3968 qt)
External System Per OEM ⁽¹⁾	

⁽¹⁾ The External System includes a radiator or an expansion tank with the following components: heat exchanger and piping. Refer to the OEM specifications. Enter the value for the capacity of the External System in this row.

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Maintenance Interval Schedule

SMCS Code: 1000; 7500

When Required

Battery - Replace	41
Battery or Battery Cable - Disconnect	42
Engine - Clean	51
Engine Air Cleaner Element (Dual Element) - Clean/Replace	51
Engine Air Cleaner Element (Single Element) - Inspect/Replace	54
Fuel System - Prime	60
Severe Service Application - Check	68

Daily

Alternator Belt - Inspect/Adjust/Replace	41
Cooling System Coolant Level - Check	46
Driven Equipment - Check	50
Engine Air Cleaner Service Indicator - Inspect	54
Engine Air Precleaner - Check/Clean	55
Engine Oil Level - Check	55
Fuel System Primary Filter/Water Separator - Drain	61
V-Belts - Inspect/Adjust/Replace	70
Walk-Around Inspection	71

Every 50 Service Hours or Weekly

Fuel Tank Water and Sediment - Drain	63
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Every 250 Service Hours

Cooling System Coolant Sample (Level 1) - Obtain	47
Engine Oil Sample - Obtain	56

Every 500 Service Hours

V-Belts - Inspect/Adjust/Replace	70
--	----

Every 500 Service Hours or 6 Months

Engine Protective Devices - Check	58
---	----

Every 500 Service Hours or 1 Year

Battery Electrolyte Level - Check	42
Cooling System Supplemental Coolant Additive (SCA) - Test/Add	48
Crankcase Breather (Canister) - Replace	50
Engine Air Cleaner Element (Dual Element) - Clean/Replace	51
Engine Oil and Filter - Change	56
Fuel System Secondary Filter - Replace	61
Hoses and Clamps - Inspect/Replace	64
Radiator - Clean	68

Every 1000 Service Hours

Engine Valve Lash - Inspect/Adjust	59
--	----

Every 2000 Service Hours

Alternator - Inspect	41
Starting Motor - Inspect	69
Turbocharger - Inspect	69
Water Pump - Inspect	72

Every 2000 Service Hours or 1 Year

Engine Mounts - Inspect	55
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Every Year

Cooling System Coolant Sample (Level 2) - Obtain	48
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Every 3000 Service Hours

Alternator Belt - Inspect/Adjust/Replace	41
Fuel Injection Nozzles - Test/Exchange	59

Every 3000 Service Hours or 2 Years

Cooling System Coolant (DEAC) - Change	43
Cooling System Water Temperature Regulator - Replace	49

Every 12 000 Service Hours or 6 Years

Cooling System Coolant (ELC) - Change	45
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Overhaul

Overhaul Considerations	65
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i02704667

Alternator - Inspect

SMCS Code: 1405-040

Caterpillar recommends a scheduled inspection of the alternator. Inspect the alternator for loose connections and proper battery charging. Inspect the ammeter (if equipped) during engine operation in order to ensure proper battery performance and/or proper performance of the electrical system. Make repairs, as required.

Check the alternator and the battery charger for proper operation. If the batteries are properly charged, the ammeter reading should be very near zero. All batteries should be kept charged. The batteries should be kept warm because temperature affects the cranking power. If the battery is too cold, the battery will not crank the engine. The battery will not crank the engine, even if the engine is warm. When the engine is not run for long periods of time or if the engine is run for short periods, the batteries may not fully charge. A battery with a low charge will freeze more easily than a battery with a full charge.

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Alternator Belt - Inspect/Adjust/Replace (Poly V-Belt)

SMCS Code: 1357-036; 1357-510

Inspection

To maximize the engine performance, inspect the belt (1) for wear and for cracking. Replace the belt if the belt is worn or damaged.

- If the belt (1) has more than four cracks per 25.4000 mm (1 inch) the belt must be replaced.
- Check the belt of cracks, splits, glazing, grease, and splitting.

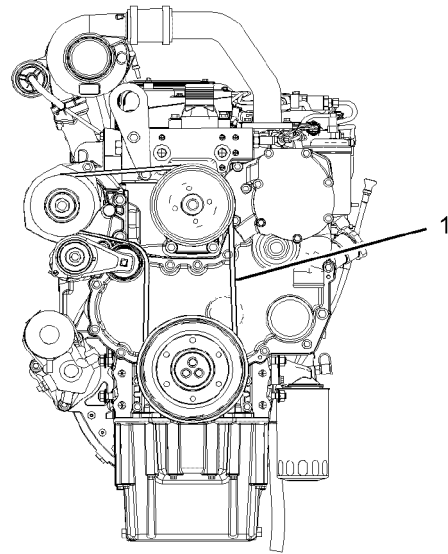


Illustration 21

g01251375

Typical example

Adjustment

This type of belt has an automatic belt tensioner.

Replace

Refer to Disassembly and Assembly manual, "Alternator Belt - Remove and Install".

i02322315

Battery - Replace

SMCS Code: 1401-510

⚠ WARNING

Batteries give off combustible gases which can explode. A spark can cause the combustible gases to ignite. This can result in severe personal injury or death.

Ensure proper ventilation for batteries that are in an enclosure. Follow the proper procedures in order to help prevent electrical arcs and/or sparks near batteries. Do not smoke when batteries are serviced.

 **WARNING**

The battery cables or the batteries should not be removed with the battery cover in place. The battery cover should be removed before any servicing is attempted.

Removing the battery cables or the batteries with the cover in place may cause a battery explosion resulting in personal injury.

1. Switch the engine to the OFF position. Remove all electrical loads.
2. Turn off any battery chargers. Disconnect any battery chargers.
3. The NEGATIVE “-” cable connects the NEGATIVE “-” battery terminal to the NEGATIVE “-” terminal on the starting motor. Disconnect the cable from the NEGATIVE “-” battery terminal.
4. The POSITIVE “+” cable connects the POSITIVE “+” battery terminal to the POSITIVE “+” terminal on the starting motor. Disconnect the cable from the POSITIVE “+” battery terminal.

Note: Always recycle a battery. Never discard a battery. Dispose of used batteries to an appropriate recycling facility.

5. Remove the used battery.
6. Install the new battery.

Note: Before the cables are connected, ensure that the engine start switch is OFF.

7. Connect the cable from the starting motor to the POSITIVE “+” battery terminal.
8. Connect the NEGATIVE “-” cable to the NEGATIVE “-” battery terminal.

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Battery Electrolyte Level - Check

SMCS Code: 1401-535

When the engine is not run for long periods of time or when the engine is run for short periods, the batteries may not fully recharge. Ensure a full charge in order to help prevent the battery from freezing. If batteries are properly charged, ammeter reading should be very near zero, when the engine is in operation.

 **WARNING**

All lead-acid batteries contain sulfuric acid which can burn the skin and clothing. Always wear a face shield and protective clothing when working on or near batteries.

1. Remove the filler caps. Maintain the electrolyte level to the “FULL” mark on the battery.

If the addition of water is necessary, use distilled water. If distilled water is not available use clean water that is low in minerals. Do not use artificially softened water.

2. Check the condition of the electrolyte with the 245-5829 Coolant Battery Tester Refractometer.
3. Keep the batteries clean.

Clean the battery case with one of the following cleaning solutions:

- A mixture of 0.1 kg (0.2 lb) of baking soda and 1 L (1 qt) of clean water
- A mixture of 0.1 L (0.11 qt) of ammonia and 1 L (1 qt) of clean water

Thoroughly rinse the battery case with clean water.

Use a fine grade of sandpaper to clean the terminals and the cable clamps. Clean the items until the surfaces are bright or shiny. DO NOT remove material excessively. Excessive removal of material can cause the clamps to not fit properly. Coat the clamps and the terminals with 5N-5561 Silicone Lubricant, petroleum jelly or MPGM.

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Battery or Battery Cable - Disconnect

SMCS Code: 1402-029

 **WARNING**

The battery cables or the batteries should not be removed with the battery cover in place. The battery cover should be removed before any servicing is attempted.

Removing the battery cables or the batteries with the cover in place may cause a battery explosion resulting in personal injury.

1. Turn the start switch to the OFF position. Turn the ignition switch (if equipped) to the OFF position and remove the key and all electrical loads.
2. Disconnect the negative battery terminal. Ensure that the cable cannot contact the terminal. When four 12 volt batteries are involved, two negative connections must be disconnected.
3. Remove the positive connection.
4. Clean all disconnected connections and battery terminals.
5. Use a fine grade of sandpaper to clean the terminals and the cable clamps. Clean the items until the surfaces are bright or shiny. DO NOT remove material excessively. Excessive removal of material can cause the clamps to not fit correctly. Coat the clamps and the terminals with a suitable silicone lubricant or petroleum jelly.
6. Tape the cable connections in order to help prevent accidental starting.
7. Proceed with necessary system repairs.
8. In order to connect the battery, connect the positive connection before the negative connector.

i02710742

Cooling System Coolant (DEAC) - Change

SMCS Code: 1350-070; 1395-044

Clean the cooling system and flush the cooling system before the recommended maintenance interval if the following conditions exist:

- The engine overheats frequently.
- Foaming is observed.
- The oil has entered the cooling system and the coolant is contaminated.
- The fuel has entered the cooling system and the coolant is contaminated.

NOTICE

Use of commercially available cooling system cleaners may cause damage to cooling system components. Use only cooling system cleaners that are approved for Caterpillar engines.

Note: Inspect the water pump and the water temperature regulator after the cooling system has been drained. This is a good opportunity to replace the water pump, the water temperature regulator and the hoses, if necessary.

Drain

WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

1. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap.

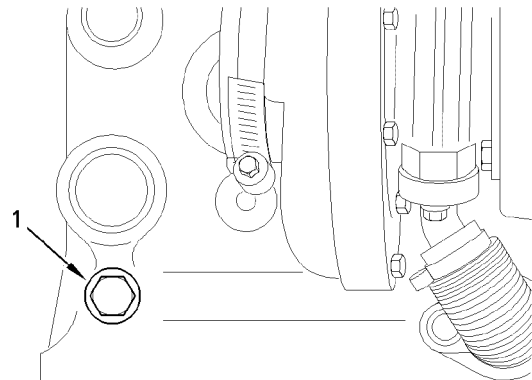


Illustration 22

g01003928

2. Open the cooling system drain valve (if equipped). If the cooling system is not equipped with a drain valve, remove the drain plug (1).

Allow the coolant to drain.

NOTICE

Dispose of used engine coolant properly or recycle. Various methods have been proposed to reclaim used coolant for reuse in engine cooling systems. The full distillation procedure is the only method acceptable by Caterpillar to reclaim the used coolant.

For information regarding the disposal and the recycling of used coolant, consult your Caterpillar dealer or consult Dealer Service Tools Group:

Outside Illinois: 1-800-542-TOOL
Inside Illinois: 1-800-541-TOOL
Canada: 1-800-523-TOOL

Flush

1. Flush the cooling system with clean water in order to remove any debris.
2. Close the drain valve (if equipped). Clean the drain plug (1). Install the drain plug. Refer to Torque Specifications, SENR3130 for more information on the correct torques.

NOTICE

Do not fill the cooling system faster than 5 L (1.3 US gal) per minute to avoid air locks.

Cooling system air locks may result in engine damage.

3. Fill the cooling system with a mixture of clean water and Caterpillar Fast Acting Cooling System Cleaner. Add 0.5 L (1 pint) of cleaner per 15 L (4 US gal) of the cooling system capacity. Install the cooling system filler cap.
4. Start and run the engine at low idle for a minimum of 30 minutes. The coolant temperature should be at least 82 °C (180 °F).

NOTICE

Improper or incomplete rinsing of the cooling system can result in damage to copper and other metal components.

To avoid damage to the cooling system, make sure to completely flush the cooling system with clear water. Continue to flush the system until all signs of the cleaning agent are gone.

5. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap. Open the drain valve (if equipped) or remove the cooling system drain plug (1). Allow the water to drain. Flush the cooling system with clean water. Close the drain valve (if equipped). Clean the drain plug. Install the drain plug. Refer to Torque Specifications, SENR3130 for more information on the correct torques.

Cooling Systems with Heavy Deposits or Plugging

Note: For the following procedure to be effective, there must be some active flow through the cooling system components.

1. Flush the cooling system with clean water in order to remove any debris.

2. Close the drain valve (if equipped). Clean the drain plug (1). Install the drain plug. Refer to Torque Specifications, SENR3130 for more information on the correct torques.

NOTICE

Do not fill the cooling system faster than 5 L (1.3 US gal) per minute to avoid air locks.

Cooling system air locks may result in engine damage.

3. Fill the cooling system with a mixture of clean water and Caterpillar Fast Acting Cooling System Cleaner. Add 0.5 L (1 pint) of cleaner per 3.8 to 7.6 L (1 to 2 US gal) of the cooling system capacity. Install the cooling system filler cap.
4. Start and run the engine at low idle for a minimum of 90 minutes. The coolant temperature should be at least 82 °C (180 °F).

NOTICE

Improper or incomplete rinsing of the cooling system can result in damage to copper and other metal components.

To avoid damage to the cooling system, make sure to completely flush the cooling system with clear water. Continue to flush the system until all signs of the cleaning agent are gone.

5. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap. Open the drain valve (if equipped) or remove the cooling system drain plug (1). Allow the water to drain. Flush the cooling system with clean water. Close the drain valve (if equipped). Clean the drain plug. Install the drain plug. Refer to Torque Specifications, SENR3130 for more information on the correct torques.

Fill

NOTICE

Do not fill the cooling system faster than 5 L (1.3 US gal) per minute to avoid air locks.

Cooling system air locks may result in engine damage.

1. Fill the cooling system with coolant or antifreeze. Refer to this Operation and Maintenance Manual, "Refill Capacities and Recommendations" topic (Maintenance Section) for more information on cooling system specifications. Do not install the cooling system filler cap.

2. Start and run the engine at low idle. Increase the engine rpm to 1500 rpm. Run the engine at high idle for one minute in order to purge the air from the cavities of the engine block. Stop the engine.
3. Check the coolant level. Maintain the coolant level within 13 mm (0.5 inch) below the bottom of the pipe for filling. Maintain the coolant level within 13 mm (0.5 inch) to the proper level on the sight glass (if equipped).
4. Clean the cooling system filler cap. Inspect the gasket that is on the cooling system filler cap. If the gasket that is on the cooling system filler cap is damaged, discard the old cooling system filler cap and install a new cooling system filler cap. If the gasket that is on the cooling system filler cap is not damaged, perform a pressure test. A 9S-8140 Pressurizing Pump is used to perform the pressure test. The correct pressure for the cooling system filler cap is stamped on the face of the cooling system filler cap. If the cooling system filler cap does not retain the correct pressure, obtain a new cooling system filler cap. Install the cooling system filler cap.
5. Start the engine. Inspect the cooling system for leaks and for the correct operating temperature.

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Cooling System Coolant (ELC) - Change

SMCS Code: 1350-070; 1395-044

Clean the cooling system and flush the cooling system before the recommended maintenance interval if the following conditions exist:

- The engine overheats frequently.
- Foaming is observed.
- The oil has entered the cooling system and the coolant is contaminated.
- The fuel has entered the cooling system and the coolant is contaminated.

Note: When the cooling system is cleaned, only clean water is needed when the ELC is drained and replaced.

Note: Inspect the water pump and the water temperature regulator after the cooling system has been drained. This is a good opportunity to replace the water pump, the water temperature regulator and the hoses, if necessary.

Drain



WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

1. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap.
2. Open the cooling system drain valve (if equipped). If the cooling system is not equipped with a drain valve, remove the cooling system drain plugs.

Allow the coolant to drain.

NOTICE

Dispose of used engine coolant properly or recycle. Various methods have been proposed to reclaim used coolant for reuse in engine cooling systems. The full distillation procedure is the only method acceptable by Caterpillar to reclaim the used coolant.

For information regarding the disposal and the recycling of used coolant, consult your Caterpillar dealer or consult Dealer Service Tools:

Outside Illinois: 1-800-542-TOOL
Inside Illinois: 1-800-541-TOOL
Canada: 1-800-523-TOOL

Flush

1. Flush the cooling system with clean water in order to remove any debris.
2. Close the drain valve (if equipped). Clean the drain plugs. Install the drain plugs. Refer to Torque Specifications, SENR3130 for more information on the correct torques.

NOTICE

Do not fill the cooling system faster than 5 L (1.3 US gal) per minute to avoid air locks.

Cooling system air locks may result in engine damage.

3. Fill the cooling system with clean water. Install the cooling system filler cap.
4. Start and run the engine at low idle until the temperature reaches 49 to 66 °C (120 to 150 °F).

5. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap. Open the drain valve (if equipped) or remove the cooling system drain plugs. Allow the water to drain. Flush the cooling system with clean water. Close the drain valve (if equipped). Clean the drain plugs. Install the drain plugs. Refer to Torque Specifications, SENR3130 for more information on the correct torques.

Fill

NOTICE

Do not fill the cooling system faster than 5 L (1.3 US gal) per minute to avoid air locks.

Cooling system air locks may result in engine damage.

1. Fill the cooling system with Extended Life Coolant (ELC). Refer to this Operation and Maintenance Manual, "Refill Capacities and Recommendations" topic (Maintenance Section) for more information on cooling system specifications. Do not install the cooling system filler cap.
2. Start and run the engine at low idle. Increase the engine rpm to high idle. Run the engine at high idle for one minute in order to purge the air from the cavities of the engine block. Stop the engine.
3. Check the coolant level. Maintain the coolant level within 13 mm (0.5 inch) below the bottom of the pipe for filling. Maintain the coolant level within 13 mm (0.5 inch) to the proper level on the sight glass (if equipped).
4. Clean the cooling system filler cap. Inspect the gasket that is on the cooling system filler cap. If the gasket that is on the cooling system filler cap is damaged, discard the old cooling system filler cap and install a new cooling system filler cap. If the gasket that is on the cooling system filler cap is not damaged, use a 9S-8140 Pressurizing Pump in order to pressure test the cooling system filler cap. The correct pressure for the cooling system filler cap is stamped on the face of the cooling system filler cap. If the cooling system filler cap does not retain the correct pressure, install a new cooling system filler cap.
5. Start the engine. Inspect the cooling system for leaks and for proper operating temperature.

Cooling System Coolant Level - Check

SMCS Code: 1395-082

Engines With a Coolant Recovery Tank

Note: The cooling system may not have been provided by Caterpillar. The procedure that follows is for typical cooling systems. Refer to the OEM information for the correct procedures.

Check the coolant level when the engine is stopped and cool.

1. Observe the coolant level in the coolant recovery tank. Maintain the coolant level to "COLD FULL" mark on the coolant recovery tank.

WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

2. Loosen filler cap slowly in order to relieve any pressure. Remove the filler cap.
3. Pour the correct coolant mixture into the tank. Refer to the Operation and Maintenance Manual, "Refill Capacities and Recommendations" for information on the correct mixture and type of coolant. Refer to the Operation and Maintenance Manual, "Refill Capacities and Recommendations" for the cooling system capacity. Do not fill the coolant recovery tank above "COLD FULL" mark.

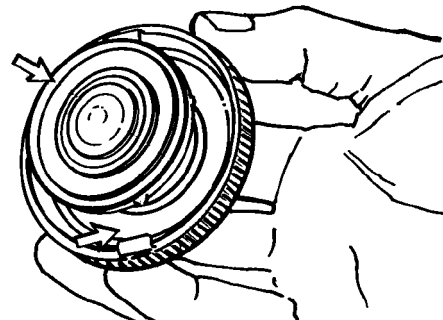


Illustration 23

4. Clean filler cap and the receptacle. Reinstall the filler cap and inspect the cooling system for leaks.

Note: The coolant will expand as the coolant heats up during normal engine operation. The additional volume will be forced into the coolant recovery tank during engine operation. When the engine is stopped and cool, the coolant will return to the engine.

Engines Without a Coolant Recovery Tank

Check the coolant level when the engine is stopped and cool.

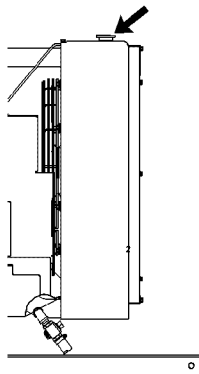


Illustration 24

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Cooling system filler cap

WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

1. Remove the cooling system filler cap slowly in order to relieve pressure.
2. Maintain the coolant level within 13 mm (0.5 inch) of the bottom of the filler pipe. If the engine is equipped with a sight glass, maintain the coolant level to the correct level in the sight glass.
3. Clean the cooling system filler cap and inspect the gasket. If the gasket is damaged, discard the old filler cap and install a new filler cap. If the gasket is not damaged, use a suitable pressurizing pump in order to pressure test the filler cap. The correct pressure is stamped on the face of the filler cap. If the filler cap does not retain the correct pressure, install a new filler cap.
4. Inspect the cooling system for leaks.

Cooling System Coolant Sample (Level 1) - Obtain

SMCS Code: 1350-008; 1395-008; 1395-554; 7542

Note: Obtaining a Coolant Sample (Level 1) is optional if the cooling system is filled with Cat ELC (Extended Life Coolant). Cooling systems that are filled with Cat ELC should have a Coolant Sample (Level 2) that is obtained at the recommended interval that is stated in the Maintenance Interval Schedule.

Note: Obtain a Coolant Sample (Level 1) if the cooling system is filled with any other coolant instead of Cat ELC. This includes the following types of coolants:

- Commercial long life coolants that meet the Caterpillar Engine Coolant Specification - 1 (Caterpillar EC-1)
- Cat DEAC (Diesel Engine Antifreeze/Coolant)
- Commercial heavy-duty coolant/antifreeze

Table 10

Recommended Interval		
Type of Coolant	Level 1	Level 2
Cat DEAC	Every 250 Hours ⁽¹⁾	Yearly ⁽¹⁾⁽²⁾
Cat ELC	Optional ⁽²⁾	Yearly ⁽²⁾

⁽¹⁾ This is the recommended interval for coolant samples for all conventional heavy-duty coolant/antifreeze. This is also the recommended interval for coolant samples of commercial coolants that meet the Cat EC-1 specification for engine coolant.

⁽²⁾ The Level 2 Coolant Analysis should be performed sooner if a problem is suspected or identified.

NOTICE

Always use a designated pump for oil sampling, and use a separate designated pump for coolant sampling. Using the same pump for both types of samples may contaminate the samples that are being drawn. This contaminate may cause a false analysis and an incorrect interpretation that could lead to concerns by both dealers and customers.

Note: Level 1 results may indicate a need for Level 2 Analysis.

Obtain the sample of the coolant as close as possible to the recommended sampling interval. In order to receive the full effect of S·O·S analysis, you must establish a consistent trend of data. In order to establish a pertinent history of data, perform consistent samplings that are evenly spaced. Supplies for collecting samples can be obtained from your Caterpillar dealer.

Use the following guidelines for proper sampling of the coolant:

- Complete the information on the label for the sampling bottle before you begin to take the samples.
- Keep the unused sampling bottles stored in plastic bags.
- Obtain coolant samples directly from the coolant sample port. You should not obtain the samples from any other location.
- Keep the lids on empty sampling bottles until you are ready to collect the sample.
- Place the sample in the mailing tube immediately after obtaining the sample in order to avoid contamination.
- Never collect samples from expansion bottles.
- Never collect samples from the drain for a system.

Submit the sample for Level 1 analysis.

For additional information about coolant analysis, see Special Publication, SEBU6251, "Caterpillar Commercial Diesel Engine Fluids Recommendations" or consult your Caterpillar dealer.

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Cooling System Coolant Sample (Level 2) - Obtain

SMCS Code: 1350-008; 1395-008; 1395-554; 7542

NOTICE

Always use a designated pump for oil sampling, and use a separate designated pump for coolant sampling. Using the same pump for both types of samples may contaminate the samples that are being drawn. This contaminate may cause a false analysis and an incorrect interpretation that could lead to concerns by both dealers and customers.

Refer to Operation and Maintenance Manual, "Cooling System Coolant Sample (Level 1) - Obtain" for the guidelines for proper sampling of the coolant.

Submit the sample for Level 2 analysis.

For additional information about coolant analysis, see Special Publication, SEBU6251, "Caterpillar Commercial Diesel Engines Fluids Recommendations" or consult your Caterpillar dealer.

i02456600

Cooling System Supplemental Coolant Additive (SCA) - Test/Add

SMCS Code: 1352-045; 1395-081

WARNING

Cooling system coolant additive contains alkali. To help prevent personal injury, avoid contact with the skin and the eyes. Do not drink cooling system coolant additive.

Note: Test the concentration of the Supplemental Coolant Additive (SCA) or test the SCA concentration as part of an S·O·S Coolant Analysis.

Test for SCA Concentration

Coolant and SCA

NOTICE

Do not exceed the recommended six percent supplemental coolant additive concentration.

Use the 8T-5296 Coolant Conditioner Test Kit or use the 4C-9301 Coolant Conditioner Test Kit in order to check the concentration of the SCA. Refer to this Operation and Maintenance Manual, "Refill Capacities and Recommendations" for more information.

Water and SCA

NOTICE

Do not exceed the recommended eight percent supplemental coolant additive concentration.

Test the concentration of the SCA with the 8T-5296 Coolant Conditioner Test Kit. Refer to the Special Publication, SEBU6251, "Caterpillar Commercial Diesel Engine Fluids Recommendations" for more information.

S·O·S Coolant Analysis

S·O·S coolant samples can be analyzed at your Caterpillar dealer. S·O·S Coolant Analysis is a program that is based on periodic samples.

Level 1

Level 1 is a basic analysis of the coolant. The following items are tested:

- Glycol Concentration
- Concentration of SCA
- pH
- Conductivity

The results are reported, and recommendations are made according to the results. Consult your Caterpillar dealer for information on the benefits of managing your equipment with an S·O·S Coolant Analysis.

Level 2

This level coolant analysis is recommended when the engine is overhauled. Refer to this Operations and Maintenance Manual, "Overhaul Considerations" for further information.

Add the SCA, If Necessary

NOTICE

Do not exceed the recommended amount of supplemental coolant additive concentration. Excessive supplemental coolant additive concentration can form deposits on the higher temperature surfaces of the cooling system, reducing the engine's heat transfer characteristics. Reduced heat transfer could cause cracking of the cylinder head and other high temperature components. Excessive supplemental coolant additive concentration could also result in radiator tube blockage, overheating, and/or accelerated water pump seal wear. Never use both liquid supplemental coolant additive and the spin-on element (if equipped) at the same time. The use of those additives together could result in supplemental coolant additive concentration exceeding the recommended maximum.

WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

1. Slowly loosen the cooling system filler cap in order to relieve the pressure. Remove the cooling system filler cap.

Note: Always discard drained fluids according to local regulations.

2. If necessary, drain some coolant from the cooling system into a suitable container in order to allow space for the extra SCA.
3. Add the proper amount of SCA. Refer to the Special Publication, SEBU6251, "Caterpillar Commercial Diesel Engines Fluids Recommendations" for more information on SCA requirements.
4. Clean the cooling system filler cap. Inspect the gaskets of the cooling system filler cap. If the gaskets are damaged, replace the old cooling system filler cap with a new cooling system filler cap. Install the cooling system filler cap.

i02623972

Cooling System Water Temperature Regulator - Replace

SMCS Code: 1355-510

Replace the water temperature regulator before the water temperature regulator fails. This is a recommended preventive maintenance practice. Replacing the water temperature regulator reduces the chances for unscheduled downtime.

A water temperature regulator that fails in a partially opened position can cause overheating or overcooling of the engine.

A water temperature regulator that fails in the closed position can cause excessive overheating. Excessive overheating could result in cracking of the cylinder head or piston seizure problems.

A water temperature regulator that fails in the open position will cause the engine operating temperature to be too low during partial load operation. Low engine operating temperatures during partial loads could cause an excessive carbon buildup inside the cylinders. This excessive carbon buildup could result in an accelerated wear of the piston rings and wear of the cylinder liner.

NOTICE

Failure to replace your water temperature regulator on a regularly scheduled basis could cause severe engine damage.

Caterpillar engines incorporate a shunt design cooling system and require operating the engine with a water temperature regulator installed.

If the water temperature regulator is installed incorrectly, the engine may overheat, causing cylinder head damage. Ensure that the new water temperature regulator is installed in the original position. Ensure that the water temperature regulator vent hole is open.

Do not use liquid gasket material on the gasket or cylinder head surface.

Refer to two articles in the Disassembly and Assembly Manual, "Water Temperature Regulators - Remove and Water Temperature Regulators - Install" for the replacement procedure of the water temperature regulator, or consult your Caterpillar dealer.

Note: If only the water temperature regulators are replaced, drain the coolant from the cooling system to a level that is below the water temperature regulator housing.

i02711635

Crankcase Breather (Canister) - Replace

SMCS Code: 1317-510

NOTICE

Ensure that the engine is stopped before any servicing or repair is performed.

Note: This breather assembly is not installed on all engines.

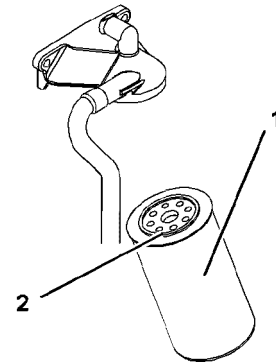


Illustration 25

g01350307

Typical example

1. Place a container under the canister (1).
2. Clean the outside of the canister. Remove the canister with a 1U-8760 Chain Wrench.
3. Lubricate the O ring seal (2) on the new canister (3) with clean engine lubricating oil. Install the new canister. Tighten the canister to 12 N·m (8 lb ft). Do not overtighten the canister.
4. Remove the container. Dispose of the old canister and any split oil in a safe place.

i00174798

Driven Equipment - Check

SMCS Code: 3279-535

Refer to the OEM specifications for more information on the following maintenance recommendations for the driven equipment:

- Inspection
- Adjustment
- Lubrication
- Other maintenance recommendations

Perform any maintenance for the driven equipment which is recommended by the OEM.

i02708606

i02708051

Engine - Clean

SMCS Code: 1000-070

WARNING

Personal injury or death can result from high voltage.

Moisture can create paths of electrical conductivity.

Make sure that the electrical system is OFF. Lock out the starting controls and tag the controls "DO NOT OPERATE".

NOTICE

Accumulated grease and oil on an engine is a fire hazard. Keep the engine clean. Remove debris and fluid spills whenever a significant quantity accumulates on the engine.

NOTICE

Failure to protect some engine components from washing may make your engine warranty invalid. Allow the engine to cool for one hour before washing the engine.

Periodic cleaning of the engine is recommended. Steam cleaning the engine will remove accumulated oil and grease. A clean engine provides the following benefits:

- Easy detection of fluid leaks
- Maximum heat transfer characteristics
- Ease of maintenance

Note: Caution must be used in order to prevent electrical components from being damaged by excessive water when the engine is cleaned. When a pressure washer or steam cleaner is used to clean the engine, a minimum distance of 300 mm (12 inch) must be maintained between the components of the engine and the jet nozzle of the pressure washer or steam cleaner. Pressure washers and steam cleaners should not be directed at any electrical connectors or the junction of cables into the rear of the connectors. Avoid electrical components such as the alternator and the starter. Protect the fuel injection pump from fluids in order to wash the engine.

Engine Air Cleaner Element (Dual Element) - Clean/Replace

SMCS Code: 1054-037; 1054-510

NOTICE

Never run the engine without an air cleaner element installed. Never run the engine with a damaged air cleaner element. Do not use air cleaner elements with damaged pleats, gaskets or seals. Dirt entering the engine causes premature wear and damage to engine components. Air cleaner elements help to prevent airborne debris from entering the air inlet.

NOTICE

Never service the air cleaner element with the engine running since this will allow dirt to enter the engine.

Servicing the Air Cleaner Elements

Note: The air filter system may not have been provided by Catapillar. The procedure that follows is for a typical air filter system. Refer to the OEM information for the correct procedure.

If the air cleaner element becomes plugged, the air can split the material of the air cleaner element. Unfiltered air will drastically accelerate internal engine wear. Refer to the OEM information for the correct air cleaner elements for your application.

- Check the precleaner (if equipped) and the dust bowl daily for accumulation of dirt and debris. Remove any dirt and debris, as needed.
- Operating in dirty conditions may require more frequent service of the air cleaner element.
- The air cleaner element should be replaced at least one time per year. This replacement should be performed regardless of the number of cleanings.

Replace the dirty air cleaner elements with clean air cleaner elements. Before installation, the air cleaner elements should be thoroughly checked for tears and/or holes in the filter material. Inspect the gasket or the seal of the air cleaner element for damage. Maintain a supply of suitable air cleaner elements for replacement purposes.

Dual Element Air Cleaners

The dual element air cleaner contains a primary air cleaner element and a secondary air cleaner element.

The primary air cleaner element can be used up to six times if the element is properly cleaned and properly inspected. The primary air cleaner element should be replaced at least one time per year. This replacement should be performed regardless of the number of cleanings.

The secondary air cleaner element is not serviceable. Refer to the OEM information for instructions in order to replace the secondary air cleaner element.

When the engine is operating in environments that are dusty or dirty, air cleaner elements may require more frequent replacement.

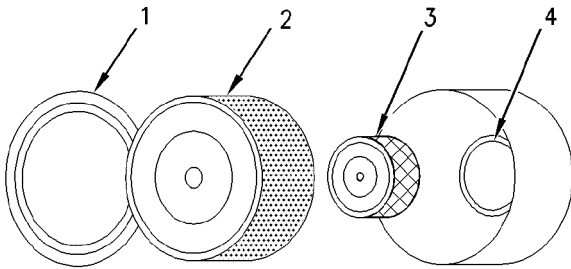


Illustration 26

g00736431

- (1) Cover
- (2) Primary air cleaner element
- (3) Secondary air cleaner element
- (4) Air inlet

1. Remove the cover. Remove the primary air cleaner element.
2. The secondary air cleaner element should be removed and discarded for every three cleanings of the primary air cleaner element.

Note: Refer to "Cleaning the Primary Air Cleaner Elements".

3. Cover the air inlet with tape in order to keep dirt out.
4. Clean the inside of the air cleaner cover and body with a clean, dry cloth.
5. Remove the tape for the air inlet. Install the secondary air cleaner element. Install a primary air cleaner element that is new or cleaned.
6. Install the air cleaner cover.
7. Reset the air cleaner service indicator.

Cleaning the Primary Air Cleaner Elements

NOTICE

Caterpillar recommends certified air filter cleaning services that are available at Caterpillar dealers. The Caterpillar cleaning process uses proven procedures to assure consistent quality and sufficient filter life.

Observe the following guidelines if you attempt to clean the filter element:

Do not tap or strike the filter element in order to remove dust.

Do not wash the filter element.

Use low pressure compressed air in order to remove the dust from the filter element. Air pressure must not exceed 207 kPa (30 psi). Direct the air flow up the pleats and down the pleats from the inside of the filter element. Take extreme care in order to avoid damage to the pleats.

Do not use air filters with damaged pleats, gaskets, or seals. Dirt entering the engine will cause damage to engine components.

The primary air cleaner element can be used up to six times if the element is properly cleaned and properly inspected. When the primary air cleaner element is cleaned, check for rips or tears in the filter material. The primary air cleaner element should be replaced at least one time per year. This replacement should be performed regardless of the number of cleanings.

Use clean primary air cleaner elements while dirty elements are being cleaned.

NOTICE

Do not clean the air cleaner elements by bumping or tapping. This could damage the seals. Do not use elements with damaged pleats, gaskets or seals. Damaged elements will allow dirt to pass through. Engine damage could result.

Visually inspect the primary air cleaner elements before cleaning. Inspect the air cleaner elements for damage to the seal, the gaskets, and the outer cover. Discard any damaged air cleaner elements.

There are two common methods that are used to clean primary air cleaner elements:

- Pressurized air
- Vacuum cleaning

Pressurized Air

WARNING

Personal injury can result from air pressure.

Personal injury can result without following proper procedure. When using pressure air, wear a protective face shield and protective clothing.

Maximum air pressure at the nozzle must be less than 205 kPa (30 psi) for cleaning purposes.

Pressurized air can be used to clean primary air cleaner elements that have not been cleaned more than three times. Use filtered, dry air with a maximum pressure of 207 kPa (30 psi). Pressurized air will not remove deposits of carbon and oil.

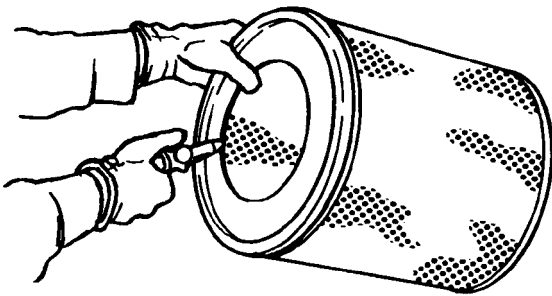


Illustration 27

g00281692

Note: When the primary air cleaner elements are cleaned, always begin with the clean side (inside) in order to force dirt particles toward the dirty side (outside).

Aim the air hose so that air flows along the length of the filter. Follow the direction of the paper pleats in order to prevent damage to the pleats. Do not aim the air directly at the face of the paper pleats.

Note: Refer to "Inspecting the Primary Air Cleaner Elements".

Vacuum Cleaning

Vacuum cleaning is a good method for removing accumulated dirt from the dirty side (outside) of a primary air cleaner element. Vacuum cleaning is especially useful for cleaning primary air cleaner elements which require daily cleaning because of a dry, dusty environment.

Cleaning from the clean side (inside) with pressurized air is recommended prior to vacuum cleaning the dirty side (outside) of a primary air cleaner element.

Note: Refer to "Inspecting the Primary Air Cleaner Elements".

Inspecting the Primary Air Cleaner Elements

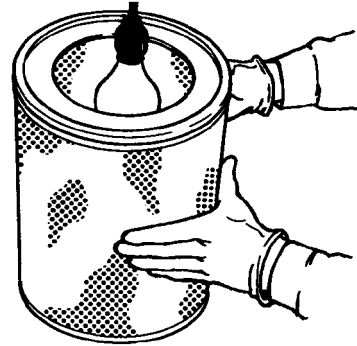


Illustration 28

g00281693

Inspect the clean, dry primary air cleaner element. Use a 60 watt blue light in a dark room or in a similar facility. Place the blue light in the primary air cleaner element. Rotate the primary air cleaner element. Inspect the primary air cleaner element for tears and/or holes. Inspect the primary air cleaner element for light that may show through the filter material. If it is necessary in order to confirm the result, compare the primary air cleaner element to a new primary air cleaner element that has the same part number.

Do not use a primary air cleaner element that has any tears and/or holes in the filter material. Do not use a primary air cleaner element with damaged pleats, gaskets or seals. Discard damaged primary air cleaner elements.

Storing Primary Air Cleaner Elements

If a primary air cleaner element that passes inspection will not be used, the primary air cleaner element can be stored for future use.

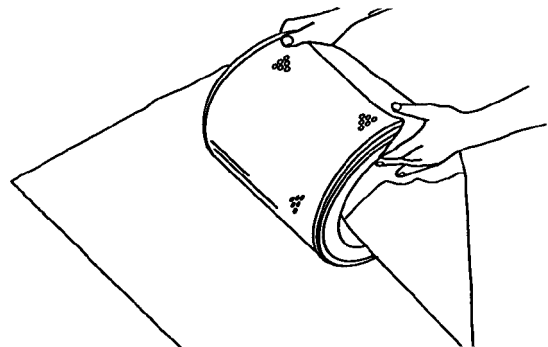


Illustration 29

g00281694

Do not use paint, a waterproof cover, or plastic as a protective covering for storage. An air flow restriction may result. To protect against dirt and damage, wrap the primary air cleaner elements in Volatile Corrosion Inhibited (VCI) paper.

Place the primary air cleaner element into a box for storage. For identification, mark the outside of the box and mark the primary air cleaner element. Include the following information:

- Date of cleaning
- Number of cleanings

Store the box in a dry location.

i02708042

Engine Air Cleaner Element (Single Element) - Inspect/Replace

SMCS Code: 1054-040; 1054-510

Refer to Operation and Maintenance Manual, "Engine Air Cleaner Service Indicator-Inspect".

NOTICE

Never run the engine without an air cleaner element installed. Never run the engine with a damaged air cleaner element. Do not use air cleaner elements with damaged pleats, gaskets or seals. Dirt entering the engine causes premature wear and damage to engine components. Air cleaner elements help to prevent air-borne debris from entering the air inlet.

NOTICE

Never service the air cleaner element with the engine running since this will allow dirt to enter the engine.

A wide variety of air cleaners may be installed for use with this engine. Consult the OEM information for the correct procedure to replace the air cleaner.

i02708041

Engine Air Cleaner Service Indicator - Inspect

SMCS Code: 7452-040

Some engines may be equipped with a different service indicator.

Some engines are equipped with a differential gauge for inlet air pressure. The differential gauge for inlet air pressure displays the difference in the pressure that is measured before the air cleaner element and the pressure that is measured after the air cleaner element. As the air cleaner element becomes dirty, the pressure differential rises. If your engine is equipped with a different type of service indicator, follow the OEM recommendations in order to service the air cleaner service indicator.

The service indicator may be mounted on the air cleaner element or in a remote location.

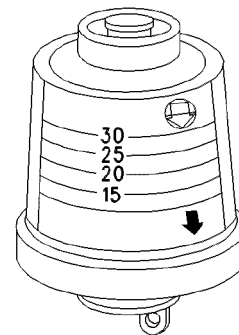


Illustration 30

g00103777

Typical service indicator

Observe the service indicator. The air cleaner element should be cleaned or the air cleaner element should be replaced when one of the following conditions occur:

- The yellow diaphragm enters the red zone.
- The red piston locks in the visible position.

Test the Service Indicator

Service indicators are important instruments.

- Check for ease of resetting. The service indicator should reset in less than three pushes.
- Check the movement of the yellow core when the engine is accelerated to the engine rated speed. The yellow core should latch at the greatest vacuum that is attained.

If the service indicator does not reset easily, or if the yellow core does not latch at the greatest vacuum, the service indicator should be replaced. If the new service indicator will not reset, the hole for the service indicator may be restricted.

The service indicator may need to be replaced frequently in environments that are severely dusty.

i02708039

i02708019

Engine Air Precleaner - Check/Clean

SMCS Code: 1055-070; 1055-535

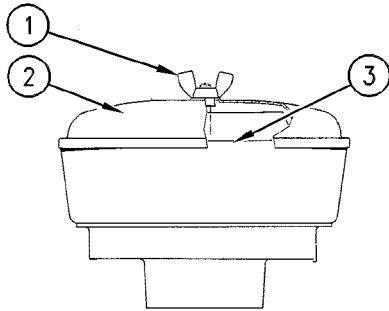


Illustration 31

g00287039

Typical precleaner

- (1) Wing nut
(2) Cover
(3) Body

Remove wing nut (1) and cover (2). Check for an accumulation of dirt and debris in body (3). Clean the body, if necessary.

After cleaning the precleaner, install cover (2) and wing nut (1).

Note: When the engine is operated in dusty applications, more frequent cleaning is required.

i02456872

Engine Mounts - Inspect

SMCS Code: 1152-040

Inspect the engine mounts for deterioration and for proper bolt torque. Engine vibration can be caused by the following conditions:

- Improper mounting of the engine
- Deterioration of the engine mounts

Any engine mount that shows deterioration should be replaced. Refer to Special Publication, SENR3130, "Torque Specifications" for the recommended torques. Refer to the OEM recommendations for more information.

Engine Oil Level - Check

SMCS Code: 1348-535-FLV

WARNING

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact the skin.

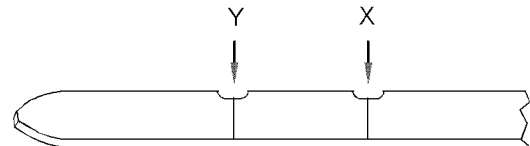


Illustration 32

g01165836

(Y) "Min" mark. (X) "Max" mark.

NOTICE

Perform this maintenance with the engine stopped.

Note: Ensure that the engine is either level or that the engine is in the normal operating position in order to obtain a true level indication.

Note: After the engine has been switched OFF, wait for ten minutes in order to allow the engine oil to drain to the oil pan before checking the oil level.

1. Maintain the oil level between the "MIN" mark (Y) and the "MAX" mark (X) on the engine oil dipstick. Do not fill the crankcase above the "MAX" mark (X).

NOTICE

Operating your engine when the oil level is above the "FULL" mark could cause your crankshaft to dip into the oil. The air bubbles created from the crankshaft dipping into the oil reduces the oil's lubricating characteristics and could result in the loss of power.

2. Remove the oil filler cap and add oil, if necessary. Clean the oil filler cap. Install the oil filler cap.

i01935337

Engine Oil Sample - Obtain

SMCS Code: 1000-008; 1348-554-SM;
7542-554-OC, SM

In addition to a good preventive maintenance program, Caterpillar recommends using S·O·S oil analysis at regularly scheduled intervals in order to monitor the condition of the engine and the maintenance requirements of the engine. S·O·S oil analysis provides infrared analysis, which is required for determining nitration and oxidation levels.

Obtain the Sample and the Analysis

WARNING

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact the skin.

Before you take the oil sample, complete the Label, PEEP5031 for identification of the sample. In order to help obtain the most accurate analysis, provide the following information:

- Engine model
- Service hours on the engine
- The number of hours that have accumulated since the last oil change
- The amount of oil that has been added since the last oil change

To ensure that the sample is representative of the oil in the crankcase, obtain a warm, well mixed oil sample.

To avoid contamination of the oil samples, the tools and the supplies that are used for obtaining oil samples must be clean.

Caterpillar recommends using the sampling valve in order to obtain oil samples. The quality and the consistency of the samples are better when the sampling valve is used. The location of the sampling valve allows oil that is flowing under pressure to be obtained during normal engine operation.

The 169-8373 Fluid Sampling Bottle is recommended for use with the sampling valve. The fluid sampling bottle includes the parts that are needed for obtaining oil samples. Instructions are also provided.

NOTICE

Always use a designated pump for oil sampling, and use a separate designated pump for coolant sampling. Using the same pump for both types of samples may contaminate the samples that are being drawn. This contaminate may cause a false analysis and an incorrect interpretation that could lead to concerns by both dealers and customers.

If the engine is not equipped with a sampling valve, use the 1U-5718 Vacuum Pump. The pump is designed to accept sampling bottles. Disposable tubing must be attached to the pump for insertion into the sump.

For instructions, see Special Publication, PEHP6001, "How To Take A Good Oil Sample". Consult your Caterpillar dealer for complete information and assistance in establishing an S·O·S program for your engine.

i02712378

Engine Oil and Filter - Change

SMCS Code: 1318-510; 1348-044

WARNING

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact the skin.

Do not drain the oil when the engine is cold. As the oil cools, suspended waste particles settle on the bottom of the oil pan. The waste particles are not removed with the draining cold oil. Drain the crankcase with the engine stopped. Drain the crankcase with the oil warm. This draining method allows the waste particles that are suspended in the oil to be drained properly.

Failure to follow this recommended procedure will cause the waste particles to be recirculated through the engine lubrication system with the new oil.

Drain the Engine Oil

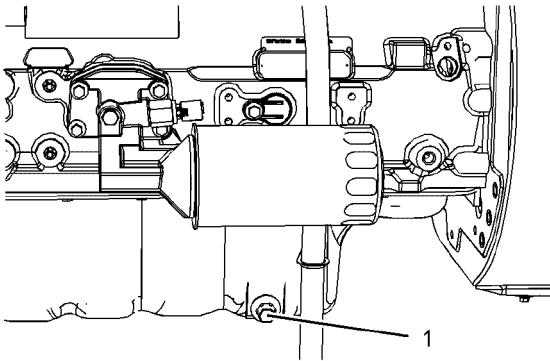


Illustration 33
Oil drain plug

g01356033

After the engine has been run at the normal operating temperature, stop the engine. Use one of the following methods to drain the engine crankcase oil:

- If the engine is equipped with a drain valve, turn the drain valve knob counterclockwise in order to drain the oil. After the oil has drained, turn the drain valve knob clockwise in order to close the drain valve.
- If the engine is not equipped with a drain valve, remove the oil drain plug (1) in order to allow the oil to drain. If the engine is equipped with a shallow sump, remove the bottom oil drain plugs from both ends of the oil pan.

After the oil has drained, the oil drain plugs should be cleaned and installed. If necessary, renew the O ring seal on the drain plug.

Some types of oil pans have oil drain plugs that are on both sides of the oil pan, because of the shape of the pan. This type of oil pan requires the engine oil to be drained from both plugs.

Replace the Spin-on Oil Filter

NOTICE

Caterpillar oil filters are built to Caterpillar specifications. Use of an oil filter not recommended by Caterpillar could result in severe engine damage to the engine bearings, crankshaft, etc., as a result of the larger waste particles from unfiltered oil entering the engine lubricating system. Only use oil filters recommended by Caterpillar.

1. Remove the oil filter with a 1U-8760 Chain Wrench.

Note: The following actions can be carried out as part of the preventive maintenance program.

2. Cut the oil filter open with a 175-7546 Oil Filter Cutter Gp. Break apart the pleats and inspect the oil filter for metal debris. An excessive amount of metal debris in the oil filter may indicate early wear or a pending failure.

Use a magnet to differentiate between the ferrous metals and the nonferrous metals that are found in the oil filter element. Ferrous metals may indicate wear on the steel and cast iron parts of the engine.

Nonferrous metals may indicate wear on the aluminum parts, brass parts or bronze parts of the engine. Parts that may be affected include the following items: main bearings, rod bearings, turbocharger bearings, and cylinder heads.

Due to normal wear and friction, it is not uncommon to find small amounts of debris in the oil filter. Consult your Caterpillar dealer in order to arrange for a further analysis if an excessive amount of debris is found in the oil filter.

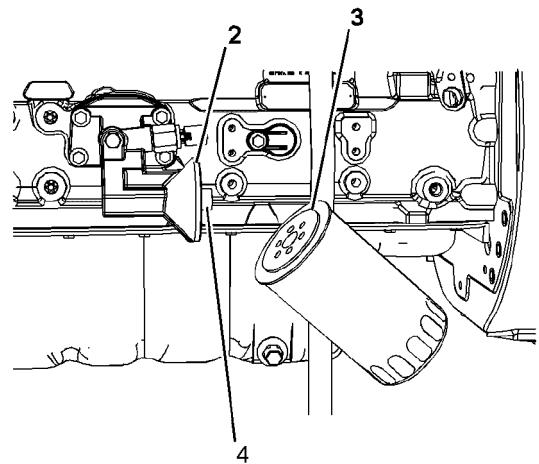


Illustration 34

g01356034

- (2) Filter head
- (3) O ring seal
- (4) Union

3. Clean the sealing surface of the oil filter head (2). Ensure that the union (4) in the filter head is secure.
4. Clean the sealing surface of the oil filter head (2). Ensure that the union (4) in the filter head is secure.

NOTICE

Do not fill the oil filters with oil before installing them. This oil would not be filtered and could be contaminated. Contaminated oil can cause accelerated wear to engine components.

5. Install the oil filter. Tighten the oil filter by hand according to the instructions that are shown on the oil filter. Do not overtighten the oil filter.

Note: Some oil filters may be installed vertically. Refer to illustration 35. Start at step (1) in order to remove the oil filter and install the oil filter.

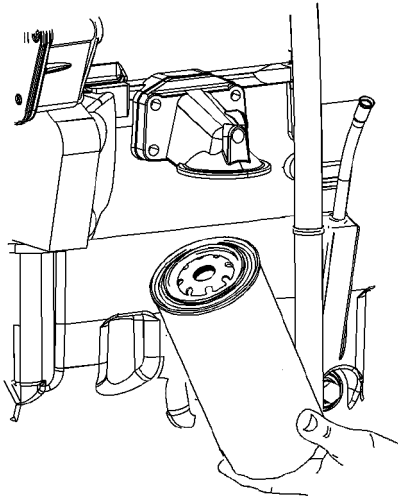


Illustration 35
Typical example

g01356074

Fill the Engine Crankcase

1. Remove the oil filler cap. Refer to the Operation and Maintenance Manual for more information on lubricant specifications. Fill the crankcase with the proper amount of oil. Refer to the Operation and Maintenance Manual for more information on refill capacities.

NOTICE

If equipped with an auxiliary oil filter system or a remote oil filter system, follow the OEM or filter manufacturer's recommendations. Under filling or overfilling the crankcase with oil can cause engine damage.

NOTICE

To prevent crankshaft bearing damage, crank the engine with the fuel OFF. This will fill the oil filters before starting the engine. Do not crank the engine for more than 30 seconds.

2. Start the engine and run the engine at "LOW IDLE" for two minutes. Perform this procedure in order to ensure that the lubrication system has oil and that the oil filters are filled. Inspect the oil filter for oil leaks.
 3. Stop the engine and allow the oil to drain back to the sump for a minimum of ten minutes.
-

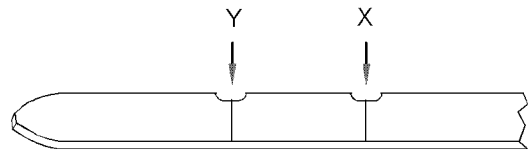


Illustration 36
(Y) "MIN" mark. (X) "MAX" mark.

g01165836

4. Remove the oil level gauge in order to check the oil level. Maintain the oil level between the "MIN" and "MAX" marks on the oil level gauge.

i00626013

Engine Protective Devices - Check

SMCS Code: 7400-535

Alarms and shutoffs must function properly. Alarms provide timely warning to the operator. Shutoffs help to prevent damage to the engine. It is impossible to determine if the engine protective devices are in good working order during normal operation. Malfunctions must be simulated in order to test the engine protective devices.

A calibration check of the engine protective devices will ensure that the alarms and shutoffs activate at the setpoints. Ensure that the engine protective devices are functioning properly.

NOTICE

During testing, abnormal operating conditions must be simulated.

The tests must be performed correctly in order to prevent possible damage to the engine.

To prevent damage to the engine, only authorized service personnel or your Caterpillar dealer should perform the tests.

i02707243

Visual Inspection

Visually check the condition of all gauges, sensors and wiring. Look for wiring and components that are loose, broken, or damaged. Damaged wiring or components should be repaired or replaced immediately.

i02707257

Engine Valve Lash - Inspect/Adjust

SMCS Code: 1102-025

This maintenance is recommended by Caterpillar as part of a lubrication and preventive maintenance schedule in order to help provide maximum engine life.

NOTICE

Only qualified service personnel should perform this maintenance. Refer to the Systems Operation/Testing and Adjusting Manual, "Valve Lash and Valve Bridge Adjustment" article or consult your Caterpillar dealer for the complete valve lash adjustment procedure.

Operation of Caterpillar engines with improper valve adjustments can reduce engine efficiency. This reduced efficiency could result in excessive fuel usage and/or shortened engine component life.

WARNING

Ensure that the engine can not be started while this maintenance is being performed. To help prevent possible injury, do not use the starting motor to turn the flywheel.

Hot engine components can cause burns. Allow additional time for the engine to cool before measuring/adjusting valve lash clearance.

Ensure that the engine is stopped before measuring the valve lash. To obtain an accurate measurement, allow the valves to cool before this maintenance is performed.

Refer to the Service Manual for more information.

Fuel Injection Nozzles - Test/Exchange

SMCS Code: 1254-013; 1254-081

WARNING

Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire.

NOTICE

Do not allow dirt to enter the fuel system. Thoroughly clean the area around a fuel system component that will be disconnected. Fit a suitable cover over disconnected fuel system component.

Fuel injection nozzles are subject to tip wear. Tip wear is a result of fuel contamination. Tip wear can cause the following problems:

- Increased fuel consumption
- Black smoke
- Misfire
- Rough running

Fuel Injection nozzles should be cleaned, inspected, tested, and replaced, if necessary. Refer to Special Instruction, SEHS7292 for using the 8S-2245 Injector Cleaning Tool Gp. Consult your Caterpillar dealer about cleaning the fuel injection nozzle and testing the fuel injection nozzle.

NOTICE

Never wire brush or scrape a fuel injection nozzle. Wire brushing or scraping a fuel injection nozzle will damage the finely machine orifice. Proper tools for cleaning and testing the fuel injection nozzles can be obtained from Caterpillar dealers.

The following items are symptoms of a malfunction of the fuel injection nozzle:

- Abnormal engine operation
- Smoke emission
- Engine knock

Each fuel injection nozzle must be isolated one at a time in order to determine the malfunctioning fuel injection nozzle.

1. Start the engine.

2. Loosen each fuel line nut one at a time at the fuel injection pump. A cloth or similar material must be used in order to prevent fuel from spraying on the hot exhaust components. Tighten each nut before loosening the next nut.
3. Worn fuel injection nozzles or faulty fuel injection nozzles may be identified when a fuel line nut is loosened and the following conditions are present:
 - The exhaust smoke is partially eliminated or the exhaust smoke is completely eliminated.
 - Engine performance is not affected.

A fuel injection nozzle that is suspected of being worn and/or faulty should be removed. A new fuel injection nozzle should be installed in the cylinder in order to determine if the removed fuel injection nozzle is worn and/or faulty.

Removal and Installation of the Fuel Injection Nozzles

For the removal and the installation of fuel injection nozzles, special tooling is required. Refer to the Service Manual for more information. Consult your Caterpillar dealer for assistance.

102677377

Fuel System - Prime

SMCS Code: 1258-548

If air enters the fuel system, the air must be purged from the fuel system before the engine can be started. Air can enter the fuel system when the following events occur:

- The fuel tank is empty or the fuel tank has been partially drained.
- The low pressure fuel lines are disconnected.
- A leak exists in the low pressure fuel system.
- The fuel filter is replaced.
- A new injection pump is installed.

Use the following procedure in order to remove air from the fuel system:

1. Remove the cover for the fuel injectors. Refer to the Disassembly and Assembly Manual.
2. Turn the ignition key to the RUN position. Leave the ignition key in the RUN position for three minutes.

3. Turn the ignition key to the OFF position.

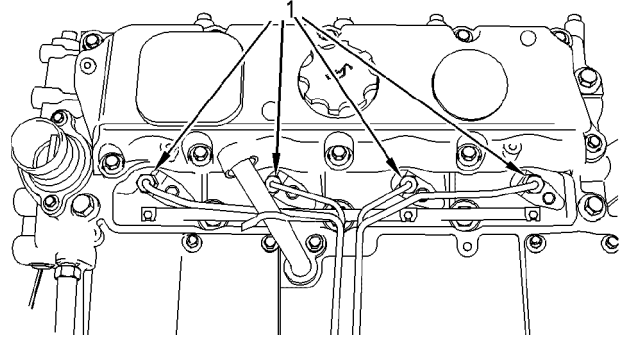


Illustration 37
Injector nuts

g01003929

Note: Damage to the fuel injection pump, to the battery, and to the starting motor can occur if the starting motor is used excessively to purge the air from the fuel system.

4. Loosen the flare nuts (1) for the high pressure fuel lines on all of the fuel injectors.

NOTICE

Do not crank the engine continuously for more than 30 seconds. Allow the starting motor to cool for two minutes before cranking the engine again.

5. Observe the connection at the flare nut. Operate the starting motor and crank the engine until the fuel is free of air.
6. Tighten the flare nuts (1) to a torque of 30 N·m (22 lb ft).
7. The engine is now ready to start. Operate the engine at low idle for a minimum of five minutes immediately after air has been removed from the fuel system.

Note: Running the engine for this period of time will help ensure that the pump is completely free of air.

i02699081

Fuel System Primary Filter/Water Separator - Drain

SMCS Code: 1260-543; 1263-543

WARNING

Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire. To help prevent possible injury, turn the start switch off when changing fuel filters or water separator elements. Clean up fuel spills immediately.

NOTICE

The water separator is not a filter. The water separator separates water from the fuel. The engine should never be allowed to run with the water separator more than half full. Engine damage may result.

NOTICE

The water separator is under suction during normal engine operation. Ensure that the drain valve is tightened securely to help prevent air from entering the fuel system.

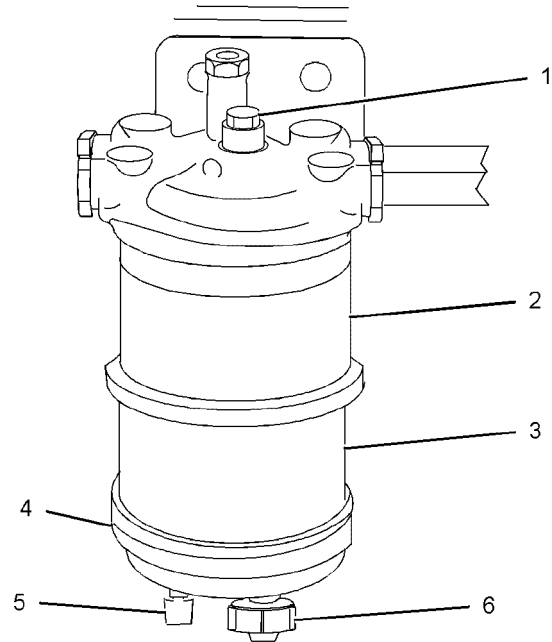


Illustration 38

g01353878

- (1) Screw
- (2) Element
- (3) Bowl
- (4) Bottom cover
- (5) Drain
- (6) Sensor connection

1. Place a suitable container below the water separator.
2. Open the drain (5). Allow the fluid to drain into the container.
3. When clean fuel drains from the water separator close the drain (5). Tighten the drain by hand pressure only. Dispose of the drained fluid correctly.

i02699073

Fuel System Secondary Filter - Replace

SMCS Code: 1261-510-SE

WARNING

Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire. To help prevent possible injury, turn the start switch off when changing fuel filters or water separator elements. Clean up fuel spills immediately.

NOTICE

Do not allow dirt to enter the fuel system. Thoroughly clean the area around a fuel system component that will be disconnected. Fit a suitable cover over disconnected fuel system component.

Element filter

Turn the valves for the fuel lines (if equipped) to the OFF position before performing this maintenance. Place a tray under the fuel filter in order to catch any fuel that might spill. Clean up any spilled fuel immediately.

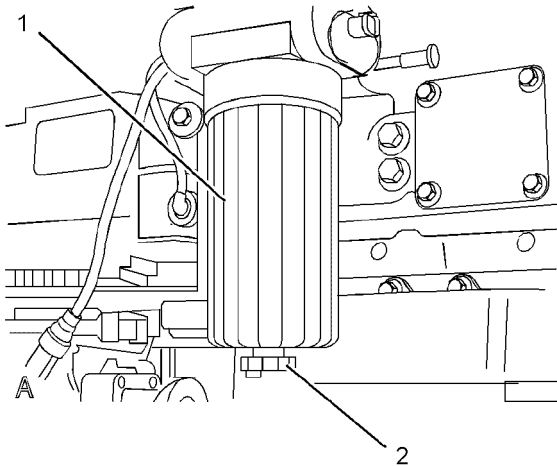


Illustration 39

g01353856

- (1) Filter bowl
- (2) Drain

1. Close the valves for the fuel lines (if equipped).
2. Clean the outside of the fuel filter assembly. Open the fuel drain (2) and drain the fuel into a suitable container.

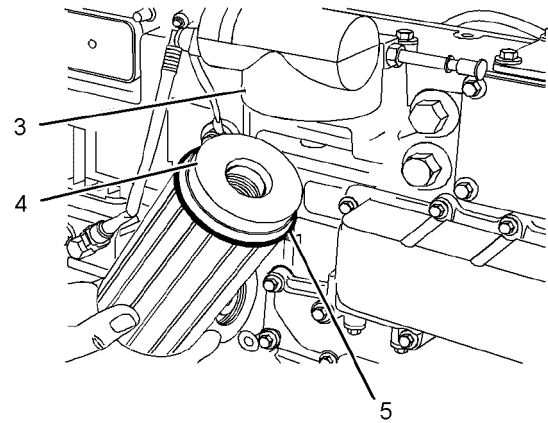


Illustration 40

g01353857

- (3) Filter head
- (4) Element
- (5) O ring seal

3. Remove the filter bowl (1) from the filter head (3). Press on the element (4). Rotate the element counterclockwise in order to release the element for the filter bowl and remove the element from the bowl. Discard the used element.
4. Remove the O ring (5) from the filter bowl and clean the filter bowl. Check that the threads of the filter bowl are not damaged.
5. Install a new O ring seal (5) to the filter bowl (1).
6. Locate a new filter element (4) into the filter bowl (1). Press on the element and rotate the element clockwise in order to lock the element into the filter bowl.
7. Install the filter bowl (1) into the top of the filter head (3).
8. Tighten the filter bowl by hand until the filter bowl contacts the filter head. Rotate the filter bowl through 90 degrees.

Note: Do not use a tool to tighten the filter bowl.

9. Open the valves for the fuel lines (if equipped).

Spin-on filter

Turn the valves for the fuel lines (if equipped) to the OFF position before performing this maintenance. Place a tray under the fuel filter in order to catch any fuel that might spill. Clean up any spilled fuel immediately.

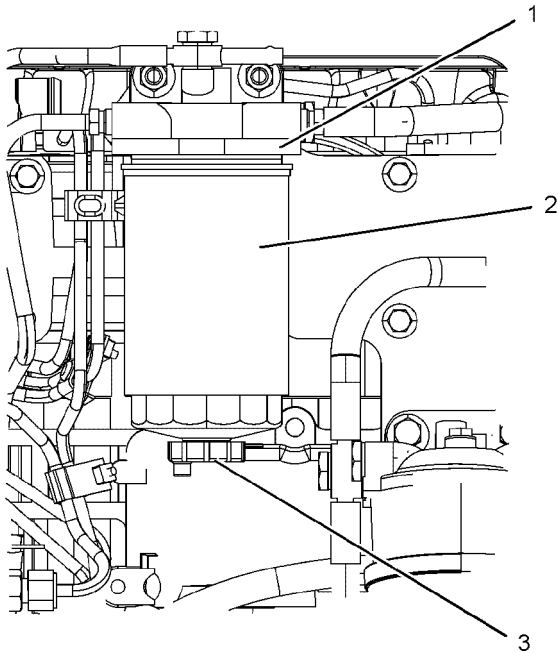


Illustration 41

g01353858

- (1) Filter Head
- (2) Spin-on filter
- (3) Drain

1. Clean the outside of the fuel filter assembly. Open the fuel drain (3) and drain the fuel into a suitable container.
2. Use a suitable tool in order to remove the spin-on filter (2) from the filter head (1).
3. Ensure that the fuel drain (3) on the new spin-on filter is closed.

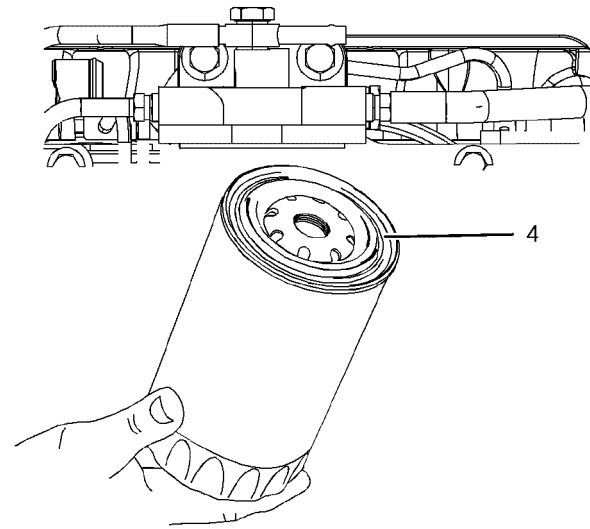


Illustration 42

g01353860

- (4) O ring seal

4. Lubricate the sealing ring (4) with clean fuel oil.
5. Install the spin-on filter (2) into the top of the filter head (1).
6. Tighten the spin-on filter by hand until the sealing ring contacts the filter head. Rotate the spin-on filter through 90 degrees.
7. Prime the fuel system. Refer to Operation and Maintenance Manual, "Fuel System - Prime".

i02702048

Fuel Tank Water and Sediment - Drain

SMCS Code: 1273-543-M&S

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

Fuel Tank

Fuel quality is critical to the performance and to the service life of the engine. Water in the fuel can cause excessive wear to the fuel system.

Water can be introduced into the fuel tank when the fuel tank is being filled.

Condensation occurs during the heating and cooling of fuel. The condensation occurs as the fuel passes through the fuel system and the fuel returns to the fuel tank. This causes water to accumulate in fuel tanks. Draining the fuel tank regularly and obtaining fuel from reliable sources can help to eliminate water in the fuel.

Drain the Water and the Sediment

Fuel tanks should contain some provision for draining water and draining sediment from the bottom of the fuel tanks.

Open the drain valve on the bottom of the fuel tank in order to drain the water and the sediment. Close the drain valve.

Check the fuel daily. Allow five minutes after the fuel tank has been filled before draining water and sediment from the fuel tank.

Fill the fuel tank after operating the engine in order to drive out moist air. This will help prevent condensation. Do not fill the tank to the top. The fuel expands as the fuel gets warm. The tank may overflow.

Some fuel tanks use supply pipes that allow water and sediment to settle below the end of the fuel supply pipe. Some fuel tanks use supply lines that take fuel directly from the bottom of the tank. If the engine is equipped with this system, regular maintenance of the fuel system filter is important.

Fuel Storage Tanks

Drain the water and the sediment from the fuel storage tank at the following intervals:

- Weekly
- Service intervals
- Refill of the tank

This will help prevent water or sediment from being pumped from the storage tank into the engine fuel tank.

If a bulk storage tank has been refilled or moved recently, allow adequate time for the sediment to settle before filling the engine fuel tank. Internal baffles in the bulk storage tank will also help trap sediment. Filtering fuel that is pumped from the storage tank helps to ensure the quality of the fuel. When possible, water separators should be used.

i02705980

Hoses and Clamps - Inspect/Replace

SMCS Code: 7554-040; 7554-510

Inspect all hoses for leaks that are caused by the following conditions:

- Cracking
- Softness
- Loose clamps

Replace hoses that are cracked or soft. Tighten any loose clamps.

NOTICE

Do not bend or strike high pressure lines. Do not install bent or damaged lines, tubes or hoses. Repair any loose or damaged fuel and oil lines, tubes and hoses. Leaks can cause fires. Inspect all lines, tubes and hoses carefully. Tighten all connections to the recommended torque.

Check for the following conditions:

- End fittings that are damaged or leaking
- Outer covering that is chafed or cut
- Exposed wire that is used for reinforcement
- Outer covering that is ballooning locally
- Flexible part of the hose that is kinked or crushed
- Armoring that is embedded in the outer covering

A constant torque hose clamp can be used in place of any standard hose clamp. Ensure that the constant torque hose clamp is the same size as the standard clamp.

Due to extreme temperature changes, the hose will heat set. Heat setting causes hose clamps to loosen. This can result in leaks. A constant torque hose clamp will help to prevent loose hose clamps.

Each installation application can be different. The differences depend on the following factors:

- Type of hose
- Type of fitting material
- Anticipated expansion and contraction of the hose

- Anticipated expansion and contraction of the fittings

Replace the Hoses and the Clamps

WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

1. Stop the engine. Allow the engine to cool.
2. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap.

Note: Drain the coolant into a suitable, clean container. The coolant can be reused.

3. Drain the coolant from the cooling system to a level that is below the hose that is being replaced.
4. Remove the hose clamps.
5. Disconnect the old hose.
6. Replace the old hose with a new hose.
7. Install the hose clamps with a torque wrench.

Note: Refer to the Specifications, SENR3130, "Torque Specifications" in order to locate the proper torques.

8. Refill the cooling system.
9. Clean the cooling system filler cap. Inspect the cooling system filler cap's gaskets. Replace the cooling system filler cap if the gaskets are damaged. Install the cooling system filler cap.
10. Start the engine. Inspect the cooling system for leaks.

i02708037

Overhaul Considerations

SMCS Code: 7595-043

Reduced hours of operation at full load will result in a lower average power demand. A decreased average power demand should increase both the engine service life and the overhaul interval.

The need for an overhaul is generally indicated by increased fuel consumption and by reduced power.

The following factors are important when a decision is being made on the proper time for an engine overhaul:

- The need for preventive maintenance
- The quality of the fuel that is being used
- The operating conditions
- The results of the S-O-S analysis

Oil Consumption as an Overhaul Indicator

Oil consumption, fuel consumption, and maintenance information can be used to estimate the total operating cost for your Caterpillar engine. Oil consumption can also be used to estimate the required capacity of a makeup oil tank that is suitable for the maintenance intervals.

Oil consumption is in proportion to the percentage of the rated engine load. As the percentage of the engine load is increased, the amount of oil that is consumed per hour also increases.

The oil consumption rate (brake specific oil consumption) is measured in grams per kW/h (lb per bhp). The brake specific oil consumption (BSOC) depends on the engine load. Consult your Caterpillar dealer for assistance in determining the typical oil consumption rate for your engine.

When an engine's oil consumption has risen to three times the original oil consumption rate due to normal wear, an engine overhaul should be scheduled. There may be a corresponding increase in blowby and a slight increase in fuel consumption.

Overhaul Options

Before Failure Overhaul

A planned overhaul before failure may be the best value for the following reasons:

- Costly unplanned downtime can be avoided.
- Many original parts can be reused according to the standards for reusable parts.
- The engine's service life can be extended without the risk of a major catastrophe due to engine failure.

- The best cost/value relationship per hour of extended life can be attained.

After Failure Overhaul

If a major engine failure occurs and the engine must be removed, many options are available. An overhaul should be performed if the engine block or the crankshaft needs to be repaired.

If the engine block is repairable and/or the crankshaft is repairable, the overhaul cost should be between 40 percent and 50 percent of the cost of a new engine with a similar exchange core.

This lower cost can be attributed to three aspects:

- Specially designed Caterpillar engine features
- Caterpillar dealer exchange components
- Caterpillar Inc. remanufactured exchange components

Overhaul Recommendation

To minimize downtime, Caterpillar Inc. recommends a scheduled engine overhaul by your Caterpillar dealer before the engine fails. This will provide you with the best cost/value relationship.

Note: Overhaul programs vary according to the engine application and according to the dealer that performs the overhaul. Consult your Caterpillar dealer for specific information about the available overhaul programs and about overhaul services for extending the engine life.

If an overhaul is performed without overhaul service from your Caterpillar dealer, be aware of the following maintenance recommendations.

Rebuild or Exchange

Cylinder Head Assembly, Oil Pump, and Fuel Transfer Pump

These components should be inspected according to the instructions that are found in various Caterpillar reusability publications. The Special Publication, SEBF8029 lists the reusability publications that are needed for inspecting the engine parts.

If the parts comply with the established inspection specifications that are expressed in the reusable parts guideline, the parts should be reused.

Parts that are not within the established inspection specifications should be dealt with in one of the following manners:

- Salvaging
- Repairing
- Replacing

Using out-of-spec parts can result in the following problems:

- Unscheduled downtime
- Costly repairs
- Damage to other engine parts
- Reduced engine efficiency
- Increased fuel consumption

Reduced engine efficiency and increased fuel consumption translates into higher operating costs. Therefore, Caterpillar Inc. recommends repairing out-of-spec parts or replacing out-of-spec parts.

Inspection and/or Replacement

Crankshaft Bearings and Crankshaft Seals

The following components may not last until the second overhaul.

- Thrust bearings
- Main bearings
- Rod bearings
- Crankshaft seals

Caterpillar Inc. recommends the installation of new parts at each overhaul period.

Inspect these parts while the engine is disassembled for an overhaul.

Inspect the crankshaft for any of the following conditions:

- Deflection
- Damage to the journals
- Bearing material that has seized to the journals

Check the journal taper and the profile of the crankshaft journals. Check these components by interpreting the wear patterns on the following components:

- Rod bearing

- Main bearings

Inspect the camshaft for damage to the journals and to the lobes.

Note: If the camshaft is removed for any reason, use the magnetic particle inspection process to check for cracks in the camshaft.

Inspect the following components for signs of wear or for signs of scuffing:

- Camshaft bearings
- Lifters

Caterpillar Inc. recommends replacing the crankshaft vibration damper.

Oil Cooler Core

During an overhaul, Caterpillar Inc. recommends the removal of the oil cooler core. Clean the oil cooler core. Then, pressure test the oil cooler core.

NOTICE

Do not use caustic cleaners to clean the core.

Caustic cleaners can attack the internal metals of the core and cause leakage.

Note: Use this cleaning procedure to clean the oil cooler core.

1. Remove the oil cooler core.
2. Remove any debris from the oil cooler core. To remove debris from the oil cooler core, turn the oil cooler core onto one end.
3. Flush the oil cooler core internally with cleaner in order to loosen foreign substances. This will also help to remove oil from the oil cooler core.

Note: Caterpillar Inc. recommends the use of Hydrosolv Liquid Cleaners. Table 11 lists the Hydrosolv Liquid Cleaners that are available from your Caterpillar dealer.

Table 11

Hydrosolv Liquid Cleaners		
Part Number	Description	Size
1U-5490	Hydrosolv4165	19 L (5 US gal)
1U-5492	Hydrosolv100	19 L (5 US gallon)

4. Use steam to clean the oil cooler core. This removes any remaining residue from the cleaner. Flush the fins of the oil cooler core. Remove any other trapped debris.
5. Wash the oil cooler core with hot, soapy water. Rinse the oil cooler core thoroughly with clean water.

WARNING

Personal injury can result from air pressure.

Personal injury can result without following proper procedure. When using pressure air, wear a protective face shield and protective clothing.

Maximum air pressure at the nozzle must be less than 205 kPa (30 psi) for cleaning purposes.

6. Dry the oil cooler core with compressed air. Direct the air in the reverse direction of the normal flow.
7. Inspect the components in order to ensure cleanliness. The oil cooler core should be pressure tested. Repair the oil cooler core, if necessary. Install the oil cooler core.

For more information about cleaning the cores, consult your Caterpillar dealer.

Obtain Coolant Analysis

The concentration of supplemental coolant additive (SCA) should be checked regularly with test kits or with S-O-S Coolant Analysis (Level 1). Further coolant analysis is recommended when the engine is overhauled.

For example, considerable deposits are found in the water jacket areas on the external cooling system, but the concentrations of coolant additives were carefully maintained. The coolant water probably contained minerals that were deposited on the engine over time.

A coolant analysis can be conducted in order to verify the condition of the water that is being used in the cooling system. A full water analysis can be obtained by consulting your local water utility company or an agricultural agent. Private laboratories are also available for water analysis.

Caterpillar Inc. recommends an S-O-S Coolant Analysis (Level 2).

S-O-S Coolant Analysis (Level 2)

An S-O-S Coolant Analysis (Level 2) is a comprehensive coolant analysis which completely analyzes the coolant and the effects on the cooling system. An S-O-S Coolant Analysis (Level 2) provides the following information:

- Complete S-O-S Coolant Analysis (Level 1)
- Visual inspection of properties
- Identification of metal corrosion
- Identification of contaminants
- Identification of built up impurities (corrosion and scale)

S-O-S Coolant Analysis (Level 2) provides a report of the results of both the analysis and the maintenance recommendations.

For more information about coolant analysis, see your Caterpillar dealer.

i02708040

Radiator - Clean

SMCS Code: 1353-070

The radiator is not usually supplied by Caterpillar. The following text describes a typical cleaning procedure for the radiator. Refer to OEM information for further information on cleaning the radiator.

Note: Adjust the frequency of cleaning according to the effects of the operating environment.

Inspect the radiator for these items: damaged fins, corrosion, dirt, grease, insects, leaves, oil, and other debris. Clean the radiator, if necessary.



WARNING

Personal injury can result from air pressure.

Personal injury can result without following proper procedure. When using pressure air, wear a protective face shield and protective clothing.

Maximum air pressure at the nozzle must be less than 205 kPa (30 psi) for cleaning purposes.

Pressurized air is the preferred method for removing loose debris. Direct the air in the opposite direction of the fan's air flow. Hold the nozzle approximately 6 mm (0.25 inch) away from the fins. Slowly move the air nozzle in a direction that is parallel with the tubes. This will remove debris that is between the tubes.

Pressurized water may also be used for cleaning. The maximum water pressure for cleaning purposes must be less than 275 kPa (40 psi). Use pressurized water in order to soften mud. Clean the core from both sides.

Use a degreaser and steam for removal of oil and grease. Clean both sides of the core. Wash the core with detergent and hot water. Thoroughly rinse the core with clean water.

After cleaning, start the engine and accelerate the engine to high idle rpm. This will help in the removal of debris and drying of the core. Stop the engine. Use a light bulb behind the core in order to inspect the core for cleanliness. Repeat the cleaning, if necessary.

Inspect the fins for damage. Bent fins may be opened with a "comb". Inspect these items for good condition: welds, mounting brackets, air lines, connections, clamps, and seals. Make repairs, if necessary.

For more detailed information on cleaning and inspection, refer to Special Publication, SEBD0518, "Know Your Cooling System".

i00151038

Severe Service Application - Check

SMCS Code: 1000-535

Severe service is an application of an engine that exceeds current published standards for that engine. Caterpillar maintains standards for the following engine parameters:

- Performance (power range, speed range, and fuel consumption)
- Fuel quality
- Altitude range
- Maintenance intervals
- Oil selection and maintenance
- Coolant selection and maintenance
- Environmental qualities

- Installation

Refer to the standards for the engine or consult with your Caterpillar dealer in order to determine if the engine is operating within the defined parameters.

Severe service operation can accelerate component wear. Engines that operate under severe conditions may need more frequent maintenance intervals in order to ensure maximum reliability and retention of full service life.

Due to individual applications, it is not possible to identify all of the factors which can contribute to severe service operation. Consult your Caterpillar dealer for the unique maintenance that is necessary for the engine.

The operating environment, improper operating procedures and improper maintenance procedures can be factors which contribute to severe service conditions.

Environmental Factors

Ambient temperatures – The engine may be exposed to extended operation in extremely cold environments or hot environments. Valve components can be damaged by carbon buildup if the engine is frequently started and stopped in very cold temperatures. Extremely hot inlet air reduces engine performance.

Air Quality – The engine may be exposed to extended operation in an environment that is dirty or dusty, unless the equipment is cleaned regularly. Mud, dirt and dust can encase components. Maintenance can be very difficult. The buildup can contain corrosive chemicals.

Buildup – Compounds, elements, corrosive chemicals and salt can damage some components.

Altitude – Problems can arise when the engine is operated at altitudes that are higher than the intended settings for that application. Necessary adjustments should be made.

Improper Operating Procedures

- Extended operation at low idle
- Frequent hot shutdowns
- Operating at excessive loads
- Operating at excessive speeds
- Operating outside the intended application

Improper Maintenance Procedures

- Extending the maintenance intervals
- Failure to use recommended fuel, lubricants and coolant/antifreeze

i02348493

Starting Motor - Inspect

SMCS Code: 1451-040; 1453-040

Caterpillar recommends a scheduled inspection of the starting motor. If the starting motor fails, the engine may not start in an emergency situation.

Check the starting motor for correct operation. Check the electrical connections and clean the electrical connections. Refer to the Systems Operation, Testing and Adjusting Manual, "Electric Starting System - Test" for more information on the checking procedure and for specifications or consult your Caterpillar dealer for assistance.

i02710646

Turbocharger - Inspect

SMCS Code: 1052-040; 1052

A regular visual inspection of the turbocharger is recommended. Any fumes from the crankcase are filtered through the air inlet system. Therefore, by-products from oil and from combustion can collect in the turbocharger compressor housing. Over time, this buildup can contribute to loss of engine power, increased black smoke and overall loss of engine efficiency.

If the turbocharger fails during engine operation, damage to the turbocharger compressor wheel and/or to the engine may occur. Damage to the turbocharger compressor wheel can cause additional damage to the pistons, the valves, and the cylinder head.

NOTICE

Turbocharger bearing failures can cause large quantities of oil to enter the air intake and exhaust systems. Loss of engine lubricant can result in serious engine damage.

Minor leakage of oil into a turbocharger under extended low idle operation should not cause problems as long as a turbocharger bearing failure has not occurred.

When a turbocharger bearing failure is accompanied by a significant engine performance loss (exhaust smoke or engine rpm up at no load), do not continue engine operation until the turbocharger is renewed.

A visual inspection of the turbocharger can minimize unscheduled downtime. A visual inspection of the turbocharger can also reduce the chance for potential damage to other engine parts.

Removal and Installation

Note: The turbochargers that are supplied are non-serviceable.

For options regarding the removal, installation, and replacement, consult your Carerpillar dealer or your Carerpillar distributor. Refer to the Disassembly and Assembly Manual, "Turbocharger - Remove and Turbocharger - Install" for further information.

Inspecting

NOTICE

The compressor housing for the turbocharger must not be removed from the turbocharger for cleaning.

The actuator linkage is connected to the compressor housing. If the actuator linkage is moved or disturbed the engine may not comply with emissions legislation.

1. Remove the pipe from the turbocharger exhaust outlet and remove the air intake pipe to the turbocharger. Visually inspect the piping for the presence of oil. Clean the interior of the pipes in order to prevent dirt from entering during reassembly.
2. Check for the presence of oil. If oil is leaking from the back side of the compressor wheel, there is a possibility of a failed turbocharger oil seal.

The presence of oil may be the result of extended engine operation at low idle. The presence of oil may also be the result of a restriction of the line for the intake air (clogged air filters), which causes the turbocharger to slobber.

3. Inspect the bore of the housing of the turbine outlet for corrosion.
4. Fasten the air intake pipe and the exhaust outlet pipe to the turbocharger housing.

i02517672

V-Belts - Inspect/Adjust/Replace

SMCS Code: 1357-025; 1357-040; 1357-510

Inspection

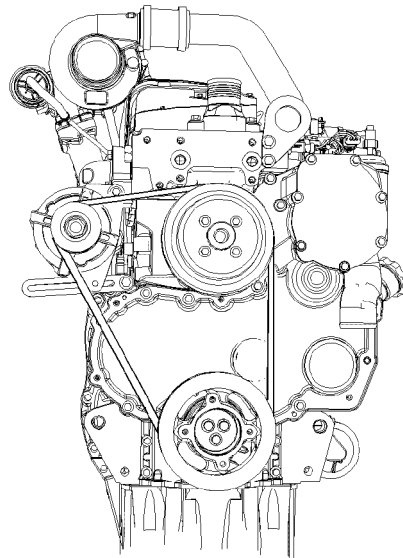


Illustration 43

g01249073

Arrangement for the V-belts

To maximize the engine performance, inspect the belts for wear and for cracking. Replace belts that are worn or damaged.

For applications that require multiple drive belts, replace the belts in matched sets. Replacing only one belt of a matched set will cause the new belt to carry more load because the older belt is stretched. The additional load on the new belt could cause the new belt to break.

If the belts are too loose, vibration causes unnecessary wear on the belts and pulleys. Loose belts may slip enough to cause overheating.

To accurately check the belt tension, install 144-0235 Belt Tension Gauge.

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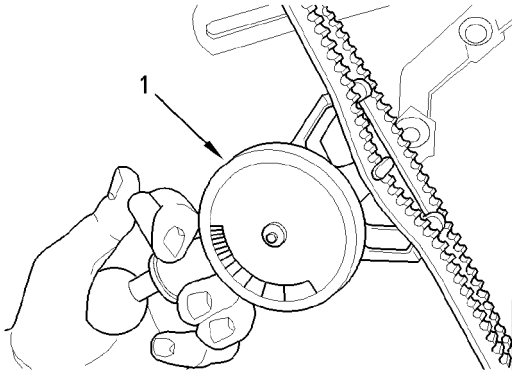


Illustration 44 g01003936

Typical example
(1) Gauge

Fit the gauge (1) at the center of the longest free length and check the tension. The correct tension is 400 N (90 lb). If the tension of the belt is below 250 N (56 lb) adjust the belt to 400 N (90 lb).

If twin belts are installed, check and adjust the tension on both belts.

Adjustment

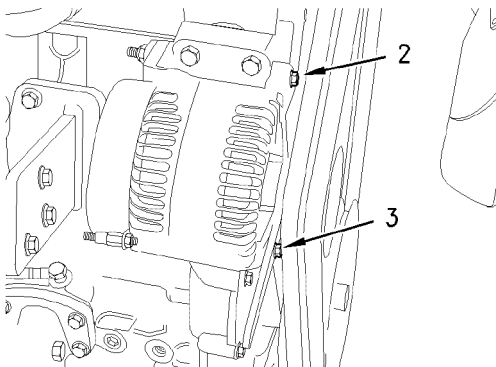


Illustration 45 g01003939

1. Loosen The alternator pivot bolt (2) and the bolt (3).
2. Move the alternator in order to increase or decrease the belt tension. Tighten the alternator pivot bolt and the link bolt to 22 N·m (16 lb ft).(1).

Replace

Refer to Disassembly and Assembly manual for more information.

Walk-Around Inspection

SMCS Code: 1000-040

Inspect the Engine for Leaks and for Loose Connections

A walk-around inspection should only take a few minutes. When the time is taken to perform these checks, costly repairs and accidents can be avoided.

For maximum engine service life, make a thorough inspection of the engine compartment before starting the engine. Look for items such as oil leaks or coolant leaks, loose bolts, worn belts, loose connections and trash buildup. Make repairs, as needed:

- The guards must be in the correct place. Repair damaged guards or replace missing guards.
- Wipe all caps and plugs before the engine is serviced in order to reduce the chance of system contamination.

NOTICE

For any type of leak (coolant, lube, or fuel) clean up the fluid. If leaking is observed, find the source and correct the leak. If leaking is suspected, check the fluid levels more often than recommended until the leak is found or fixed, or until the suspicion of a leak is proved to be unwarranted.

NOTICE

Accumulated grease and/or oil on an engine is a fire hazard. Remove the accumulated grease and oil. Refer to this Operation and Maintenance Manual, "Engine - Clean" for more information.

- Ensure that the cooling system hoses are correctly clamped and that the cooling system hoses are tight. Check for leaks. Check the condition of all pipes.
- Inspect the water pump for coolant leaks.

Note: The water pump seal is lubricated by the coolant in the cooling system. It is normal for a small amount of leakage to occur as the engine cools down and the parts contract.

Excessive coolant leakage may indicate the need to replace the water pump seal. For the removal of the water pump and the installation of water pump and/or seal, refer to the Disassembly and Assembly Manual, "Water Pump - Remove and Install" for more information or consult your Caterpillar dealer.

- Inspect the lubrication system for leaks at the front crankshaft seal, the rear crankshaft seal, the oil pan, the oil filters and the rocker cover.
- Inspect the fuel system for leaks. Look for loose fuel line clamps and/or tie-wraps.
- Inspect the piping for the air intake system and the elbows for cracks and for loose clamps. Ensure that hoses and tubes are not contacting other hoses, tubes, wiring harnesses, etc.
- Inspect the alternator belts and any accessory drive belts for cracks, breaks or other damage.

Belts for multiple groove pulleys must be replaced as matched sets. If only one belt is replaced, the belt will carry more load than the belts that are not replaced. The older belts are stretched. The additional load on the new belt could cause the belt to break.

- Drain the water and the sediment from the fuel tank on a daily basis in order to ensure that only clean fuel enters the fuel system.
- Inspect the wiring and the wiring harnesses for loose connections and for worn wires or frayed wires.
- Inspect the ground strap for a good connection and for good condition.
- Disconnect any battery chargers that are not protected against the current drain of the starting motor. Check the condition and the electrolyte level of the batteries, unless the engine is equipped with a maintenance free battery.
- Check the condition of the gauges. Replace any gauges that are cracked. Replace any gauge that can not be calibrated.

Note: The water pump seal is lubricated by the coolant in the cooling system. It is normal for a small amount of leakage to occur as the engine cools down and parts contract.

Visually inspect the water pump for leaks. Renew the water pump seal or the water pump if there is an excessive leakage of coolant. Refer to Disassembly and Assembly, "Water Pump - Remove" for the disassembly procedure and then refer to Disassembly and Assembly, "Water Pump - Install" for the assembly procedure.

i02457735

Water Pump - Inspect

SMCS Code: 1361-040; 1361

A failed water pump may cause severe engine overheating problems that could result in the following conditions:

- Cracks in the cylinder head
- A piston seizure
- Other potential damage to the engine

Warranty Section

Warranty Information

i01087950

Emissions Warranty Information

SMCS Code: 1000

This engine may be certified to comply with exhaust emission standards and gaseous emission standards that are prescribed by law at the time of manufacture, and this engine may be covered by an Emissions Warranty. A detailed explanation of the Emissions Warranty that is applicable to emissions certified engines is found in Supplement, SEBU6981, "Federal Emissions Control Warranty Information". Consult your authorized Caterpillar dealer to determine if your engine is emissions certified and if your engine is subject to an Emissions Warranty.

Reference Information Section

i00819749

Engine Ratings

i00727327

Engine Rating Conditions

SMCS Code: 1000

All engine ratings are in compliance with the following standard ambient air conditions of "SAE J1349":

- 99 kPa (29.3 inches of Hg)
- 30 percent relative humidity
- A temperature of 25 °C (77 °F)

Ratings relate to the standard conditions of "ISO8665", of "ISO3046/1", of "DIN6271", and of "BS5514".

The engine ratings are based on the following fuel specifications:

- Low heat value (LHV) of the fuel of 42 780 kJ/kg (18,390 Btu/lb) at 29 °C (84 °F)
- Gravity (API) of 35 degrees at 15 °C (60 °F)
- Specific gravity of .849 at 15 °C (60 °F)
- Density of 850 kg/m³ (7.085 lb/US gal)

The engine ratings are gross output ratings.

Gross Output Ratings – The total output capability of the engine that is equipped with standard accessories.

Standard accessories include the following components:

- Oil pumps
- Fuel pumps
- Water pumps

Subtract the power that is required to drive auxiliary components from the gross output. This will produce the net power that is available for the external load (flywheel).

Engine Rating Definitions

SMCS Code: 1000

It is important to know the use of the engine so that the rating will match the operating profile. The proper rating selection is also important so that the customer's perception of price and value is realized.

In selecting a rating for a specific application, the most important consideration is the time that is spent at full throttle. These rating definitions identify the percent of time at full throttle. The definitions also identify the corresponding times below rated rpm.

Note: The examples of the applications are only for reference. For an exact determination of the appropriate rating, follow the OEM specifications or consult your Caterpillar dealer.

A Rating – This rating is used for heavy-duty applications that are operated at rated load and at rated rpm up to 100 percent. This rating is used for engines that operate without interruption of load cycling. Typical applications include the following examples: pipeline pumping and ventilation.

B Rating – This rating is used when power and/or rpm are cyclic. The engine should be run at full load. The engine should not exceed 80 percent of the duty cycle. Typical applications include the following examples: irrigation, operation where normal pump demand is 85 percent of the engine rating, oil pumping/drilling, field mechanical pumping/drilling, and stationary/plant air compressors.

C Rating – This rating is used when power and/or rpm are cyclic. The horsepower and the rpm of the engine can be utilized continuously for one hour. This is followed by one hour of operation at the A rating or below the A rating. The engine should be run at full load. The engine should not exceed 50 percent of the duty cycle. Typical applications include the following examples: agricultural tractors, harvesters and combines, off-highway trucks, fire pumps, blast hole drills, rock crushers, wood chippers with high torque rise, and oil field hoisting.

D Rating – This rating is used when rated power is required for periodic overloads. The maximum horsepower and the rpm of the engine can be utilized continuously for a maximum of 30 minutes. This is followed by one hour of operation at the C rating. The engine should be run at full load. The engine should not exceed 10 percent of the duty cycle. Typical applications include the following examples: offshore cranes, runway snow blowers, water well drills, portable air compressors, and fire pump certification power.

E Rating – This rating is used when rated power is required for a short time for initial starting or for sudden overload. The rating is also used for emergency service when standard power is not available. The horsepower and the rpm of the engine can be utilized continuously for a maximum of 15 minutes. This is followed by one hour of operation at the C rating or by the duration of the emergency. The engine should be run at full load. The engine should not exceed 5 percent of the duty cycle. Typical applications include the following examples: standby centrifugal water pumps, oil field well servicing, crash trucks, portable air compressors, and gas turbine starting motors.

NOTICE

Operating engines above the rating definitions can result in shorter service life before overhaul.

Customer Service

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Customer Assistance

SMCS Code: 1000

USA and Canada

When a problem arises concerning the operation of an engine or concerning the service of an engine, the problem will normally be managed by the dealer in your area.

Your satisfaction is a primary concern to Caterpillar and to Caterpillar dealers. If you have a problem that has not been handled to your complete satisfaction, follow these steps:

1. Discuss your problem with a manager from the dealership.
2. If your problem cannot be resolved at the dealer level without additional assistance, use the phone number that is listed below to talk with a Field Service Coordinator:

1-800-447-4986

The normal hours are from 8:00 to 4:30 Monday through Friday Central Standard Time.

3. If your needs have not been met still, submit the matter in writing to the following address:

Caterpillar Inc.
Manager, Customer Service, Engine Division
Mossville Bldg AC
P.O. Box 610
Mossville, Illinois 61552-0610

Please keep in mind: probably, your problem will ultimately be solved at the dealership, using the dealership's facilities, equipment, and personnel. Therefore, follow the steps in sequence when a problem is experienced.

Outside of the USA and of Canada

If a problem arises outside the USA and outside Canada, and if the problem cannot be resolved at the dealer level, consult the appropriate Caterpillar office.

Latin America, Mexico, Carribean
Caterpillar Americas Co.
701 Waterford Way, Suite 200
Miami, FL 33126-4670
USA
Phone: 305-476-6800
Fax: 305-476-6801

Europe, Africa, and Middle East
Caterpillar Overseas S.A.
76 Route de Frontenex
P.O. Box 6000
CH-1211 Geneva 6
Switzerland
Phone: 22-849-4444
Fax: 22-849-4544

Far East
Caterpillar Asia Pte. Ltd.
7 Tractor Road
Jurong, Singapore 627968
Republic of Singapore
Phone: 65-662-8333
Fax: 65-662-8302

China
Caterpillar China Ltd.
37/F., The Lee Gardens
33 Hysan Avenue
Causeway Bay
G.P.O. Box 3069
Hong Kong
Phone: 852-2848-0333
Fax: 852-2848-0440

Japan
Shin Caterpillar Mitsubishi Ltd.
SBS Tower
10-1, Yoga 4-Chome
Setagaya-Ku, Tokyo 158-8530
Japan
Phone: 81-3-5717-1150
Fax: 81-3-5717-1177

Japan
Caterpillar Power Systems, Inc.
SBS Tower (14th floor)
4-10-1, Yoga
Setagaya-Ku, Tokyo 158-0097
Phone: 81-3-5797-4300
Fax: 81-3-5797-4359

Australia and New Zealand
Caterpillar of Australia Ltd.
1 Caterpillar Drive
Private Mail Bag 4
Tullamarine, Victoria 3043
Australia
Phone: 03-9953-9333
Fax: 03-9335-3366

i01028392

Ordering Replacement Parts

SMCS Code: 7567

WARNING

When replacement parts are required for this product Caterpillar recommends using Caterpillar replacement parts or parts with equivalent specifications including, but not limited to, physical dimensions, type, strength and material.

Failure to heed this warning can lead to premature failures, product damage, personal injury or death.

Quality Caterpillar replacement parts are available from Caterpillar dealers throughout the world. Caterpillar dealers' parts inventories are up-to-date. The parts stocks include all of the parts that are normally needed to protect your Caterpillar engine investment.

When you order parts, please specify the following information:

- Part number
- Part name
- Quantity

If there is a question concerning the part number, please provide your dealer with a complete description of the needed item.

When a Caterpillar engine requires maintenance and/or repair, provide the dealer with all the information that is stamped on the Information Plate. This information is described in this Operation and Maintenance Manual (Product Information Section).

Discuss the problem with the dealer. Inform the dealer about the conditions of the problem and the nature of the problem. Inform the dealer about when the problem occurs. This will help the dealer in troubleshooting the problem and solving the problem faster.

Reference Materials

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Reference Material

SMCS Code: 1000

The following literature can be obtained through any Caterpillar dealer.

Lubricants

- Special Publication, PEHP8038, "Data Sheet - Caterpillar Diesel Engine Oils (DEO) (CH-4) (North America)"
- Special Publication, PEHP9536, "Data Sheet - Caterpillar Diesel Engine Oil (DEO) (CF-4) (International only)"
- Special Publication, NEDG6022, "Cat Lubricating Grease"
- Special Publication, PEHP0002, "Data Sheet - Molybdenum (MPGM) Grease"
- Special Publication, NEHP6015, "Data Sheet - Caterpillar Special Purpose Grease (SPG)"
- Special Publication, SEBD0640, "Oil and Your Engine"
- Operation and Maintenance Manual, SEBU5898, "Cold Weather Recommendations"
- Operation and Maintenance Manual, SEBU6251, "Caterpillar Commercial Diesel Engine Fluids Recommendations"
- Special Publication, PEHP6001, "How To Take A Good Oil Sample"

Fuels

- Special Publication, SEBD0717, "Diesel Fuels and Your Engine"

Coolants

- Special Publication, PEHP4036, "Data Sheet - Extended Life Coolant"
- Special Publication, PEHP7057, "Data Sheet - S·O·S Coolant Analysis"
- Special Publication, SEBD0518, "Know Your Cooling System"

- Special Publication, SEBD0970, "Coolant and Your Engine"

- Label, PEEP5027, "Extended Life Coolant/Antifreeze"

Miscellaneous

- Service Manual, REG1139F, "Service Manual Contents Microfiche"
- Service Manual, KENR6217, "C4.4 Industrial Engines"
- Systems Operation, Testing and Adjusting, RENR9965, "C4.4 Industrial Engines"
- Specifications, RENR9961, "C4.4 Industrial Engines."
- Disassembly and Assembly, KENR6216, "C4.4 Industrial Engines"
- Specifications, SENR3130, "Torque Specifications"
- Special Publication, PECP9067, "One Safe Source" English language for use in NACD
- Special Publication, LEDM5615, "Caterpillar Marine Parts and Service Locations Directory"
- Special Publication, SEBF8029, "Index to Guidelines for Reusable Parts and Salvage Operations"
- Special Publication, SEBF8062, "Procedure to Inspect and Clean Air Filters"
- Special Instruction, SEHS9031, "Storage Procedure for Caterpillar Products"
- Special Publication, NEHS0526, "Service Technician Application Guide"
- Special Publication, SEBU6251, "Caterpillar Commercial Diesel Engine Fluids Recommendations"
- Special Instruction, SEHS7633, "Battery Test Procedure"
- Label, SEHS7332, "Danger Do Not Operate"

Emissions Warranty

This engine may be Certified and this engine may be covered by an Emissions Warranty. A detailed explanation of the Emissions Warranty that is applicable to Certified engines is found in Supplement, SMBU6981, "Emissions Control Warranty Information". The engine is Certified if the engine has a special label that verifies the certification. A Caterpillar dealer can also inform you if the engine is certified.

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Additional Reference Material

SMCS Code: 1000

The "Engine Fluids Data Book" can be obtained from the following locations: local technological society, local library, and local college. If necessary, consult EMA at the following address:

Engine Manufacturers Association
Two North LaSalle Street, Suite 2200
Chicago, Illinois, USA 60602
E-mail: ema@enginemanufacturers.org
(312) 827-8700
Facsimile: (312) 827-8737

The "Society of Automotive Engineers (SAE) Specifications" can be found in your SAE handbook. This publication can also be obtained from the following locations: local technological society, local library, and local college. If necessary, consult SAE at the following address:

SAE International
400 Commonwealth Drive
Warrendale, PA, USA 15096-0001
Telephone: (724) 776-4841

The "American Petroleum Institute Publication No. 1509" can be obtained from the following locations: local technological society, local library, and local college. If necessary, consult API at the following address:

American Petroleum Institute
1220 L St. N.W.
Washington, DC, USA 20005
Telephone: (202) 682-8000

The International Organization for Standardization (ISO) offers information and customer service regarding international standards and standardizing activities. ISO can also supply information on the following subjects that are not controlled by ISO: national standards, regional standards, regulations, certification, and related activities. Consult the member of ISO in your country.

International Organization for Standardization (ISO)
1, rue de Varembe
Case postale 56
CH-1211 Genève 20
Switzerland
Telephone: +41 22 749 01 11
Facsimile: +41 22 733 34 30
E-mail: central@iso.ch
Web site: <http://www.iso.ch>

European classifications are established by the Conseil International Des Machines a Combustion (CIMAC) (International Council on Combustion Engines).

CIMAC Central Secretariat
Lyoner Strasse 18
60528 Frankfurt
Germany
Telephone: +49 69 6603 1567
Facsimile: +49 69 6603 1566

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Maintenance Records

SMCS Code: 1000

Caterpillar Inc. recommends the retention of accurate maintenance records. Accurate maintenance records can be used for the following purposes:

- Determine operating costs.
- Establish maintenance schedules for other engines that are operated in the same environment.
- Show compliance with the required maintenance practices and maintenance intervals.

Maintenance records can be used for a variety of other business decisions that are related to engine maintenance.

Maintenance records are a key element of a maintenance program that is well managed. Accurate maintenance records can help your Caterpillar dealer to fine tune the recommended maintenance intervals in order to meet the specific operating situation. This should result in a lower engine operating cost.

Records should be kept for the following items:

Fuel Consumption – A record of fuel consumption is essential in order to determine when the load sensitive components should be inspected or repaired. Fuel consumption also determines overhaul intervals.

Service Hours – A record of service hours is essential to determine when the speed sensitive components should be inspected or repaired.

Documents – A record of all documents should be obtained, and all documents should be kept in the engine history file. All of the documents should show this information: date, service hours, fuel consumption, unit number, and engine serial number. The following types of documents should be kept as proof of maintenance or repair for warranty:

Keep the following types of documents as proof of maintenance for warranty. Also, keep these types of documents as proof of repair for warranty:

- Dealer work orders and itemized bills
- Owner's repair costs
- Owner's receipts
- Maintenance log

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Maintenance Log

SMCS Code: 1000

Table 12

Engine Model		Customer Identifier		
Serial Number		Arrangement Number		
Service Hours	Quantity Of Fuel	Service Item	Date	Authorization

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Product and Dealer Information

Note: For product identification plate locations, see the section “Product Identification Information” in the Operation and Maintenance Manual.

Delivery Date: _____

Product Information

Model: _____

Product Identification Number: _____

Engine Serial Number: _____

Transmission Serial Number: _____

Generator Serial Number: _____

Attachment Serial Numbers: _____

Attachment Information: _____

Customer Equipment Number: _____

Dealer Equipment Number: _____

Dealer Information

Name: _____ Branch: _____

Address: _____

Dealer Contact

Phone Number

Hours

Sales: _____

Parts: _____

Service: _____

