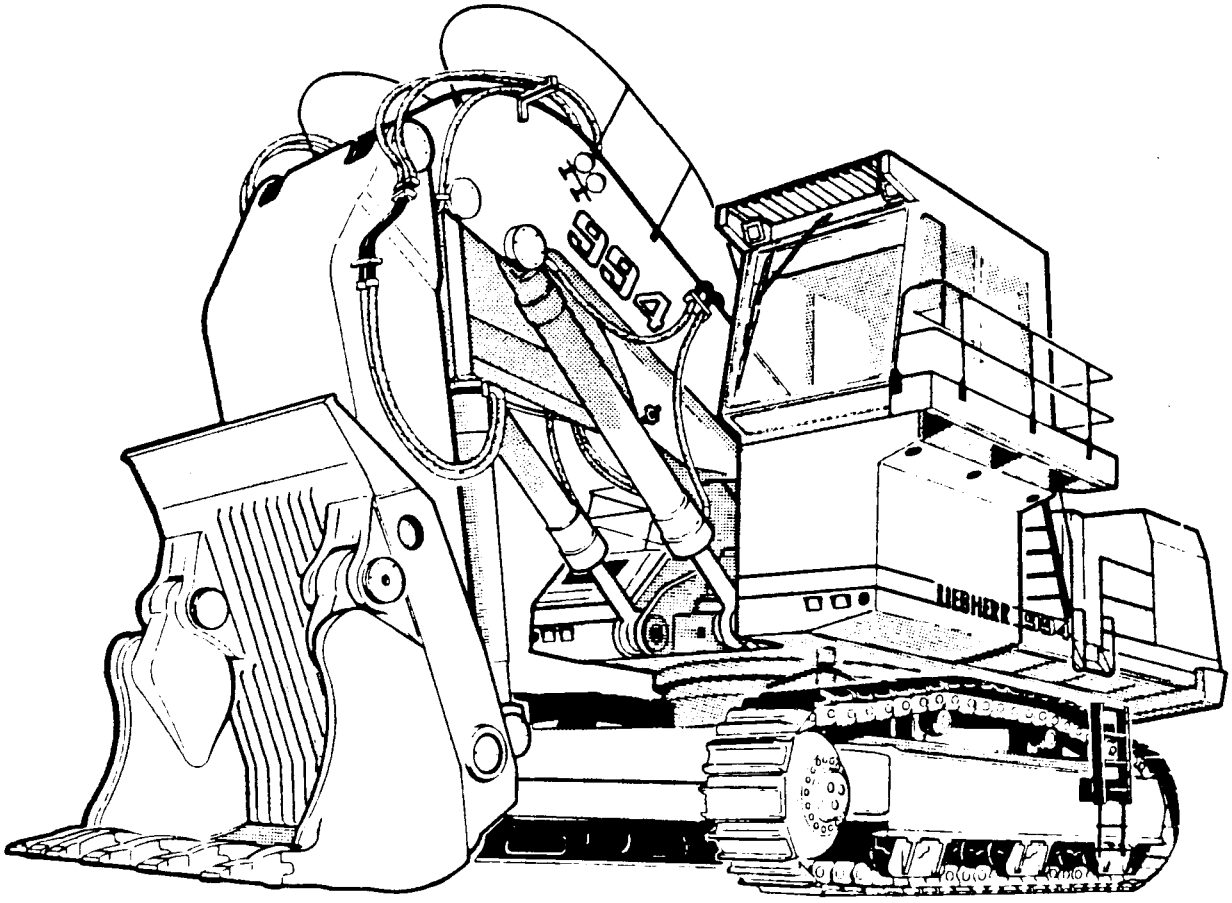
Operation and Maintenance Manual

P 994

Litronic



FOREWORD

This manual is primarily **for the operator** and **the maintenance crew** and contains information which is vital to the correct and secure operation and proper maintenance of the **LIEBHERR excavator.**

It includes:

- **Accident Prevention Guidelines**
- **Operating Instructions**
- **Maintenance Instructions.**

This Operation and Maintenance manual should be given to the **OPERATOR** and any other person, who might work on the machine. It is very important that should read the manual carefully before operating or working on the **LIEBHERR** excavator and at regular intervals thereafter, for example:

- **Operation,** including installing and removing the attachments, trouble shooting during operation, removing production residue, care, disposing of operating and auxiliary fluids,
- **Maintenance work** (maintenance, inspection, repair),
- **Transportation.**

The manual will make it easier for the operator to get accustomed to the hydraulic excavator and to prevent any problems due to improper handling.

All maintenance personnel should follow the operating and maintenance instructions and your **LIEBHERR** excavator will give you constant and reliable service with excellent performance, reducing repair costs and down time.

In addition to the operating and maintenance guidelines is this manual, additional local and national accident prevention guidelines and environmental regulations might be applicable and must be observed.

The Operation and Maintenance Manual is part of the machine and should be left in the glove compartment of the operator's cab.

Please take notice that we cannot honor any claims which could arise due to careless handling, improper operation, inadequate maintenance, use of unauthorized oils or lubricants, non-observance of the safety instructions, etc.

LIEBHERR reserves the right to cancel any warranty claims, service contracts etc. without prior notice if any other than Original **LIEBHERR** parts or parts sold by **LIEBHERR** are being used for maintenance and repairs.

This Operation and Maintenance manual contains all necessary information to operate and maintain your Litronic track type excavator. However, should you need additional information or explanations, please contact **LIEBHERR's** Technical Documentation, Service school or Customer Service Department.

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INFORMATION TO THE OPERATION AND MAINTENANCE MANUAL R 994 Litronic PONTOON

ISSUE : 12/93

ID. / NO : 8503068 SP5

This **Operation and Maintenance Manual** is valid for **R 994 Litronic** excavators on a pontoon from the following serial numbers :

TYPE	Valid from Serial Number
314 /	.165

We recommend that you fill in the following table as soon as you receive your excavator. This will also be helpful when you order parts.

Product Id. No. (PIN No.):	... / .... ★
Manufacturing Date:	.... ★
Delivery Date:	.. / .. / ..

★ This data can be found on the R 994 Litronic's Id. Tag , right front on the uppercarriage.

We reserve the right to make any technical changes compared to data and illustrations given in this manual.

Warranty and liability are subject to LIEBHERR's general business terms and conditions are not changed in any way by instructions in this manual.

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Technical Description
Hydraulic Excavator

R 994
Litronic®

Operating Weight with Backhoe Attachment 229 t/504,900 lb
Operating Weight with Shovel Attachment 226,4 t/499,150 lb
Engine Output 937 kW (1273 HP)
Bucket Capacity 4,5 to 20,0 m³/5.9 to 26.2 cuyd
Shovel Capacity 10,5 to 18,0 m³/13.7 to 23.5 cuyd

LIEBHERR

Technical Data

Engine

Cummins diesel engine	
Rating per	
DIN/ISO 3046-1	937 kW (1273 HP) at 2100 RPM reduced to 840 kW (1142 HP) at 1800 RPM
Model	KTTA38-C 1350
Type	12 cylinder V-engine water-cooled direct injection turbo-charged after-cooled
Displacement	37,8 l/2307 cu.in
Bore/Stroke	159/159 mm/6.26/6.26 in
Air cleaner	dry-type air cleaner with automatical dust ejector, primary and safety elements
Fuel tank	3900 l/1030 gal
Electrical system	
Voltage	24 V
Batteries	2 x 170 Ah/12 V
Alternator	24 V/100 Amp
Engine idling	sensor controlled
Air system	1 cylinder compressor maintenance-free pressure regulator anti-freeze pump

Hydraulic System

Hydraulic pumps	
for attachment and travel drive	3 variable flow axial piston pumps
Max. flow	2 x 757 l/min. + 1 x 505 l/min./ 2 x 200 gpm + 1 x 133 gpm
Max. hydraulic pressure	320 bar/4640 PSI
Hydraulic pump	
for swing drive	1 reversible swash plate pump, closed-loop circuit
Max. flow	450 l/min./119 gpm
Max. hydraulic pressure	400 bar/5800 PSI
Pump regulation	electro-hydraulic, pressure compensation, flow compensation, automatic oil flow optimizer
Hydraulic tank pressurization	0,5 bar/7.3 PSI
Hydraulic tank capacity	1800 l/476 gal
Hydraulic system capacity	2400 l/634 gal
Hydraulic oil filter	1 full flow filter in return line, 1 high pressure filter for each main pump
Hydraulic oil cooler	separate vertically mounted cooler, thermostatically regulated fan
Electronic engine speed sensing	at rated engine speed setting
Lubrication	central lubrication system

Hydraulic Controls

Servo circuit	independant, electric over hydraulic proportional controls of each function
Emergency control	via accumulator for attachment functions with stopped engine
Power distribution	via monoblock control valves with integrated primary and flanged-on secondary relief valves
Flow summation	to attachment, hoist, stick and bucket cylinders and travel drive
Control functions	
Attachment and swing	– proportional via joystick levers
Travel	– proportional via foot pedals or hand levers for all travel functions
Additional functions	via foot pedals or joystick toggle switch

Swing Drive

Hydraulic motor	2 Liebherr axial piston motors
Gear	2 Liebherr planetary reduction gears
Swing ring	Liebherr, sealed triple roller swing ring, internal teeth
Swing speed	0–3,7 RPM
Swing torque	677 kNm
Swing-Holding brake	hydraulically released multi-disc brakes, maintenance-free

Uppercarriage

Design	torque resistant designed upper frame in box type construction for superior strength and durability
Attachment mounting	parallel length girders
Catwalks	on the left side of the upper

Operator's Cab

Design	resiliently mounted, sound insulated, large windows for 360° visibility, integrated falling object protection (FOPS)
Operator's seat	suspended, body-contoured with shock absorber, adjustable to operator's weight, additional training seat is standard equipment
Controls	joystick levers integrated into armrest of seat
Monitoring	via LED Display
Acoustical and optical signal	in case of low engine oil pressure or low coolant level. Automatic engine shut of
Optical signal	in case of engine overheating or low hydraulic oil level. Destroking of main pumps
Heating system/ Air conditioning	heavy duty, high output air conditioner and heater unit

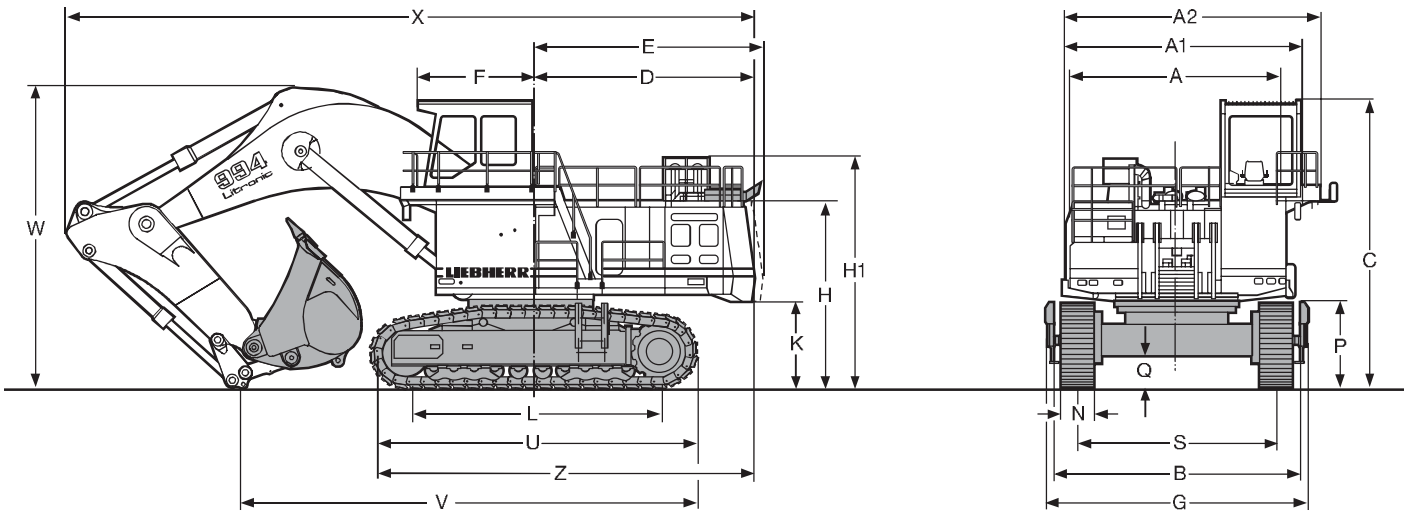
Undercarriage

Design	3-piece undercarriage, box type structures for center piece and side frames, stress relieved
Hydraulic motor	axial piston motor
Travel gear	Liebherr planetary reduction gear
Travel speed	0–2,6 km/h/0–1.6 mph
Drawbar pull	1480 kN
Parking brake	hydraulically actuated wet multi-disc brakes, maintenance-free
Hydraulic brake valve	mounted separately in the undercarriage
Track components	B 11, maintenance-free
Track rollers/ Carrier rollers	10/2
Track pads	forged double grouser
Track chain adjustment	hydraulic
Transport	undercarriage side frames are removable

Attachment

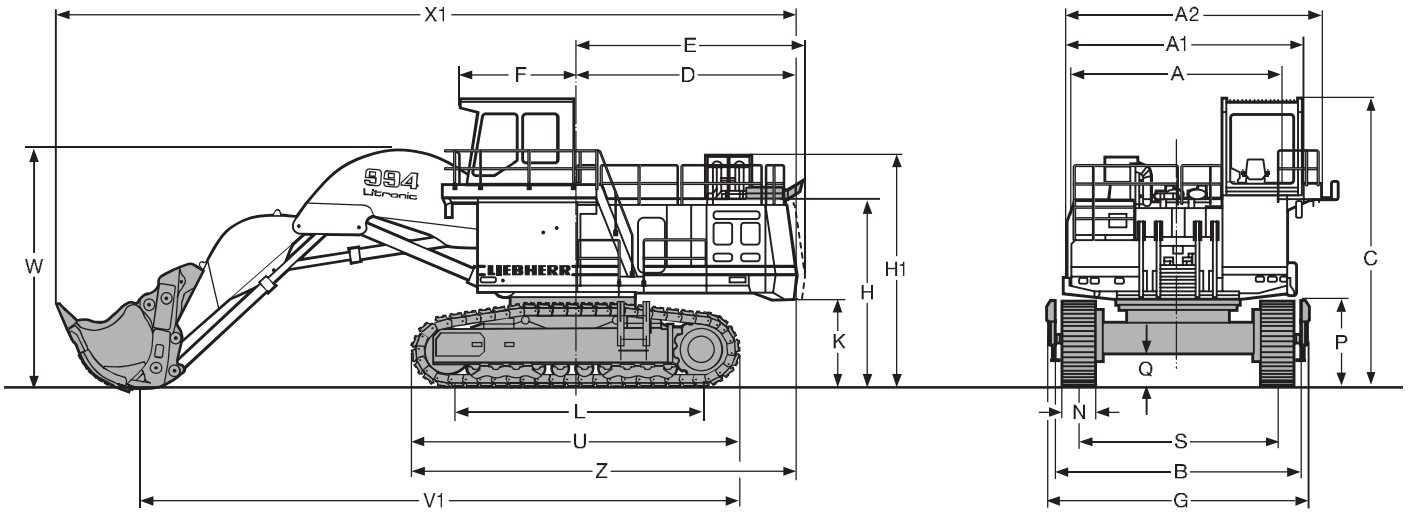
Design	box-type, welded structures with large cast steel components
Pivots	sealed
Pivots bucket-to-stick	
Pivots bucket-to-link	O-ring sealed and completely enclosed
Lubrication	connected to the centralized lubrication system
Hydraulic cylinder	Liebherr manufactured cylinders, sealed bearings, hydraulic piston cushioning
Hydraulic connections	pipes and hoses equipped with SAE split-flange connections
Bucket	with lifting eye 50 t/110,230 lb

Dimensions



	mm/ft-in
A	5400/17’ 9”
A1	5800/19’ 0”
A2	6360/20’10”
C	7100/23’ 4”
D	5540/18’ 2”
E	5740/18’10”
F	2780/ 9’ 1”
H	4480/14’ 8”
H1	5690/18’ 8”
K	2120/ 6’11”
L	6280/20’ 7”

	mm/ft-in
P	2100/ 6’11”
Q	820/ 2’ 8”
S	4900/16’ 1”
U	8070/26’ 6”
Z	9580/31’ 5”
N	800/ 2’ 7”
B	6120/20’ 1”
G	6440/21’ 2”
V	11200/36’ 9”
W	7700/25’ 3”
X	17200/56’ 5”



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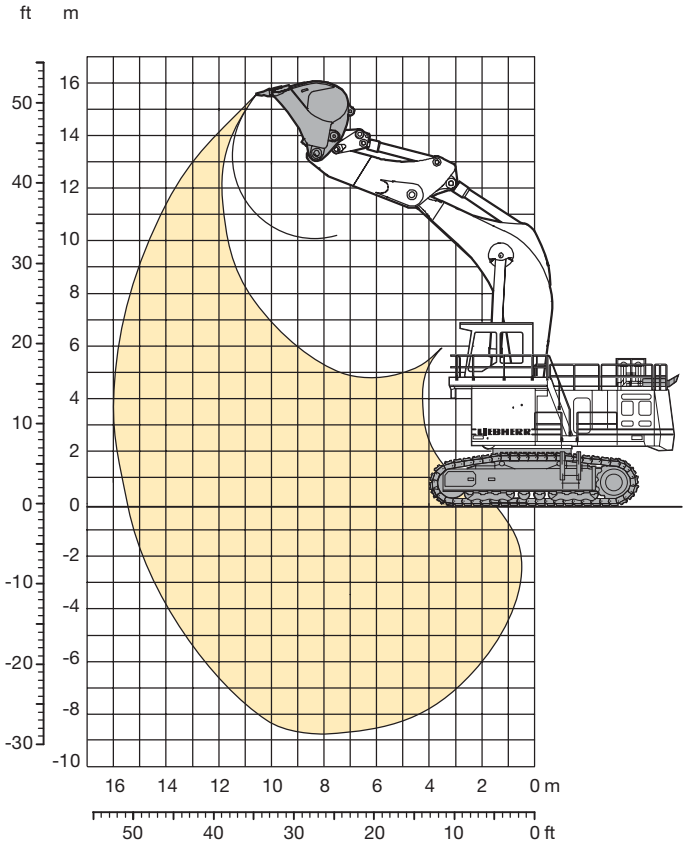
Z	9575/31’ 5”
N	800/ 2’ 7”
B	6120/20’ 1”
G	6440/21’ 2”
W1	6000/19’ 8”
V1	10000/32’10”
X1	12350/40’ 6”

Backhoe Attachment

with Gooseneck Boom 9,00 m/29'6"



Digging Envelope

Max. reach at ground level	15,50 m/50'10"
Max. teeth height	15,60 m/51' 2"
Max. dump height	10,30 m/33'10"
Max. digging depth	8,70 m/28' 7"
Max. digging force	780 kN (79,5 t/175,300 lb)
Max. breakout force	859 kN (87,5 t/193,120 lb)

Operating Weight and Ground Pressure

The operation weight includes the basic machine with backhoe attachment and bucket 13,00 m³/17.0 cuyd.

Pad width	mm/in	800/31
Weight	kg/lb	229000/504,900
Ground pressure	kg/cm²/PSI	2,07/29.44

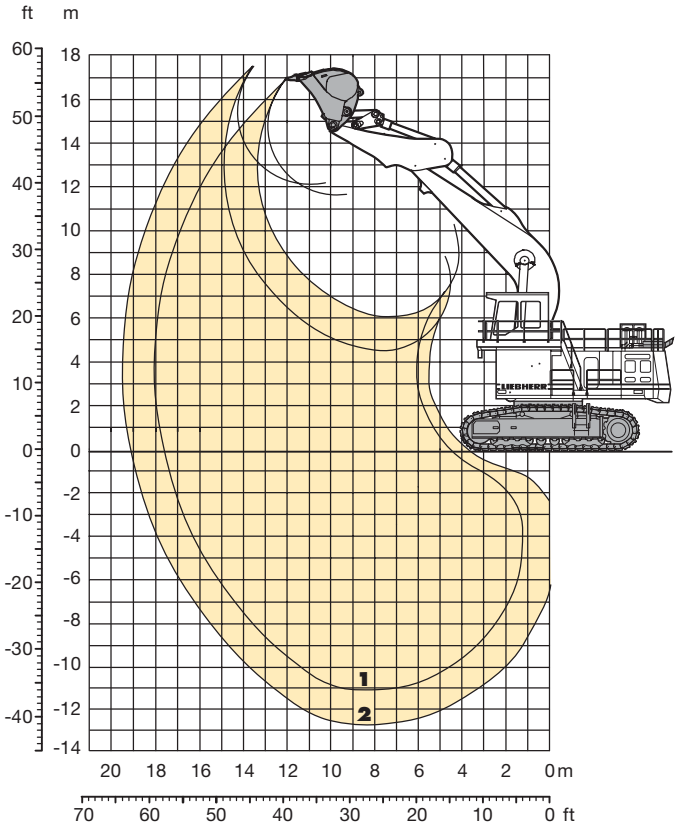
Buckets

Cutting width	mm/in	2900/114[1)]	3150/124[2)]	3200/126[2)]	3500/138[3)]	4200/165[4)]
Capacity SAE heaped	m³/cuyd	11,00/14.4	13,00/17.0	14,00/18.3	15,00/19.6	20,00/26.2
Weight	kg/lb	13400/29,540	14000/30,860	14500/31,970	14200/31,310	14300/31,530
Suitable for material up to a specific weight of	t/m³/lb/cuyd	2,00/3,400	1,80/3,000	1,65/2,800	1,50/2,500	1,20/2,000

[1)] Heavy duty rock bucket with teeth size V 81 (SD) and Delta cutting edge
[2)] Bucket with teeth size V 81 (SD)
[3)] Bucket for material weighing not more than 1400 kg/m³/2,400 lb/cuyd, with teeth size 71 (SD)
[4)] Coal bucket, with teeth size 76 (FP)

Backhoe Attachment

with Gooseneck Boom 10,80 m/35’5”



Digging Envelope

		1	2
Löffelstiellänge	m	4,00/13’1”	5,60/18’4”
Max. reach at ground level	m/ft-in	17,70/58’ 1”	19,20/63’0”
Max. teeth height	m/ft-in	17,00/55’ 9”	17,70/58’1”
Max. dump height	m/ft-in	11,60/38’ 1”	12,30/40’4”
Max. digging depth	m/ft-in	10,95/35’11”	12,50/41’0”
Max. digging force		660 kN (67,3 t/148,400 lb)	
Max. breakout force		753 kN (76,7 t/169,100 lb)	

Operating Weight and Ground Pressure

The operation weight includes the basic machine with backhoe attachment, stick 4,00 m/13’1” and bucket 7,20 m³/9.4 cuyd.

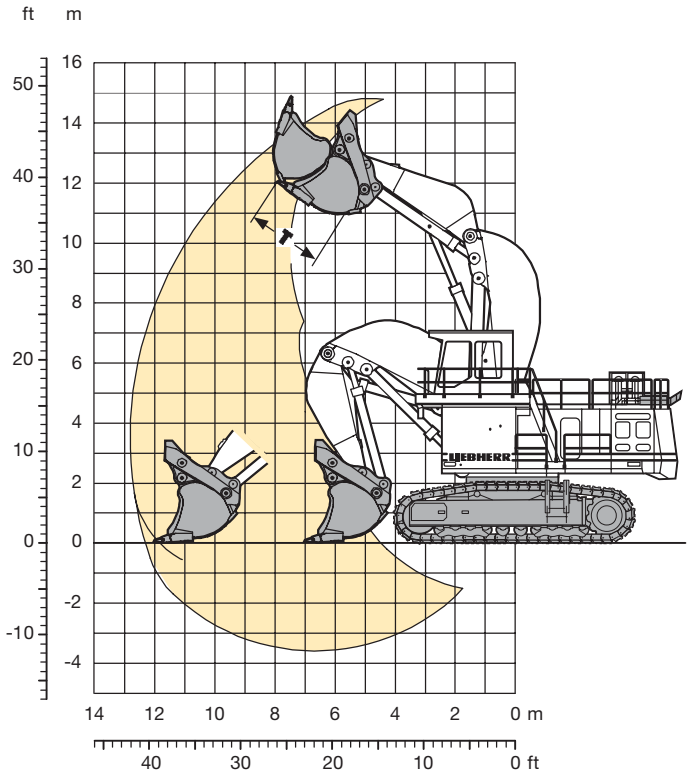
Pad width	mm/in	800/31
Weight	kg/lb	217600/479,700
Ground pressure	kg/cm²/PSI	1,97/28.02

Buckets

Cutting width	mm/in	1900/75	2050/81	2300/91	2800/110
Capacity SAE heaped	m³/cuyd	4,50/5.9	5,70/7.5	7,20/9.4	9,00/11.8
Weight	kg/lb	6000/13,230	7200/15,870	8450/18,630	10000/22,050
Suitable for material up to a specific weight of					
with stick 4,00 m/13’1”	kg/m³/lb/cuyd	–	2200/3,800	1800/3,000	1500/2,500
with stick 5,60 m/18’4”	kg/m³/lb/cuyd	2200/3,800	1800/3,000	1500/2,500	–

All buckets are heavy duty rock bucket with teeth size 86 (LP)

Shovel Attachment



Digging Envelope

Max. reach at ground level	12,65 m/41'6"
Max. dump height	11,00 m/36'1"
Max. crowd length	5,00 m/16'5"
Bucket opening width T	2,35 m/ 7'9"
Crowd force at ground level	1000 kN (102,0 t/224,900 lb)
Max. crowd force	1075 kN (109,5 t/241,400 lb)
Max. breakout force	920 kN (93,7 t/206,600 lb)

Operating Weight and Ground Pressure

The operation weight includes the basic machine with shovel attachment and bucket 13,50 m^3/17.7 cuyd.

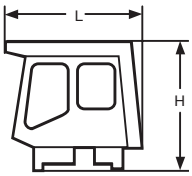
Pad width	mm/in	800/31
Weight	kg/lb	226400/499,150
Ground pressure	kg/cm^2/PSI	2.05/29.16

Buckets

Cutting width	mm/in	3150/124[1)]	3500/138[1)]	3800/150[1)]	3800/150[2)]	4050/159[3)]
Capacity SAE heaped	m^3/cuyd	10,50/13.7	12,00/15.7	13,50/17.7	15,00/19.6	18,00/23.5
Weight	kg/lb	18000/39,680	19600/43,210	21500/47,400	21800/48,060	22000/48,500
Suitable for material up to a specific weight of	kg/m^3/lb/cuyd	2400/4,000	2000/3,400	1800/3,000	1500/2,500	1200/2,000

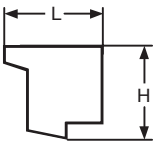
1) Bottom dump bucket with Delta cutting edge and teeth size 81 (RYL)
2) Bottom dump bucket with straight spade nose cutting edge and teeth size 81 (SYL)
3) Coal bottom dump bucket with straight spade nose and teeth size 76 (FP)

Dimensions and Weights



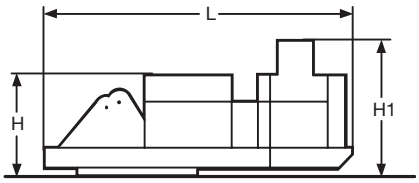
Cab

L	Length	mm/ft-in	2875/9’5”
H	Height	mm/ft-in	2850/9’4”
	Width	mm/ft-in	2020/6’8”
	Weight	kg/lb	2570/5,670



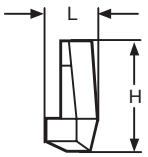
Cab Elevation

L	Length	mm/ft-in	2050/6’9”
H	Height	mm/ft-in	2450/8’0”
	Width	mm/ft-in	2460/8’1”
	Weight	kg/lb	2200/4,850



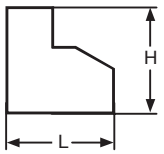
Upper with Swing Ring

L	Length	mm/ft-in	7650/25’1”
H	Height	mm/ft-in	2455/ 8’1”
H1	Height	mm/ft-in	3668/12’0”
	Width	mm/ft-in	3750/12’4”
	Weight	kg/lb	45200/99,650



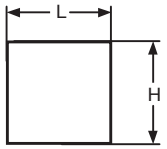
Counterweight

L	Length	mm/ft-in	1215/ 4’0”
H	Height	mm/ft-in	2355/ 7’9”
	Width	mm/ft-in	5600/18’4”
	Weight	kg/lb	22500/49,600



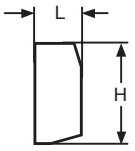
Fuel Tank (one)

L	Length	mm/ft-in	2130/7’ 0”
H	Height	mm/ft-in	2130/7’ 0”
	Width	mm/ft-in	1775/5’10”
	Weight	kg/lb	1550/3,420



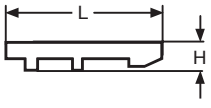
Hydraulic Oil Cooling Unit (one)

L	Length	mm/ft-in	2000/6’7”
H	Height	mm/ft-in	2140/7’0”
	Width	mm/ft-in	1565/5’2”
	Weight	kg/lb	1900/4,190



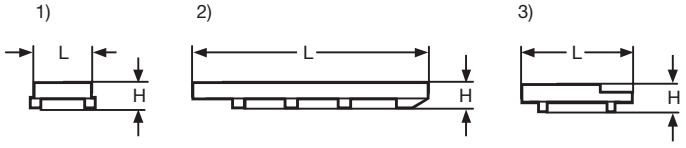
Side Panel (one each)

			left	right
L	Length	mm/ft-in	940/3’1”	990/3’3”
H	Height	mm/ft-in	2140/7’0”	2140/7’0”
	Width	mm/ft-in	1600/5’3”	2070/6’9”
	Weight	kg/lb	480/1,060	900/1,980



Catwalk

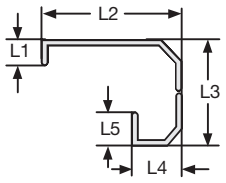
L	Length	mm/ft-in	3200/10’6”
H	Height	mm/ft-in	680/ 2’3”
	Width	mm/ft-in	810/ 2’8”
	Weight	kg/lb	180/400



Catwalk for Cab

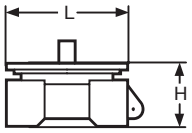
			front[1]	lateral[2]	back[3]
L	Length	mm/ft-in	583/1’11”	3400/11’2”	1210/3’12”
H	Height	mm/ft-in	336/1’ 1”	440/ 1’5”	440/1’ 5”
	Width	mm/ft-in	805/2’ 8”	410/ 1’4”	500/1’ 8”
	Weight	kg/lb	41/90	130/285	40/88

Dimensions and Weights



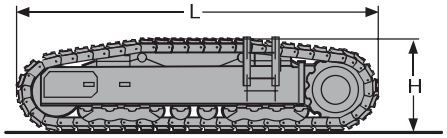
Railing (1 Kit)

L1	Length	mm/ft-in	1550/ 5'1"
L2	Length	mm/ft-in	4500/14'9"
L3	Length	mm/ft-in	5040/16'6"
L4	Length	mm/ft-in	1450/ 4'9"
L5	Length	mm/ft-in	650/ 2'2"
	Height	mm/ft-in	1010/ 3'4"
	Weight	kg/lb	300/660



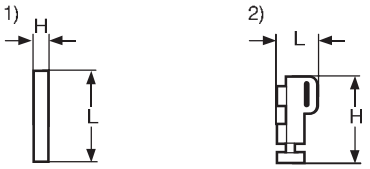
Undercarriage Central Girder

L	Length	mm/ft-in	4610/15' 1"
H	Height	mm/ft-in	2100/ 6'11"
	Width	mm/ft-in	3650/12' 0"
	Weight	kg/lb	22000/48,500



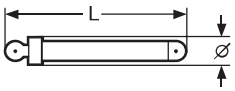
Side Frame (each) with Complete Travel Drive

L	Length	mm/ft-in	8070/26' 6"
H	Height	mm/ft-in	2100/ 6'11"
	Width	mm/ft-in	2200/ 7' 3"
	Weight	kg/lb	33900/74,740



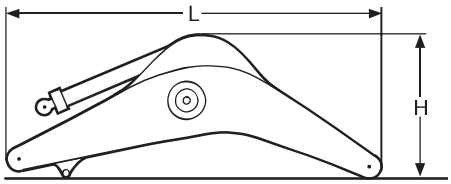
Ladder

			Cab[1]	Undercarriage[2]
L	Length	mm/ft-in	200/ 8"	285/ 11"
H	Height	mm/ft-in	1850/6'1"	1500/4'11"
	Width	mm/ft-in	460/1'6"	750/2' 6"
	Weight	kg/lb	40/88	2 x 75/165



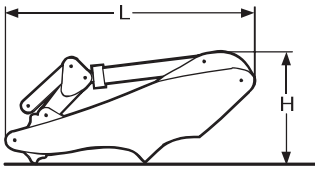
Hoist Cylinder (two)

Gooseneck Boom		m/ft-in	9,00/29'6"	10,80/35'5"
L	Length	mm/ft-in	4450/14'7"	4080/13'5"
Ø	Diameter	mm/ft-in	450/ 1'6"	450/ 1'6"
	Weight	kg/lb	2 x 2700/5,950	2 x 2260/4,980



Gooseneck Boom with Stick Cylinders

Boom Length		m/ft-in	9,00/29'6"	10,80/35' 5"
L	Length	mm/ft-in	9500/31'2"	11400/37' 5"
H	Height	mm/ft-in	3800/12'6"	3700/12' 2"
	Width	mm/ft-in	1900/6' 3"	1790/ 5'10"
	Weight	kg/lb	24000/52,910	22000/48,500

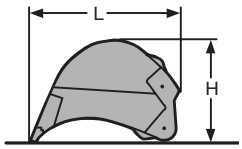


Stick with Bucket Cylinders

Stick Length		m/ft-in	4,00/13' 1"*	4,00/13'1"	5,60/18' 4"
L	Length	mm/ft-in	5800/19' 0"*	5650/18'6"	7600/24'11"
H	Height	mm/ft-in	2300/ 7' 7"*	2500/ 8'2"	2400/ 7'10"
	Width	mm/ft-in	1800/ 5'11"*	1450/ 4'9"	1450/ 4' 9"
	Weight	kg/lb	16000/35,270*	12700/28,000	13500/29,760

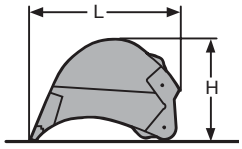
* for gooseneck boom 9,00 m/29'6"

Dimensions and Weights



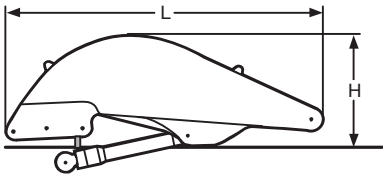
Backhoe Buckets

Cutting width	mm/ft-in		1900/ 6'3"	2050/ 6'9"	2300/ 7'7"	2800/ 9'2"
Capacity	m³/cuyd		4,50/5.9	5,70/7.5	7,20/9.4	9,00/11.8
L Length	mm/ft-in		3200/10'6"	3200/10'6"	3200/10'6"	3400/11'2"
H Height	mm/ft-in		2050/ 6'9"	2050/ 6'9"	2050/ 6'9"	2200/ 7'3"
Width	mm/ft-in		1900/ 6'3"	2050/ 6'9"	2300/ 7'7"	2800/ 9'2"
Weight	kg/lb		6000/13,230	7200/15,870	8450/18,630	10000/22,050



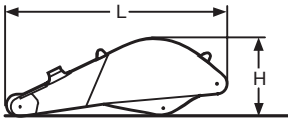
Backhoe Buckets

Cutting Width	mm/ft-in	2900/ 9' 6"	3150/10'4"	3200/10'6"	3500/11'6"	4200/13'9"
Capacity	m³/cuyd	11,00/14.4	13,00/17.0	14,00/18.3	15,00/19.6	20,00/26.2
L Length	mm/ft-in	3650/12' 0"	3500/11'6"	3550/11'8"	3400/11'2"	3550/11'8"
H Height	mm/ft-in	2700/ 8'10"	2600/ 8'6"	2850/ 9'4"	2600/ 8'6"	2800/ 9'2"
Width	mm/ft-in	2900/ 9' 6"	3150/10'4"	3200/10'6"	3500/11'6"	4200/13'9"
Weight	kg/lb	13400/29,540	14000/30,860	14500/31,970	14200/31,310	14300/31,530



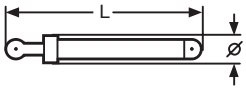
Shovel Boom with Two Crowd Cylinders

L Length	mm/ft-in	6800/22' 4"
H Height	mm/ft-in	2400/ 7'10"
Width	mm/ft-in	2510/ 8' 3"
Weight without cylinders	kg/lb	14500/31,970
Weight of crowd cylinders	kg/lb	2 x 1250/2,760



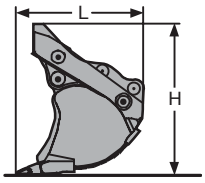
Shovel Stick

L Length	mm/ft-in	4700/15'5"
H Height	mm/ft-in	1700/5' 7"
Width	mm/ft-in	2600/8' 6"
Weight	kg/lb	10000/22,050



Bucket Tilt Cylinders (two)

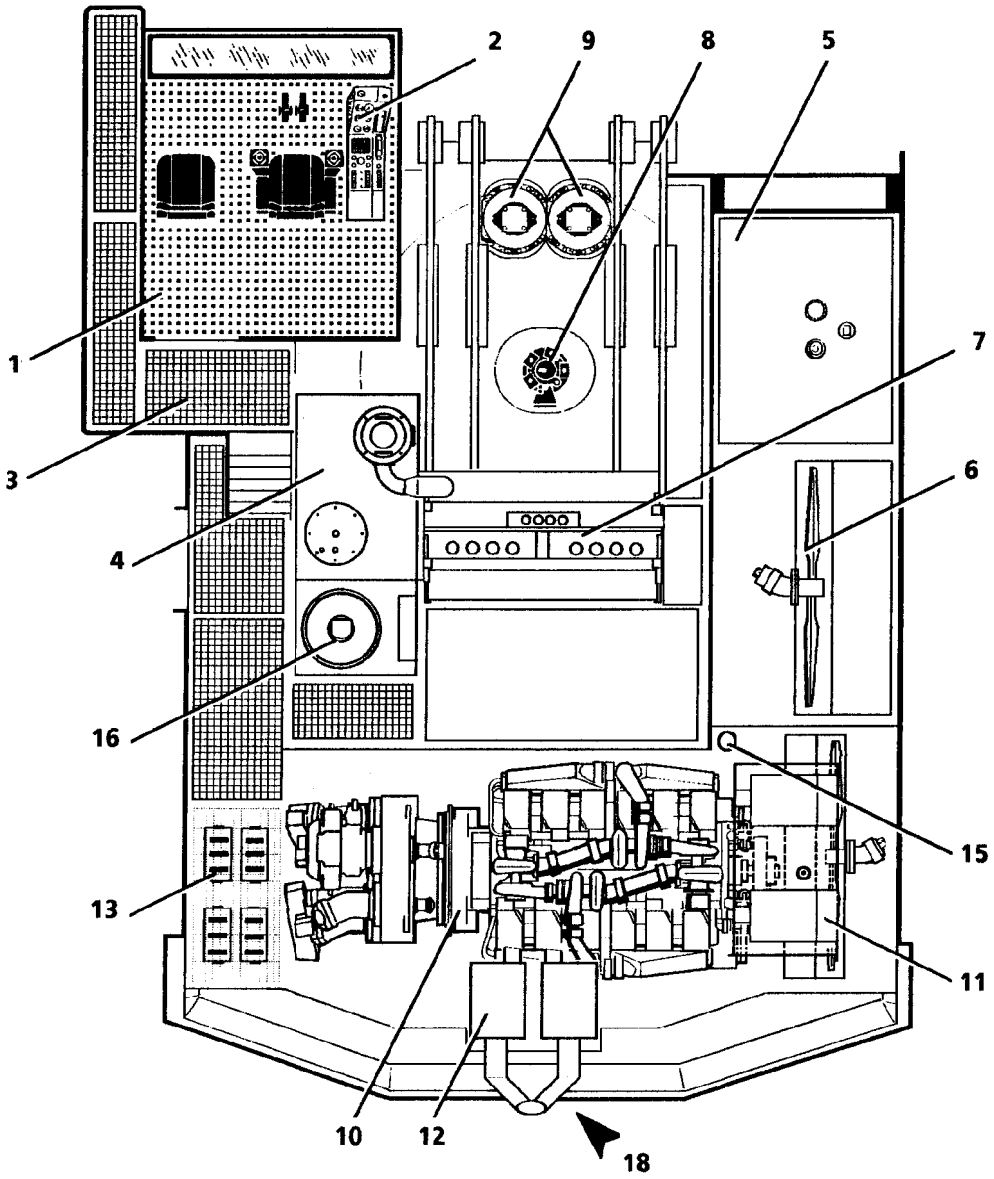
L Length	mm/ft-in	3840/12'7"
Ø Diameter	mm/ft-in	320/ 1'1"
Weight	kg/lb	2 x 1450/3,200



Bottom Dump Buckets

Cutting Width	mm/ft-in	3150/10'4"	3500/11'6"	3800/12'6"	3800/12'6"	4050/13' 3"
Capacity	m³/cuyd	10,50/13.7	12,00/15.7	13,50/17.7	15,00/19.6	18,00/23.5
L Length	mm/ft-in	3450/11'4"	3450/11'4"	3450/11'4"	3650/12'0"	3800/12' 6"
H Height	mm/ft-in	3500/11'6"	3500/11'6"	3500/11'6"	3500/11'6"	3600/11'10"
Width	mm/ft-in	3150/10'4"	3450/11'4"	3450/11'4"	3450/11'4"	4050/13' 3"
Weight	kg/lb	19000/41,890	20600/45,420	22500/49,600	22800/50,270	23000/50,710

UPPER R 994



1 Cab

2 Control panel

3 Entrance into the cab elevation, electric switcheboards, , heater, condenser for air conditioner, grease container for centralized lubrication

4 Hydraulic oil tank

5 Fueltank

6 Hydraulic oil cooler

7 Control valves

8 Hydraulic swivel

9 Swing gear

10 Engine with pumps

11 Air filter

12 Exhaust installation

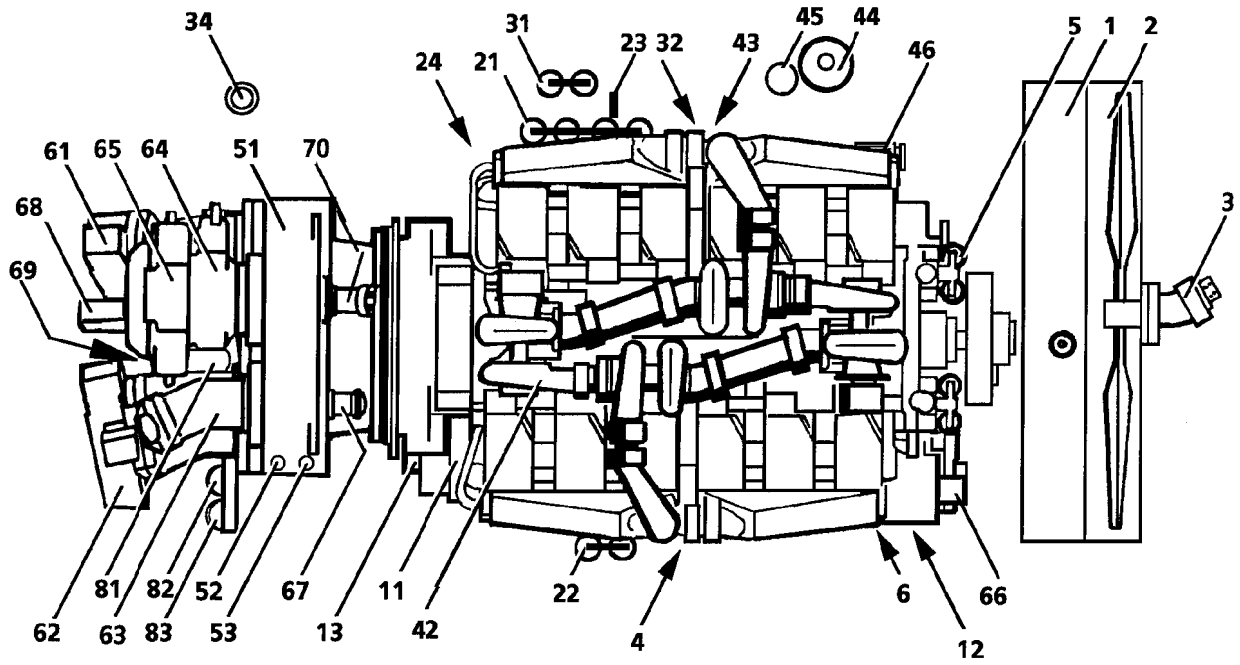
13 Batteries

15 Air tank

16 Grease container for centralized lubrication

18 Emergency switch

ENGINE COMPARTMENT R 994



1	Water radiator	45	Air dryer
2	Cooling fan	46	Compressor for air conditioner
3	Hydraulic engine for cooling fan	51	Splitter box
4	Engine water pump	52	Dipstick - splitter box
5	Water filter (4×)	53	Oil filler neck - splitter box
6	Heater valves	61	Main pump P1
11	Starter (2×)	62	Main pump P2
12	Alternator	63	Main pump P3
13	Electrical box	64	Swing pump
21	Lube oil filter (3×)	65	Replenishing pump
22	Bypass oil filter (2×)	66	Pump bearing lubrication
23	Dipstick	67	Hydraulic pump - servo oil
24	Oil filler plug	68	Hydraulic pump - oil cooler
31	Diesel oil filter	69	Lubrication pump for splitter box
32	Injection pump	70	Pump for cooler fan drive
34	Cold starting aid	81	Replenishing oil filter
42	Engine turbo-charger	82	Filter servo oil
43	Air compressor	83	Filter for bearings lubrication oil
44	Compressed air tank		

2.SAFETY INFORMATION

Working with an excavator can be dangerous, it could result in injury or death if proper precautions are not taken! **WE URGE YOU TO READ THIS MANUAL CAREFULLY!** This safety information is provided to operators and maintenance mechanics to ensure the safe operation and maintenance of the excavator. It is essential that you read and familiarize yourself with this information, which explains safety requirements and precautions and specific hazards of which you should be aware. This also applies to any personnel which might be working on the machine only occasionally, such as during set up or maintenance.

- Careful adherence to these safety guidelines will permit safe operation and maintenance and potentially prevent personal injury to yourself and others, and possible damage to the excavator.
- Important safety notes such as **DANGER, CAUTION** or **NOTE** are used throughout this manual to emphasize important or critical instructions.
  In this manual, **DANGER, CAUTION** or **NOTE** are defined as follows :

⚠ DANGER

Denotes an extreme intrinsic hazard which could result in a high probability of death or serious injury if proper precautions are not taken.

⚠ CAUTION

Denotes a reminder of safety practices or directs attention to unsafe practices if proper precautions are not taken.

☞ NOTE

NOTE describes operation and maintenance procedures which should be followed to keep your excavator operation and to insure long machine life and/ or to facilitate certain procedures.

In addition to these instructions you must follow the safety regulations applicable to your work environment and job site and any federal, state and local safety requirements. (A model excavators must also follow local and federal highway regulations).

For EC countries, guidelines 89 / 655 / EWG contain the minimum safety guidelines for users.

DESTINED USE

The excavator with the standard backhoe, grapple or bucket attachment may only be used to loosen, pick up, move, load and dump soil, gravel, rock, or other material and to load trucks, barges, conveyor belts, or rock crushing systems.

Special guidelines are applicable for machines used for lifting applications and special safety devices must be installed.

Any other use above and beyond the applications described above, such as breaking out rock or demolishing buildings, pounding in posts etc. requires special attachments and safety devices.

If the machine is exposed to the risk of falling down objects during operation, the cab of the machine must be fitted with a safety device according to the FOPS prescriptions.

Transporting personnel or loads etc. is not considered destined use and is therefore prohibited. The manufacturer / dealer is not responsible for any resulting damage. Any risk must be carried by the user himself.

Destined use is considered part of observing and adhering to all regulations and inspection and maintenance guidelines given in this Operation and Maintenance Manual.

GENERAL SAFETY INFORMATION

- Study the Operation and Maintenance Manual before operating or working on the excavator.
  Make sure that you have additional information for special attachments of your machine, read it and understand it!
- Allow only authorized personnel informed about the safety rules to operate, service or repair the excavator. Make sure to observe any minimum applicable age requirement.
- Allow only properly trained personnel to operate or work on the excavator, make sure to clearly specify the person who is responsible for set up, maintenance and repairs.
- Make sure the operator knows his responsibility regarding the observance of traffic regulations and permit him to refuse any unsafe instructions given by a third person.
- Any persons still in training should only operate or work on the machine under the supervision and guidance of an experienced person.
- Check and observe any person working or operating the excavator periodically and regularly, if they observe safety instructions and guidelines given in the Operation and Maintenance Manual.
- Wear proper work clothing when operating or working on the excavator. Rings, watches, bracelets and loose clothing such as ties, scarves, unbuttoned or unzipped shirts and jackets are dangerous and could cause injury!
  Wear proper safety equipment, such as safety glasses, safety shoes, hard hats, work gloves, reflector vests and ear protection.
- Consult your employer or supervisor for specific safety equipment requirements and safety regulations on the job site.
- Always tilt up the safety lever before leaving the operator's seat.
- Do not carry tools, replacement parts or other supplies while climbing on or off the excavator. Never use the steering column, control levers or joysticks as handholds.
- Never jump off the excavator, climb on and off the excavator using only the steps, rails and handles provided.
  When climbing on or off the excavator, use both hands for support and face the machine.
- If needed, use the front window as an escape hatch.
- If no other guidelines are given, perform maintenance and repairs utilizing the following precautions :
  - Park excavator on firm and level ground. Rest the attachment on the ground.
  - Place all control in neutral position and raise the safety lever.
  - Turn the engine off and remove the ignition key.
- Before working on the hydraulic circuit, move all joysticks and pedals with the ignition key in contact position and the safety lever tilted down to relieve the servo pressure and the remaining pressures in the different main circuits. In addition, relieve the pressure in the hydraulic tank as described in the Operation and Maintenance Manual.
- Secure all loose parts on the excavator.
- Never operate the excavator without a complete walk around inspection. Check if all warning decals are on the machine and if they are all legible.
- Observe all danger and safety guidelines.
- For certain special applications, the excavator must be equipped with specific safety equipment. Use the excavator only, if they are installed and functioning properly.
- Never perform any changes, additions or modifications on the machine, which could influence the safety, without obtaining the written permission from the manufacturer. This also applies to the installation and adjustment of safety devices and safety valves as well as to any welding on load carrying parts.
  It is forbidden to repair the cab.
- Do not install any equipment or attachments made by other manufacturers or any which are not specifically authorized by LIEBHERR for installation without first obtaining the written permission from LIEBHERR.
  LIEBHERR will issue any required technical documentation for approved installations.
- Should the electrical circuit be modified or additional components be installed, so the modification must be performed according to the national standards and safety regulations (such as OSHA per the USA).
  The installation must be certificated by an approved organization and a copy of the certification has to be sent to the LIEBHERR company.

CRUSHING AND BURN PREVENTION

- Never work underneath the excavator unless it is safely resting on the ground and / or is properly blocked and supported.
- Never use damaged or insufficient wire ropes, slings or chains.
  Always wear gloves when handling wire ropes.
- Never reach into bores during attachment installation or removal. Never align bores with your fingers or hands. Use proper alignment tools when installing, changing or servicing attachments.
- Keep objects away from the radiator fan. Rotating fans will swirl and throw out objects, which can become very dangerous and cause severe injury to yourself and others.
- Avoid contact with any components containing coolant. At or near operating temperature, the engine coolant is hot and under pressure and could cause severe burns.
- Check the coolant level only after the radiator cap is cool enough to touch. Remove the radiator cap slowly to relieve pressure .
- Do not allow your skin to come into contact with hot oil or components containing hot oil. At or near operating temperature, engine and hydraulic oil is hot and can be under pressure.
- Always wear safety glasses and protective gloves when handling batteries. Keep sparks or open flames away!
- Never permit anyone to hand guide the bucket or grapple into position.
- When working in the engine area, make sure the top covers and side doors are properly secured or closed with the appropriate supports.
- Never work underneath or on the excavator unless it is properly blocked and supported.

FIRE AND EXPLOSION PREVENTION

- Always turn off the engine while refueling the excavator.
- Never smoke or allow an open flame in refueling areas or where batteries are being charged, or where batteries or flammable materials are stored.
- Always start the engine as described in the **Operation and Maintenance Manual.**
- Check the electrical system regularly and frequently.

  All defects, such as loose connections, burnt out fuses and bulbs, burnt or damaged cables must be repaired immediately by an electrician or especially trained personnel.
- Never store flammable fluids on the machine except in storage tanks intended for the excavator's operation.
- Inspect all components, lines, tubes and hoses for oil and fuel leaks and / or damage.

  Replace or repair any damaged components immediately.
  Any oil, which escapes from leaks, can easily cause a fire.
- Be certain that all clamps, guards and heat shields are installed. These components prevent vibration, rubbing, chafing and heat build-up. Install tie wraps to fasten hoses and wires, as required.
- Cold start ether is extremely flammable. Use ether only in ventilated areas and as directed. Never use it near heat sources or open flames, do not permit anybody to smoke.
- Know the location of the excavator's fire extinguisher and be familiar with its operation. Make sure you know your local fire regulations and fire reporting procedures.

MACHINE START UP SAFETY

- Before excavator start up, perform a thorough walk around inspection.
- Visually inspect the excavator, look for loose bolts, cracks, wear, any leaks and any evidence of vandalism.
- Never start or operate an unsafe excavator.
- Report all defects to your foreman or supervisor and make sure they are corrected immediately.
- Make sure all covers and doors are closed and locked and all warning decals are on the machine.
- Make sure all windows, as well as inside and outside mirrors are clean, and secure all doors and windows to prevent any unintentional movement.

- Be certain that the area surrounding the excavator is free of other personnel, and that no one is working on or under the excavator before starting the engine.
- After entering the cab, adjust the operator's seat and controls, the inside and outside mirror, the armrests and fasten and adjust the seat belt. Be certain that all controls can be reached comfortably.
- All noise protection devices on the machine must be functional during operation.

ENGINE START UP AND OPERATING SAFETY

- Before start up, check if all indicator lights and instruments are functioning properly, place all controls in neutral position and tilt the safety lever up.
- Before starting the engine, alert any nearby personnel that the excavator is being started by sounding the horn.
- Start the machine only when seated in the operator's seat, and with the seat belt fastened (if installed).
- If you have no other instructions, start the engine as outlined in the **Operation and Maintenance Manual**.
- Tilt the safety lever down and check all indicators, gauges, warning devices and controls for their proper indication.
- Start and operate the engine only in a well ventilated area. If necessary, open doors and windows.
  Warm up the engine and hydraulic system to operating temperatures. Low engine and hydraulic oil temperatures can cause the excavator to be unresponsive.
- Check that all attachment functions are operating properly.
- Move the excavator slowly into an open area and check all travel functions for their proper operation, check travel and swing brakes, the steering function as well as the turn signals and lights.

MACHINE OPERATING SAFETY

- Familiarize yourself with job site rules. Be informed about traffic and hand signals and safety signs. Ask who is responsible for signaling.
  Check your surrounding for any obstacles in the working and movement range, check the load carrying capacity of the terrain, and secure the job site to shield it from any public highway traffic. Rope off the working area of the machine and install the necessary signs to forbid any non authorized person entering the area.
- Always keep a safe distance from overhangs, walls, drop offs, and unstable ground.
- Be alert of changing weather conditions, bad or insufficient visibility and of changing ground conditions.
- Be alert for utility lines, check the location of underground cables, gas and water lines, and work especially careful in that vicinity. If necessary and/ or if required, call local authorities to mark the location, and take precaution against contact with underground utilities.
- Keep sufficient distance to electrical lines. When working in the vicinity of high voltage electrical lines, keep proper distance to assure that the attachment does not come close to the lines.
  DANGER! You must inform yourself about safe distances.

  Preferably have the electrical lines de-energized (and lockout / tagged out according to the regulations applicable on the job-site) each time it is possible, and in any case if the closeness of the working area make it necessary.
- In case you do touch a high voltage line by accident, proceed as follows:
  - do not leave the machine,
  - move the machine, if possible, from the danger zone until you obtain sufficient distance,
  - warn any personnel in the vicinity not to come close to the excavator and not to touch it,
  - instruct or initiate that someone turns off the voltage.
  - Do not leave the machine until you are absolutely sure that voltage in the line, which had been touched or damaged, has been turned off!
- Before moving the machine, make sure that the attachments and equipment is secured properly to avoid accidents.
- When traveling on public roads, make sure to observe traffic regulations, and make sure that the machine meets federal and local public highway standards.
- Always turn on the lights if visibility is bad or if you are still working during dusk.

- Never allow other personnel on the excavator.
- Operate the excavator only while seated and with the seat belt fastened, if installed.
- Report any problems or needed repairs to your foreman or supervisor and make sure they are corrected immediately.
- Do not move the excavator until you are certain that no one is endangered by moving the excavator.
- On machines without negative brakes check the brake system before starting to work, as outlined in the **Operation and Maintenance Manual.**
- Never leave the operator's seat while the machine is still moving.
- Never leave the machine unattended (within view of machine), with the engine running.
- When moving the excavator, keep the upper-carriage in lengthwise direction and keep the load as close as possible to the ground.
- Prevent any working movements, which could tip the machine over. If the excavator begins to tip or slip on a grade, immediately lower the attachment and load to the ground and turn the excavator facing downhill.
  If possible, always operate the excavator with the attachment positioned uphill or downhill, never sideways.
- Always travel slowly on rough or slippery ground and on slopes, and on loose soils.
- Always travel downhill at permissible speed, so you don't loose control over the machine. The engine must run at nominal speed, use only the foot pedals to brake and slow down the machine.
  Never shift during down hill travel, always shift to a lower gear before traveling downhill.
- Never load over an occupied truck. Request that the driver leave the cab, even if a rock protection is installed.
- For demolition work, clearing, crane operation, etc. always use the appropriate protection device designed for this specific application.
- If operating in visually obstructed terrain or whenever necessary, have another person guide you. Always have only one person signal you.
- Allow only experienced persons to attach loads or to guide operators. The guide must be visible by the operator and / or must be in voice contact with him.
- Depending on the attachment combination, it is possible for the bucket teeth to hit the cab, the cab protection or the boom cylinders. Be very careful when the bucket teeth get in this range to prevent any damage.
- In case of a thunderstorm :
  - lower the attachment to the ground and if possible anchor the digging tool into the soil.
  - leave the cab and move away from the machine before the storm breaks out. Otherwise, you must stop the excavator, turn off the radio and keep inside the closed cab until the end of the storm.

MACHINE PARKING SAFETY

- Park the excavator only on firm and level ground .
  If it becomes necessary to park the machine on a grade, properly block and secure it with wedges.
- Lock the uppercarriage with the lock pin.
- Lower the attachments to the ground and anchor the bucket lightly in the ground.
- Bring all operating levers in neutral position and engage the travel and swing brakes.
- Turn the engine off as outlined in the Operation and Maintenance Manual and raise the safety lever before you leave the operator's seat.
- Lock the machine, remove all keys and secure the excavator against vandalism, unauthorized use, and any attractive nuisance.

MACHINE TRANSPORTING SAFETY

- Use only suitable transporting and lifting devices with sufficient capacity.
- Park the machine on firm and level ground and block the chains or wheels.
- If necessary, remove part of the attachments during transport.
- When loading the machine on a flatbed trailer or railroad car, be sure that the loading ramp incline is less than 30° and covered with wooden planks to prevent skidding.
- Remove all mud, snow or ice from track components before moving up the ramp.
- Before loading, secure the uppercarriage with the undercarriage with the lock pin .
- Align the machine with the loading ramp.
- Attach the manual control levers to the foot pedals for sensitive control.
- Have another person guide and signal the operator.

- Have blocks or wedges ready to block the machine, if necessary, to prevent the machine from rolling backwards.
- Retract the attachment as far as possible and lower the attachment as close as possible to the loading surface and carefully drive up the ramp and onto the flat bed trailer.
- When the excavator is on the trailer, release the uppercarriage lock pin, turn the uppercarriage back and lower the attachment.
  If the backhoe attachment is attached, tilt the stick and bucket in and relock the uppercarriage.
- Carefully secure the uppercarriage and other parts with chains, wedges and blocks to prevent slipping.
- Release the hydraulic pressure, remove the ignition key, raise the safety lever, close and lock the cab and close and secure all other doors and leave the machine.
- Carefully check out the transport route. Make sure that width, height and weight allowances are within the permitted limits.
- Check that there is enough clearance underneath all bridges, underpasses, utility lines, and in tunnels.
- During the unloading procedure, proceed with the same care and caution as during the loading procedure. Remove all chains and wedges. Start the engine as outlined in the Operation and Maintenance Manual. Carefully drive off the loading platform. Keep the attachment as close as possible to the ground level. Have another person guide and signal you.

MACHINE TOWING SAFETY

- Observe the correct procedure: check the index in your Operation and Maintenance manual and refer to the appropriate section : "Towing the Excavator".
- Only tow the excavator if absolutely necessary, for example to remove it for repairs from a dangerous job site.
- Be sure all towing and pulling devices such as cables, hooks, and couplers are safe and adequate.
- Make sure that the cable or the towing rod are strong enough and are routed around the center of the undercarriage or to the towing hook on the undercarriage, which is designated for this purpose. Be aware that any damage to the machine caused by towing is never covered by the manufacturer's warranty.
- Never allow anyone to stand near the cable when pulling or towing the excavator.
- Keep the cable tight and free of kinks.
- Engage travel slowly, and do not jerk. With a slack cable, the sudden impact of the load being towed could snap and break.
- During the towing procedure, keep within the required transport position, permissible speed and distance.
- After the towing procedure is completed, return the machine to its previous state.
- Proceed as outlined in the Operation and Maintenance Manual when putting the excavator back in service.

MACHINE MAINTENANCE SAFETY

- The machine may not be made unsafe when performing maintenance work. Never attempt maintenance procedures or repairs you do not understand.
- Check the Operator's and Maintenance Manual for service and maintenance intervals. Make sure you use only appropriate tools for all maintenance work.
- Refer to your **Operator's and Maintenance Manual** to see, who is authorized to perform certain repairs. The operator should only perform the daily / weekly maintenance procedures.

  The remaining work may only be performed by especially trained personnel.
- Use only replacement parts corresponding to the technical requirements specified by the manufacturer. This is assured by using only original Liebherr replacement parts.
- Always wear proper work clothing when maintaining the excavator. Certain work may only be performed with a hard hat, safety shoes, safety glasses and gloves.
- During maintenance, do not allow unauthorized personnel to enter the maintenance area.
- Secure the maintenance area, as necessary.

- Inform the operator before any special or maintenance work. Make sure he knows the person, who is in charge of the work.
- If not otherwise noted in the **Operation and Maintenance Manual**, always make sure the excavator is parked on firm an level ground and the engine is turned off.
- During maintenance and service work, make sure you always retighten any loosened screw connections!
- If it is necessary to disconnect or remove any safety devices during set up, maintenance or repair, make sure that after completion of repairs, the safety devices are reinstalled and checked for proper function.
- Before any maintenance work and especially when working under the machine, make sure a "Do not operate' tag is attached to the starter switch. Remove the ignition key.
  After end of maintenance works or repair, restart the machine according to the instructions "Machine start up", in this manual.
- Before any repairs or maintenance work, clean any oil, fuel and / or cleaning substances from any fittings and connections.
  Don't use any harsh cleaners and use only lint free cloths.
- Use only nonflammable cleaning fluids to clean the machine.
- Any welding, torch or grinding work on the machine must be explicitly authorized. Written authorization is necessary for welding on carrying structures. Before any using a welder, torch or grinder, clean off any dust and dirt and remove any flammable materials from the surrounding area. Make sure the area is sufficiently ventilated.
  Danger of Fire and Explosion!
- Before cleaning the machine with water or steam (high pressure cleaning) or other cleaning fluids, make sure that all openings, which , for safety and/ or functioning reasons should not be exposed to water / steam/ cleaners, are covered and / or masked off. Especially sensitive are electrical motors, control boxes and plug connectors.
  Make sure that the temperature sensors of the fire alarm and extinguishers system do not come in contact with the hot cleaning fluids, which could trigger the fire extinguishing system.
  Remove all coverings and masking material after completing the cleaning procedure.
  Then check all fuel lines, engine oil lines and hydraulic oil lines for leaks, loose connections, chafing and / or damage. Fix any problems immediately.
- If you use a high pressure cleaner with steam or hot water to clean the machine, observe following recommendations :
  - the distance between the nozzle and the surface to be cleaned must be no lowerthan 20 inches
  - the water temperature should not exceed 60°c (140°F)
  - limit the water pressure to 80 bar maximum (11500 PSI)
  - if you employ cleaning fluid, only use neutral cleaning agents such as customary car shampoos diluted to 2 or 3 percent maximum
- Never employ high pressure cleaning apparatus during the two first months following machine delivery or repainting.
- Observe all product safety guidelines when handling oils, grease, and other chemical substances.
- Make sure service fluids and replacement parts are disposed of properly and in an environmentally sound manner.
- When using hot service fluids, be very careful. (They can cause severe burns and injury!).
- Operate combustion motors and fuel operated heaters only in well ventilated areas. Before operating these units, check ventilation.
  In addition, always follow applicable local regulations.
- Never try to lift heavy parts. Use appropriate lifting devices with sufficient load carrying capacity. When replacing or repairing parts or components,make sure they are mounted very carefully on lifting devices, to prevent any possible danger. Use only suitable and technically sound lifting devices, make sure that lifting tackle, wire cables, etc. has adequate load carrying capacity.
  Never position yourself, walk or work underneath suspended loads.
- Never use damaged lifting devices, or devices which are not sufficient to carry the load.
  Always wear gloves when handling wire cables.
- Ask only experienced personnel to attach loads and guide and signal the crane operator. The guide must be within the visibility range of the operator and / or must be in direct voice contact with the operator.

- When working overhead, use appropriate and safe ladders, scaffolding or other working platforms designated for that purpose.
  Never step on parts or components on the machine when maintaining or repairing items overhead.
  When working high above ground, make sure you are fitted with ropes and appropriate safety devices which will prevent a possible fall.
  Always keep handles, steps, railings, platforms and ladders free of dirt, snow and ice!
- When working on the attachments, for example when replacing the bucket teeth, makes sure the attachment is supported properly. Never use metal on metal support!
- Never work underneath the machine if it is raised or propped up with the attachment. The undercarriage must be supported with wooden blocks and supports.
- Always support the raised machine in such a way that any shifting to the weight change will not influence the stability. Do not support the machine with metal on metal support.
- Only qualified, especially trained personnel may work on travel gear, brake and steering systems.
- If it becomes necessary that the machine must be repaired on a grade, block the chains with wedges and secure the uppercarriage to the undercarriage with the lock pin.
- Only qualified, especially trained personnel may work on the hydraulic system.
- Never check for leaks with your bare hands, always wear gloves. Fluid escaping from a small hole can have enough force to penetrate the skin.
- Never loosen or remove lines or fittings before the attachment has been lowered to the ground and the engine has been turned off. Then turn the ignition key to contact position with tilted down safety lever, move all servo controls (joysticks and foot pedals) in both direction to release pressures. Then release the tank pressure as outlined in this Operation and Maintenance Manual.
- Always disconnect the battery cable before working on the electrical system or before any arc welding on the machine. Always disconnect the negative (-) cable first and reconnect it last.
- Check the electrical system regularly.
  Make sure that any problems, such as loose connections, burnt out fuses and bulbs, scorched or chafed cables are fixed immediately by an electrician or qualified personnel.
- Use only Original fuses with the specified amperage. Never use a different size or stronger fuse than the original fuse.
- On machines with electrical medium or high voltage systems:
  - If there is any problem with the electrical energy supply, turn the machine off immediately.
  - Follow established lockout / tagout procedures where applicable.
  - Any work on the electrical system may only be performed by a qualified electrician or qualified personnel under the guidance and supervision of an electrician, according to electro-technical regulations.
- If any work is required on any parts which carry current, use a second person to turn off the main battery switch, if necessary. Rope the work area off with a safety rope or chain, and set up warning signs. Use only insulated tools.
- When working on medium and high voltage components, shut off the voltage and connect the supply cable to the ground and ground the components, such as the condensor, with a grounding rod.
- Check all disconnected parts if they are truly free of current, ground them and close them off quickly. Insulate any close-by, current carrying parts.

HYDRAULIC LINES AND HOSES

- Hydraulic lines and hoses may never be repaired!
- All hoses, lines and fittings must be checked daily, but at least every 2 weeks for leaks and any externally visible damage! Any damaged sections must be replaced immediately! Escaping oil can cause injuries and fires!
- Even if hoses and lines are stored and used properly, they undergo a natural aging process. For that reason, their service life is limited.
  Improper storage, mechanical damage and improper use are the most frequent causes of hose failures.

  The service life of a hose may not exceed six years, including a storage period of not more than two years (always check the manufacturer's date on the hoses).

  Using hoses and lines close to the limit ranges of permitted use can shorten the service life (for example at high temperatures, frequent working cycles, extremely high impulse frequencies, multi shift or around the clock operations).
- Hoses and lines must be replaced if any of the following points are found during an inspection:
  - Damage on the external layer into the inner layer (such as chaffings, cuts and rips);
  - Brittleness of the outer layer (crack formation of the hose material);
  - Changes in shape, which differ from the natural shape of the hose or line, when under pressure or when not under pressure, or in bends or curves, such as separation of layers, blister or bubble formation;
  - Leaks;
  - Non observance of installation requirements;
  - Damage or deformation of hose fittings, which might reduce the strength of the fitting or the connection between hose and fitting;
  - Any movement of hose away from the fitting;
  - Corrosion on fittings, which might reduce the function or the strength of the fitting;
  - Storage or service life has been exceeded.

  When replacing hoses or lines, always use Original replacement parts.
- Route or install the hoses and lines properly. Do not mix up the connections!
- Always take care to avoid torsional strain when installing a new hose. On high pressure hydraulic hoses, the mounting screws must be first mounted on both hose ends (full flange or half clamp) and tightened only thereafter.
  On high pressure hoses having one curved end, always tighten first the screws on the curved hose end and only then the screws on the straight hose end.
  Install and tighten the hose clips that may be mounted on the hose middle only when the both hose ends are already tightened.
- Always install hoses so to avoid any friction with other hoses and parts.
  We recommand to keep a distance between hose and other parts of at least one half of the hose outer diameter. Keep a minimum gap of 1/2 inch in any case.
  After mounting a hose connecting two parts that are movable to each other, check during the return to service that the hose is not rubbing in the whole moving range.

Additional safety guidelines for excavators fitted with a cab elevation

When operating an excavator with a cab elevation, observe the following safety instructions which complete the general safety information provided in the operation and maintenance manual for the machine.

- Keep ladders, footsteps, handles and handrail in clean condition and always free them from mud, oil, grease, ice, snow or any other obstacles.
- To guarantee an easy opening of the cab door in all weather conditions, coat the rubber seals around the door with silicon oil or talcum every two months and more often if necessary.
  Regularly grease the hinges and lock of the cab door as well the fixing device of the door in opened position.
  During maintenance works, always wear safety glasses and proper protective clothes.
- To climb up or down the cab, the excavator must be parked on firm, flat and level ground and the uppercarriage must be swung so to align ladders and steps on upper and undercarriage.
- Face the excavator when climbing up and always hold on to the machine at three points, i. e. keep the contact with the access components at the same time with two hands and one foot or with one hand and the two feet.
- As soon as you can reach the handle of the door with your free hand unlock and open the door before climbing up any more .

  Keep and guide the door all the way with your hand and lock it in its opened position, making sure it is securely fixed in this position, so it can not be slammed by the wind.

  Take care to keep yourself apart from the slewing range of the door during the whole of its opening motion.
  Some external influences, and especialy the wind, may make the opening of the door uneasy.
- Go on climbing up, always holding yourself by three points, enter the cab and seat down to the seat.
  If applying fasten the seat belt. Unlock the door using the unlocking lever and close the door holding it by the handle designed for this purpose.
  Only thereafter lower the safety lever and start the machine.
- It is essential to have your seat belt fastened if you want to operate the machine with the cab door opened.
  Should the belt be missing on your machine, so you must compulsorily get one installed before you start working with opened cab door.
- Before climbing down the cab, you must make sure the machine is parked on a flat, firm and level ground and the ladders and steps are aligned on upper and undercarriage.
- Then open the cab door and lock it in opened position and make sure it is securely fixed in this position.
  Be aware of difficult weather conditions and anticipate their possible consequences. The wind for example could slam the cab door.
- If necessary unfasten the seat belt.
- Carefully begin climbing down, facing the machine and always holding the contact at three points, until you reach the height where you can close the cab door in the best conditions, keeping yourself apart from its slewing range and guiding it with the hand until closed.
  If you want so lock the door and take away the key.
- Slowly and carefully go down to the floor.

3. CONTROLS AND INSTRUMENTATION

THE AIR CUSHIONED OPERATOR'S SEAT

CAUTION

Before adjusting the operator's seat and the joysticks, make sure that the safety lever (Fig. 1) is in the uppermost position to avoid any unexpected movements of the hydraulic excavator.

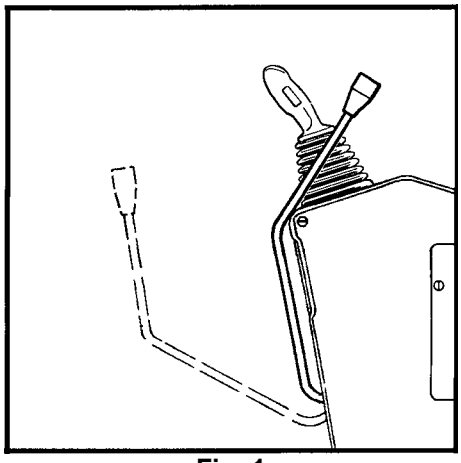


Fig. 1

ADJUSTING THE OPERATOR'S SEAT

Adjusting the operator's seat horizontally with respect to the two control panels is possible after lifting lever 1 (Fig. 1).

Independent of this adjustment, the entire seat including the two control panels can be slid horizontally after lifting lever 2 (Fig. 2).

Adjusting the seating suspension to body weight is done via key 7 (Fig. 3).

Adjusting the seat cushion angle and the seat height is done via levers 4a and 4b (Fig. 3).

- By lifting lever 4a the seat cushion in back can be tilted up or down.
- By lifting lever 4b the seat cushion in front can be tilted up or down.

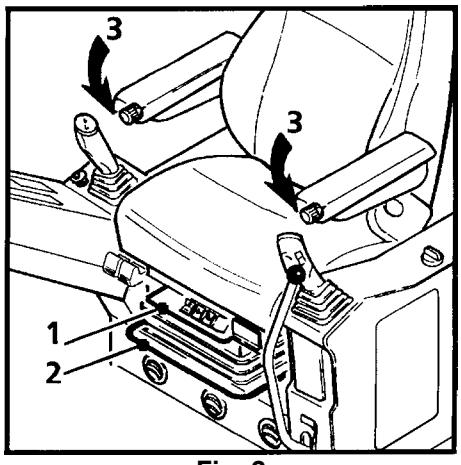


Fig. 2

Adjusting the angle of the backrest is done via lever 6 (Fig. 3).

- Lift lever 6
- Move the backrest to the desired angle
- Release lever 6

Adjusting the lower back support in the backrest occurs via keys 8 and 9 (Fig. 3),

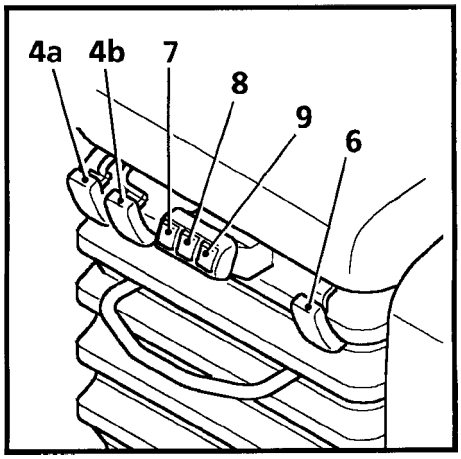


Fig. 3

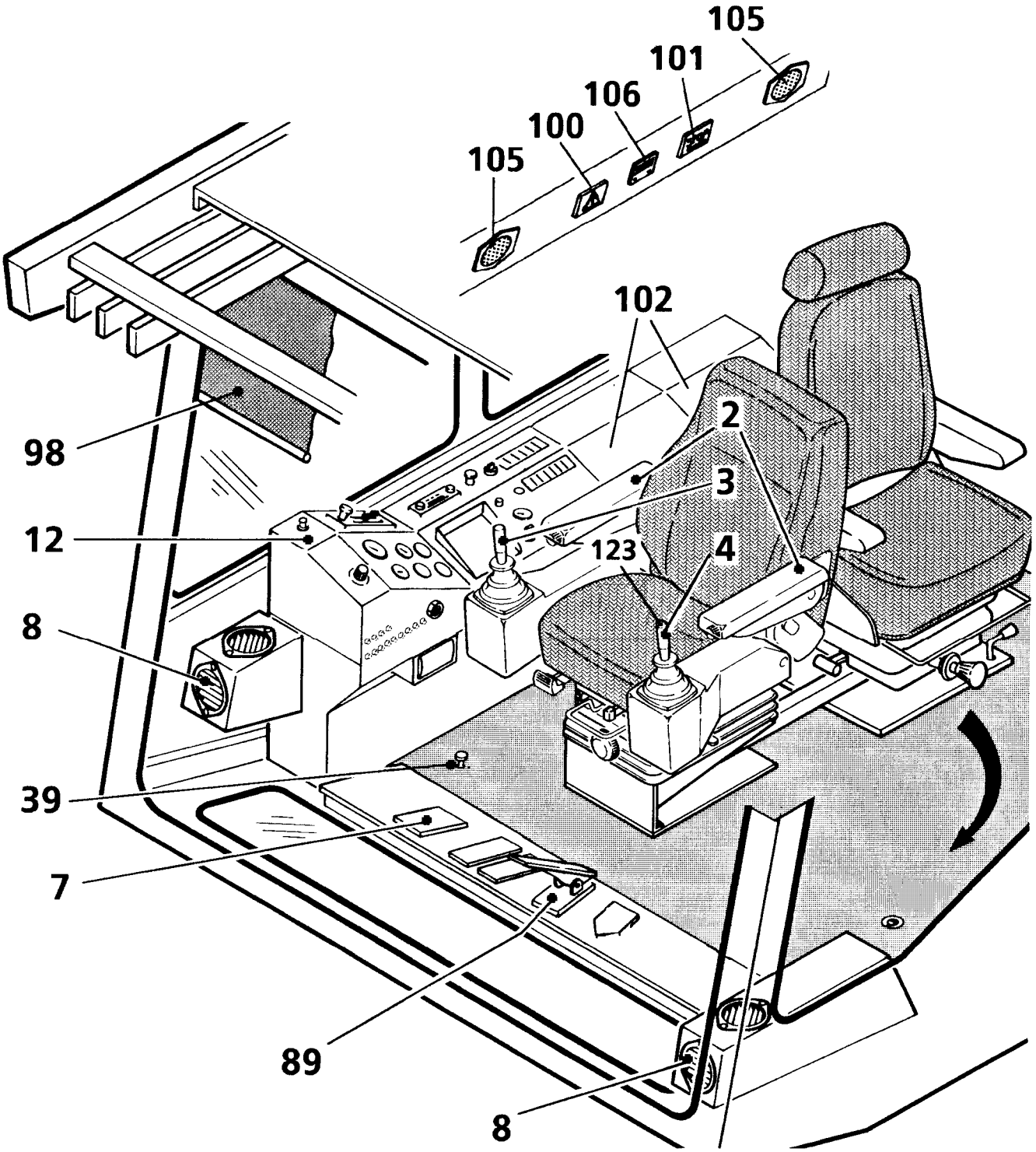
The angle of the right and left armrests can be adjusted. Turn the knurled screws 3 (Fig. 2) beneath the arm rests in the appropriate direction.

VIBRATION DAMPING

The seat mounted in the excavator corresponds to ISO 7096 standards.

When used according to the excavator's specifications, the values of the vibration load transmitted by the operator's seat are less than or equal to the test vibrations of the corresponding machine type according to ISO 7096 standards. The resulting vibration acceleration values "a_{zw}", measured according to ISO 2631, part1, standards, meet the demands for vibration protection of the entire body according to EN 474-1 (acceleration " a_{zw}" between 0,5 and 2,5 m.s-2).

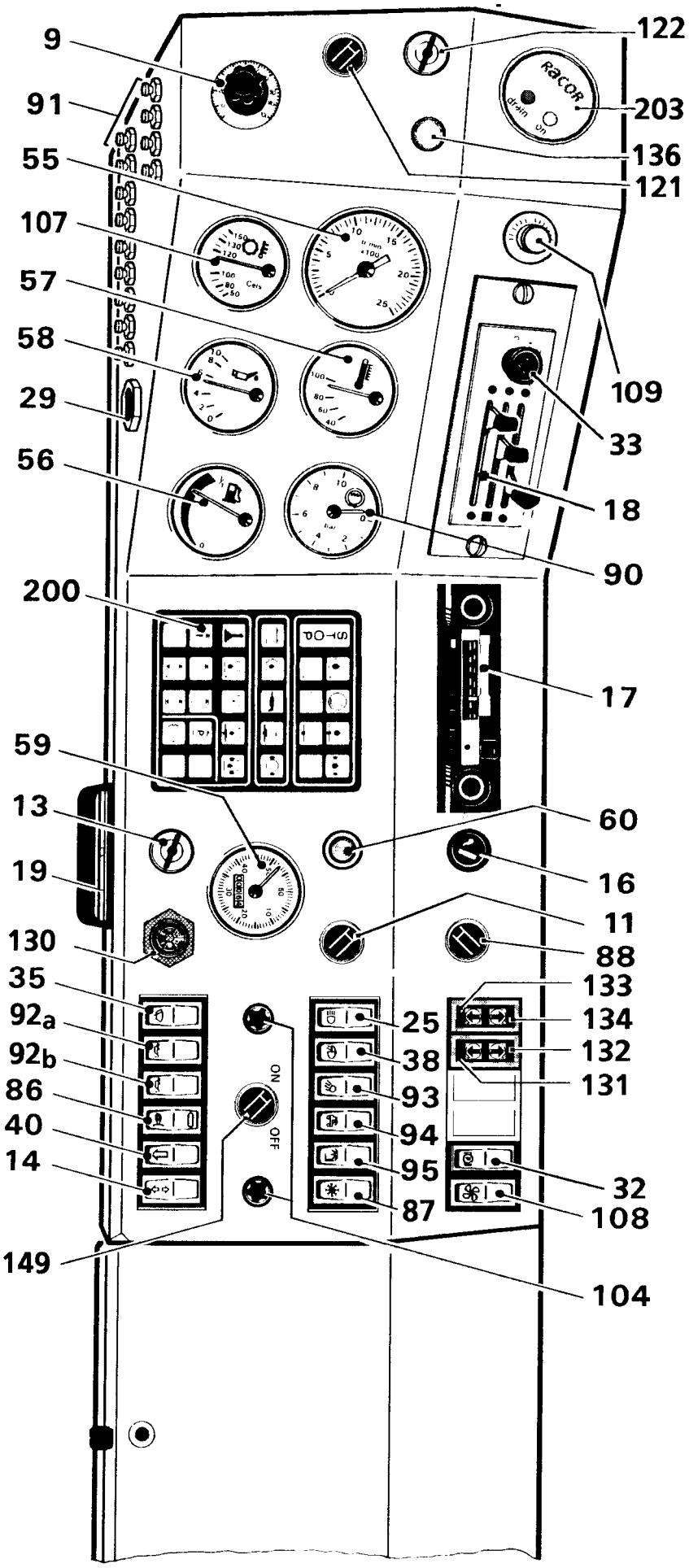
CONTROLS AND INSTRUMENTATION IN THE CAB



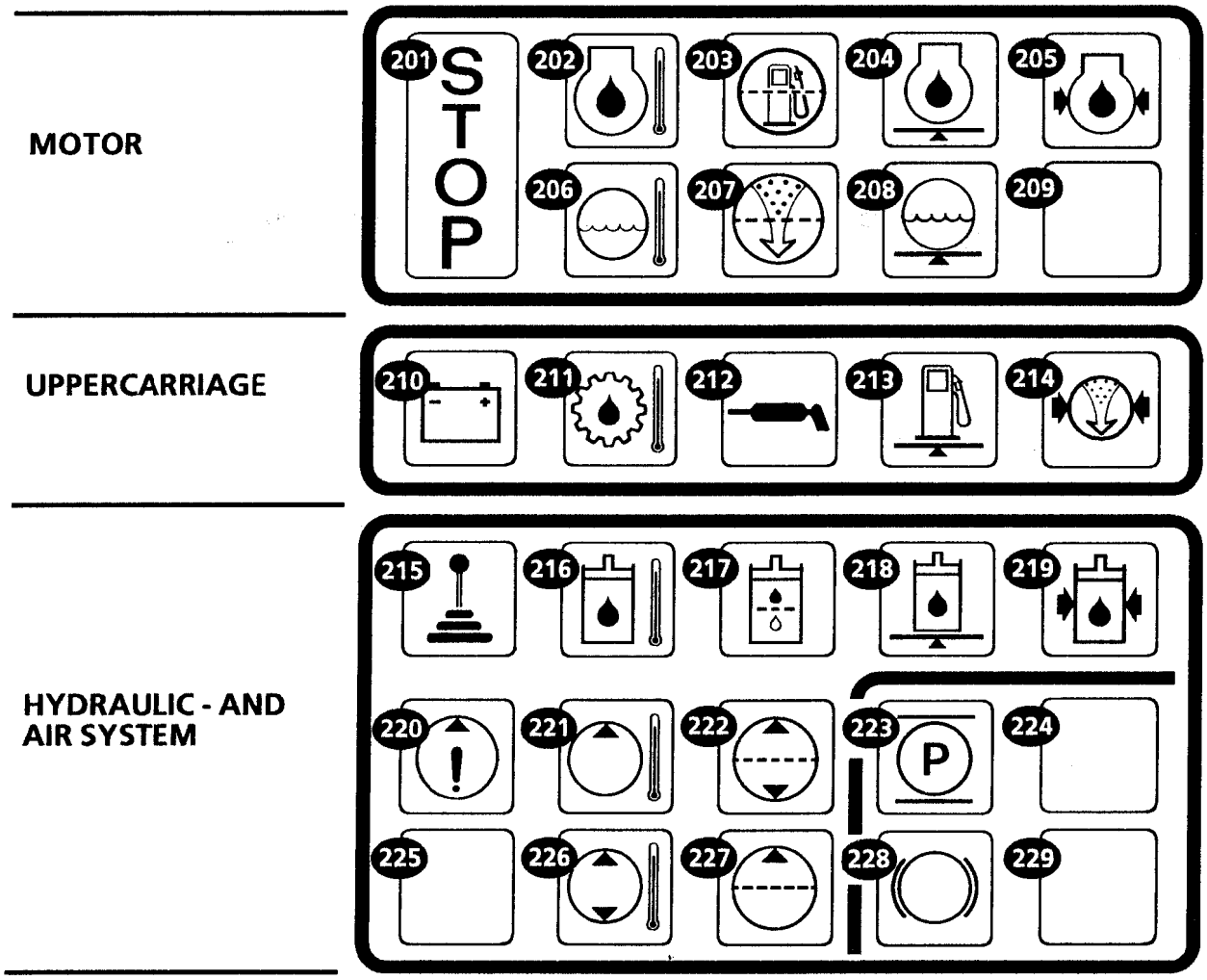
2	Arm rests	98	Sun shade
3	Right joystick	100	"DANGER" warning light
4	Left joystick	101	"STOP ENGINE" warning light
7	Special attachment control	102	Storage bins
8	Heater vent	105	Loud speaker
12	Control panel	106	Clock
39	Windshield washer system	123	Inhibition of the uppercarriage swing limitation
89	Swing brake		

CONTROL AND INSTRUMENT PANEL

9 ..... Potentiometer for sensor control
11 ..... Uppercarriage lock
13 ..... Ignition key
14 ..... Throttle control
16 ..... Cigarette lighter
17 ..... Radio
18 ..... Heater control
19 ..... Ashtray
25 ..... Headlights (on upper)
29 ..... Buzzer
32 ..... Swing brake
33 ..... Heater fan
35 ..... Windshield wiper
38 ..... Floodlights (on boom)
40 ..... Sensor control
55 ..... RPM gauge
56 ..... Fuel gauge
57 ... Engine coolant temperature gauge
58 ..... Engine oil pressure gauge
59 ..... Hour meter
60 ..... Test indicator lights
86 ..... Cold start system
87 ..... Air conditioner
88 ..... Swing ring teeth lubrication
90 ..... Air pressure gauge
91 ..... Overcurrent cut out
92_a Central lubrication system attachment
92_b . Central lubrication system uppercarr.
93 ..... Floodlights (on cab)
94 ..... Adjustable floodlight
95 ..... Dome light
104 ..... Servo control fuses
107 ..... Engine oil temperature gauge
108 ..... Air conditioner fan
109 ..... Air conditioner thermostat
121 ..... Servo control commutation /
..... excavator - Pontoon
122 ..... Float position pontoon
130 ..... Buzzer / Hydraulic oil level
131 Minimum oil level / hydraulic tank exc
132 Maximum oil level / hydraulic tank exc
133 ..... Minimum oil level / pontoon
134 ..... Maximum oil level / pontoon
136 ..... Control light / float position
149 .... Flow reduction of working pumps
200 ..... Monitoring display
203 ..... Fuel filter monitoring



MONITORING DISPLAY



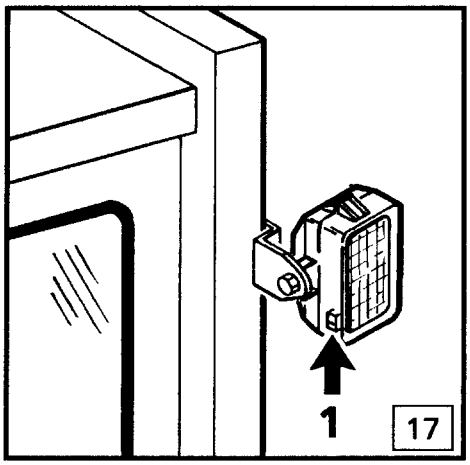
R	201	Stop	
R	202	Engine oil overheating	
O	203	Fuel filter clogged (not used)	
R	204	Engine oil level too low (not used)	
R	205	Engine oil pressure too low	
R	206	Engine coolant overheating	
O	207	Air filter clogged (not used)	
R	208	Engine coolant level too low	
R	209	Open	
O	210	Charge indicator	
R	211	Splitterbox lube oil overheating	
G	212	Central lubrication system	
O	213	Fuel reserve	
O	214	Air pressure too low	
O	215	Servo oil pressure too low	
R	216	Hydraulic oil overheating	
R	217	Filter for leaks of hydraulic motors and pumps clogged	
O	218	Oil level in hydraulic tank too low	
O	219	Hydraulic tank pressurization too low	
R	220	Detector for steel particles in main pumps	
R	221	Main pump overheating	
O	222	Replenishing filter, servo oil filter or pump lube oil filter clogged	
O	223	Uppercarriage lock (not used)	
R	224	Open	
O	225	Grease container level too low	
R	226	Swing pump overheating	
R	227	High pressure filter clogged	
O	228	Default in swing brake circuit	
R	229	Default in central lubrication system	

Color of lights :

R = red
O = orange
G = green

Adjustable service floodlights (fig.15 and 17) :

By pushing the switch 94 in direction B the circuit of the service floodlight is made alive.
This light can then be switched on via its individual switch (fig. 17, pos. 1).

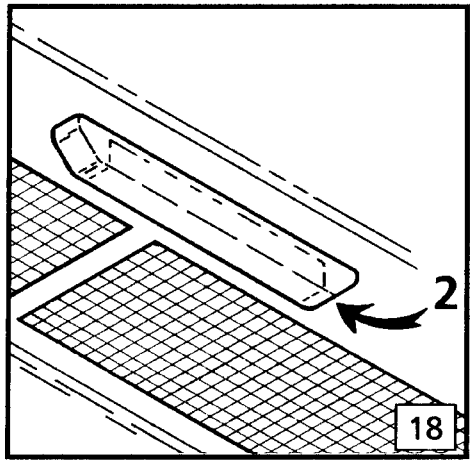


Dome light in the cab (fig. 15 and 18) :

By pushing the switch 95 the dome light is connected to the circuit. The light itself can be switched on and off by a button at the light (fig. 18, pos. 2).

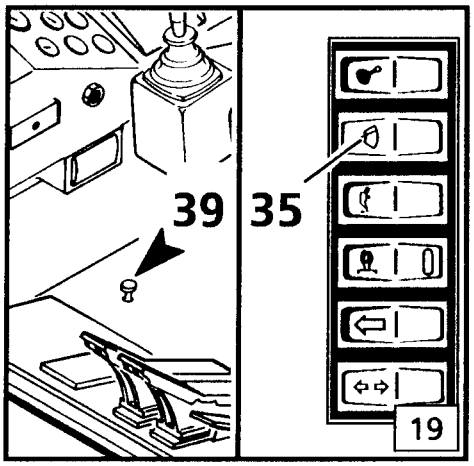
Dome light in the cab elevation :

Switch this light on and off by pushing the button on the dome light.

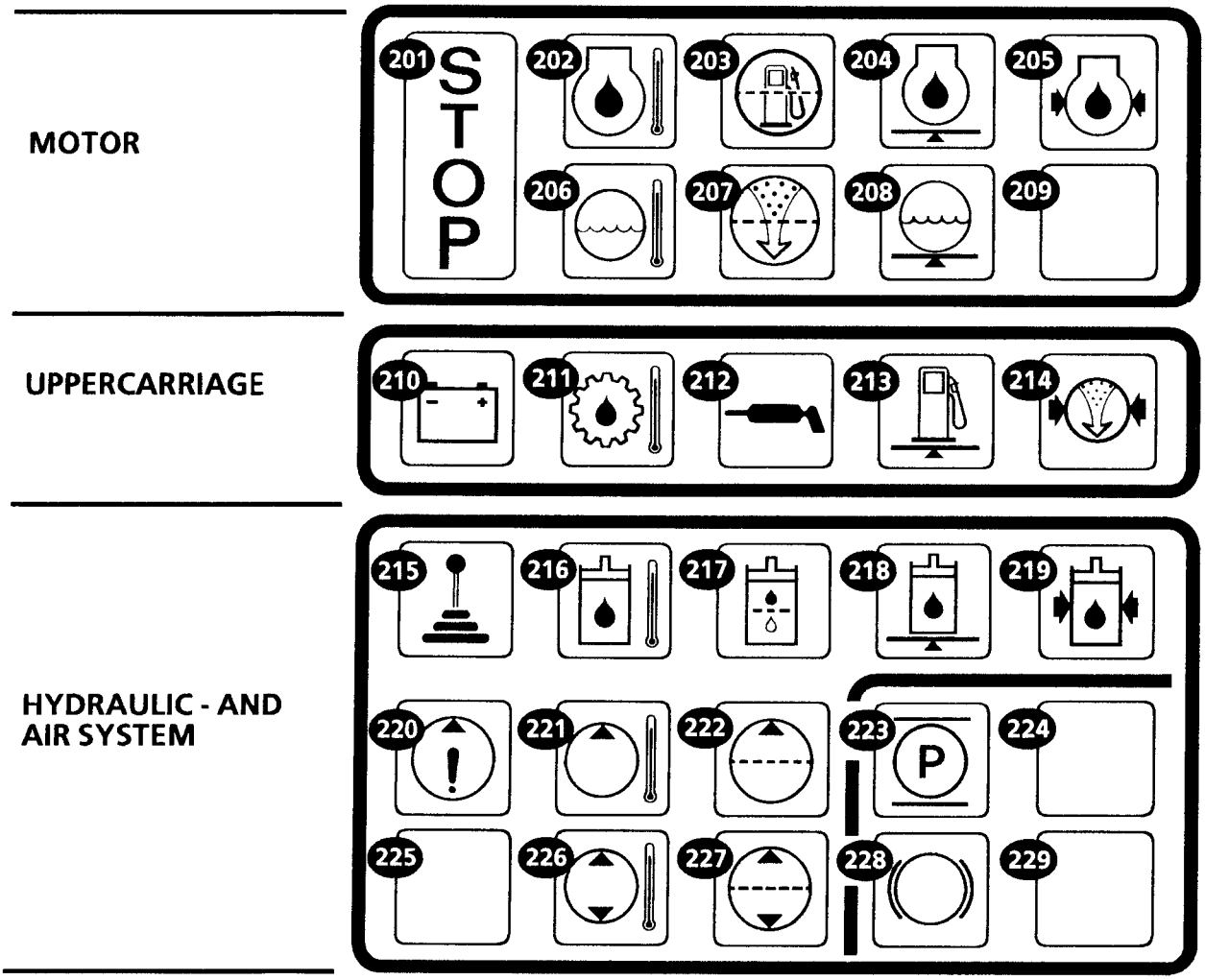


WINDSHIELD WASHER - WINDSHIELD WIPER

The container for windshield washer liquid is located in the cab elevation and contains approximately 12 gal. (45 ltrs).
The windshield washer is activated by pushing the foot control button (fig. 19, pos. 39).
The windshield wiper is activated by the two speeds switch (fig. 19, pos. 35).



MONITORING DISPLAY



R	201	....	Stop
R	202	....	Engine oil overheating
O	203	....	Fuel filter clogged
R	204	....	Engine oil level too low
R	205	....	Engine oil pressure too low
R	206	....	Engine coolant overheating
O	207	....	Air filter clogged
R	208	....	Engine coolant level too low
R	209	....	Open
O	210	....	Charge indicator
R	211	....	Splitterbox lube oil overheating
G	212	....	Central lubrication system
O	213	....	Fuel reserve
O	214	....	Air pressure too low
O	215	....	Servo oil pressure too low
R	216	....	Hydraulic oil overheating
R	217	....	Return oil filter or filter for leaks clogged of hydraulic motors and pumps
O	218	....	Oil level in hydraulic tank too low
O	219	....	Hydraulic tank pressurization too low
R	220	....	Detector for steel particles in main pumps
R	221	....	Main pump overheating
O	222	....	Replenishing filter, servo oil filter or pump lube oil filter clogged
O	223	....	Uppercarriage locked
R	224	....	Open
O	225	....	Open
R	226	....	Swing pump overheating
R	227	....	High pressure filter clogged
O	228	....	Uppercarriage swing limit reached
R	229	....	Open

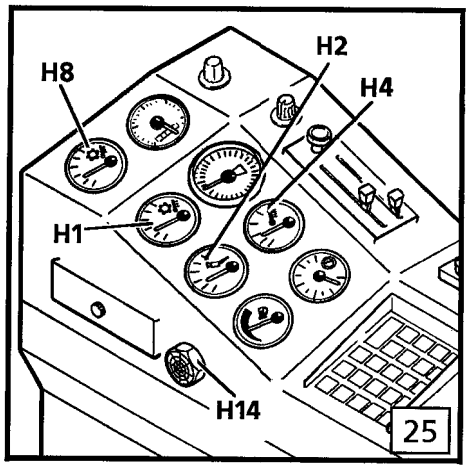
Color of lights :

R = red
O = orange
G = green

If any red coloured control light is lighting up, the buzzer alarms the operator acoustically at the same time.

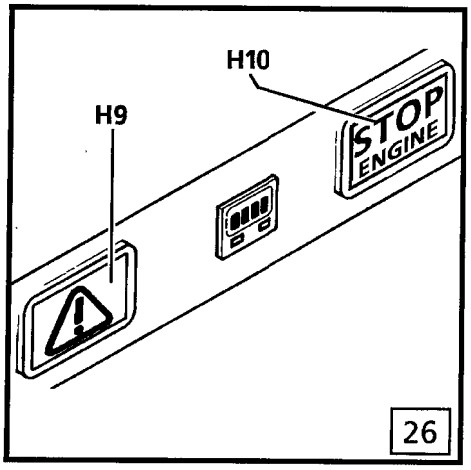
Indicator light 228 - Default in swing brake control circuit

This indicator light lights up when the electronic control circuit of the swing brake is defective, (as an example if the pulse transmitter mounted to the swing motor does not work properly).
Get the circuit repaired as soon as possible, seeing that this failure hinders the swing brake to apply in semiautomatic mode. (However it remains possible to apply the brake by pushing the button S36 in position "brake applied".)
At the same time the buzzer sounds in the cab. To stop the buzzer, tilt the rocker switch S35 to position "A" - brakes released (see also page 4.10) .
The indicator light 228 will turn off only after turning the ignition key to the "off" position.



Indicator light 229 - Default in central lubrication system

This indicator light lights up if 5 minutes after begin of automatic lubrication no grease pressure increase has occured in the concerned main lube line.
For possible causes, refer to page 5.17.



CENTRALIZED WARNING LIGHTS OF THE MONITORING SYSTEM

In order to make the operator more careful to the coming out of the troubles, the lights of the monitoring display are also connected to two warning lights above the windshield (fig. 26, pos. H9 and H10) depending on the urgency of the troubles.

WARNING LIGHT "STOP ENGINE" AND "STOP":

Simultaneously with the lighting up of any red coloured control light on the monitoring display, the warning light S35 "STOP ENGINE" situated above the windshield, the control light "STOP"on the monitor (fig. 21, pos. 201) start blinking, and the buzzer (fig.27, pos. H14) starts buzzing.

Immediately locate the fault on the monitoring display.
In case of engine oil pressure drop, (respec. of a coolant level drop) control light 205, (respec. 208) goes on.
Reduce the engine speed to low idle, it will be shut down automatically after a few seconds.
In case of engine coolant overheating, (resp. of engine oil overheating) let engine run unloaded at full RPM and observe evolution of temperature at gauge H4, respec. pos. H1 (fig. 25). If overheating persists after a few minutes, shut down the engine.
In any other cases idle engine for 2 or 3 minutes and then shut it down.

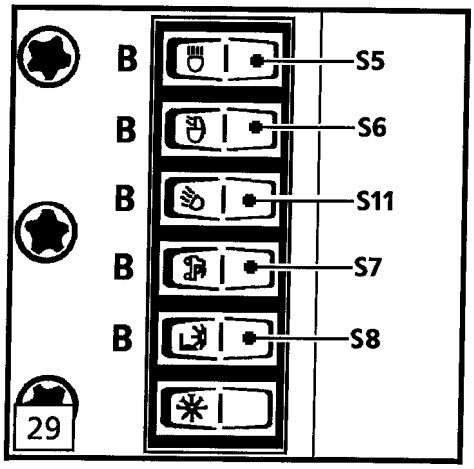
WARNING LIGHT "DANGER"

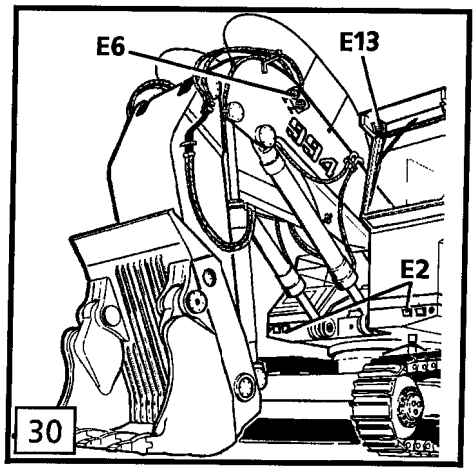
The alarm light "DANGER" H9 starts blinking when any orange control light on the monitoring display lights up.

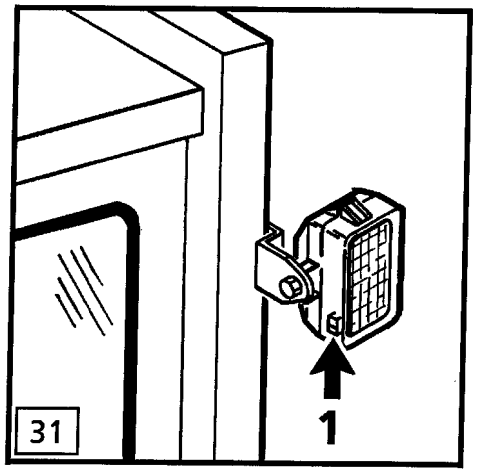
Immediately locate the fault on the monitoring display.
If one of the faults listed below occurs, normally shut down the engine, find the reason for the trouble and eliminate it.

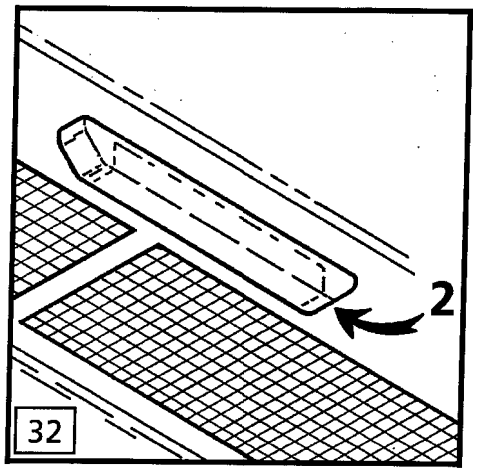
- 210 - Charge indicator
- 214 - Low air pressure
- 215 - Low servo oil pressure
- 218 - Low oil level in hydraulic tank
- 219 - Low hydraulic tank pressurization

In any other cases, inform maintenance crew to get the trouble eliminated as soon as possible.









OPERATION OF LIGHTING SYSTEM

Upper frame floodlights :

By pushing the switch S5 in direction "B", the standard floodlights E2 in the upper frame and the instrument lights are switched on.

Note :
When the switch S5 is pushed, the rocker switches in the control panel light up. The intensity of the lighting of each rocker switch depends on its individual switch position.

- switched off : low intensity
- switched on : high intensity

Attachment floodlights :

By pushing the switch S6 in direction "B" the floodlights E6 on the attachment are switched on.

Cab floodlights :

By pushing the switch S11 in direction "B" the floodlights E13 mounted at the top of the cab are switched on.

Adjustable service floodlights :

By pushing the switch S7 in direction B the circuit of the service floodlight is made alive.
This light can then be switched on via its individual switch pos. 1.

Dome light in the cab

By pushing the switch S8 the dome light is connected to the circuit. The light itself can be switched on and off by the button 2 at the light.

Dome light in the cab elevation :

Switch this light on and off by pushing the button on the dome light.

Indicator light 222 - Replenishing filter, servo oil filter or pump lubrication filter clogged

The light lights up when one of the above mentioned filters is clogged and has to be replaced.

Find out the filter and replace its element. When the hydraulic oil is cold the indicator light may light up even if no filter is clogged. In this case, the light must go out when operating temperature is reached.

Indicator light 223 - Uppercarriage locked

This light lights up to show that the uppercarriage is locked via switch 11, see on page 4.13.

Indicator lights 224 und 225 - Open

Indicator light 226 -

The light lights up when the temperature within the swing pump rises beyond 200°F (92°C°).

Stop engine. Find and correct problem.

Indicator light 227 - High pressure filter clogged

This indicator light lights up when one of the high pressure filters is dirty.

This could possibly indicate that the concerned working pumps defective.

Turn the engine off, have maintenance personnel to clean or replace the filter element.

Indicator light 228 - Uppercarriage swing limit reached

This light lights up when the maximum swing angle of the uppercarriage (from zero position= normal working position) has been reached.
In this case the swing brake automatically applies, see also § "Swing limitation of uppercarriage" on page 4.11.

Indicator light 229 - Open

Safety lever - servo control S30 (see page 3.2)

For safety reasons, a safety lever is installed on the left control console, and the operator must raise this lever before he leaves the operator's seat.
He must be safely seated before lowering the safety lever to start a new working cycle.

When the safety lever is raised, the servo pressure supply is interrupted, and no working movements can be carried out when the servo controls are actuated.
At the same time, the travel and swing brakes are applied. If the safety lever is raised, the travel and swing brakes cannot be released via buttons S17 and S36 .

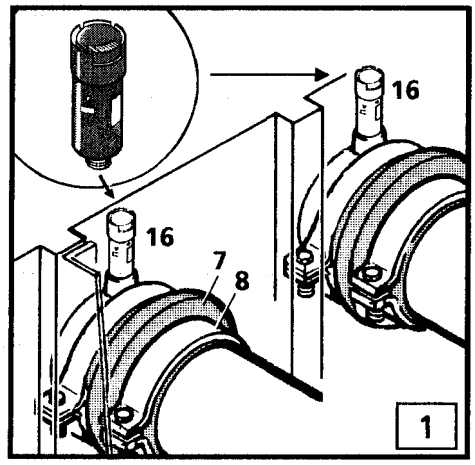
When changing the safety lever back to the lower position, the brakes are returned to the same condition they were in before the lever was raised (released or applied).

4. OPERATING PROCEDURES

PRE-STARTING INSPECTION

CHECK AIR FILTERS FOR CONTAMINATION

Check the two dry air filters on top of the Diesel engine to determine degree of contamination.
When the maximum permissible depression has been reached, a red stripe will appear in the inspection port of the maintenance indicator 16 (fig. 1) and the filters must be serviced, see page 6.16.

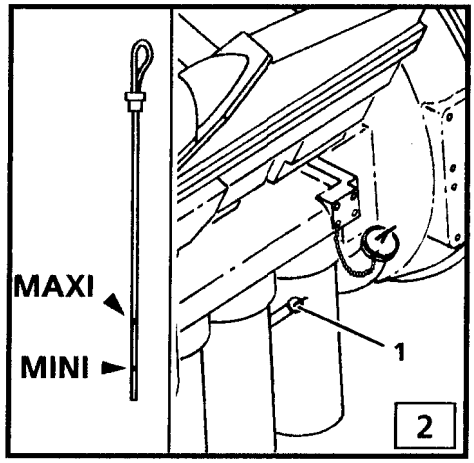


CHECK ENGINE OIL LEVEL

Check the engine oil level with the machine on level ground. After engine shut down, allow 5 minutes for the oil to drain into the oil pan.
The oil level must be between the MIN. and MAX. mark on the dipstick 1, (fig. 2).

CAUTION

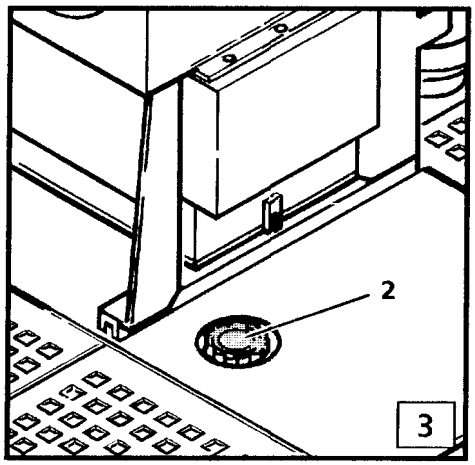
The engine oil is very hot at or near operating temperature.
Avoid contact with hot oil and components containing oil, since it could cause severe burns.



CHECK COOLANT LEVEL

CAUTION

At or near operating temperature, the engine coolant is hot and under pressure.
Avoid contact with components containing coolant, since it could cause severe burns.
Check coolant level only when the radiator is cool enough to touch (fig. 3). Turn cap slowly to release pressure.

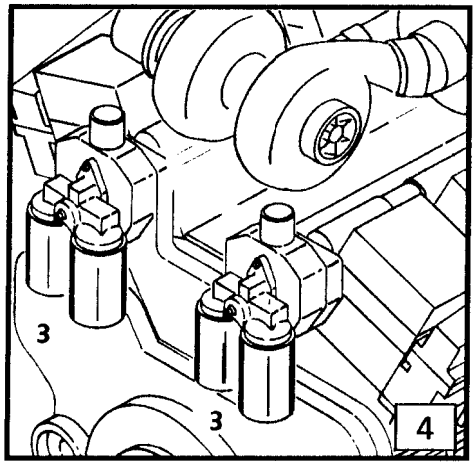


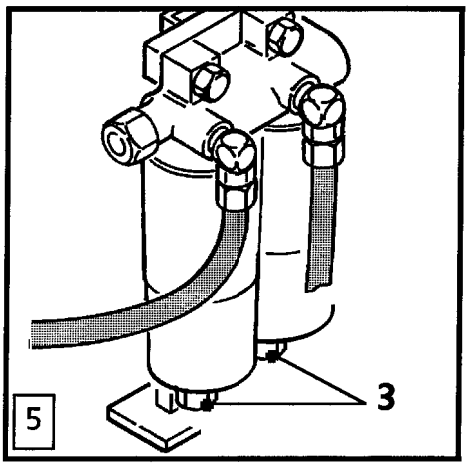
Check the coolant level. When cold, the coolant level should not drop below the bottom end of the filler neck under the radiator cap 2.

The proper antifreeze concentration must be maintained all year long.

The excavator is delivered from the factory with a cooling system protection to - 31° F(-35° C) , which corresponds to a concentration of about 50% anti-freeze.

The water filters (fig. 4, pos. 3), which are installed on the engine, contain a corrosion protector.
Regularly check its concentration in the coolant circuit, see Cummins Operation and Maintenance Manual.



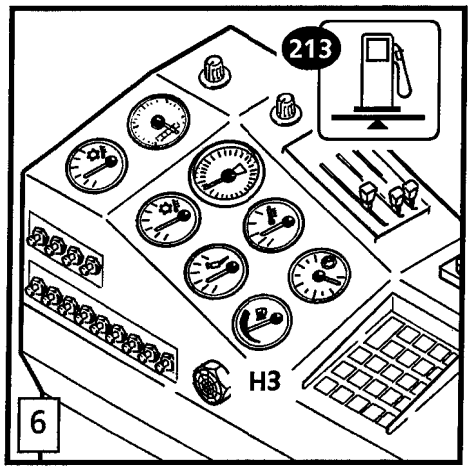


CHECK FUEL SYSTEM / FUEL LEVEL

The condensation in the fuel system and fuel tank must be drained daily.

Turn the plugs on the water separator (fig. 5, pos. 3), drain the condensation until fuel drains off and retighten the plug.

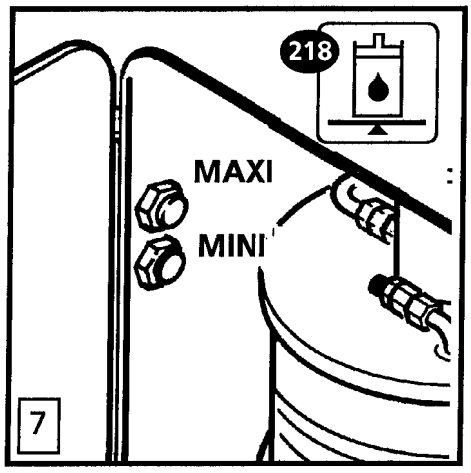
In some cases, ideal operating conditions and fuel quality make it possible to extend this interval to once a week.



Check fuel gauge H3 (Fig. 6) on the instrument panel before starting to work.

If indicator light **213** lights up, only a little reserve of fuel remains in the tank.
For remaining quantity, see page 3.6

Refill the tank, if fuel level is low. Maintain a high fuel level in tank to reduce condensation.



CHECK HYDRAULIC OIL LEVEL

When checking the oil level or adding oil,

- park the machine on level ground,
- rest the attachments on the ground,
- with stick and tilt cylinders fully extended
- and bottom dump bucket closed.

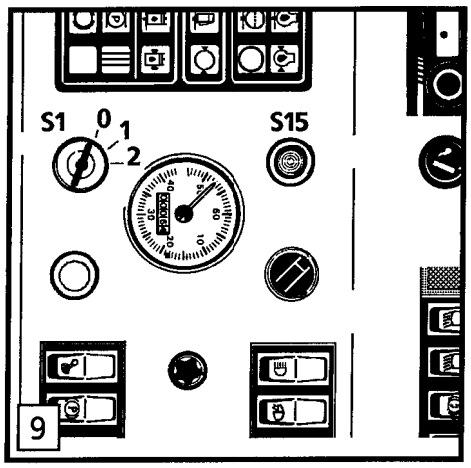
Checking oil level in hydraulic tank :

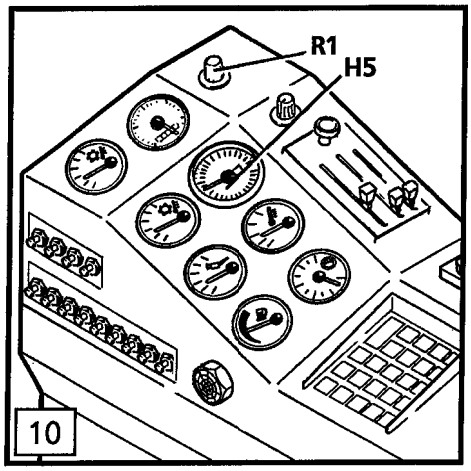
If the oil level is below the center of the lower sight gauge (Fig. 7 - MINI), oil has to be added through the return filter until the oil level reaches the center of the top sight gauge (Fig. 7 - MAXI).
See page 5.14 for description of procedure for adding oil.

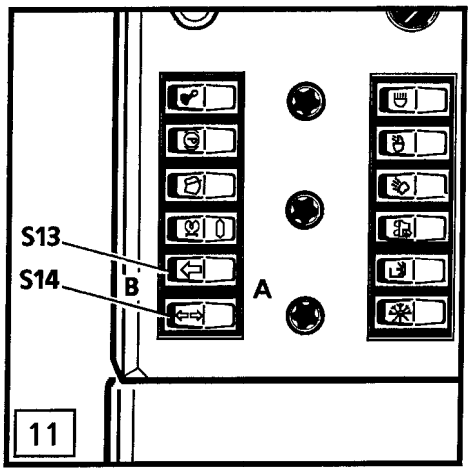
If the oil level drops below the lower sight gauge, the indicator light **218** will light up and, at the same time, the pumps will move to minimum angle.

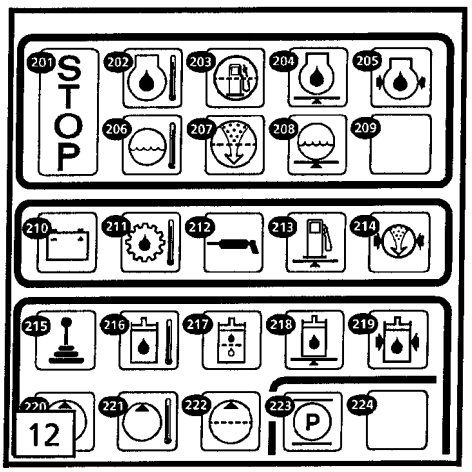
MACHINE START UP SAFETY

- Before excavator start up, perform a thorough walk around inspection.
- Visually inspect the excavator, look for loose bolts, cracks, wear, any leaks and any evidence of vandalism.
- Never start or operate an unsafe excavator.
- Report all defects to your foreman or supervisor and make sure they are corrected immediately.
- Make sure all covers and doors are closed and locked and all warning decals are on the machine.
- Make sure all windows, as well as inside and outside mirrors are clean, and secure all doors and windows to prevent any unintentional movement.
- Be certain that the area surrounding the excavator is free of other personnel, and that no one is working on or under the excavator before starting the engine.
- After entering the cab, adjust the operator's seat and controls, the inside and outside mirror, the armrests and fasten and adjust the seat belt. Be certain that all controls can be reached comfortably.
- All noise protection devices on the machine must be functional during operation.









DIESEL ENGINE OPERATION

IGNITION KEY POSITIONS (fig. 9)

- 0 - Off
- 1 - Contact position
- 2 - Starting position

ENGINE SPEED ADJUSTMENT

The engine speed is shown by the RPM gauge (fig. 10, pos.H5).

The excavator is fitted serially with an engine low idle automatic device which can be either switched on (rocker switch S13, fig. 11 in position B) or switched off (rocker switch S13 in position A).

When the low idle automatic is switched off, the engine speed can be adjusted continuously over the whole RPM range via the rocker switch S14 (fig.11).

-pushing the switch to A reduces the engine RPM.

-pushing the switch to B increases the engine RPM.

When the low idle automatic is on the engine speed raises to high idle as soon as either a joystick or a pedal is actuated, and the Diesel engine speed automatically reduces to low idle if neither the joystick nor the pedals are moved within a certain period of time.

This time period can be set (from 3 up to 10 seconds) on the potentiometer R1.

TO ENERGIZE THE ELECTRICAL SYSTEM

Turn the ignition key to pos. 1.
The warning lights H9 and H10 (fig.15) as well as the following indicator lights must light up (fig. 12):

- 204 - Engine oil level too low (lights turns off 7 sec.)
- 205 - Engine oil pressure too low
- 208 - Coolant level too low (turns off after 7 sec.)
- 210 - Charge indicator
- 213 - Fuel reserve (light turns off after 7 sec.)
- 214 - Air pressure too low (if low pressure)
- 215 - Servo oil pressure too low (if low pressure)
- 218 - Hydraulic oil level too low (turns off aft. 7 sec.)
- 219 - Tank pressurization too low (if low pressure)

Push the test indicator S15 (fig. 19), all the other control lights must light up (this test of the control lights can only performed while the engine is not running).
Turn ignition key to Off position.

ENGINE STARTING AT AMBIENT TEMPERATURES TO 32°F (0°C)

Turn the ignition key to pos. 1.

Switch off the engine idle automatic (rocker switch S13 in pos. A) and increase the engine RPM a little via rocker switch S14.

Turn the ignition key to starting position 2.

If the ignition key is longer than 10 seconds in position 1, return the key to 0 position before turning to position 2, or current flow to the starter will be interrupted.

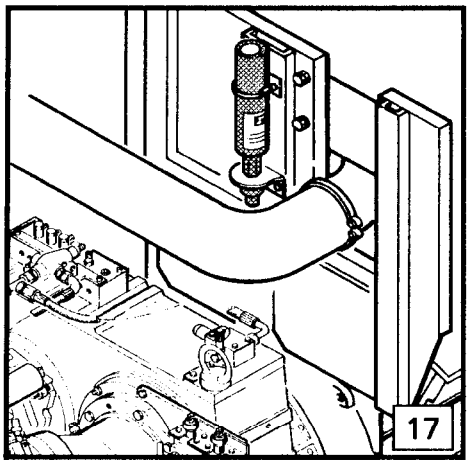
During the starting procedure, the starter first drives an engine oil pump to establish the correct lube oil pressure in the engine, before it is being started ("PRELUBE" procedure).
Depending on engine oil temperature, a prelube time of up to 15 seconds might be necessary to obtain the correct pressure. Then the starter stops and after another 3 seconds, starts the Diesel engine.

As soon as the engine is running, release the key and lower the engine RPM.

Do not crank the engine for more than 10 seconds !
If the engine does not start, repeat the starting procedure at one minute intervals to allow the starter motor to cool off.

Turn the ignition key to starting position 2.
If the ignition key is longer than 10 seconds in position 1, return the key to 0 position before turning to position 2, or current flow to the starter will be interrupted.
As soon as the engine is running, release the key and lower the engine RPM.

Do not crank the engine for more than 10 seconds !
If the engine does not start, repeat the starting procedure at one minute intervals to allow the starter motor to cool off.

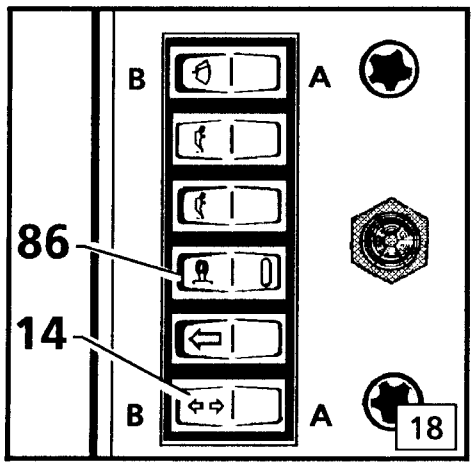


STARTING THE ENGINE WITH THE COLD START SYSTEM AT AMBIENT TEMPERATURES BELOW 32° F (0° C)

A cold start system is standard equipment (fig. 17), it greatly improves starting the engine at low temperatures.
- Switch off the engine idle automatic.
- Reduce the engine RPM to low idle via switch 14 .
- Turn the ignition key to starting position and at the same time move the impulse switch 86 (fig. 18) to actuate the cold start system.

Release the ignition key as soon as the engine has started.

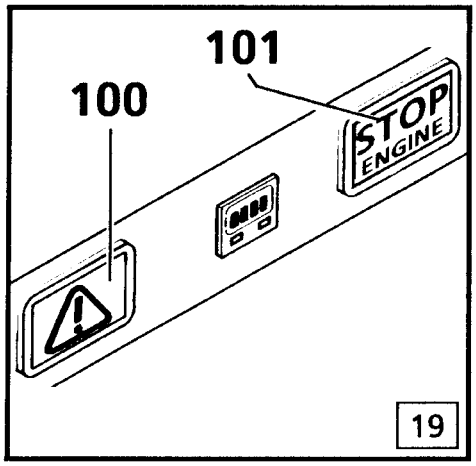
Do not crank the engine for more than 10 seconds!
If the engine does not start, repeat the starting procedure at one minute intervals to allow the starter motor to cool off.



AFTER THE ENGINE IS RUNNING :

The warning light 101 (fig. 19) and the following indicator lights must turn off after the engine is running (Fig. 16) :

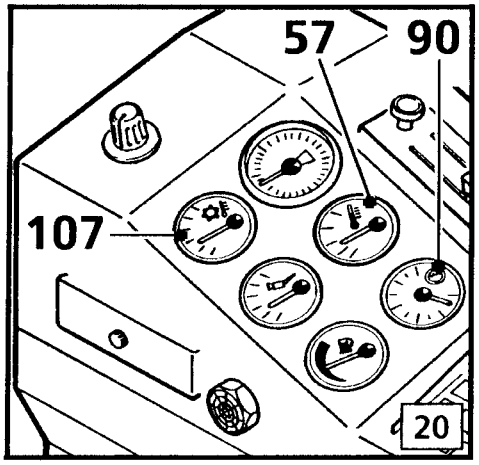
- 205 - Engine oil pressure too low
- 210 - Battery charge indicator



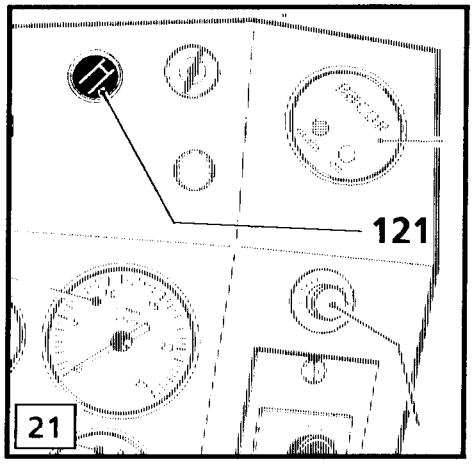
At low engine oil pressure or engine coolant level in the radiator a buzzer will sound, and the appropriate indicator light (205 or 208) lights up (fig. 16).

In both cases, immediately reduce engine speed to idle. The engine will automatically turn off after several seconds.

Run the engine at idle until the indicator light for low hydraulic tank pressurization 219 turns off, the air pressure shown on pressure gauge 90 reaches at least 6,2 bar, and the engine oil temperature on gauge 107 reaches at least 60°C.
Until the coolant temperature reaches 50°C on thermometer 57, increase the engine load only slowly.



Do not run the engine for more than 10 minutes at idle, or the engine can be damaged. Turn the engine off if the machine is not used for a longer period of time.

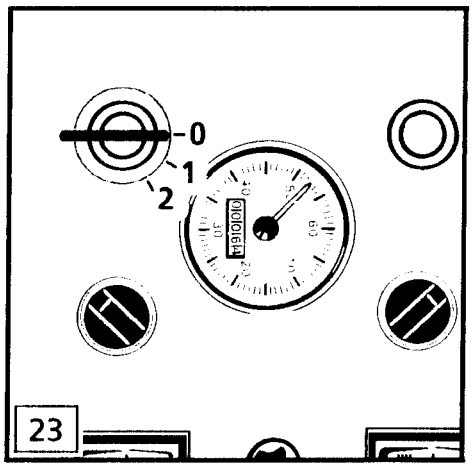


To actuate the working attachment, the servo circuit for excavator movements must first be switch on by turning the selector switch 121 (fig 21) to position "excavator".

WARNING

- **Only run the engine if good ventilation is provided. Open doors and windows, if necessary, to provide sufficient ventilation.**
- **Run the engine until the hydraulic oil is at operating temperature.**
  Low engine and hydraulic oil temperatures cause the excavator to be sluggish and unresponsive.
- **Carefully move the machine outside and check the function of the travel and swing brakes.**
- **Check if all attachment functions are operating properly.**

STOPPING THE ENGINE



Do not turn the engine off while the engine is at high idle, run it at low idle for a short time (3 - 5 minutes) to lower the temperature.

Turn the ignition key to "O" position (fig. 23) and remove the key.

ENGINE EMERGENCY SHUT DOWN

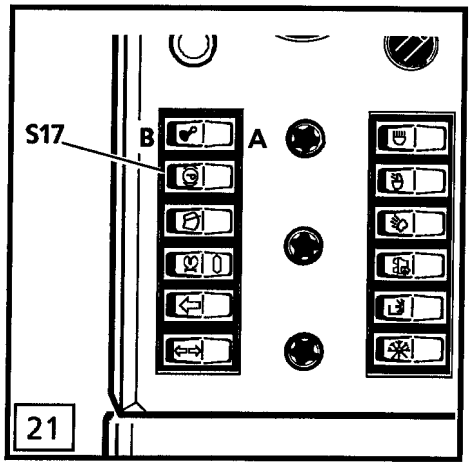
Turn the ignition key to "O" position.

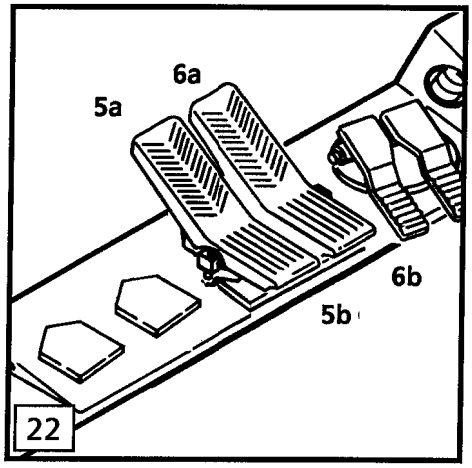
CAUTION

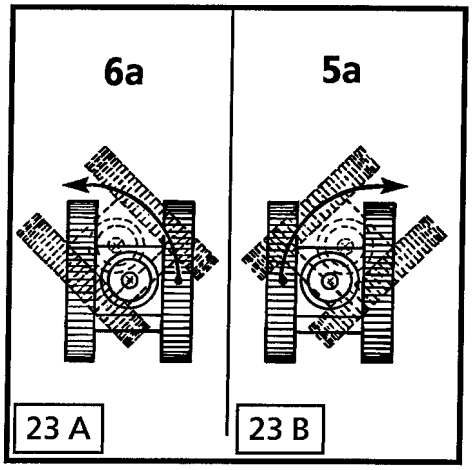
The engine should be stopped this way only in emergencies. If the engine was turned off in an emergency shut down, it is important to let the engine run at low idle for a short time after restarting.

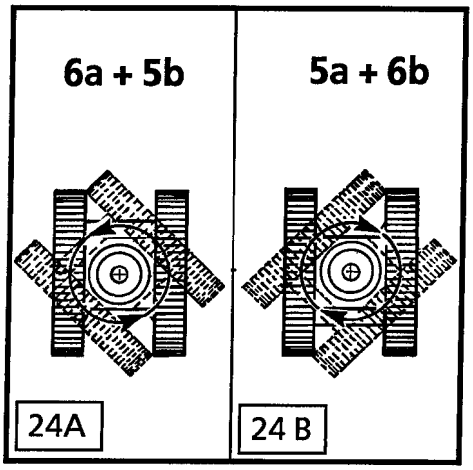
MACHINE OPERATING SAFETY

- Familiarize yourself with job site rules. Be informed about traffic and hand signals and safety signs. Ask who is responsible for signaling.
  Check your surrounding for any obstacles in the working and movement range, check the load carrying capacity of the terrain, and secure the job site to shield it from any public highway traffic.
- Always keep a safe distance from overhangs, walls, drop offs, and unstable ground.
- Be alert of changing weather conditions, bad or insufficient visibility and of changing ground conditions.
- Be alert for utility lines, check the location of underground cables, gas and water lines, and work especially careful in that vicinity. If necessary and/ or if required, call local authorities to mark the location.
- Keep sufficient distance to electrical lines. When working in the vicinity of high voltage electrical lines, keep proper distance to assure that the attachment does not come close to the lines.
  DANGER! You must inform yourself about safe distances.
- In case you do touch a high voltage line by accident, proceed as follows:
  - do not leave the machine,
  - move the machine, if possible, from the danger zone until you obtain sufficient distance,
  - warn any personnel in the vicinity not to come close to the excavator and not to touch it,
  - instruct or initiate that someone turns off the voltage.
  - Do not leave the machine until you are absolutely sure that voltage in the line, which had been touched or damaged, has been turned off!
- Before moving the machine, make sure that the attachments and equipment is secured properly to avoid accidents.
- When traveling on public roads or highways, make sure to observe traffic regulations, and make sure that the machine meets federal and local public highway standards.
- Always turn on the lights if visibility is bad or if you are still working during dusk.
- Never allow other personnel on the excavator.
- Operate the excavator only while seated and with the seat belt fastened, if installed.
- Report any problems or needed repairs to your foreman or supervisor and make sure they are corrected immediately.
- Do not move the excavator until you are certain that no one is endangered by moving the excavator.
- On machines without negative brakes check the brake system before starting to work, as outlined in the **Operation and Maintenance Manual.**
- Never leave the operator's seat while the machine is still moving.
- Never leave the machine unattended, with the engine running.
- When moving the excavator, keep the upper-carriage in lengthwise direction and keep the load as close as possible to the ground.
- Prevent any working movements, which could tip the machine over. If the excavator begins to tip or slip on a grade, immediately lower the attachment and load to the ground and turn the excavator facing downhill.
  If possible, always operate the excavator with the attachment positioned uphill or downhill, never sideways.
- Always travel slowly on rough or slippery ground and on slopes.
- Always travel downhill at permissible speed, so you don't loose control over the machine. The engine must run at nominal speed, use only the foot pedals to brake and slow down the machine.
  Never shift during down hill travel, always shift to a lower gear before traveling downhill.
- Never load over an occupied truck. Request that the driver leave the cab, even if a rock protection is installed.
- For demolition work, clearing, crane operation, etc. always use the appropriate protection device designed for this specific application.
- If operating in visually obstructed terrain or whenever necessary, have another person guide you. Always have only one person signal you.
- Allow only experienced persons to attach loads or to guide operators. The guide must be visible by the operator and / or must be in voice contact with him.
- Depending on the attachment combination, it is possible for the bucket teeth to hit the cab, the cab protection or the boom cylinders. Be very careful when the bucket teeth get in this range to prevent any damag
- In case of a thunderstorm :
  - lower the attachment to the ground and if possible anchor the digging tool into the soil.
  - leave the cab and move away from the machine before the storm breaks out. Otherwise, you must stop the excavator, turn off the radio and keep inside the closed cab until the end of the storm.









TRAVEL FUNCTIONS

When traveling, align the uppercarriage up with the undercarriage (idlers in front, sprocket wheels in the rear).

TO RELEASE THE TRAVEL BRAKES

The travel brakes are controlled by push button S17 (Fig. 21). If the brakes are released, the button lights up with a green light.

STRAIGHT TRAVEL

- **Travel forward** :
Push both foot pedals equally forward with your toes (Fig. 22, pos. 5a and 6a).

- **Travel reverse** :
Push both foot pedals equally downward with your heels (Fig. 22, pos. 5b and 6b).

⚠ DANGER

Before you travel in reverse make sure , it is clear and nobody is in your way!

TO TURN OVER ONE TRACK

- **To turn left forward** (Fig. 23 A) :
Push the right foot pedal forward (pos. 6a).

- **To turn right forward** (Fig. 23 B) :
Push the left foot pedal forward (pos. 5a)

⚠ CAUTION

To protect the track components, reverse turns should be avoided.

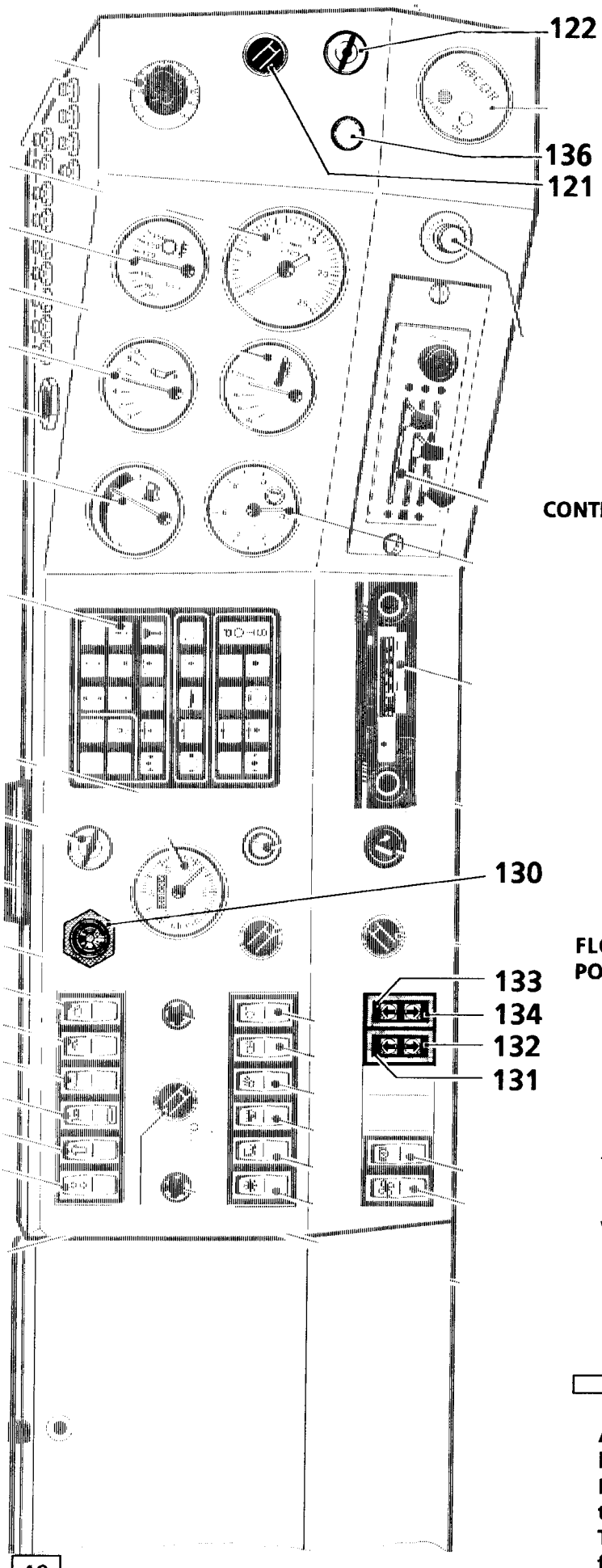
COUNTER ROTATION (Fig. 22)

- **To turn left** (Fig. 24A) :
Push the right pedal forward (pos. 6a) and at the same time push the left pedal down with your heel (pos. 5b).

- **To turn right** (Fig. 24 B) :
Push the right pedal down with your heel (pos. 6b) and at the same time push the left pedal forward (pos. 5a).

⚠ DANGER

If the uppercarriage us turned by 180°, note that the direction of travel is reversed when you push the pedals!



40

THE PONTOON OPERATION

COMMUTATION FOR SERVO CIRCUITS EXCAVATOR / PONTOON

To select the servo circuit to be pressurized ,turn the selector switch 121 either to "excavator" for excavator operation or to "pontoon" for pontoon operation.

In position "excavator", the servo controls for excavator movements are alive, these for pontoon movements are switched off.

In the opposite, with the switch 121 in position "pontoon", only the movements for pontoon can be fed with pressure oil, the excavation movements are not yet possible.

CONTROL OF OIL LEVELS IN HYDRAULIK TANKS

The hydraulic tank excavator as well the hydraulic tank pontoon are monitored by a maxi and a mini oil level transmitter which are connected to control lights on the instrument panel.

131 Minimum oil level / hydraulic tank exc.

132 Maximum oil level / hydraulic tank exc.

133 Minimum oil level / pontoon

134 Maximum oil level / pontoon

Simultaneously with the lighting of one of these lights, the buzzer 130 alarms acoustically.

FLOAT POSITION OF THE ATTACHMENT FOR PONTOON OPERATION

The float position of the bottom cylinders allows the attachment to move up and down freely to compensate the differences in water level when the digging bucket is left (during tide or in locks, ...) on an embankment or a wharf.

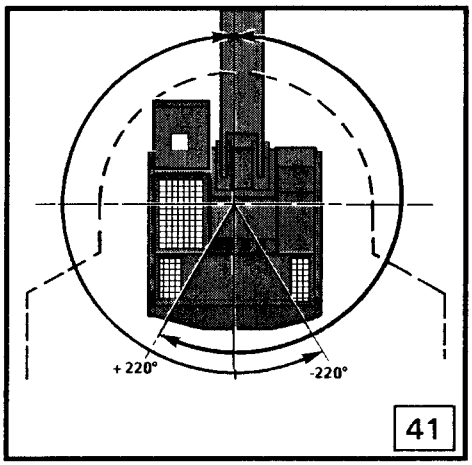
The float position is turned on and off via the key switch 122 (fig. 40).

When the float position is on, the indicator light 136 lights up and the key can be taken away.

⚠ CAUTION

Always switch on the float position before leaving the excavator.
First lower the attachment before switching on the float position, and then turn the engine off.
Take off the ignition key and the key 122 for float position when leaving the excavator.

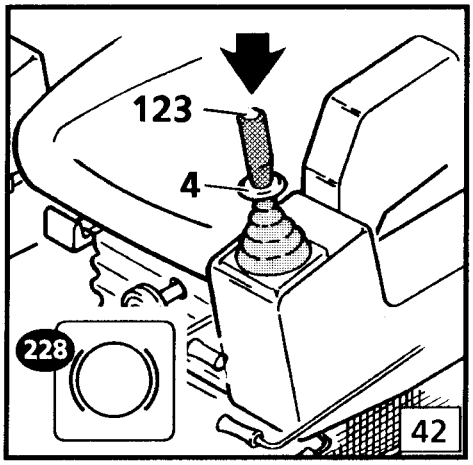
UPPERCARRIAGE SWING LIMITATION FOR EXCAVATOR ON A PONTOON



CAUTION

On your 994 pontoon, the uppercarriage may be swung at the very most by 220 degrees to the right or to the left (fig. 41).

Overpassing this maximum angle automatically cuts off the swing movement, i. e. the swing brake applies and the swing pump is swivelled back to neutral position.



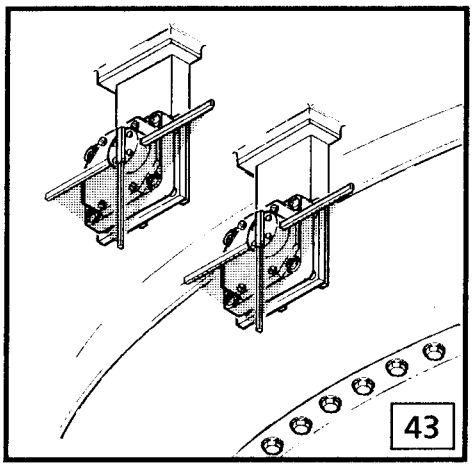
At the same time, the control light 228 (fig. 42) on the monitoring display lights up.

However it is still possible to turn the uppercarriage back in the opposite direction, while moving the left joystick 4 and depressing at the same time the push button 123 at the top of its handle.

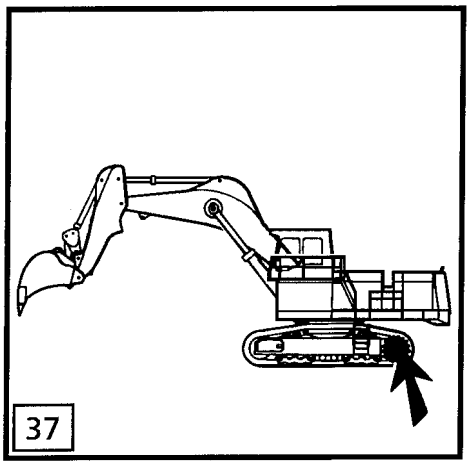
The control light 228 turns off as soon as the uppercarriage is swung back in the allowed sector.

CAUTION

The uppercarriage must always return to the authorized sector in the opposite direction it left this sector. As an example, if the sector was reached clockwise it must be reentered counterclockwise.



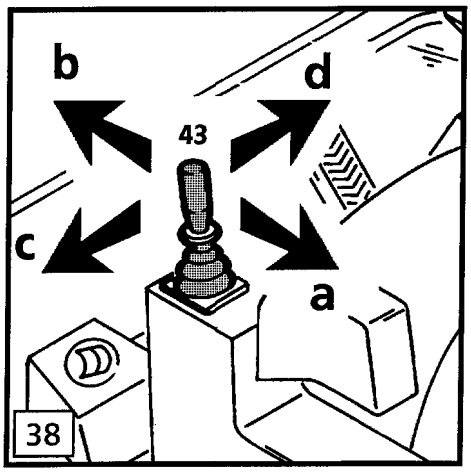
With the uppercarriage in the normal working area, the three arms of each position switch fixed to the upperstructure must shape an arrow showing down (fig. 43).



WORKING POSITION

When working in a straight line using the backhoe attachment, the machine should move backwards and work over the idler (fig. 37).

When working in a straight line with a bucket, the sprockets should be in front (fig. 40).

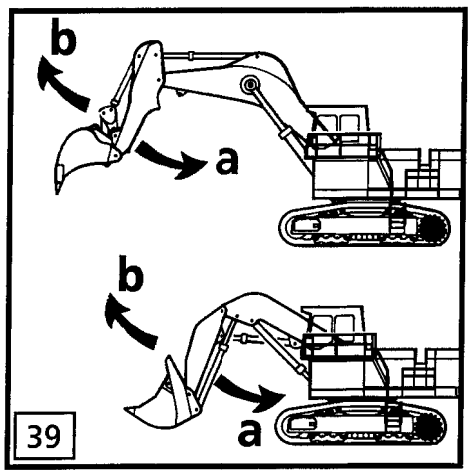


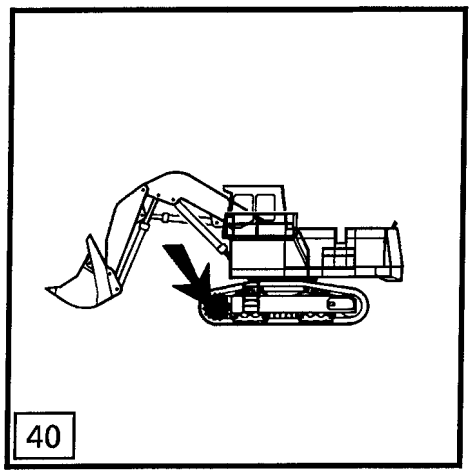
ATTACHMENT CONTROL

CONTROL OF THE STICK CYLINDER
(left joystick 43 - fig. 38)

Pull joystick 43 backwards (a) to move the stick in, (Fig. 39).

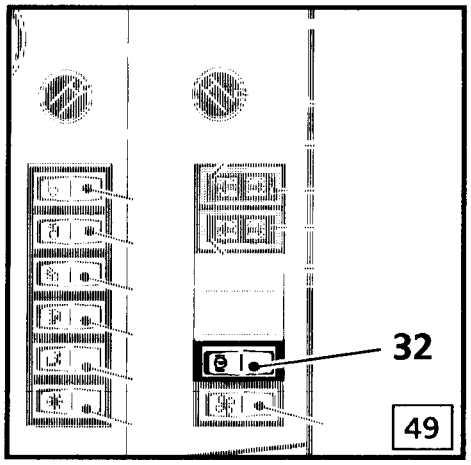
Push joystick 43 forward (b) to move the stick out.





CAUTION

APPLY THE BRAKE ONLY WHEN THE UPPERCARRIAGE IS NOT MOVING!
In order to stop the uppercarriage when working on a slope, first stop its movement with joystick 4.
Then apply the brake via pedal 89 or switch 32 and move joystick 4 to "O" position.
For machines on a pontoon which are fitted with an uppercarriage swing limitation,this brake applies as soon as a maximum swing angle of the uppercarriage has been reached, see also page 4.11.



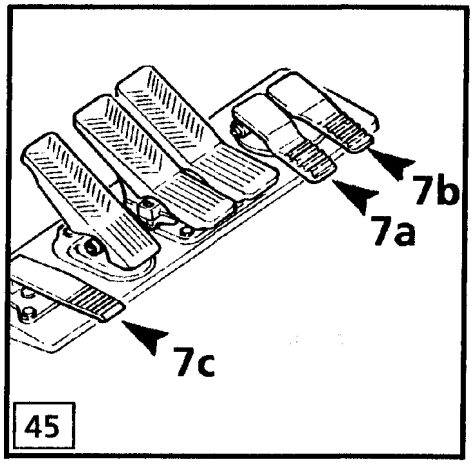
To check the mechanical brake:
Apply the swing brake by turning switch 49 (fig. 32).
Then move the left joystick 4 (fig. 46) all the way to the right and then to the left.
The brake is working properly if the uppercarriage does not move.

TO LOCK THE UPPERCARRIAGE

When traveling, during transport or non-operation as well as during maintenance and repairs, lock the uppercarriage to the undercarriage before leaving the excavator .
To lock the uppercarriage, install the attached shackle between swing ring and uppercarriage.

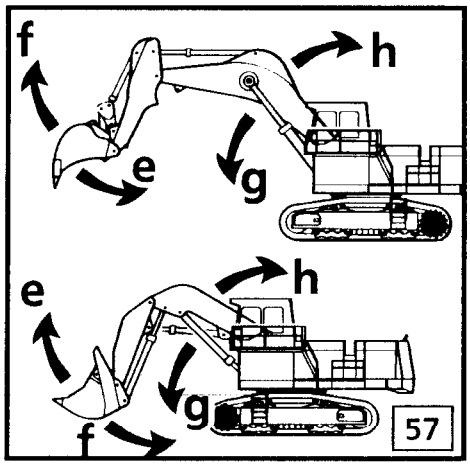
CAUTION

Do not operate the swing when the uppercarriage is locked to the undercarriage.



CONTROL OF HYDRAULIC HAMMER
(optional equipment)

The hydraulic hammer is actuated via the pilot control valve 7c (fig.45), mounted on the cab floor.



CONTROL OF THE BUCKET
(right joystick 3 - Fig. 56)

Push joystick 3 (fig 56) to the left (e) to tilt the bucket in (fig. 57).

Push joystick 3 to the right (f) to tilt the bucket out

COMBINATION MOVEMENT

A diagonal movement of the joystick combines the movements of the attachment functions.
This makes is possible for all attachment movements to be controlled at the same time.

The operator can perform the following movements without any additional manipulations :

When the swing movement is actuated, all working functions/movements are possible without affecting the swing movement.

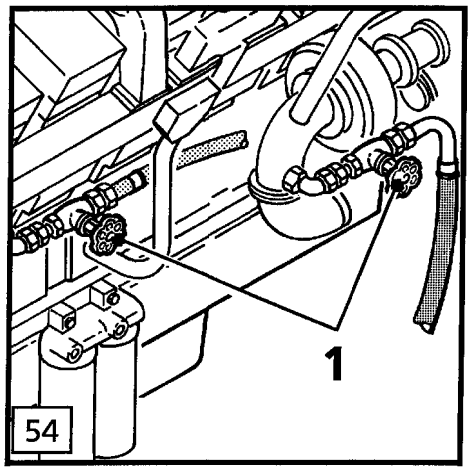
During travel, every attachment movement is possible, but the swing movement has priority. In this case, the travel movement is reduced.

THE HEATER AND AIR CONDITIONER

As standard equipment the R 994 is fitted with a heater and an air conditioner.

The heater and the condenser unit of the air conditioner are located in the cab elevation, the evaporator unit of the air conditioner is integrated in the cab roof.

The heater can also serve as a fresh air ventilation for the cab.



FRESH AIR VENTILATION

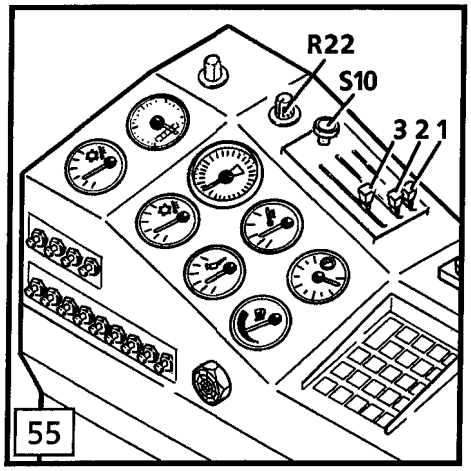
For fresh air cab ventilation close the shut off valves on the Diesel engine (fig. 54).

Push lever 1 (fig. 55) all the way forward to close off the hot water supply.

Select desired air flow by turning button S10.

The fresh air enters the cab via the adjustable louvers at the right and left front corners (fig. 56, B), as well via the gap below the control pedals plate (fig. 56, A).

Move the lever 2 to regulate the amount of fresh air entering the cab.
With lever 2 pushed forward to the stop the cab is ventilated only with recirculated air.



HEATER OPERATION

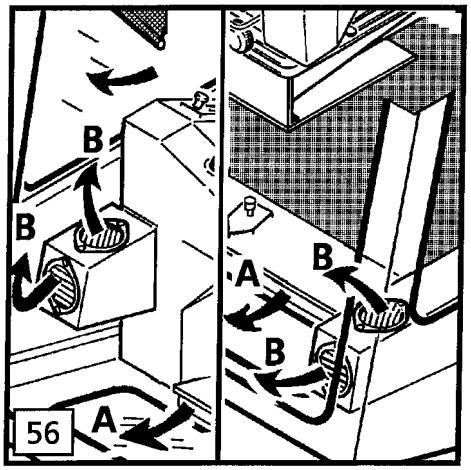
Open the shut off valves on the Diesel engine (fig. 54).

The amount of water flowing through the heat exchanger can be regulated by moving lever 1.
The warm water flow is maximum when the lever is pulled backwards to the stop.

Select desired air flow by turning button S10.

Move the lever 2 to regulate the amount of fresh air entering the cab.
The best heating, effect is reached by recirculating air, this means when the lever 2 is pushed forward to the stop.
In this position, about 10% of fresh air is mixed with recirculating warm air in the cab.

To defrost the windshield, adjust the louvers to direct the warm air flow forward, and pull back to the stop the lever 3 to have a maximum air flow over the gap of the pedal plate.



AIR CONDITIONER OPERATION

Close the shut off valves on the Diesel engine push forward to the stop the lever 1 (fig. 59), and turn button S10 to switch off the heater fan.

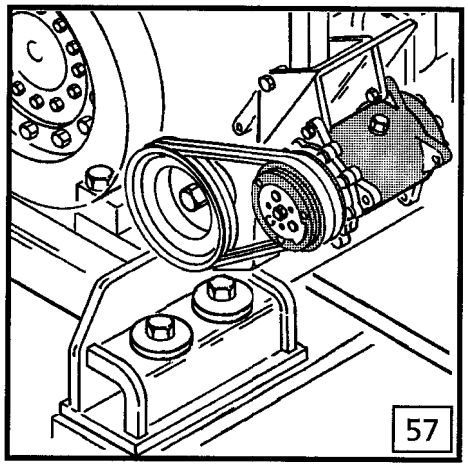
Start air conditioner compressor (fig. 57) and condenser fan via rocker switch S111 (fig. 58).
The control light in the rocker switch lights up, showing that the air conditioner is on.

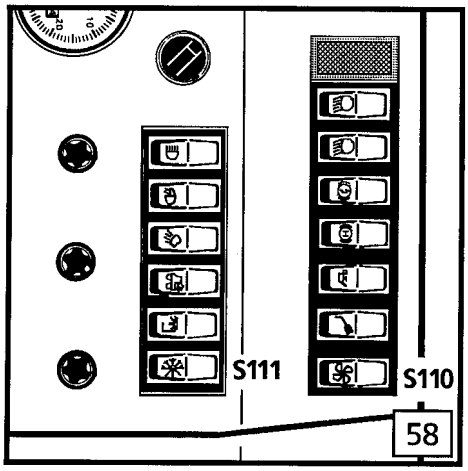
The air conditioner should only be turned on after the engine is running. This will prevent an overload on the starters and batteries.

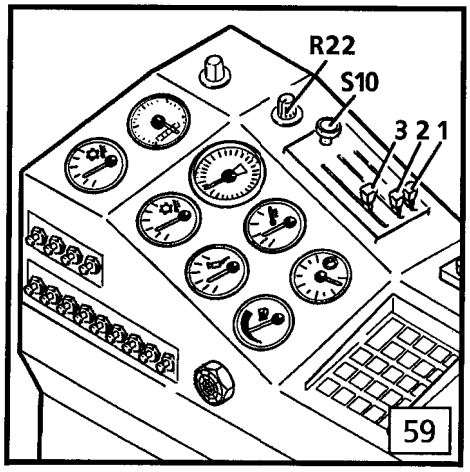
Select the desired air flow via the three position switch S110 (fig. 58).

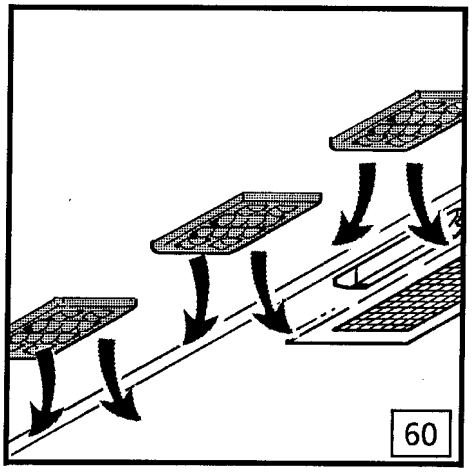
Adjust the cold air temperature by turning the thermostat R22 (fig. 59).

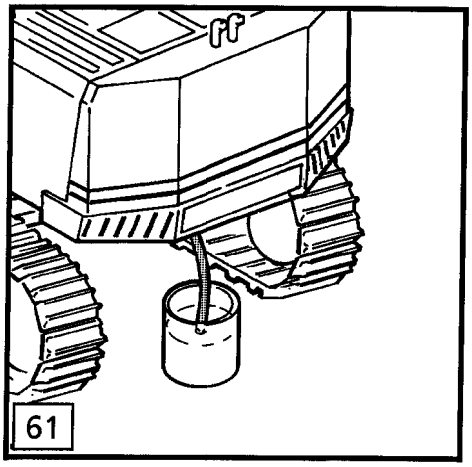
The direction of the cold air flow can be adjusted via the vents on the evaporator unit (fig. 60).

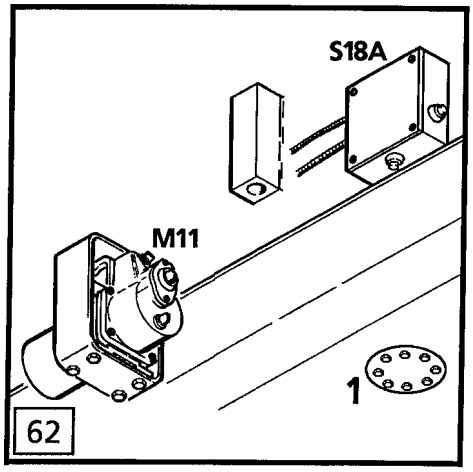




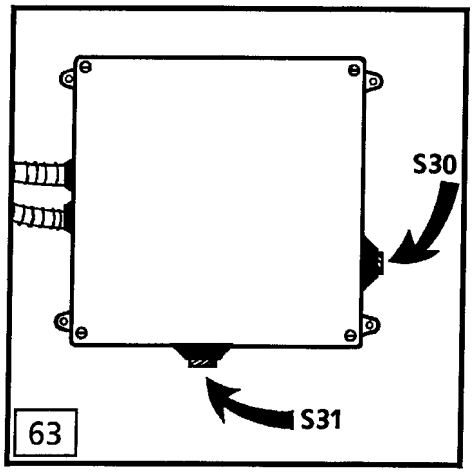





61



62



63

REFUELING PUMP (optional equipment)

The fuel tank can be refilled thanks to an optionaly mounted refueling pump (fig. 62, pos. M11) driven by an electric motor fed by the batteries.

The electric box S18A for the control of the pump in mounted to the bottom of the inner wall of the fuel tank.

A step mounted to the central piece of the undercarriage allows to access to the electric box and the hose reel.

Before refueling, the uppercarriage must be swung by 180°, i. e. the sprocket wheels must be in front.

First unwind the suction hose from its supporting hooks at the tank bottom and insert the end which is fitted with the strainer to the bottom of the Diesel fuel barrel.

The pump can now be started, by pushing the green control button on the electric box (fig. 63, pos. S30).
When the fuel reaches the maximal allowed level in the tank, the pump will automatically stop, and the green light in the control button 2 goes out.

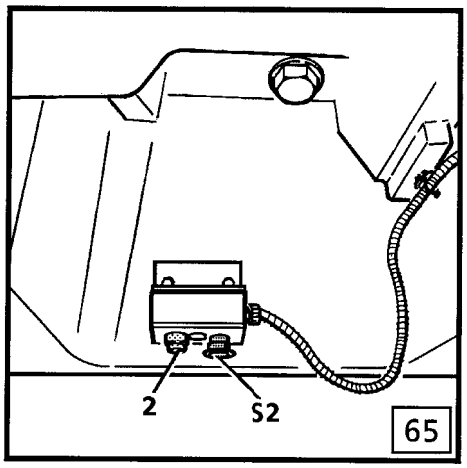
The pump can be stopped any time by pushing the red button pos. S31.

⚠ CAUTION

Only use the pump to deliver fuel.
Never let the pump run unloaded (sucking air) even for a short moment. Stop it immediately when the level in the barrel gets too low or during the lapse of time which is necessary to put the suction hose into a new barrel.
Otherwise the pump would be destroyed rapidly.

If at customer's wish the tank has to be refilled with a fast refueling system (for an exemple from Wiggins) the tank can also be fitted with the adequate receiver, mounted directly to the tank bottom after removal of the flange pos. 1 (fig. 62).

OUTSIDE OPERATED EMERGENCY OFF AND SIGNAL HORN



In case of an emergency, the **994** excavator can be shut down by an outside person by operating an emergency "OFF" switch which is located under the counterweight (fig. 65, pos. S2)

The emergency-off switch disrupts the diesel fuel supply to the engine.

To allow the restarting of the diesel engine, the emergency-off switch has to be neutralized by a rotating motion.

The excavator operator can be notified of possible danger by operating the green switch also located under the counterweight (fig. 65, pos. 2) which actuates the horn of the excavator.

5. LUBRICATION

GENERAL SAFETY INFORMATION

It is very important that all guidelines describing lubrication, checking the oil level, replacing the oil are strictly adhered to !
This maintenance increases the life of the excavator and improves its dependability.

It is especially important to change the oil regularly and in the intervals noted on the maintenance schedule ! Only use specified lubricants and oils !

⚠ CAUTION

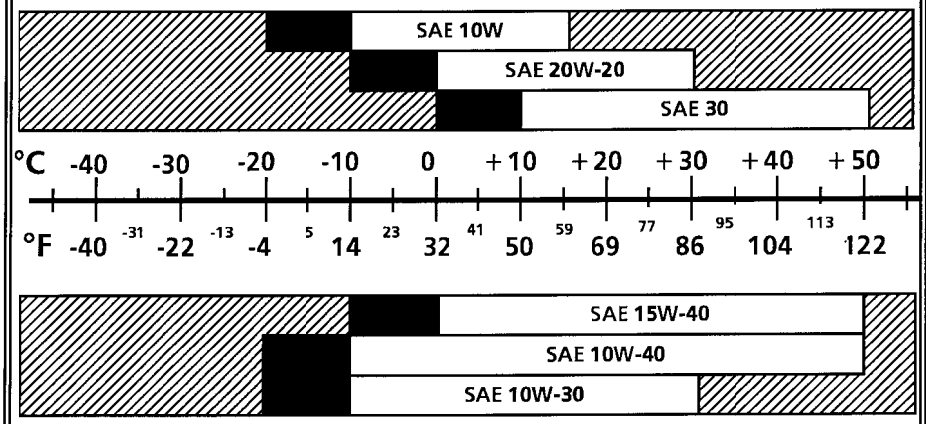
When checking or replacing the oil, observe the following :

- **Park the machine on level ground, if not otherwise stated, and turn the engine off.**
- **When working in the engine area, make sure the covers and side doors are secured.**
- **Only add fuel when the engine is turned off.**
- **Never smoke or allow an open flame in refueling areas.**
- **Cleanliness is especially important when changing engine, gear or hydraulic oil. Before removing fittings or plugs, make sure the surrounding areas are cleaned. When changing the oil, clean the fill or drain plugs.**

IMPORTANT !

Be sure to drain oil into a suitable container and dispose of oil and filter cartridges properly.

LUBRICANTS AND FUEL CHART R 994 Litronic

COMPONENTS	SYMBOL	VISCOSITY SAE DIN 51512	SPECIFICATION	QUANTITY
DIESEL ENGINE (TURBOCHARGED) - lubricant		See the Operation and Maintenance Manual for CUMMINS engine.		131l. (34 Gal) (with filters change) 114 l. (30 Gal) (without filters change)
- fuel		See the Operation and Maintenance Manual for CUMMINS engine.		3900 l. (650 Gal)
- coolant		See the Operation and Maintenance Manual for CUMMINS engine.		200 l. (53 Gal)
HYDRAULIC SYSTEM		 Warming up the hydraulic system: ■ 1. For temperatures 18°F (10° C) below the lower limits : Run engine at half speed. Warm up the hydraulic system by fully actuating hydr. cylinders and motors for short periods. Continue warm up for about 10 minutes or until operating temperatures are reached. 2. For temperatures below the limits listed under 1 : Preheat hydraulic oil in the tank before starting the engine.		2350 l. (620 Gal· (in whole circuit) 1750 l. (462 Gal· (in hydraulic tank)
SWING GEAR	①	1) We recommend use of oil according to : SAE 90 LS	API GL-5 MIL-L-2104 C or D MIL-L-2105 B	2×26 l. (2×7 Gal)
		2) Also authorized is : SAE 90	API GL-5 and MIL-L- 2105 B, C or D	
TRAVEL GEAR	②	SAE 90	API GL- 5 and MIL-L-2105 B, C or D	2 × 60 l. (2 × 16 Gal)
SPLITTERBOX	③	SAE 90	API GL-5 and MIL-L-2105 B, C or D	65 l. (17 Gal)

LUBRICANTS AND FUEL CHART R 994 Litronic

COMPONENTS	SYMBOL	VISCOSITY SAE DIN 51512	SPECIFICATION	QUANTITY
SWING RING TEETH	△	Special Grease	See lubricant specification	5 Kg (11 lbs.)
GENERAL LUBRICATION POINTS Swing ring Attachment bearings Track tensioner,..	KP 2k	down to 0°C (32°F) CONSISTENCY 2 NL GI N° 2 Grade	MULTI PURPOSE GREASE KP2k or EP2 (Extreme pressure N° 2 Grade)	180 kg. (400 lbs.) container
		Between 0°C (32°F) and -15°C (5°F)	CONSISTENCY 1 NL GI Grade	
		Between -15°C (5°F) and -40°C (-40°F)	SPECIAL GREASE as an example: Mobilith SHC 460 or SHC PM	
Hinges, couplings, locks			Engine oil	
Rubber seal on doors and covers			Silicon Spray or talcum	
WINDSHIELD WASHER SYSTEM			Commercial Windshield washer fluid or denatured alcohol	45 l. (12 gal.)
REFRIGERATING AGENT FOR AIR CONDITIONER			R 134 a	7 kg (15.5 lbs)
REFRIGERATOR OIL IN AIR CONDITIONER COMPRESSOR			PAG H 14-002-454 or PLANETELF PAG SP20 (ELF)	0,8 l (28 oz)

INFORMATION TO THE LUBRICANTS AND LUBRICATION CHARTS

The capacities in the lubricants chart and on the lubrication chart inside the cab are only given for your guidance.
Always check the level of a component after replacing its oil or when topping it up.

1) LUBRICANTS FOR DIESEL ENGINE :

See the Operation and Maintenance Manual for CUMMINS engine.

4) HYDRAULIC OIL :

Hydraulic oil specifications

1. Mineral oils

Recommended and approved are engine oils, which conform to the following specifications and regulations :

For single viscosity oils : API - CD / CCMC - D4 / ACEA - E1
Mercedes-Benz specifications - page No 226.0 and 227.0

For multi viscosity oil : API - CD+SF / CCMC - D5 / ACEA - E3
Mercedes-Benz specifications - page No 227.5, 228.1 and 228.3

2. Environmentally friendly hydraulic fluids (also called "BIO oils" -bio degradable oils-)

The "environmentally friendly hydraulic fluids" recommended by LIEBHERR are limited to synthetic ester based hydraulic fluids with a viscosity according to ISO VG 46.

Initial filling is performed ex works according to customer desires. The use of environmentally-friendly hydraulic fluids must be arranged with the LIEBHERR Co beforehand.

Organic oils should not be used due to their poor temperature consistency.

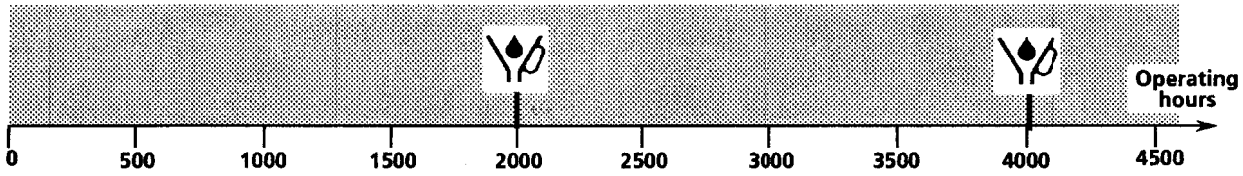
Note: It is absolutely necessary never to mix different brands of environmentally friendly hydraulic fluids or to mix fluids with mineral oils.
For further information on operating while using environmentally friendly hydraulic fluids, see page 8.7.

Hydraulic oil change intervals

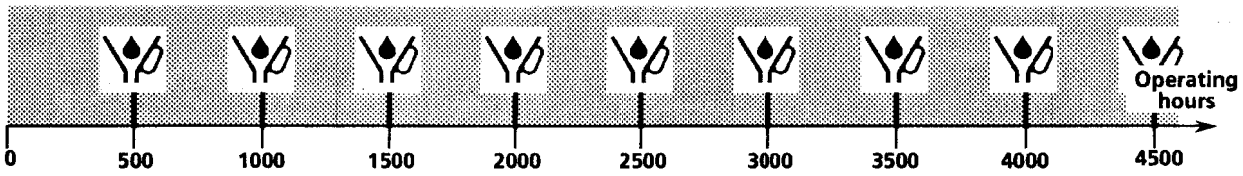
1. Oil changes in preset intervals

Note: **Oil changes in preset intervals are only permitted for mineral oils. When using environmentally friendly hydraulic fluids, oil sample analysis reports must be used to determine the time of the oil change, see §2.**

a) In standard applications



b) In dust intensive applications

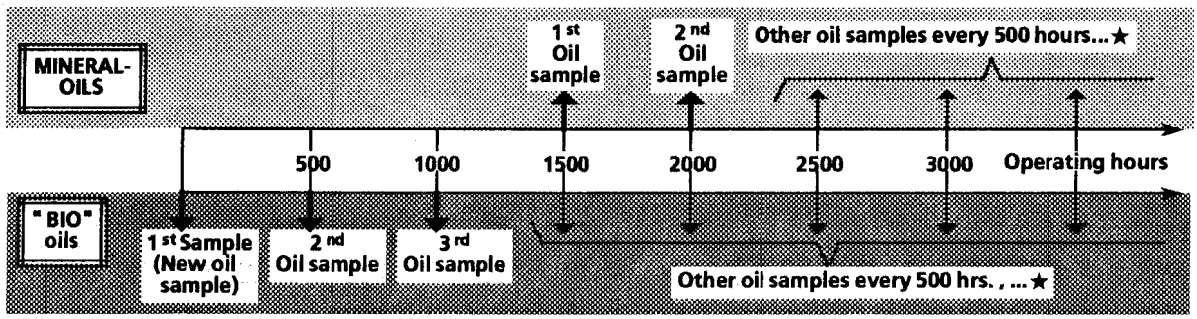


2. Optimized oil change intervals determined through oil sample analysis reports

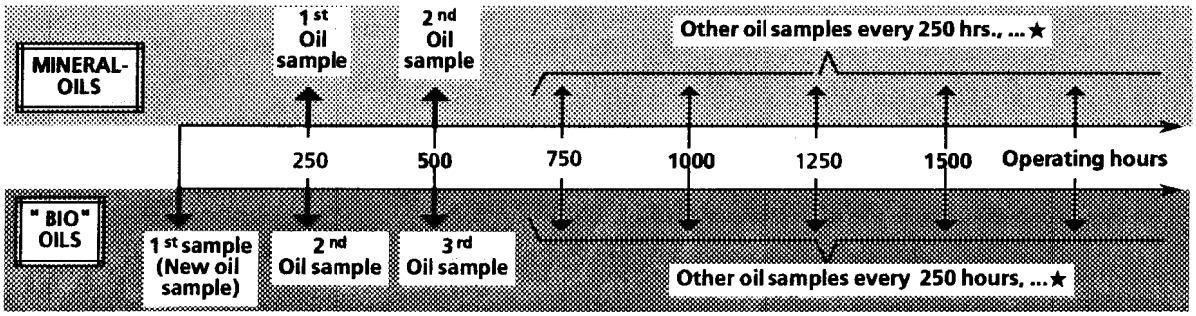
Use this procedure to take oil samples in preset intervals. The intervals may be extended between two oil changes as long as the properties of the oil are still satisfactory.
The time when the oil must be changed is determined by the lab report.

LIEBHERR recommends to submit the oil samples to "WEAR - CHECK" for oil analysis.
A kit for 6 complete analysis at WEAR - CHECK is available : Id. No. 7018368 (The kit contains the sample containers, documentation, shipping container and oil sample hose).
A hand pump is required to take the oil sample, and should be ordered separately (Id. No. 8145666).

a) In standard applications



b) In dust intensive applications



★ . . .time for oil change determined by lab report

To limit the hydraulic oil contamination when working under extreme dusty conditions

On excavators working under very dusty conditions or with a hydraulic hammer attachment, the contamination of the hydraulic oil may be significently increased.

In order to avoid any premature wear and failure of hydraulic components in consequence of this contamination reduce the oil change intervals as described above and, in addition, observe following recommandations:

- The tank return filter element(s) must be replaced every 100 operating hours.
- The tank return filter must be fitted with lower (finer) micron filter element(s) (10 µm instead 20 µm element, serially mounted).
- The breather filter on the hydraulic tank (fineness of serially mounted filter is 10 µm) must be replaced with a 3 µm fine breather filter.
- This 3 µm breather filter must be replaced every time the hydraulic oil is changed (every 500 operating hours).

Notice: The excavators delivered from factory with a hydraulic hammer attachment are fitted with the fine 10 µm return filter element(s) and with the 3 µm fine breather filter. The kit for retrofit installation of a hydraulic hammer also contains these fine element(s).

5) GEAR OILS

Gear oils for vicosity classification SAE 90 must meet the specifications API-GL-5-90 and MIL - L 2105 B, C or D.
For SAE 90 viscosity, SAE 80W90 can also be used.

6) GREASE FOR SWING RING ROLLER RACES AND GENERAL LUBRICATION POINTS :

This grease must meet 

specifications, consistency classification 2 in NL-GI viscosity per DIN 51 818 and DIN 51 825 or EP2 per NF-T-60 132.
The grease must be lithium-complex based, with VKA value of at least 2300 N per DIN 51350 or ASTM D 2596.

Between 0°C and -15C (32°F and 5°F)	Use a grease with consistency classification 1 NL GI or EP1 grease.
Between -15°C and -40°C (5°F and -40°F)	Only employ grease synthetic greases. We recommend the grease Mobilith SHC 460 or Mobilith SHC PM. LIEBHERR part N°: 8502769 for a 50 kg (110 lbs) container 8503731 for a 180 kg (400 lbs) container

7) GREASE FOR SWING RING TEETH

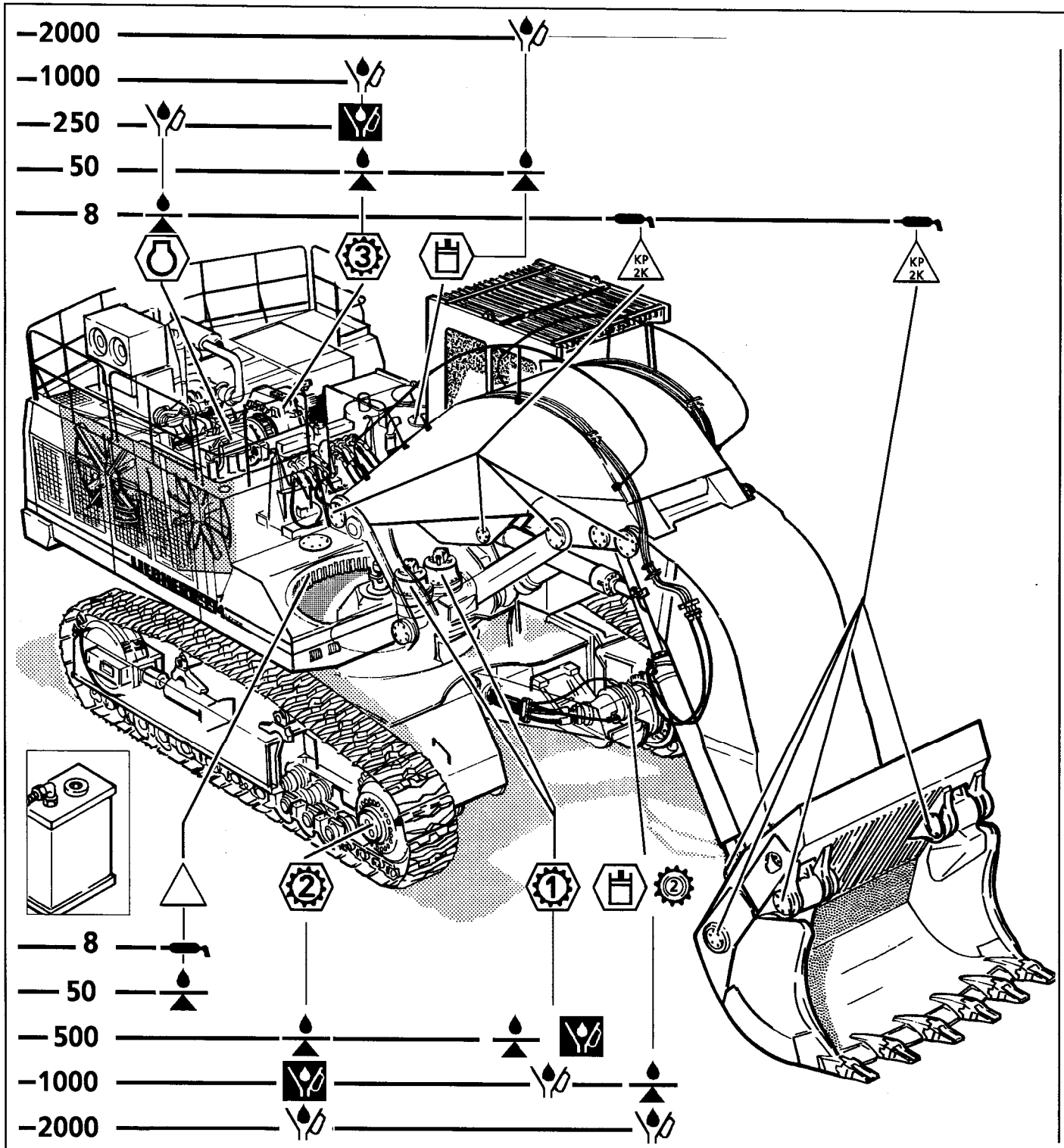
Grease RHZ 2	- also by automatic lubrication systems - LIEBHERR part N° : 8612304 / 1 piece(1Kg) 8500252 / 1 pack (10 pieces)
Molydag 147 / 400	- also by automatic lubrication systems - for cold countries (below -20° C, -4°F)
Compound Spray 2000 E	- LIEBHERR part N° : 8612107

8) REFRIGERATOR OIL IN AIR CONDITIONER COMPRESSOR :

The following refrigerator oil may be used:

Brand	**Manufacturer**	**LIEBHERR part N°** 0,25 liter (6 oz.) can of oil
PAG H 14-002-454	SANDEN	8503515
PLANETELF	ELF	8504414

At delivery, the compressor is filled with oil : **PAG H 14-002-454**
PAG oils (Polyalcylen-Glycol oils) are the only oils presently authorized by the compressor manufacturer when using refrigerant R 134 a.



R 994 Litronic

7369303- B

	Dieselmotor : Engine : Moteur thermique :	131l. 35 US gal.
	Hydraulikanlage : Hydraulic system : Circuit hydraulique :	1750 l. 463 gal.
①	Drehwerksgetriebe : Swing gear : Réducteur d'orientation :	2 × 26 l. 2 × 7 gal.
②	Fahrgetriebe : Travel gear : Réducteur de translation :	2 × 60 l. 2 × 16 gal.
③	Verteilergetriebe : Splitterbox : Réducteur de pompes :	65 l. 18 gal.

KP 2K — Allgemeine Schmierstellen
General lubrication points
Points de graissage

Drehkranzverzahnung
Swing ring teeth
Denture couronne d'orientation

Ölstand prüfen
Oil level check
Vérifier le niveau

Ölwechsel
Oil change
Vidange

Erster Ölwechsel
First oil change
Première vidange

Schmieren
Lubrication
Graissage

Die angegebenen Füllmengen sind nur Richtwerte.
Nach jedem Ölwechsel oder Nachfüllung den Ölstand prüfen.

Les capacités ne sont données qu'à titre indicatif.
Vérifiez le niveau après chaque vidange ou appoint.

The capacities are only given for your guidance.
Always check the level after replacing oil or topping up.

THE DIESEL ENGINE

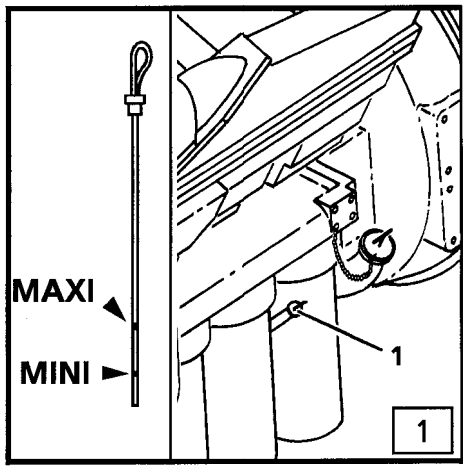
TO CHECK THE ENGINE OIL LEVEL

Park the machine on firm, level ground to check the engine oil level. Turn the engine off and wait a few minutes for the oil to collect in the oil pan.

The oil must be between the minimum and maximum mark on the dipstick (Fig. 1, pos. 1).

CAUTION

The engine oil is very hot at or near operating temperature. Avoid contact with hot oil and components containing oil, since it could cause severe burns.

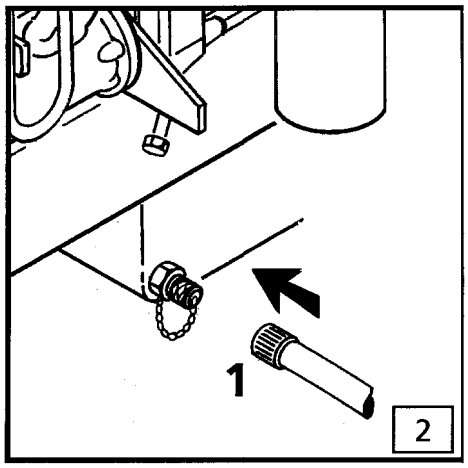


TO CHANGE THE ENGINE OIL

To drain the oil :
To change the oil, bring the engine to operating temperature.
Attach drain hose 3 (Fig. 2) to the drain and drain the oil into an appropriate container.

See Cummins Operation and Maintenance Manual for oil quality, oil quantities, oil change intervals and oil filters element changes.
For oil quantity, see lubricant chart.

Notice:
In case your machine is fitted with a "Reserve System" for engine oil, the oil and filter elements change interval can be doubled.
The oil in the additional supply tank (30 U.S. Gal.) and the oil filter mounted to it must then also be changed, see also page 8.1.



TO CHECK THE COOLANT LEVEL

CAUTION

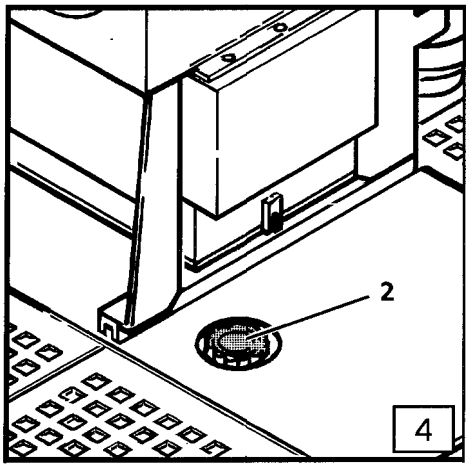
At or near operating temperature, the engine coolant is hot and under pressure.
Avoid contact with components containing coolant, since it could cause severe burns.
Check coolant level only after the radiator cap is cool enough to touch.
To check the coolant level, turn the radiator cap slowly to relieve pressure.

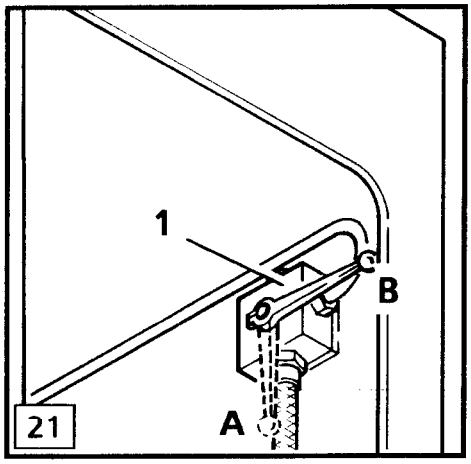
When the coolant is cold, the coolant level should reach the lower end of the filler neck under the radiator cap (fig. 4, pos. 2).

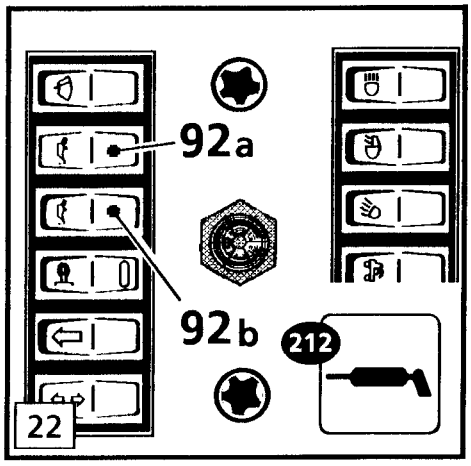
The proper antifreeze concentration must be maintained all year long.

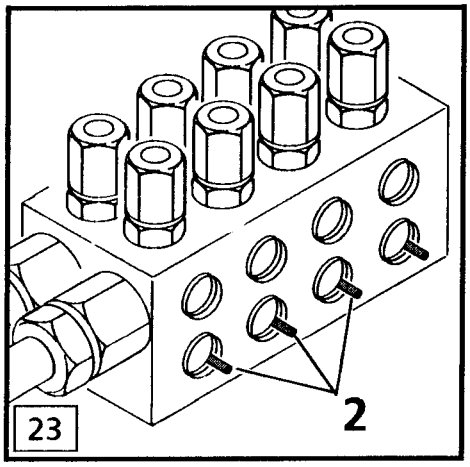
The excavator is delivered from the factory with a cooling system protection to -31° F (-35° C), which corresponds to a concentration of about 50 % antifreeze.

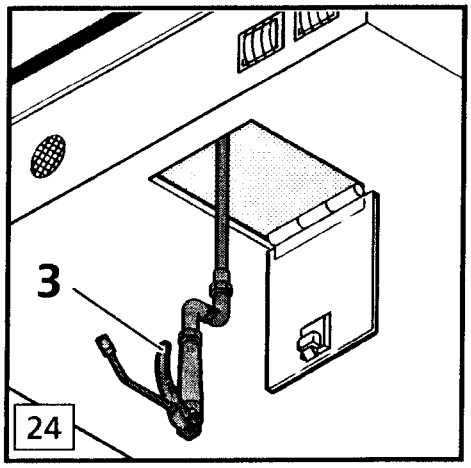
The radiator capacity:	53 gal	(200 l)
Water ratio:	26,5 gal	(100 l)
Antifreeze ratio:	26,5 gal	(100 l)











THE CENTRALIZED LUBRICATING SYSTEM

The R 994 is fitted with two centralized lubricating systems, allowing to reduce to a minimum the time which is necessary for the daily lubrication of the machine.

All the lubrication points in the area of the boom and the stick of the working attachment, as well as the lubrication points for the swing ring roller races are connected to the semi-automatic double line lubricating systems and can be greased while working , by pushing a button in the cab.

Only the bearings of the digging bucket are not connected to the automatic system and must be lubricated manually via a grease gun.
This grease gun is fed by the pump of the lubricating system after turning the selector valve (fig. 21, pos. 1) in position A.

A complete lubrication of the machine comprises the lubrication of the points attached to the semi automatic circuit and of the manually lubricated points and must be performed at least once a day.

LUBRICATION OF BEARINGS CONNECTED TO SEMI-AUTOMATIC SYSTEM

Energize the lubrication circuit for the working attachment via rocker switch 92a and the lubrication circuit for grease points on uppercarriage via rocker switch 92b (fig. 22).
The pump of each lubrication circuit begins to deliver grease through a pneumatic change-over valve to the first lubricating line until all the metering devices have been operated (i.e. until all the points connected to the first line have been greased).

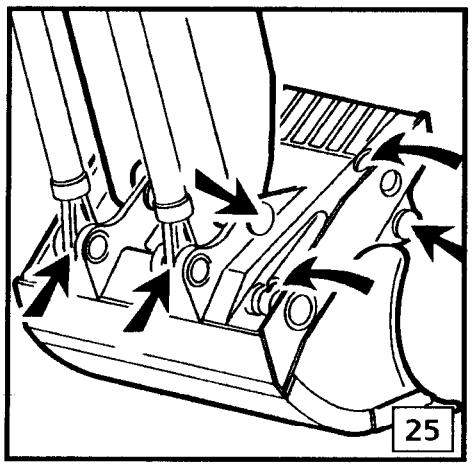
The pressure in the line now increases, until a preset pressure is reached, causing the change-over valve to reverse.

The pump now feeds into the second main line, until all the points in the second line are greases, the preset pressure is reached, the change-over valves reverses, and so on ...

At each reversing of the grease line, the state of the control light 212 on the monitoring display changes.
The operation of the metering devices can also be checked visually by observing the indicator stems 2 (fig. 23).
When the metering devices are operating, the indicator stems move from one side to the other.
The central lubrication must be switched off as soon as clean grease is emerging from the bearings.

Normaly, a lubrication cycle of half an hour is necessary for each working shift of 8 hours.
Depending on the working conditions , (ambiant temperature, quality of the grease, working under water,..) a sufficient lubrication of the bearings may be achieved only after a longer lubrication cycle.

MANUALLY LUBRICATED BEARINGS



Turn the selector valve on the hydraulic tank (fig. 21, pos. 1) to position A.

Energize the lubrication circuit for uppercarriage lube points via rocker switch 92b (fig. 22).

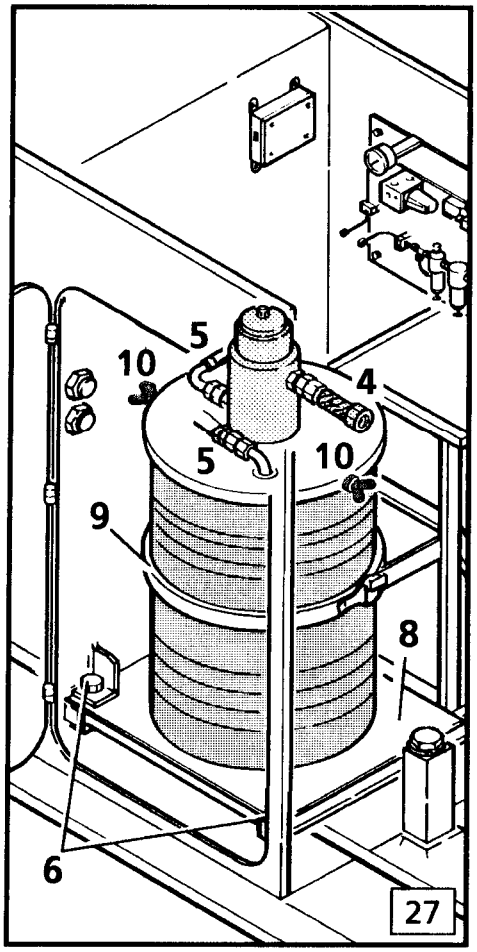
Open the cover under the cab and pull out the grease gun pos. 3 (fig. 24).

Grease every lubricator fitting which is not connected to the automatic system (fig. 25) until clean grease emerges from the attached bearing.

After completion of the lubrication, rewind the hose on the hose reel, close the cover and shift the selector valve to position B for semi automatic greasing.

Since the grease pump is actuated by the pressure of the air system, the Diesel engine must be running at low idle during manual lubrication.

REPLACING THE GREASE CONTAINER



To exchange the empty grease container, operate as follows.
Disconnect the quick coupling devices of both grease hoses (fig. 27, pos. 5) and of the air supply hose pos. 4, at the pneumatic lubrication pump.

Remove stop bolts 6 and pull roller carriage 8 outside the door (fig. 27)

Loosen the screews 10 and take the pump complete with cover and following plate off the barrel.

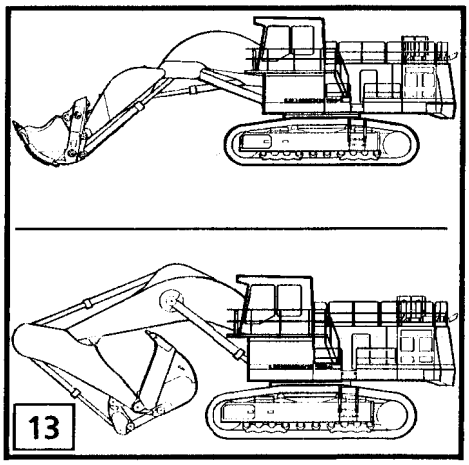
Open the steel band 9, remove the empty container, replace it with a full barrel, fix the steel band, remove the cover of the barrel and reinstall the pump with cover and following plate.

⚠ CAUTION !

During the replacement of the container, it is especially important to avoid that parts in contact with grease may be contaminated with dust, mud or dirt. Otherwise pump injury would result !

Tighten the screws 10, push the roller carriage 8 inside the compartment of the tank and tighten the bolts 6.

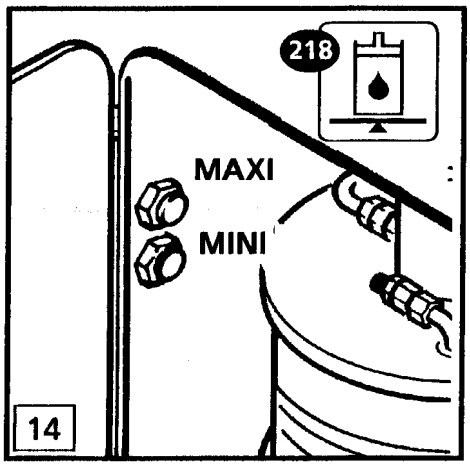
Reconnect compressed air hose 4 and grease hoses 5.



OIL IN THE HYDRAULIC SYSTEM

When checking the oil level or adding oil (Fig. 13),

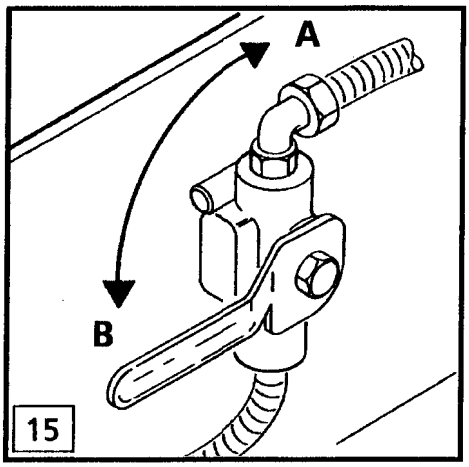
- park the machine on level ground,
- rest the attachments on the ground,
- with stick and tilt cylinders fully extended
- and bucket closed.



CHECK HYDRAULIC OIL LEVEL

The oil level may not drop below the center of the lower sight gauge (fig. 14 - min) or oil must be added to the tank.

If the oil level drops below the lower sight gauge, indicator light 218 lights up and, at the same time, the pumps will move to minimum angle.



TO ADD OIL TO THE HYDRAULIC TANK

⚠ CAUTION

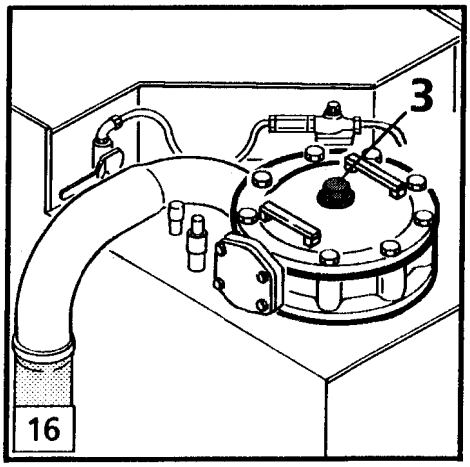
Before draining the tank or removing the cover on the oil return filter, you always must first move the lever of the three way check valve to position B to relieve tank pressure (fig. 15).

Remove the plug on the cover of the return filter (fig. 16, pos. 3) and add oil via the filter until the oil level reaches the center of the upper sight gauge.

Reinstall the plug and return the lever to pos. A to pressurize tank.

The hydraulic system should always be refilled or drained using a filler pump.

The tank can also be drained with a hose connected to the drain valve on the bottom of the tank.

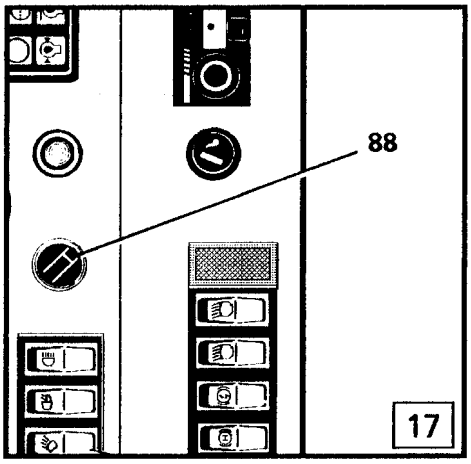


⚠ CAUTION

The hydraulic pumps must be bled after every oil change (see page 6.12).

See lubricant chart for oil specifications and maintenance chart for oil change intervals.

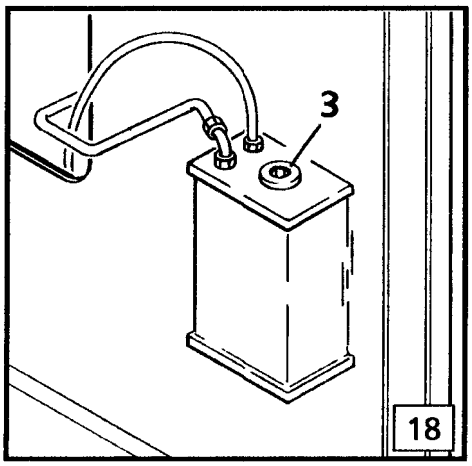
SWING RING LUBRICATION



TO LUBRICATE THE GEAR

The gear is lubricated via switch 88 (fig. 17). This procedure must occur at least once per shift. In heavy applications, lubricate the gear at least once every four hours.

During the lubrication procedure, turn the uppercarriage by at least one complete rotation (360°) to make sure, that the complete gear is lubricated. Afterward, turn the uppercarriage once more by 360°, without adding more grease.



CHECK THE GREASE TANK

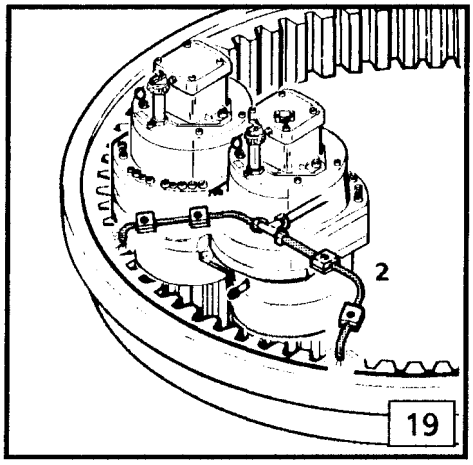
The level of the grease tank (fig. 18, pos. 3) situated inside the cab elevation must be checked at least once a week. If necessary, add more grease.

See lubrication chart for grease specifications.

TO CLEAN THE LUBE LINE

Two lube lines with a nozzle (fig. 19, pos. 2) distribute the grease evenly over the entire height of the gear.

This nozzle can be partially or totally clogged by dirt or use of the wrong grease. For this reason, the lube line must be checked regularly (about every 500 operating hours) to make sure the grease is sprayed normaly to the gear.
This must be observed by a person standing inside the central part of the undercarriage while the gear lubrication is actuated via switch 88 from inside the cab.



DANGER

Always turn off the engine and lower the working attachment to the ground before checking or cleaning the nozzles !

If necessary remove and clean the lines, blow the nozzles out with compressed air and reinstall the tube lines.

LUBRICATION OF SWING RING ROLLER RACES

The swing ring races are greased by the semi-automatic centralized lubrication system, simultaneously with the lubrication points of the working attachment, see on next page.

THE CENTRALIZED LUBRICATING SYSTEM

The R 994 is fitted with a centralized two line lubricating system which lubricates all the lubrication points for the working attachment and for the roller races of the swing ring between the uppercarriage and undercarriage automatically and in regular intervals, while working.

LUBRICATION OF BEARINGS CONNECTED TO AUTOMATIC SYSTEM

Starting the excavator automatically energizes the lubrication circuit.

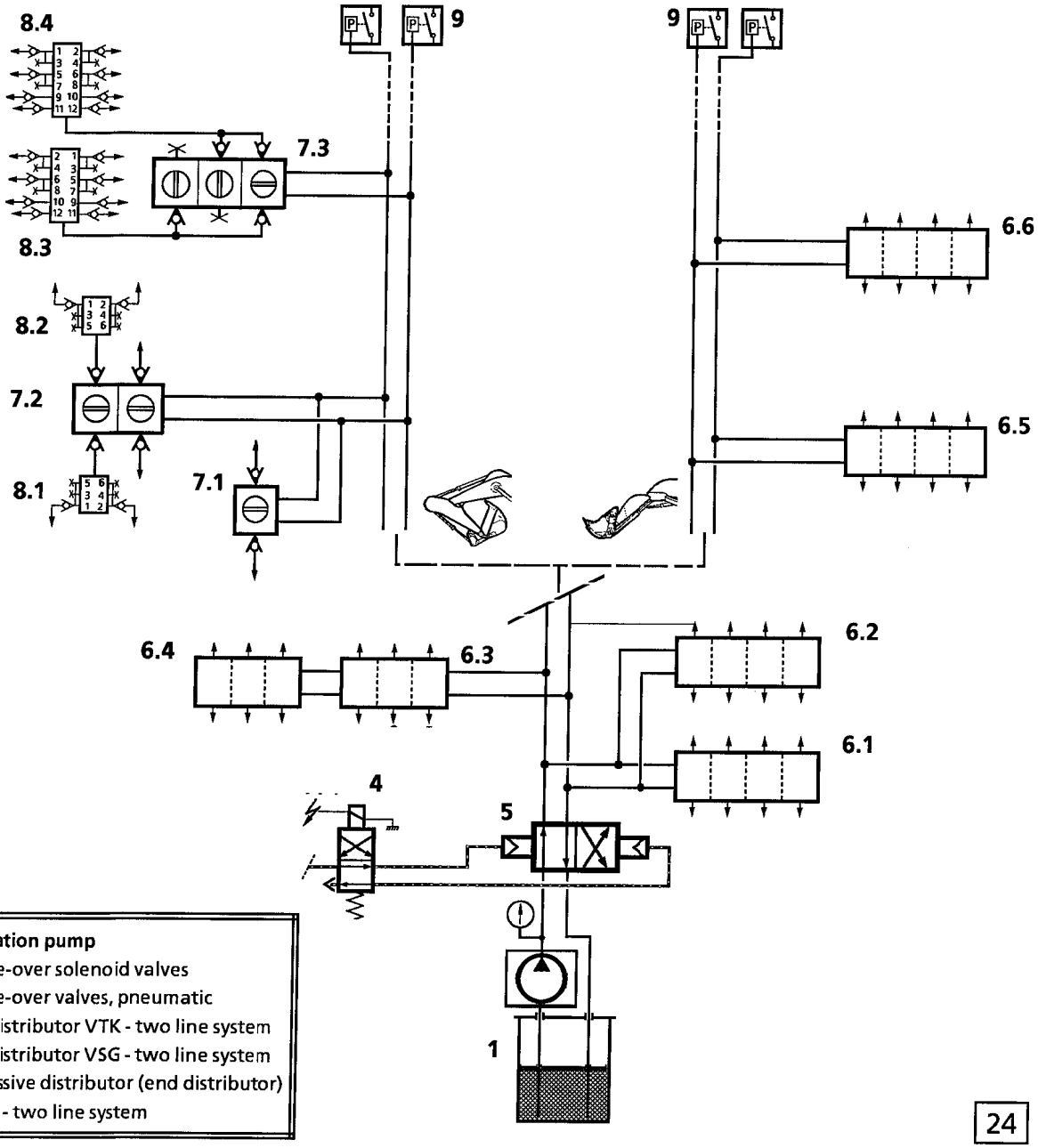
The pump 1 begins to deliver grease through a pneumatic change-over valve 5 into the main line I of the two line lubrication system.

The grease feeds all lubrication ports of main distributor 6 and 7 which are connected to this main line, then the pressure increases in the line, a pressure switch 9 is actuated, and the change-over valve 5 shifts.

The pump now supplies all lubrication ports which are connected to the second main line until the switch in this main line is actuated, the change over valve 5 shifts again and the pump stops.

A complete lubrication cycle (both main lines) is now over, the lubrication pump is stopped and a "pause time" begins. After this pre-adjusted pause time, the pump will restart automatically, grease all points connected to the first lubrication line, stop, wait for a another restart and grease the points connected to the second lubrication line, and so on. Depressing the switch S4 (Reset button) causes the whole cycle to be restarted at once (fig. 25).

With the rocker switch S20 actuated (the control light in the switch is on) the system lubricates continuously.



1	Lubrication pump
4	Change-over solenoid valves
5	Change-over valves, pneumatic
6	Main distributor VTK - two line system
7	Main distributor VSG - two line system
8	Progressive distributor (end distributor)
9	Switch - two line system

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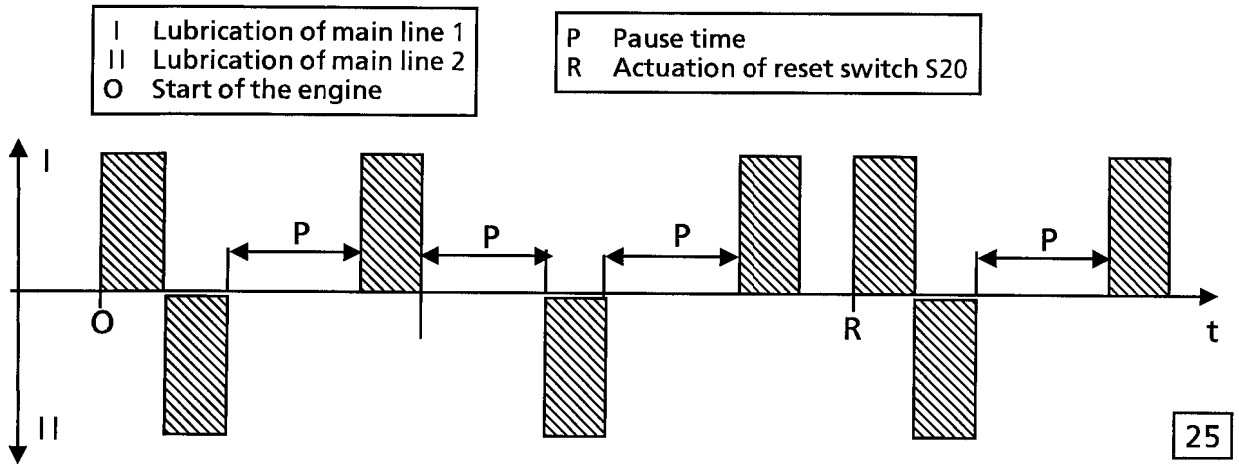
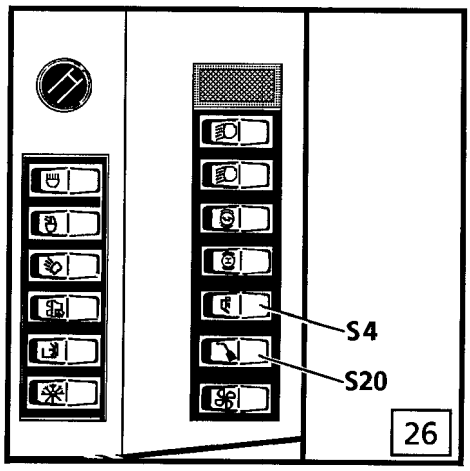


GREASE DISTRIBUTION AND CONSUMPTION

During each lubrication cycle, up to 0,6 of grease flow from each lubrication port of the two line distributor 6 (type VKT) and 2.2 cm^3 of grease flow from each lubrication port of the two line distributor 7 (type VSG), this type beeing used on the backhoe bucket attachment. For this kind, in the area stick and bucket, the grease reaches the individual lubrication points via the additional progressive distributors 8 (with 0.2cm^3 each per port).



THE LUBRICATION SYSTEM MONITOR

As long as the pump is greasing, the control light 212 on the monotoring display is on.

The delivery of grease can be checked visually by observing the indicator stems 2 (fig. 28) of the metering devices.

When the metering devices are operating, the indicator stems move from one side to the other.

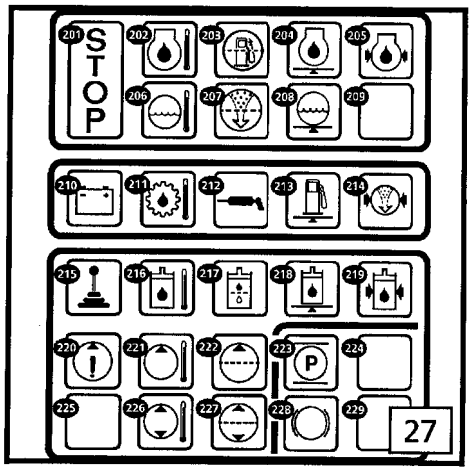
The indicator light 229 (fig. 28) lights up to warn the operator that the pump has not stopped 5 minutes (delay is adjustable) after lubrication begin (no pressure increase in this line).

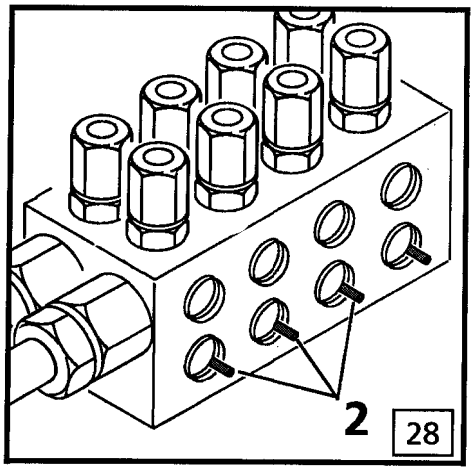
Possible causes are:

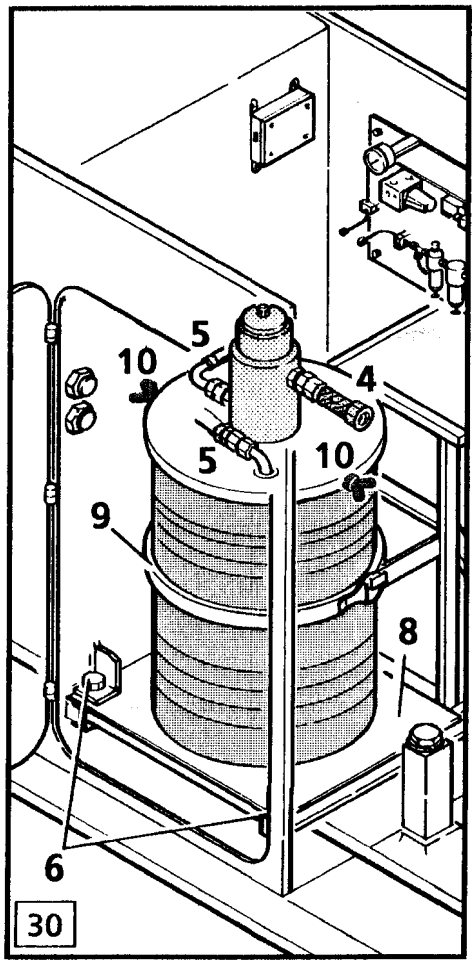
- a broken or disconnected lubrication line,
- a kinked lubrication line before a pressure switch,
- a defective switch, wire or high pressure pump,
- an empty grease container,
- a low pressure in the pneumatic system
- the use of too viscous grease at low temperature.

From factory the pause time is adjusted to 2 minutes. Depending on the working conditions, ambiant temperature, quality of the grease, working under water, ...) a sufficient lubrication of the bearings may be achieved with an increased pause time.

The pause time is adjusted via the time delay relay "KT5", situated in the electrical box mounted to the hydraulic tank.







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REPLACING THE GREASE CONTAINER

To exchange the empty grease container, operate as follows. (fig. 30).
Disconnect the quick coupling devices of both grease hoses 5 and of the air supply hose 4, at the pneumatic lubrication pump.

Remove stop bolts 6 and pull roller carriage 8 outside the door.

Loosen the screws 10 and take the pump complete with cover and following plate off the barrel.

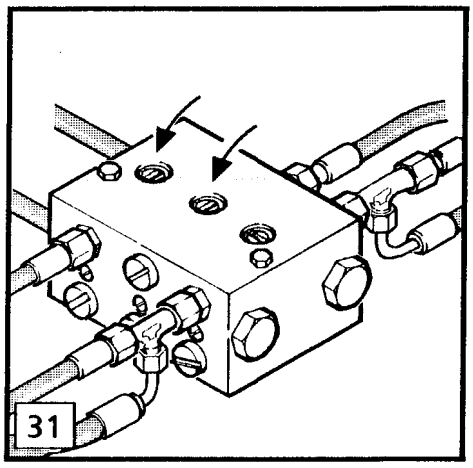
⚠ CAUTION !

Observe utmost cleanliness when changing the grease container.
To prevent premature wear of the grease pumps and other components in the lube system avoid contact with dust and dirt.

Open the steel band 9, remove the empty container, replace it with a full barrel, fix the steel band, remove the cover of the barrel and reinstall the pump with cover and following plate.

Tighten the screws 10, push the roller carriage 8 inside the compartment of the tank and tighten the bolts 6.

Reconnect compressed air hose 4 and grease hoses 5.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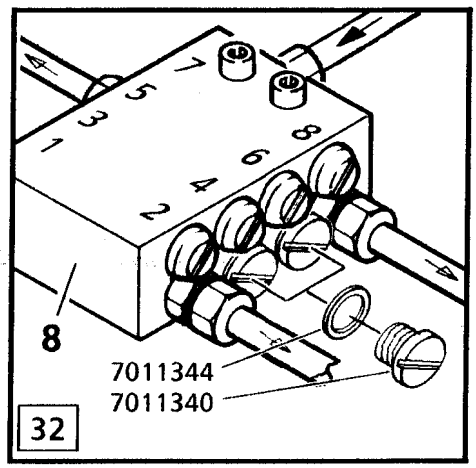
CHANGES ON THE LUBRICATION CIRCUIT

Before making any changes in the lubrication circuit, for example when changing the attachment combination, always contact your LIEBHERR service representative.

Never close off an unused distributor line:

- In case of a main distributor 6 (two line distributor type VTK), the opposite grease port exit would also be blocked.
- In case of a main distributor 7 (two line distributor type VSG, fig. 31), the rotary slide in the distribution screw must be positioned so to be crosswisse to the distributor center line if one grease point is closed.
- In case of an end distributor 8 (progressive distributor, fig. 32), a port may only be plugged after removing the line on the distributor outlet, and only with the appropriate plugs (Id. No. 7011340) and seals (Id. No. 7011344).
  The distributor outlets marked pos. 1 and 2 may never be closed off, as this would block the complete lubrication system.



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THE SERVICE ACCESS PLATE

To simplify the oil change and refilling procedure, the drain of major components on the uppercarriage are centrally connected via a service center compartment.

The service plate is fitted with following Quick coupling devices :

- Pos. 1 for the fuel tank
- Pos. 5 for the lube oil for the Diesel engine (connected to engine oil sump)
- On machines optionally fitted with a reserve system for engine oil, also with Pos. 6 connected to the additional supply tank for engine lube oil.
  On these machines the monitor box 7 must be used during the refilling and draining procedures of the supply tank, see on page 8.1.
- and in option with both couplings Pos. 3 for refilling and Pos. 4 for draining the hydraulik oil tank.

The schedule below indicates the types of adapters necessary for connection to the service plate and the maximum flow to be considered when refilling and also when draining the different components.

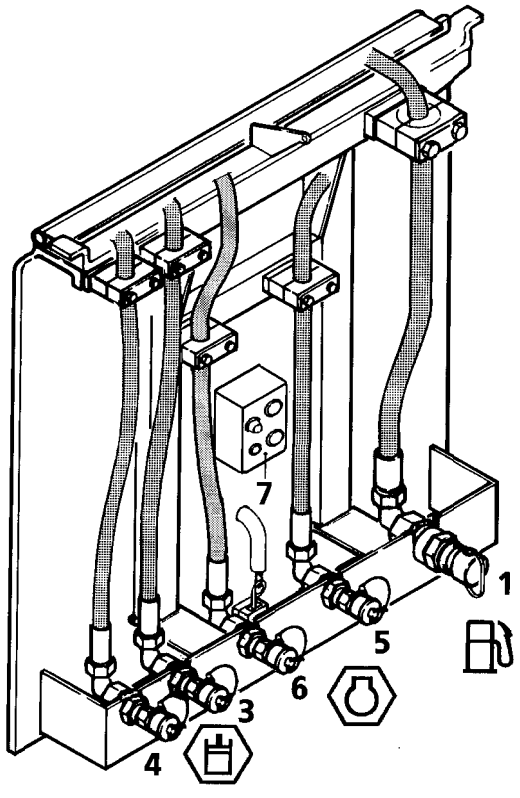
Component	Necessary adapter	Flow max. authorized
Fuel tank 1	WIGGINS nozzle ZZ9A	470 l / min - 125 Gal. / min
Engine oil 5	WIGGINS nozzle OSP2	75 l / min - 20 Gal. / min
Engine oil 6	WIGGINS nozzle ONC2	75 l / min - 20 Gal. / min
Hydraulik oil	WIGGINS nozzle 6000 B12	75 l / min - 20 gal. / min

For safety reasons and for ease of maintenance, oil for the connected components should only be drained and refilled via the quick change couplings in the service center compartment.

However, these components are also equipped with oil drain valves, see description for oil change procedure of these components in this chapter.

⚠ CAUTION

For safety reasons, the excavator can only be operated if the service center compartment is locked in its uppermost position. Otherwise, the swing and travel movements remain locked.



MACHINE MAINTENANCE SAFETY

- The machine may not be made unsafe when performing maintenance work. Never attempt maintenance procedures or repairs you do not understand.
- Check the Operator's and Maintenance Manual for service and maintenance intervals. Make sure you use only appropriate tools for all maintenance work.
- Refer to your **Operator's and Maintenance Manual** to see, who is authorized to perform certain repairs. The operator should only perform the daily / weekly maintenance procedures.

  The remaining work may only be performed by especially trained personnel.
- Use only replacement parts corresponding to the technical requirements specified by the manufacturer. This is assured by using only original Liebherr replacement parts.
- Always wear proper work clothing when maintaining the excavator. Certain work may only be performed with a hard hat, safety shoes, safety glasses and gloves.
- During maintenance, do not allow unauthorized personnel to enter the maintenance area.
- Secure the maintenance area, as necessary.
- Inform the operator before any special or maintenance work. Make sure he knows the person, who is in charge of the work.
- If not otherwise noted in the **Operation and Maintenance Manual**, always make sure the excavator is parked on firm an level ground and the engine is turned off.
- During maintenance and service work, make sure you always retighten any loosened screw connections!
- If it is necessary to disconnect or remove any safety devices during set up, maintenance or repair, make sure that after completion of repairs, the safety devices are reinstalled and checked for proper function.
- Before any maintenance work and especially when working under the machine, make sure a "Do not operate' tag is attached to the starter switch. Remove the ignition key.

  After end of maintenance works or repair, restart the machine according to the instructions "Machine start up", in this manual.
- Before any repairs or maintenance work, clean any oil, fuel and / or cleaning substances from any fittings and connections .
  Don't use any harsh cleaners and use only lint free cloths.
- Use only nonflammable cleaning fluids to clean the machine.
- Any welding, torch or grinding work on the machine must be explicitly authorized. Written authorization is necessary for welding on carrying structures. Before any using a welder, torch or grinder, clean off any dust and dirt and remove any flammable materials from the surrounding area. Make sure the area is sufficiently ventilated.
  Danger of Fire and Explosion!
- Before cleaning the machine with water or steam (high pressure cleaning) or other cleaning fluids, make sure that all openings, which , for safety and/ or functioning reasons should not be exposed to water / steam/ cleaners, are covered and / or masked off. Especially sensitive are electrical motors, control boxes and plug connectors.
  Make sure that the temperature sensors of the fire alarm and extinguishers system do not come in contact with the hot cleaning fluids, which could trigger the fire extinguishing system.
  Remove all coverings and masking material after completing the cleaning procedure.
  Then check all fuel lines, engine oil lines and hydraulic oil lines for leaks, loose connections, chafing and / or damage. Fix any problems immediately.
- If you use a high pressure cleaner with steam or hot water to clean the machine, observe following recommendations :
  - the distance between the nozzle and the surface to be cleaned must be no lowerthan 20 inches
  - the water temperature should not exceed 60°c (140°F)
  - limit the water pressure to 80 bar maximum (11500 PSI)
  - if you employ cleaning fluid, only use neutral cleaning agents such as customary car shampoos diluted to 2 or 3 percent maximum
- Never employ high pressure cleaning apparatus during the two first months following machine delivery or repainting.

- Observe all product safety guidelines when handling oils, grease, and other chemical substances.
- Make sure service fluids and replacement parts are disposed of properly and in an environmentally sound manner.
- When using hot service fluids, be very careful. (They can cause severe burns and injury!).
- Operate combustion motors and fuel operated heaters only in well ventilated areas. Before operating these units, check ventilation.
  In addition, always follow applicable local regulations.
- Never try to lift heavy parts. Use appropriate lifting devices with sufficient load carrying capacity. When replacing or repairing parts or components,make sure they are mounted very carefully on lifting devices, to prevent any possible danger. Use only suitable and technically sound lifting devices, make sure that lifting tackle, wire cables, etc. has adequate load carrying capacity.
  Never position yourself, walk or work underneath suspended loads.
- Never use damaged lifting devices, or devices which are not sufficient to carry the load.
  Always wear gloves when handling wire cables.
- Ask only experienced personnel to attach loads and guide and signal the crane operator. The guide must be within the visibility range of the operator and / or must be in direct voice contact with the operator.
- When working overhead, use appropriate and safe ladders, scaffolding or other working platforms designated for that purpose.
  Never step on parts or components on the machine when maintaining or repairing items overhead.
  When working high above ground, make sure you are fitted with ropes and appropriate safety devices which will prevent a possible fall.
  Always keep handles, steps, railings, platforms and ladders free of dirt, snow and ice!
- When working on the attachments, for example when replacing the bucket teeth, makes sure the attachment is supported properly. Never use metal on metal support!
- Never work underneath the machine if it is raised or propped up with the attachment. The undercarriage must be supported with wooden blocks and supports.
- Always support the raised machine in such a way that any shifting to the weight change will not influence the stability. Do not support the machine with metal on metal support.
- Only qualified, especially trained personnel may work on travel gear, brake and steering systems.
- If it becomes necessary that the machine must be repaired on a grade, block the chains with wedges and secure the uppercarriage to the undercarriage with the lock pin.
- Only qualified, especially trained personnel may work on the hydraulic system.
- Never check for leaks with your bare hands, always wear gloves. Fluid escaping from a small hole can have enough force to penetrate the skin.
- Never loosen or remove lines or fittings before the attachment has been lowered to the ground and the engine has been turned off. Then turn the ignition key to contact position with tilted down safety lever, move all servo controls (joysticks and foot pedals) in both direction to release pressures. Then release the tank pressure as outlined in this Operation and Maintenance Manual.
- Check all lines, hoses and screw connections regularly for leaks and externally visible damage. Fix any damage immediately. Oil escaping from fittings etc. can cause serious injury and fires .
- Before any repairs, always relieve pressures before opening up any system sections and pressure lines (hydraulic lines and air pressure lines).
- Always route and install hydraulic and air pressure lines properly. Do not interchange the connections. The length and quality of hoses must match specifications and requirements.
- Change all hydraulic hoses in specified or appropriate time intervals, even though no damage or defects are visible.
- Always disconnect the battery cable before working on the electrical system or before any arc welding on the machine. Always disconnect the negative (-) cable first and reconnect it last.
- Check the electrical system regularly.
  Make sure that any problems, such as loose connections, burnt out fuses and bulbs, scorched or chafed cables are fixed immediately by an electrician or qualified personnel.
- Use only Original fuses with the specified amperage. Never use a different size or stronger fuse than the original fuse.

- On machines with electrical medium or high voltage systems:
  - If there is any problem with the electrical energy supply, turn the machine off immediately.
  - Any work on the electrical system may only be performed by a qualified electrician or qualified personnel under the guidance and supervision of an electrician, according to electro - technical regulations.
- If any work is required on any parts which carry current, use a second person to turn off the main battery switch, if necessary. Rope the work area off with a red and white safety rope or chain, and set up warning signs. Use only insulated tools.
- When working on medium and high voltage components, shut off the voltage and connect the supply cable to the ground and ground the components, such as the condensor, with a grounding rod.
- Check all disconnected parts if they are truly free of current, ground them and close them off quickly. Insulate any close-by, current carrying parts.

Hydraulic lines and hoses - Maintenance safety

- Hydraulic lines and hoses may never be repaired!
- All hoses, lines and fittings must be checked daily, but at least every 2 weeks for leaks and any externally visible damage! Any damaged sections must be replaced immediately! Escaping oil can cause injuries and fires!
- Even if hoses and lines are stored and used properly, they undergo a natural aging process. For that reason, their service life is limited.
  Improper storage, mechanical damage and improper use are the most frequent causes of hose failures.

  The service life of a hose may not exceed six years, including a storage period of not more than two years (always check the manufacturer's date on the hoses).

  Using hoses and lines close to the limit ranges of permitted use can shorten the service life (for example at high temperatures, frequent working cycles, extremely high impulse frequencies, multi shift or around the clock operations).
- Hoses and lines must be replaced if any of the following points are found during an inspection:
  - Damage on the external layer into the inner layer (such as chaffings, cuts and rips);
  - Brittleness of the outer layer (crack formation of the hose material);
  - Changes in shape, which differ from the natural shape of the hose or line, when under pressure or when not under pressure, or in bends or curves, such as separation of layers, blister or bubble formation;
  - Leaks;
  - Non observance of installation requirements;
  - Damage or deformation of hose fittings, which might reduce the strength of the fitting or the connection between hose and fitting;
  - Any movement of hose away from the fitting;
  - Corrosion on fittings, which might reduce the function or the strength of the fitting;
  - Storage or service life has been exceeded.

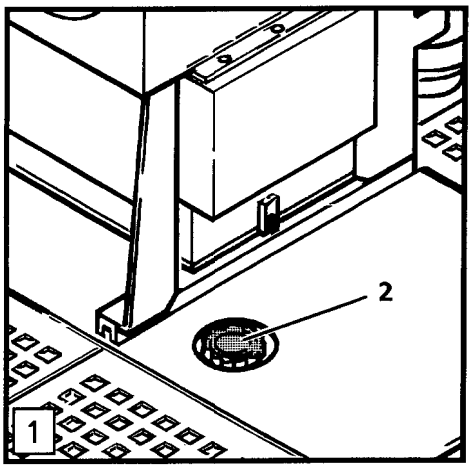
  When replacing hoses or lines, always use Original replacement parts.
- Route or install the hoses and lines properly. Do not mix up the connections!
- Always take care to avoid torsional strain when installing a new hose. On high pressure hydraulic hoses, the mounting screws must be first mounted on both hose ends (full flange or half clamp) and tightened only thereafter.

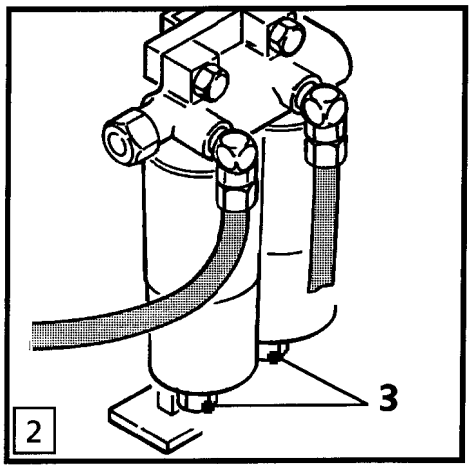
  On high pressure hoses having one curved end, always tighten first the screws on the curved hose end and only then the screws on the straight hose end.

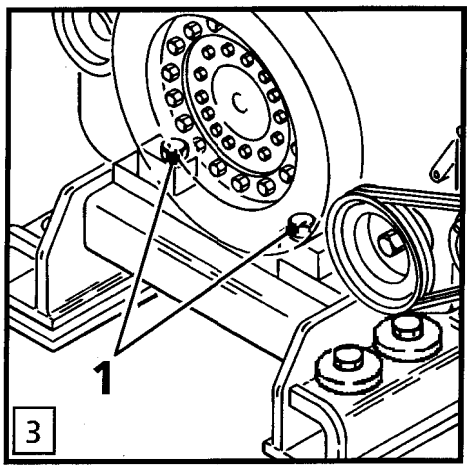
  Install and tighten the hose clips that may be mounted on the hose middle only when the both hose ends are already tightened.
- Always install hoses so to avoid any friction with other hoses and parts.

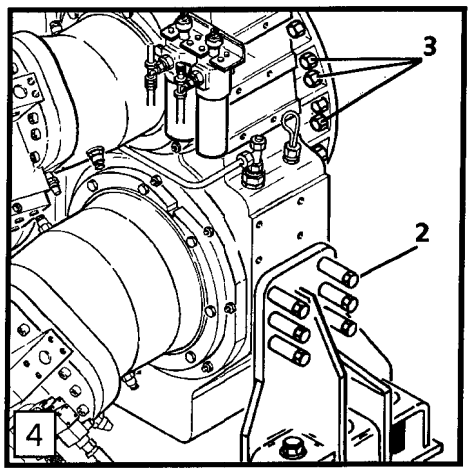
  We recommand to keep a distance between hose and other parts of at least one half of the hose outer diameter. Keep a minimum gap of 1/2 inch in any case.

  After mounting a hose connecting two parts that are movable to each other, check during the return to service that the hose is not rubbing in the whole moving range.









THE DIESEL ENGINE

Refer to the Cummins Operation and Maintenance Manual for description of maintenance work. In addition, observe the following and perform all maintenance work according to intervals given on the maintenance chart.

COOLANT CIRCUIT

If necessary, clean the cooling circuit with pressurized air or steam.

If the safety valve of the cooling system in the radiator cap 2 (fig. 1) is leaking, replace the cap.

Regularly check the condition and for leaks of the hoses between the radiator and of the heater hoses.

FUEL SYSTEM

Drain the contaminants from the fuel system and the fuel tank daily.
Open the drain plug (Fig. 2) . Drain the water until fuel emerges, then tighten the drain plug.

In some cases, ideal operating conditions and fuel quality make it possible to extend this interval to once a week.

ENGINE MOUNTING SCREWS

The engine mountings screws must be checked regularly and retightened, if necessary.

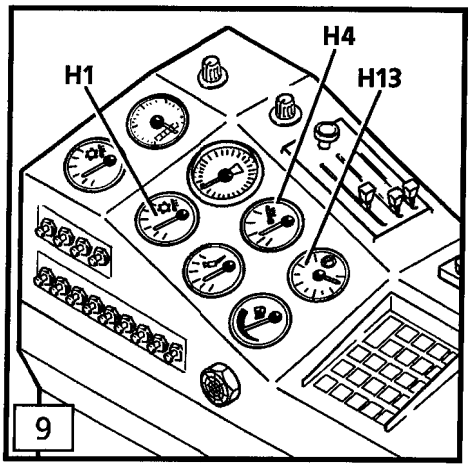
Torque the monting screws of the engine to the front bracket (fig. 3, pos. 1) to 390 Nm.

Torque the monting screws of the engine to the rear bracket (fig. 4, pos. 2) to 560 Nm.

SPLITTERBOX MOUNTING SCREWS

The mounting screws (fig. 4, pos 3) from splitterbox to the Diesel engine SAE housing must also be checked regularly and retightened, if necessary.

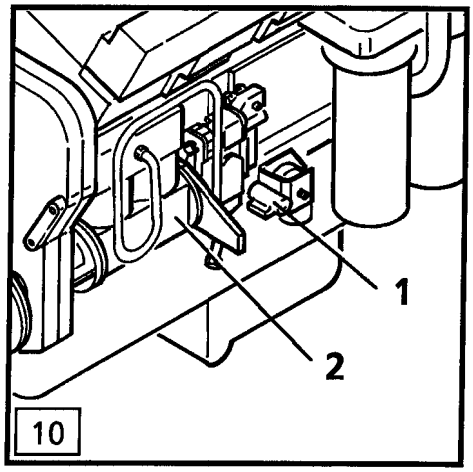
Torque to 142 Nm.



THE AIR SYSTEM

While working, the white pointer of the air pressure gauge H13 (fig. 9) must read between 6.2 and 7.2 bar (90-105 PSI).

AIR PRESSURE REGULATOR AND COMPRESSOR

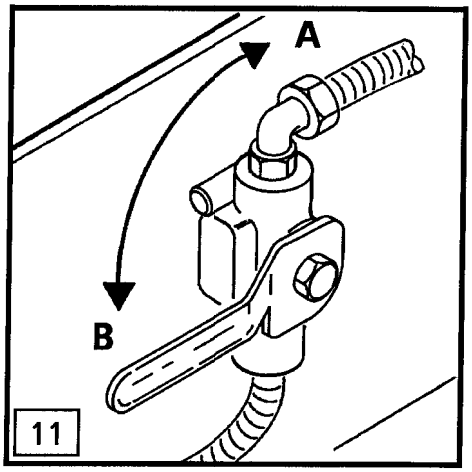


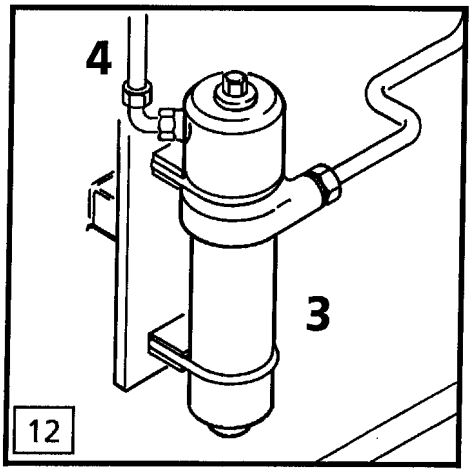
Listen to pressure regulator 1 (fig. 10), at regular intervals it should unload and switch back to charging the compressor 2.

To check this :

- run the Diesel engine at low idle,
- slightly turn the three way check valve on the hydraulic tank (fig. 11) to position B.
- the pressure regulator must then switch the compressor on,
- when a pressure of 7.2 bar is reached, it must turn it off.

Check this every 250 operating hours. If necessary, adjust the regulator until both pressures are correct.
Check the condition of the compressor every two years, as described in the Cummins Operation and Maintenance Manual.





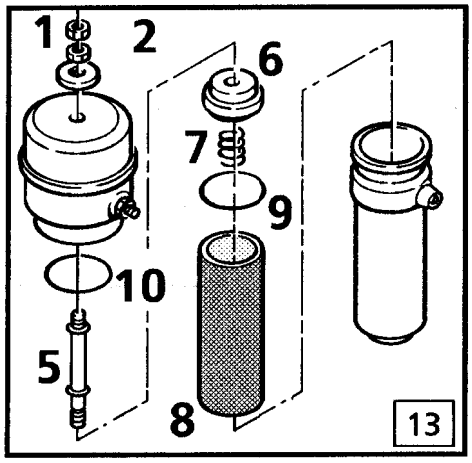
AIR DRYER

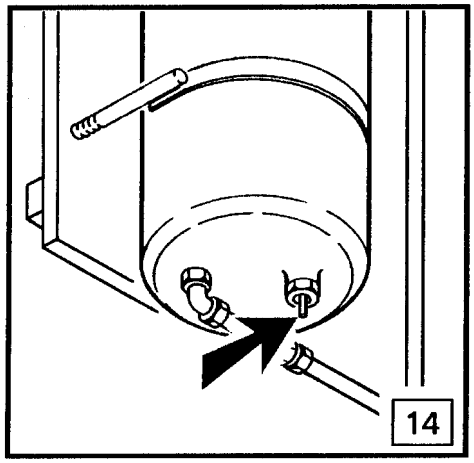
The air dryer within the air circuit (fig. 12, pos. 3) dries and filters the compressed air. The filter cartridge has to be exchanged every year before the beginning of the cold season.

⚠ CAUTION

Never open the air dryer if the air circuit is under pressure. If necessary you must first relieve the pressure in the air tank via the drain valve, (see fig. 14).

To replace the filter cartridge :
Release all the pressure from the compressed air system via the drain valve (fig. 12, pos. 3).
Disconnect the pressure line (fig. 12, pos. 4) from the air dryer.
Unscrew the nuts 1 (fig. 13) and remove the cover 2.
Unscrew the upper part of the center shaft pos. 5 by turning it counterclockwise.
Note: The shaft 5 is under the tension of the spring 7.
Remove the purge plate 6 and the spring 7.
Pull the filter cartridge (dessicant canister) 8 off the housing, with a twisting, upward motion.
Clean all the parts and lubricate O-rings 9 and 10.
Replace the O-rings and install the new filter cartridge into the housing. Make sure that the O-ring 9 fits into the housing.
Reassemble the spring 7, the purge plate 6, the O-ring 10, the cover 2 and tighten the nuts 1.
Reconnect the pressure line to the air dryer.



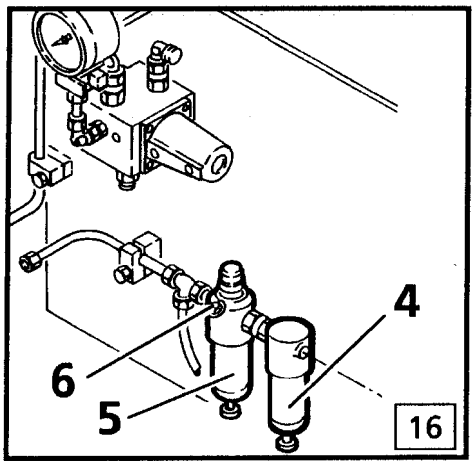


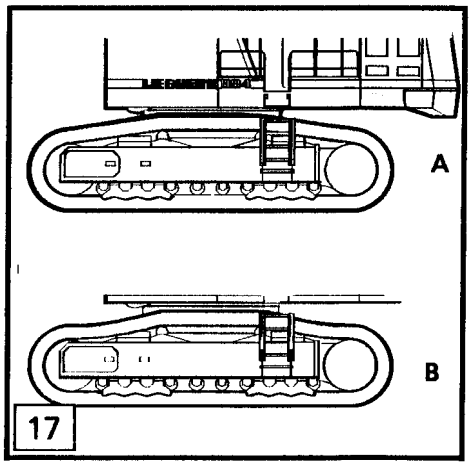
TO DRAIN THE AIR TANK

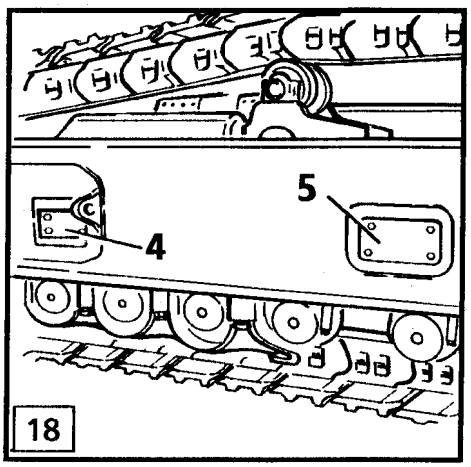
Water in the air tank is automatically drained via the drain valve when the pressure in the system drops.
However, it is recommended to manually drain any remaining water from the air tank:
- during the summer, push the pin on the underside of the drain valve (fig. 14) once a week,
- and during the winter months, push it once a day.

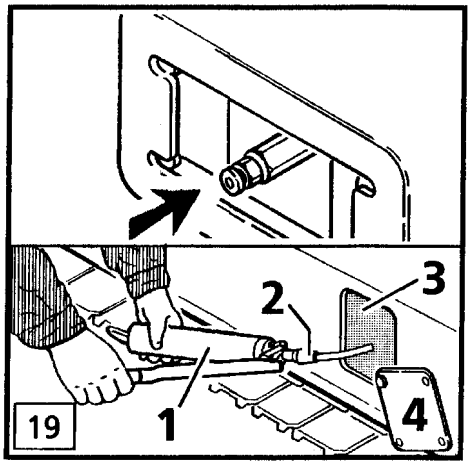
AIR FILTER AND AIR LUBRICATOR FOR CENTRAL LUBRICATION

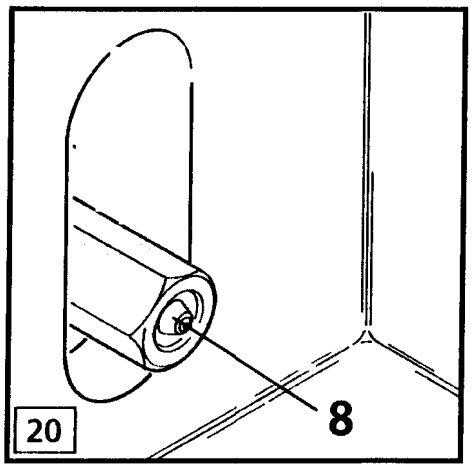
The condensation and the impurities in the air filter 4 (fig. 16) and in the lubricator must be drained weekly.
With the central lubricating in operation, turn the drain screw at the bottom of the transparent polycarbonate bowls from severals turns.
If the polycarbonate bowls are dirty, stop the central lubrication, remove the bowls and clean them in a soapy solution.
If the element of the filter 4 is clogged, replace it or clean it in alcohol.
Check the oil level in the lubricator weekly.
If necessary, remove the filler plug 6 and add oil (viscosity between SAE 10 and SAE 30) until the level is about 1 cm from the top of the transparent bowl.











THE TRACK COMPONENTS

The tracks are maintenance free until the track pads or flanges need to be reconditioned or replaced.
The lifetime seals in carrier rollers, track rollers and idlers increase the life expectancy of the tracks and protect from dirt and contamination.
However, even though the track is virtually maintenance free, the following points do need to be checked.

TIGHTENING THE TRACK TENSION

The track tension needs to be checked regularly due to normal wear of the tracks, and tightened, if necessary.
Fig. 17 A shows a track, that is not tightened properly, Fig. 17 B shows a track that is tightened properly.
Remove the access cover (Fig. 18, pos. 4) on the side frame of the undercarriage.
Attach a special fitting 2 to grease gun 1 (Fig. 19).
Connect the grease gun to cylinder through opening 3.
Pump grease into cylinder until the track chain is properly tensioned.
The track chain tension is correct when the slack between the carrier rollers and the idler is about 0.8" to 1.2" (20 to 30 mm).
To release track tension, carefully release some grease from the grease cylinder by loosening and turning the grease fitting counterclockwise.

⚠ DANGER

When adjusting the chain tension, keep your head clear of the access hole. The grease cylinder is under high pressure and the chain will sag.
Grease is under high pressure and might squirt out.

CHECK PRESSURE IN ELASTOMER TENSIONERS

After adjustment of the chain tension, check the pressure of the elastomer tensioners in each side frame.
Remove the cover on the side frame (fig. 18, pos. 5), and connect the special hand pump with elastomer fluid to the adapter 8.
The pressure shown on the gauge of the hand pump must always remain in the range 635-830 bar.
At factory, the tensioner is filled up to 735 bar at +20°C (68°F).This corresponds to a 830 bar pressure at +30°C (86°F), or to a 635 bar pressure at 10°C (50°F).
At lower temperatures, or if pressure is below 635 bar, the pressure must be refilled using the hand pump, until pressure is in the above indicated range.
At high temperature, or if pressure is over 830 bar, release some elastomer from the tensioner using a special screw.
A leaking elastomer tensioner has to be exchanged by a LIEBHERR authorized mechanic.

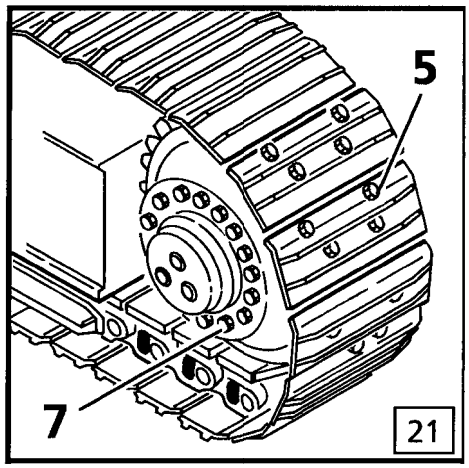
⚠ DANGER

The elastomer tensioner is a tank under very high pressure.
Repairs on this component are only to be done by its manufacturer.

CHECKING TIGHTNESS OF TRACK PADS

Check mounting screws 5 weekly for tightness and, if necessary, retighten (Fig. 25).

Torque the track pad bolts M 36 to 4300 Nm (3170 ft.lbs.).



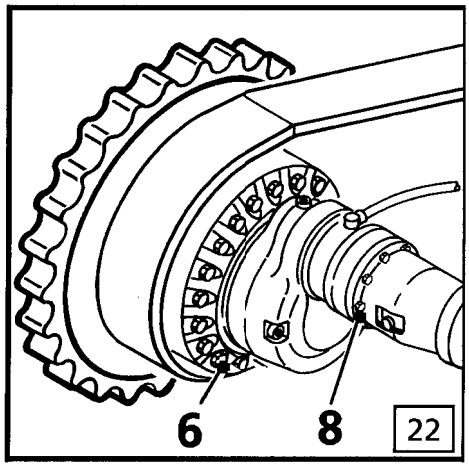
CHECKING MOUNTING SCREWS OF TRAVEL GEARS AND SPROCKET WHEELS

This screws must regularly be checked and retightened.

Torque the mounting screws M 30 of the travel gears onto the side frames (fig.26, pos.6) to 1900 Nm (1400 ft.lbs.).

Torque the mounting screws M 36 of the sprocket wheels onto the travel gears (fig.25, pos.7) to 3300 Nm (2450 ft.lbs.).

Torque the mounting screws M 20 of the hydraulic motors onto the travel gears (fig.26, pos.8) to 560 Nm (410 ft.lbs.)



CLEANING THE TRACK COMPONENTS

At the end of a workday, the complete undercarriage should be checked and, if necessary, cleaned and repaired.

⚠ CAUTION

DO NOT operate machine if large rocks or pieces of wood, steel, wires or cable are wedged into the track components.

Do not allow mud, rocks, etc. to collect on track components.
Dried or frozen mud, as well as rocks or other debris in the track components could cause serious damage to the machine if operated, or if it is attempted to break the machine loose under engine power.
If the machine is frozen to the ground, heat the ground or the track pads to free the machine.

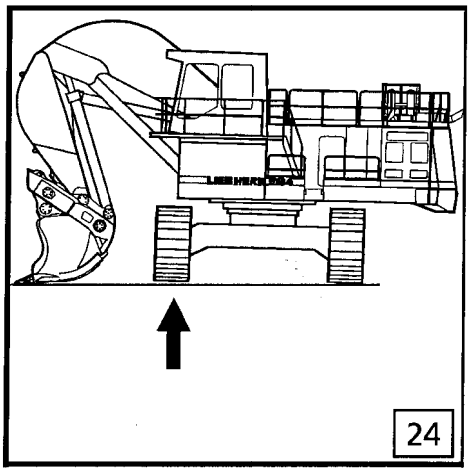
In freezing weather, park machine on planks or logs so the tracks will not freeze to the ground.

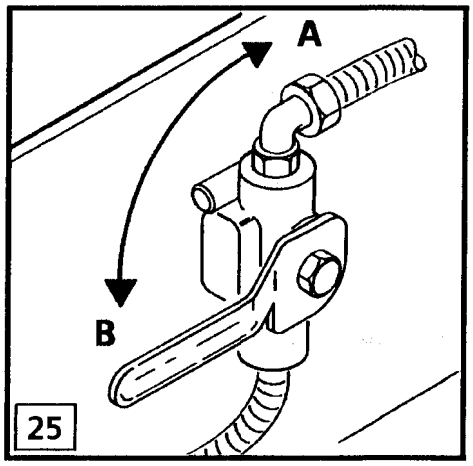
The machine can be supported and lifted slightly on each side with the attachment, so the tracks can be cleaned.

Clean the surfaces of the tension unit and apply grease.

⚠ DANGER

Make sure the excavator is supported with wooden blocks.





THE HYDRAULIC SYSTEM

Maintenance of the hydraulic system is limited to the hydraulic tank. None of the other components in the hydraulic system require special maintenance.

However, hydraulic lines and hoses must be checked regularly for leaks.

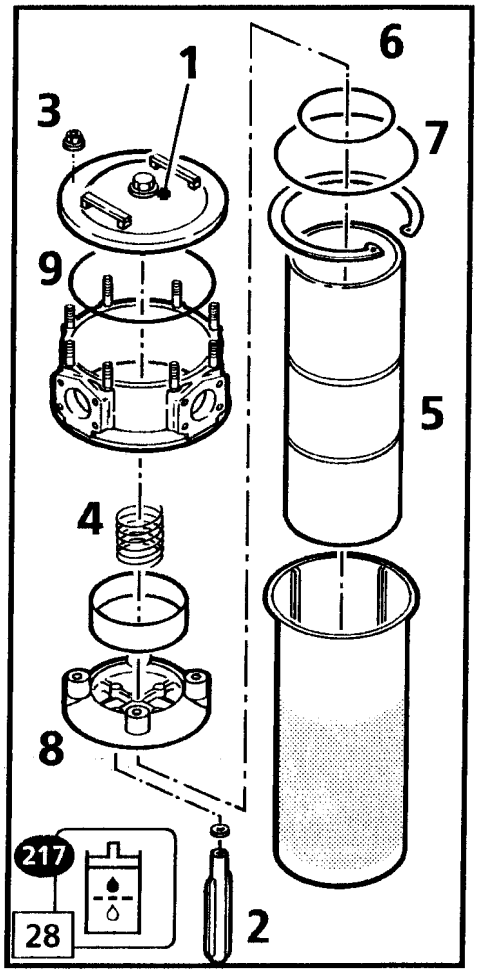
Cleanliness in the hydraulic system is especially important.

For this reason, the given maintenance intervals to replace the return filter, to clean the oil cooler, and to change the oil need to be strictly observed.

DANGER

DO NOT ALLOW YOUR SKIN TO COME INTO CONTACT WITH HOT OIL OR COMPONENTS CONTAINING HOT OIL. At or near operating temperature, engine and hydraulic oil is hot and can be under pressure.

Always relieve the hydraulic pressure before working on the hydraulic system.
Apply both joysticks (with ignition key in contact position) and then turn the three way valve to position B (fig. 25) to relieve pressure in the tank.



OIL COOLERS

Clean oil coolers are necessary to achieve optimum hydraulic oil cooling.
Clean the cooling circuit with air or steam at the intervals specified in maintenance schedule, and more often if the working conditions make it necessary.

RETURN FILTER

The magnetic rods 2 in the return filter (Fig. 28) should be cleaned daily during the first 300 operating hours, then every week.

Change filter element 5 the first time after the 500 and 1000 first operating hours.
Then change these elements
- every 1000 hours,
- when indicator light 217 on the monitoring display lights up,
- and after each major repair in the hydraulic system.

Notice: When working under very dusty conditions observe the special recommandations concerning the elements change on page 5.9.

To check and clean the magnetic rods and to replace the filter element :

Relieve the tank pressure.

Remove the nuts 3 (fig. 28) on the filter cover and pull off cover 1 and spring 4.

Pull out the support 8 with the magnetic rods 2 and remove the O-rings 6 and 7.

Carefully clean off any dirt adhering to the magnetic rods 2.

Pull out the used filter element 5 and replace it with a new one.

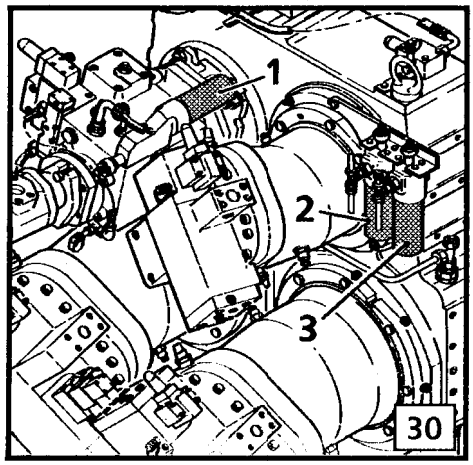
Caution !
The sludge collector of the filter cartridge has to fit solidly on the filter bottom.

Carefully insert the support 8 with the magnetic rods, while ensuring correct seat of O-rings 6 and 7.

Install spring 4 and O-ring 9 in the groove at the top of the filter body.

Install the cover 1, assure correct seat of O-ring 9 and tighten the nuts 3.

Repressurize the hydraulic tank (fig. 25).



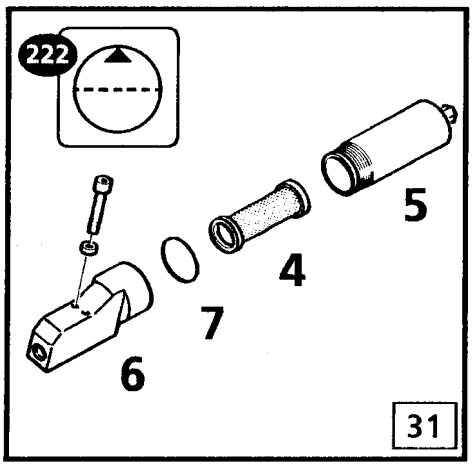
REPLENISHING OIL FILTER, SERVO OIL FILTER AND PUMP BEARINGS LUBRICATION OIL FILTER.

The replenishing filter for the closed swing loop (fig. 30, pos. 1), the servo oil filter 2 and the filter 3 for pump bearing lubrication oil are mounted on the splitterbox.

The filter cartridges must be replaced after the first 250 and 500 and then every 500 operating hours.

The control light 222 on the monitoring display indicates the clogging of one of these filters.

To find out which filter is clogged, disconnect the one after the other the three connectors on the clogging indicators of the filters.

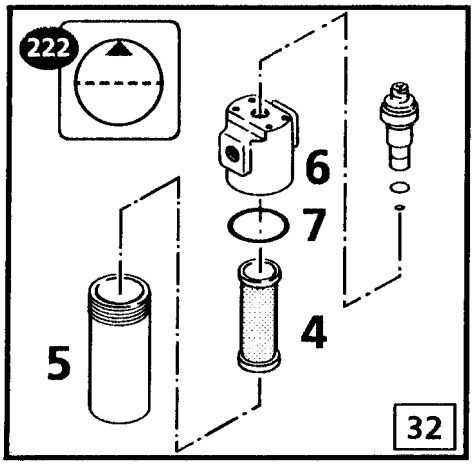


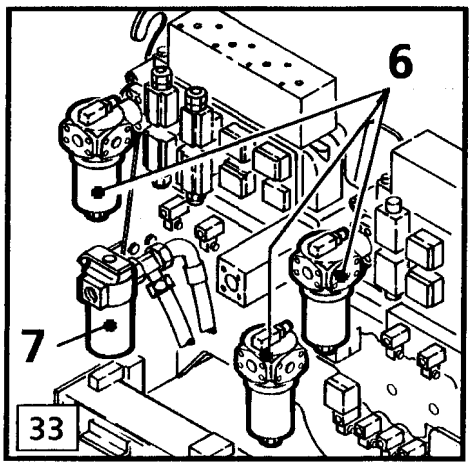
To replace a filter element (fig. 31 and 32)

Relieve the pressure in the hydraulic tank.

Remove the filter housing 5, pull out the filter element 4, clean the filter housing 5 and the filter head 6.

Reinstall a new filter element, lightly lubricate the housing threads, reattach the filter housing, make sure O-ring 7 is seated correctly and tighten the housing by hand.

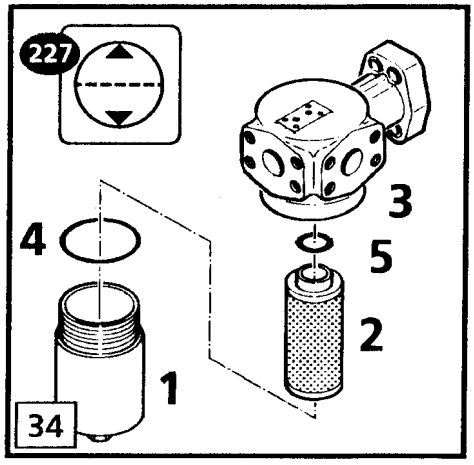




HIGH PRESSURE FILTERS IN WORKING CIRCUIT

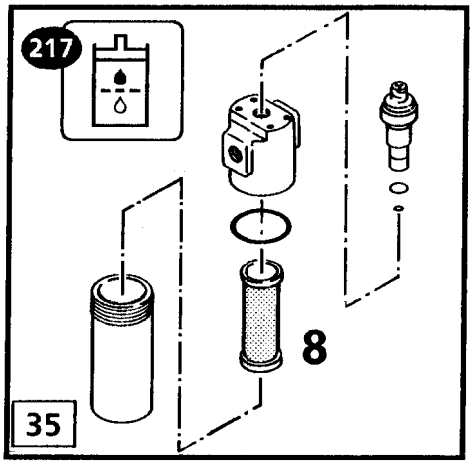
These filters (fig. 33, pos. 6) are mounted on the control valve inlets. Their contamination switches the control light 227 on .

The filters are maintenance free. However, the elements must be cleaned when the control light 227 lights up or when the working pump is replaced.



To clean the filter element :
- Relieve tank pressure (See page 6.10).
- Remove filter housing 1 (fig. 34).
- Remove filter element 2, clean it in gasoline, or replace it.
- Clean the filter housing 1 and filter top 3 and reinstall , make sure O-rings 4 and 5 are seated correctly.
- Repressurize hydraulic tank.

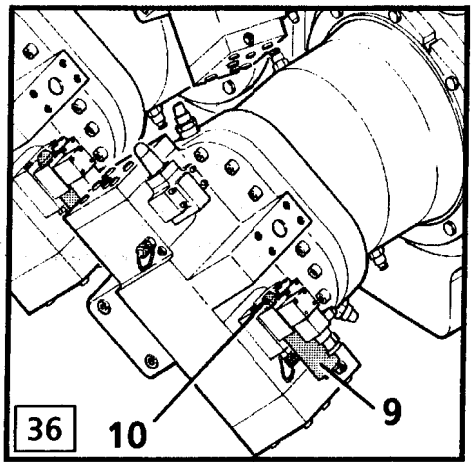
Important: Anytime the element is cleaned or replaced, check for leaks.
Start the engine, work with the machine for a short period and then check for leaks between the filter housing 1 and filter top 3.



FILTER FOR LEAKS OF HYDRAULIC PUMPS AND MOTORS

The lighting up of the control light 217 on the monotoring display indicates the clogging either of the main return filter (see fig. 28) or of the filter in the return circuit of the leaks of hydraulic pumps and motors.
This filter (fig. 33, pos. 7) is mounted to the rear of the control valve console.
Change its filter element (fig. 35, pos. 8) the first times after the, 250 and 500 first working hours.
Then change the element :
- every 500 hours
- when indicator light 217 on the monitoring display lights up,
- and after each major repair on an hydraulic pump or motor.

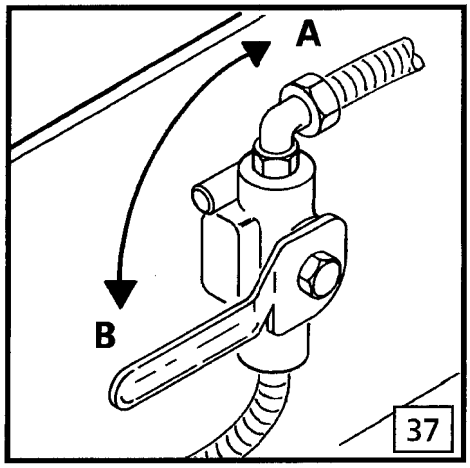
When the element is clogged, remove the filter housing and replace the element 8 (fig. 35).



REGULATING OIL FILTER ON WORKING PUMPS

Filters to protect the regulating elements from contamination are installed on the working pumps (fig. 36, pos. 9).
The elements in these filters must be cleaned after the first 500 and 1000 and every 1000 operating hours thereafter.

These filters are fitted with a visual clogging indicator (fig. 36, pos. 10).
When a filter is clogged, the red pin of its indicator is moved out to the stop (about 5 mm).
To evaluate the clogging of a filter, push in the red pin while the Diesel engine is running and then let it come back.



REPAIRING THE HYDRAULIC SYSTEM

Part of the maintenance consists of checking the complete hydraulic system for leaks, loose connections, frayed, worn or damaged lines, tubes and hoses.

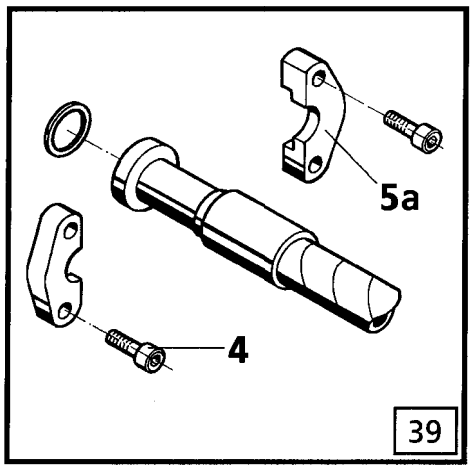
⚠ DANGER

NEVER CHECK FOR LEAKS WITH YOUR BARE HANDS. Fluids escaping from a small hole can have enough force to penetrate the skin.
Never disconnect lines or hoses before the attachment is lowered to the ground, the engine is turned off, both joysticks are moved, with ignition key in contact position, and the hydraulic pressure in the tank is relieved by moving the three way check valve (fig. 37) to position B.

NW 20, NW 25, NW 32, NW 40 and NW 60 high pressure hoses with SAE fittings (fig. 39 and 40) are installed on your machine.

⚠ DANGER

Any time a high pressure hose is defective (bubbles, moisture, damage on the surface, etc.), it must be replaced. When installing the replacement hose, avoid any stress and strain on the hose.
Do not turn or twist the hose!



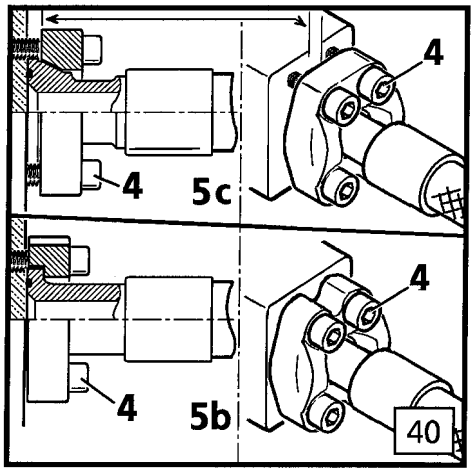
The following O-rings are needed for hydraulic hoses :

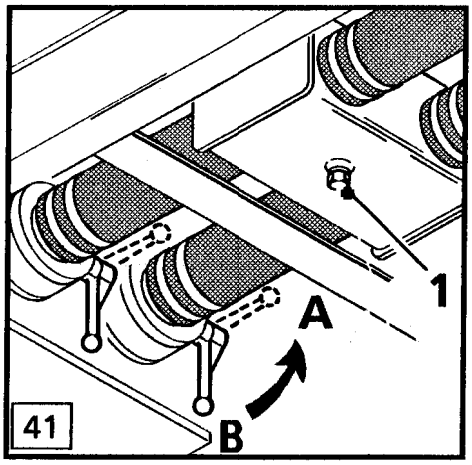
NW 20 :	25	×3,5	Id. No. 7367610
NW 25 :	32,9	×3,5	Id. No. 7367611
NW 32 :	37,7	×3,5	Id. No. 7367612
NW 40 :	47,2	×3,5	Id. No. 7367613
NW 60 :	69,5	×3,5	Id. No. 7360656

The mounting screws on the SAE fittings for hydraulic pressure hoses must be tightened to the following torque values:

Screw size	Torque value in Nm (ft.lbs) - Quality 10.9		
	Half flange **5a**	Flat flange **5b**	Conical flange **5c**
M8	31 (23)	/	/
M10	62 (45)	45 (33)	65 (48)
M12	108 (80)	70 (51)	110 (81)
M14	172 (127)	120 (88)	180 (133)
M16	264 (195)	170 (125)	250 (184)
M20	350 (258)	250 (184)	450 (332)

Note: Tighten evenly and crosswise





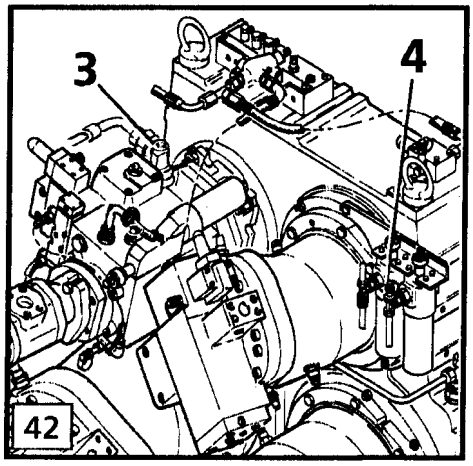
TO REMOVE THE SUCTION HOSES

If suction hoses have to be removed, the shut off valves at the hydraulic tank have to be closed.
Turn the valves by 90° to close (Fig.41).

A - Open
B - Closed

Relieve the tank pressure, and unscrew the cap of the drain valve 1, connect the drain hose and drain the hydraulic oil from the pump and the suction hose into a suitable container.

After repair, be certain to return the valves to original position , push them in their notch and repressurize the tank (turn the three way check valve to position A).
If necessary add some oil to the hydraulic tank and bleed the hydraulic pumps before restarting.



TO BLEED THE HYDRAULIC PUMP

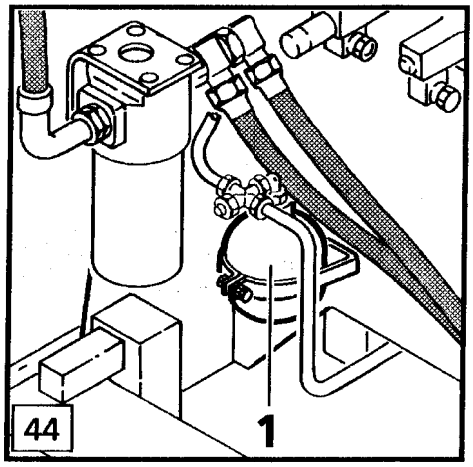
Bleed the hydraulic pump after any repairs on the pump and / or after every hydraulic oil change.

Remove the test fitting (fig. 42, pos. 4) for the working pumps, the plug or the drain hose 2 for the swing pump and let the air escape. As soon as hydraulic oil without air bubbles flows out, reinstall hose plug or fitting.

Fill the pump with hydraulic oil through the same plug or fitting before initial start up, or after repairs or replacement of a pump.

THE SERVO CONTROL SYSTEM

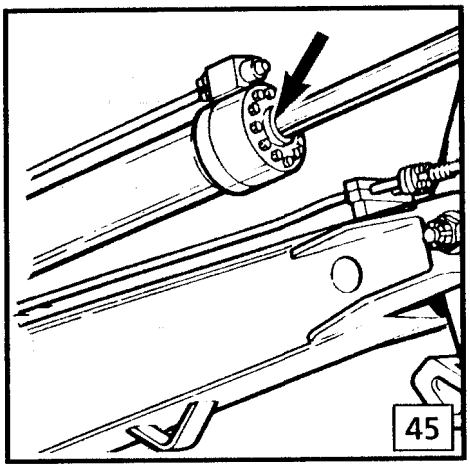
All tube and hose connections to components as accumulator, pressure relief valves, filters etc. , must be regularly checked for leaks.



⚠ DANGER

The accumulator (Fig. 44, pos. 5) keeps the servo control system pressurized even after the engine is turned off. Before any repair in the servo circuit, the pressure must be relieved :
Lower the attachment to the ground, turn the engine off, apply both joysticks several times (with ignition key in contact position).

HYDRAULIC CYLINDERS



IMPORTANT :
Before attempting to repair, replace or reseal hydraulic cylinders (Fig. 49) or any other components, contact your **LIEBHERR dealer.**

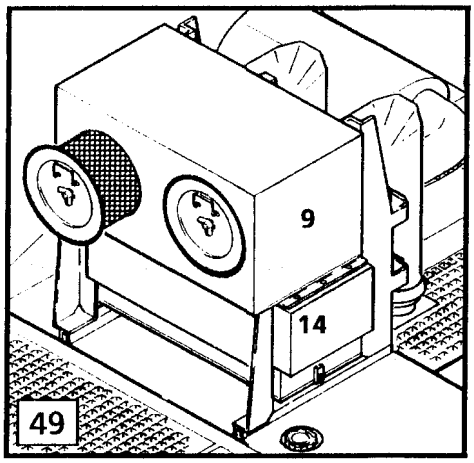
Piston rod preservation :
Corrosion is comparable to wear and tear.
Therefore, if the machine is not being used for longer than 4 weeks or if the machine is transported by ship, the following should be done:

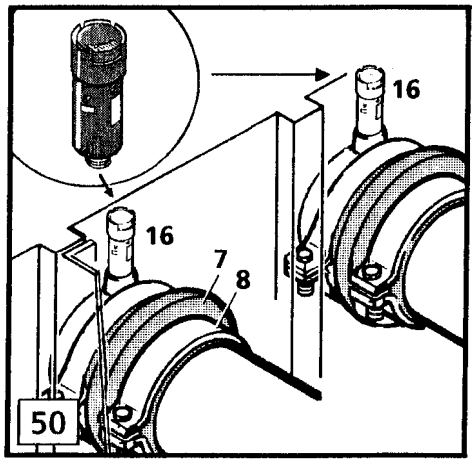
Park and transport the excavator in a way so that the piston rods are fully retracted .

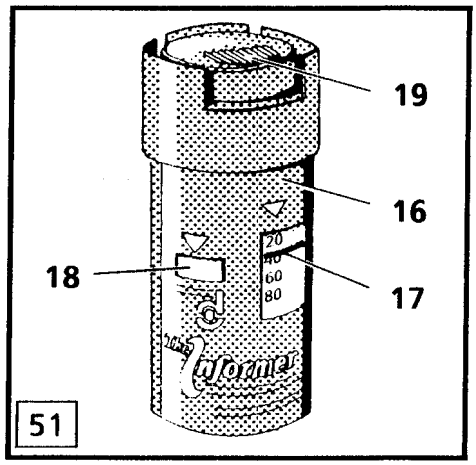
Lubricate all bearings, ball joints, hinges, exposed parts, cable connections and exposed cylinder rods with anti-corrosive grease (LIEBHERR CTK, Id. No. 861331301).

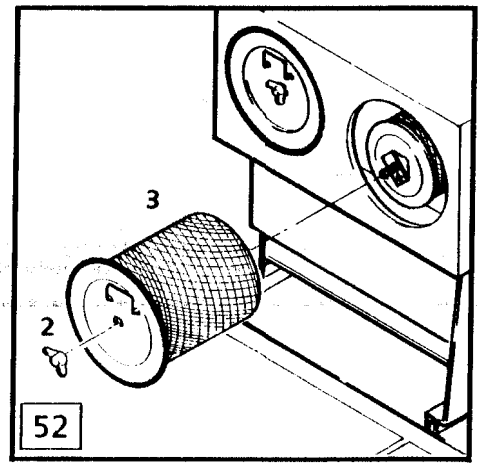
If the machine is used during certain working applications with a short stroke, the cylinder should also be lubricated.

If the machine is transported by ship (sea water) or in the winter (road salt), the preservation of the piston rods must be rechecked after the machine has been loaded since the anti-corrosive grease may have been removed by the wiper ring.









THE AIR FILTER

For maximum engine protection, the air intake system must be checked and serviced at regular intervals (Fig. 49).

The air cleaner with multi-cyclone precleaner 14 and filter element 9 with primary and safety elements is designed to give maximum protection at long maintenance intervals.

Maintenance consists of replacing the filter elements. We do not recommend to clean the filter elements.

The maintenance indicator (fig. 50, pos. 16) stores the maximum recorded depression on the filter outlet, during the Diesel engine operation.

When the red stripe (fig.53, pos. 17) appears in the window 18, the maximum permissible vacuum of 50 mbar has been reached.
At that time, the corresponding primary filter element must be replaced.

To reset the vacuum indicator, press the "Reset" button 19 (fig. 53).

We recommend to change the primary filter elements 3 only, when the maximum permissible depression has been reached, or at least once a year.

Seals between filter element and housing 3 can be damaged if the filter elements are removed too often.

The safety elements 6 should be replaced after the primary elements have been changed 3 times, or at least once a year.

Before a new element is installed, carefully clean the seal and the sealing surface of the filter housing.

The dust extracted in the whirler type precleaner is carried out over the exhaust system of the Diesel engine.

TO CHANGE A PRIMARY FILTER ELEMENT

Turn the engine off, remove the wing nut 2 with seal, and -the primary element 3 (Fig. 52).

Clean the inside of the filter housing 9 and the sealing surface with a damp rag.

Do not direct compressed air into the housing.

Insert a new element, make sure it is seated correctly, tighten nut 2.

TO REPLACE THE SAFETY ELEMENTS

The safety element 6 are mounted with a special wing nut 5 (fig. 54) containing a maintenance indicator 5a. Check the wing nut if it is mounted tightly. The safety element should be replaced at least once a year or after the main element has been replaced 3 times.

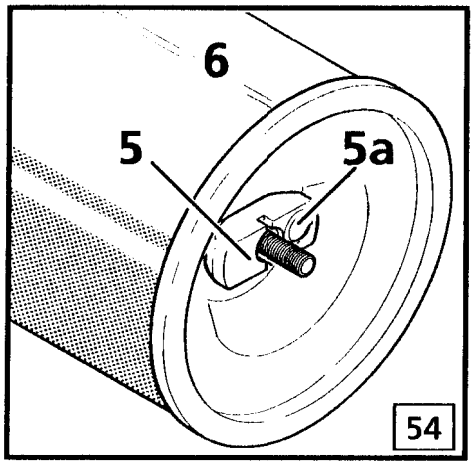
At each change of the primary element, visually check the safety element. If the green dot 5a on the wing nut turns red, replace the safety element immediately.

This safety element should only be replaced by a qualified maintenance or a LIEBHERR service technician!

Remove the main element as described above.
Remove wing nut 5 and remove safety element 6.
Carefully clean the inside of the filter housing with a damp rag.
Clean the sealing surfaces and check for damage.

Carefully insert the new safety element and reinstall wing nut 5.

Install the main filter element 3 as described before and close filter housing.

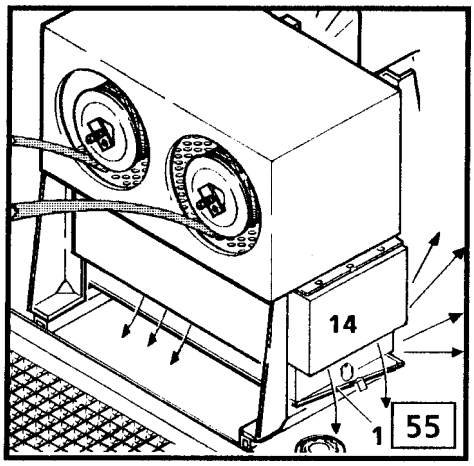


TO CLEAN THE CYCLONE TUBES OF THE PRECLEANER

Weekly open the filter cover 14 to check the cyclone tubes. If they are plugged with dust, blow them out from the filter inside with compressed air.

Important !

Never clean the precleaner section with steam.
The safety elements 6 must remain in place.
Do not direct the air flow towards the filter elements!

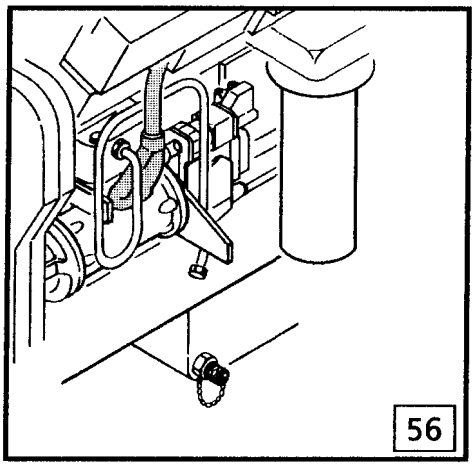


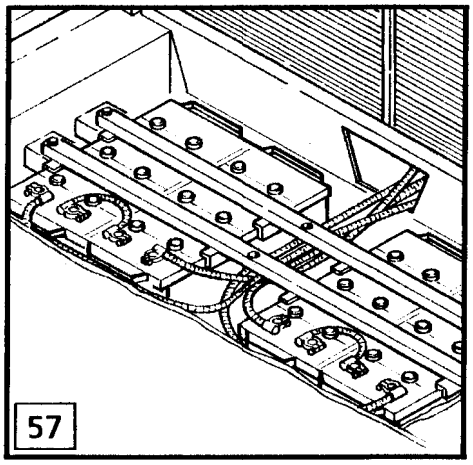
TO CHECK THE AIR INTAKE HOSES

The air intake hoses 7 (fig. 50) between air cleaners and engine intake must be checked for damage and leaks whenever the filter elements are replaced.

If necessary, retighten the clamps 8.

The connection between air pressure compressor intake must also be checked for leaks (fig. 56).





THE ELECTRICAL SYSTEM

To insure troublefree operation of your excavator, the electrical system must be in good condition. The gauges, indicators and components of the electrical system should be checked daily for proper function.
Always replace burnt out fuses and bulbs. DO NOT repair fuses.
Check for bare and damaged wires, which could cause damage to the electrical system or a fire. Check for loose, dirty or corroded connections.

IMPORTANT :
Before repairs on the electrical system, or before using an arc welder on the machine, the negative battery terminal should be disconnected first and reconnected last.

Cover the electrical components (especially the alternator) when washing the excavator to protect it from water.

BATTERY MAINTENANCE

In order for the batteries to function properly, it is important to keep them clean at all times.

The battery poles and cable clamps in particular should be cleaned regularly and then coated with acid resistant grease (Fig. 69).

To check the electrolyte level, open battery compartment door, lift up rubber cover and remove caps.
The electrolyte level should be 1/2" (10 - 15 mm) above the plates.
If the electrolyte level is low, add distilled water.

Regularly check the specific gravity with a hydrometer. A fully charged battery should have a value of 1.28 kg/l (31.5°).

Batteries with a lower value should be recharged. Reinstall caps, check if battery is mounted securely and close the battery compartment door.

⚠ DANGER

Wear protective gloves and safety glasses when handling batteries!
Keep sparks and open flame away from battery. Battery fumes are highly flammable and explosive.
Batteries contain acid which should not be touched. In case of contact, flush with water and get medical attention.

LOCATION OF CUTOUT AND FUSES

On the console next to the starters you find (fig. 73) :

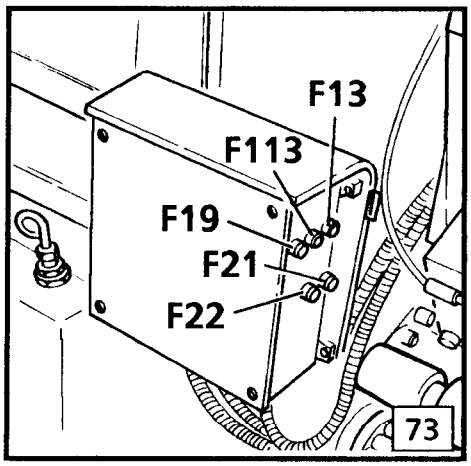
F13 : Main overcurrent cutout

F19 : Cutout for air conditioner

F21 : Cutout for clock earthing

F22 : Cutout for refueling pump control circuit

F113 : Cutout for special equipment (refueling pump, thermoline, ...)



All the other cut out are mounted to the control desk (fig. 74) :

F1 : Cutout / batteries switch

F2 : Cutout / monitoring display, gauges, centralized lubrication.

F3 : Cutout / servo control.

F4 : Cutout / buzzer, electronic horsepower, control circuit for cold starting aid, control circuit for engine.

F5 : Cutout / hourmeter, heater fan, air conditioner control circuit.

F6 : Cutout / cold starting aid solenoid valve.

F7 : Cutout / control circuit for floodlights, lighting of instrument panel, windshield wiper, horn, solenoid valves for travel brakes and float position.

F8 : Cutout / windshield washer, dome light

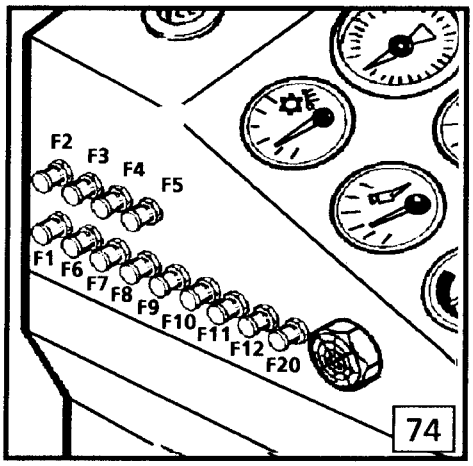
F9 : Cutout / engine RPM adjustment circuit, cigarette lighter, radio.

F10 : Cutout / floodlights on cab.

F11 : Cutout / floodlights on upper, lighting of uppercarriage.

F12 : Cutout / floodlights on attachment.

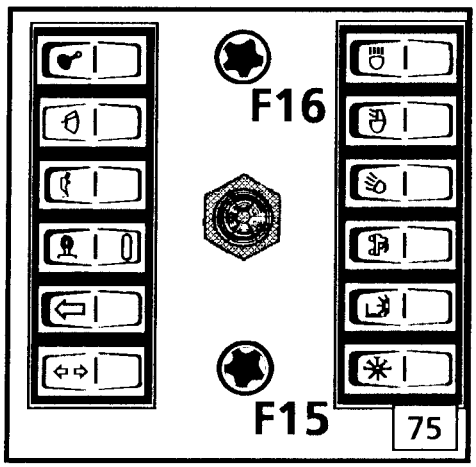
F20 : Cutout / special equipment (fire extinguishing system, ...)



Fuses for the remote control joysticks and pedals, in the control desk (fig. 75):

F15 : Fuse for right joystick

F16 : Fuse for left joystick

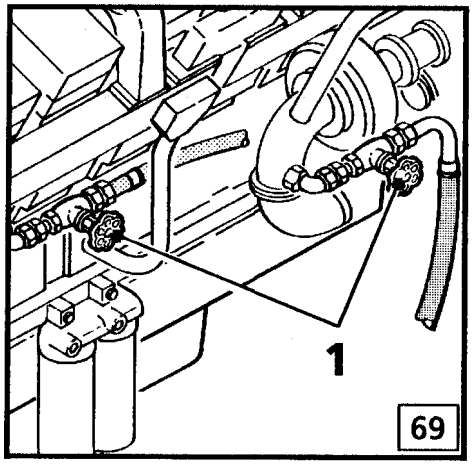


F15, F16 and F17 are 8A fuses- Ident N° 6201893

WARNING

Use only original replacement fuses.
If fuses blow frequently, look for and correct the defect in the affected circuit. Never repair a blown fuse.

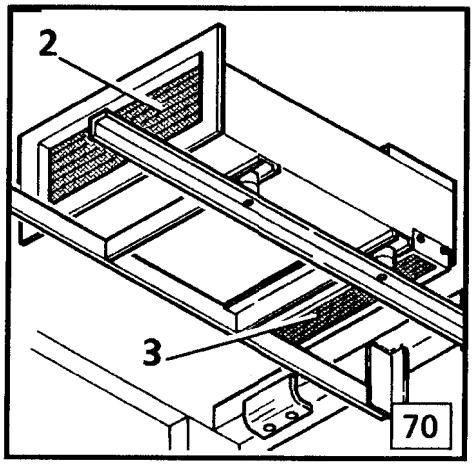
THE HEATER AND AIR CONDITIONER



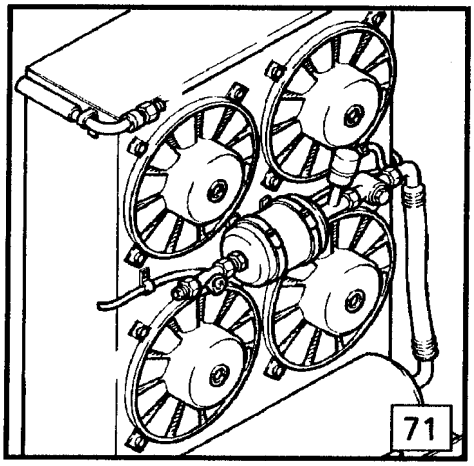
HEATING SYSTEM

The following maintenance should be performed annually before the beginning of the cold season:

- check the heater water circuit for leaks, check and retighten all connections, hose clamps and the seals on the water valves,
- if dirty, the heat exchanger has to be cleaned immediately (fig. 70, pos. 2),
- remove and clean the fresh air filter of the heater (fig. 70, pos. 3).



The heater should only be used with an antifreeze and anticorrosive mixture.
When changing the engine coolant, close the heater valves on the engine (fig. 69). Otherwise the heater core must be vented correctly after refilling

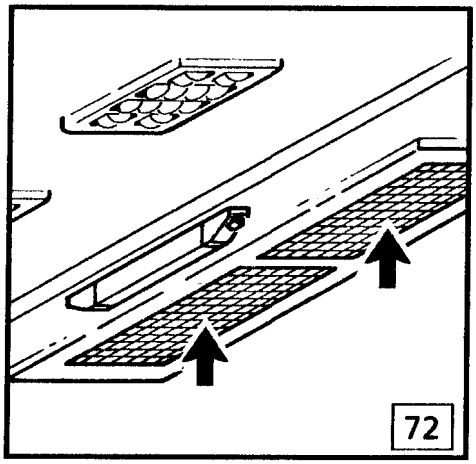


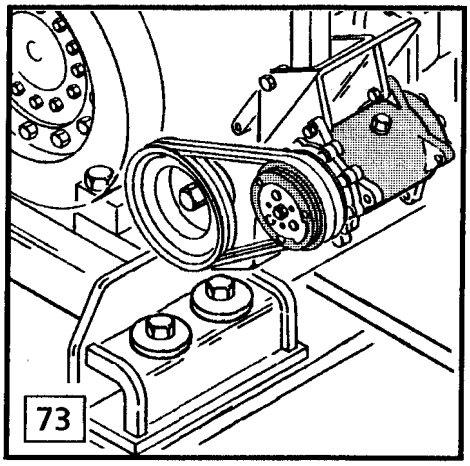
AIR CONDITIONER

Operate the air conditioner every second week for about 10 minutes regardless of the season.

During the warm season, perform following checks or maintenance works every 250 operating hours :

- check the heat exchanger of the condenser and if necessary blow it out with pressurized air or steam, from the inner (fan side) to outside (fig. 71).
- clean the recirculating air filter on the evaporator in the cab (fig. 72),

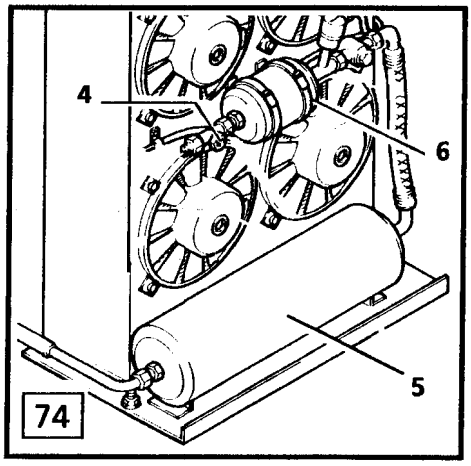




- check the V-belts of the compressor (fig. 73) for correct tension and good condition.

In addition, the refrigerant charge of the system must be checked every 250 hours, by observing the sight glass of the receiver drier (fig. 74, pos. 4) while the air conditioner is operated.
Bubbles or foam in the sight glass indicate an insufficient refrigerant charge.

In this case, the system should be checked and refilled by a trained specialist.

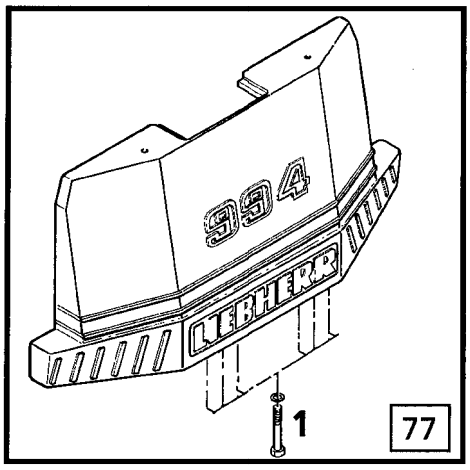


The condition of the refrigerant receiver 5 must be checked visually for corrosion and mechanical damage. Should rust formation be observed on the receveir (on mounting consoles, connecting parts, ...) it must be replaced immediately.

The filter / drier 6 must be exchanged every two years, since it may be obturated due to excessive absorption of humidity.

CHECKING MOUNTING BOLTS FOR TIGHTNESS

The mounting bolts listed below must regulary be checked and retightened if necessary.
See maintenance chart for check intervals.



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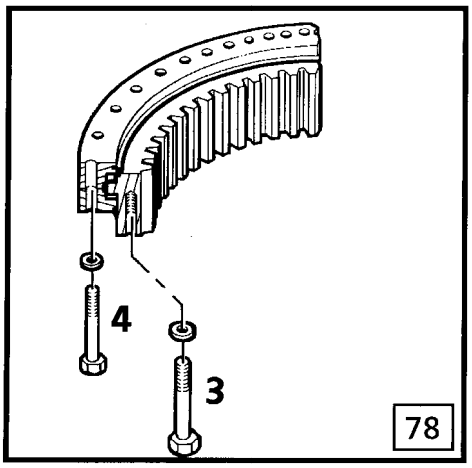
MOUNTING BOLTS OF THE COUNTERWEIGHT

The mounting bolts M42 (fig. 77, pos. 1) must be torqued to 5400 Nm (4000 ft.lbs).

MOUNTING BOLTS OF THE SWING RING

The mounting bolts M36 swing ring to undercarriadge (fig. 78, pos. 3) and uppercarriadge to swing ring (pos. 4) must be torqued to 3300 Nm (2450 ft.lbs).



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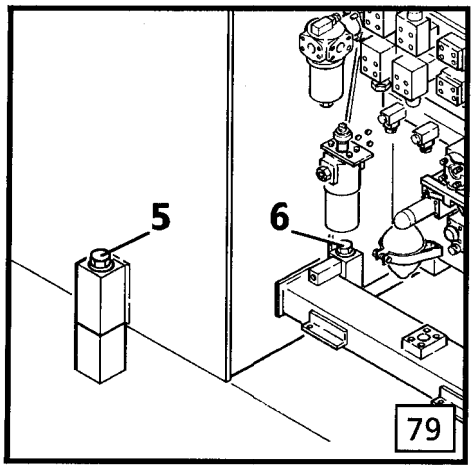
MOUNTING BOLTS OF TANKS, COOLER BOX, ...

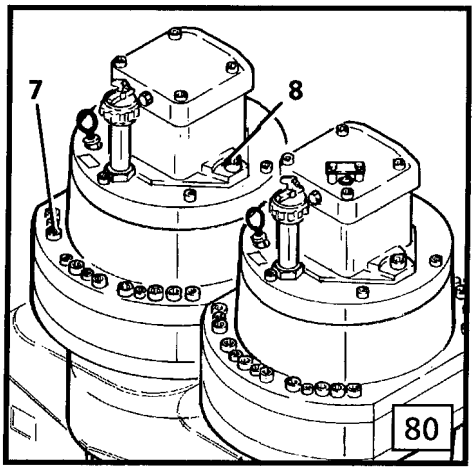
The mounting bolts M20 of the hydraulic tank (fig. 79, pos. 5), the fuel tank, the cab elevation, the cooler box must be torqued to 560 Nm (410 ft. lbs).
The mounting bolts M16 for the control valve console (fig. 79,pos. 6), the water cooler box, ... must be torqued to 280 Nm (205 ft.lbs).



79

MOUNTING BOLTS OF THE SWING GEAR AND MOTOR

The mounting bolts M24 of the swing gear (fig. 80, pos. 7) must be torqued to 960 Nm (710 ft.lbs).
The mounting bolts M24 of the swing motor (pos. 8) must be torqued to 960 Nm (710 ft.lbs).



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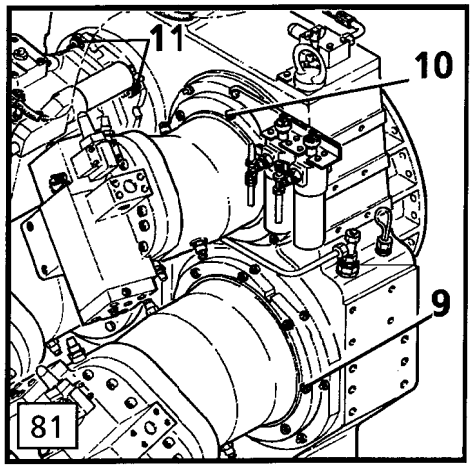
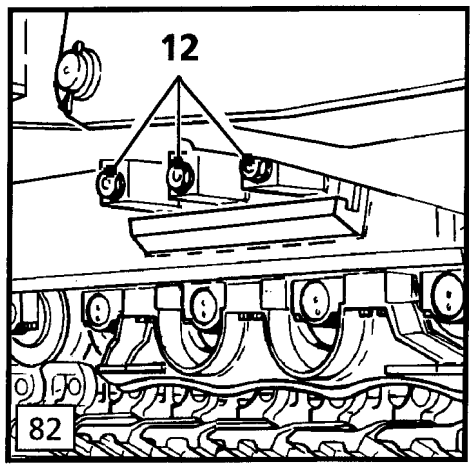


MOUNTING BOLTS OF HYDRAULIC PUMPS

The mounting bolts of both main working pumps (fig. 81, pos. 9) must be torqued to 560 Nm (460 ft.lbs).

The mounting bolts of third working pump (fig.81, pos. 10) must be torqued to 560 Nm (460 ft.lbs).

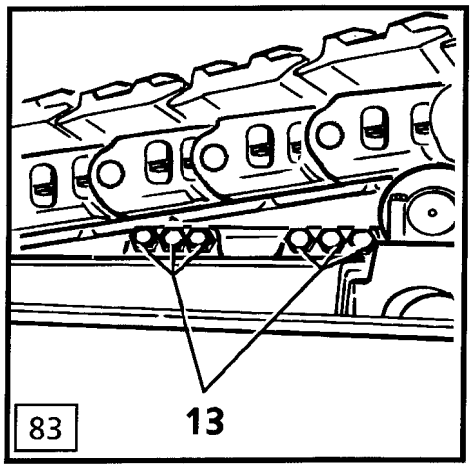
The mounting bolts of the swing pump (fig. 81, pos.11) must be torqued to 560 Nm (460 ft.lbs).



CONNECTION OF CENTRAL PIECE AND SIDE FRAMES

These bolts must be checked every 250 working hours, and if necessary retightened.

The lower bolts M42 (fig. 82, pos. 12) must be torqued to 5400 Nm (4000 ft.lbs).



The upper bolts M 42 (fig. 83, pos. 13) must be torqued to 5400 Nm (4000 ft.lbs).

REPLACING WEAR AND TEAR ITEMS

In addition to regulator maintenance, which is to be performed at given intervals, the following repairs may be performed by the operator or maintenance personnel:

Replacing or repairing the track chain, the pads, carrier or support rollers as well as replacing the idler unit. Retighten the track chain as described in his manual.

Replacing the worn teeth on the bucket.
Replacing the defective seals on hoses and pipes and connections to the hydraulic components. (However, the operator may not work on the pressure relief valves, which are secured with lead seals.)

Replacing hydraulic hoses, lines, and fittings in the hydraulic circuit.

Use only genuine **LIEBHERR parts** (i.e. hoses, hydraulic lines).
All other repairs should only be done by trained **LIEBHERR service personnel**.
Always consult your **LIEBHERR dealer**, especially when removing counterweight.

WELDING

Any welding on structural parts may only be done by **LIEBHERR service personnel**. If this rule is neglected, the warranty is voided.

Before welding repairs on other parts, always disconnect the battery. Always remove the negative terminal first and reconnect it last.

CAUTION:
Before welding, connect the ground cable as close as possible to the welding point, so the welding current will not run through the swing ring, joints, gears, bushings, rubber parts and seals.

DAILY / WEEKLY MAINTENANCE SCHEDULE R 994

Daily	Weekly	Work to be carried out	Adjustment Values, Quantities	For description refer to : - OM : Operation and maintenance manual LIEBHERR
		DIESEL ENGINE & SPLITTERBOX		
○	○	Check engine oil level		OM 5.10
○	○	Check for air filters clogging at the maintenance indicators		OM 6.16
○	○	Check coolant level		OM 5.10
○	○	Empty water separator at fuel filter and drain fuel tank		OM 6.4
	○	Check oil pressure and coolant temperature during operation		OM 4.5
	○	Check condition of the cyclone tubes of the precleaner, clean if necessary		OM 6.16
	○	Check oil level in splitterbox		OM 5.12
		HYDRAULIC SYSTEM		
▩	○	Clean magnetic rods in return filter (daily during the first 300 hrs.)		OM 6.11
	○	Check oil level in hydraulic tank		OM 5.14
		ELECTRICAL SYSTEM		
○	○	Check indicator lights and gauges on control panel when starting		OM 4.4
	○	Check head and floodlights		OM 3.4
		AIR SYSTEM		
○	○	Drain air tank (in winter daily and in summer weekly)		OM 6.7
	○	Check air filter and lubricator for central lubrication, clean and refill if necessary		OM 6.7
		SWING RING		
○		Lube swing ring bearing		OM 5 18
○	○	Lube swing ring teeth		OM 5.15
	○	Check level in grease tank for swing ring teeth, refill if necessary	11 lbs	OM 5 15
	○	Check level in grease container for central lubrication, replace container if necessary	400 lbs	OM 5.18
		TRACKS		
○	○	Clean track chain (after working)		OM 6.9
	○	Check track chain tension visually, if necessary retighten and check elastomer tensioner		OM 6.8
		UNDER/UPPERCARRIAGE, & ATTACHMENTS		
○		Lubricate all grease and lubrication points		OM 5.17
○	○	Check bucket teeth visually for wear		
○	○	The daily maintenance work of the driver include the check of the proper function of hydraulic, electric and brakes systems before starting operation. He also must daily perform a visual check of engine, hydraulic system, gears, and track parts for leaks.		
	○	Check lock of the pins and fastening of the pipe clips		
	○	Check level in reservoir for windshield washer, refill if necessary	12 Gal.	

▩ First and only maintenance interval

MAINTENANCE SCHEDULE R 994

at delivery / at 250, 750, 1250, ...hrs. / at 500, 1500, 2500, ...hrs. / at 1000, 3000, 5000, ...hrs. / at 2000, 4000, 6000, ...hrs.	Work to be carried out	Adjustment Values, Quantities	For description refer to : - **OM** : Operation and maintenance manual **LIEBHERR** - **CU** : OMM for **CUMMINS** Engine
○ ○ ○ ○ ○	**Perform all checks and works listed in the daily / weekly maintenance schedule**		
	DIESEL ENGINE & SPLITTERBOX		
○ ○ ○ ○	Replace engine oil (every 500 working hours if reserve system mounted)	34 Gal.	OM 5.11
○ ○ ○ ○	Replace full - flow and bypass lube oil filter elements (500 hours if reserve system)		CU
○ ○ ○ ○	Replace fuel filter elements		CU
○ ○ ○ ○	Check DCA concentration of coolant (replace coolant once a year)	53 Gal.	CU
○ ○ ○ ○	Replace DCA water filters		CU
○ ○ ○ ○	Clean crankcase breather, replace it if necessary		CU
○ ○ ○ ○	Check tension and condition of V-belts		CU
○ ○ ○ ○	Check and clean radiator core and fan		OM 6.4
○ ○ ○ ○	Check radiator cap for leaks, replace it if necessary		OM 6.4
○ ○ ○	Check exhaust and intake systems for condition and tightness		CU
○ ○ ○	Check engine speed under load, check and adjust engine speed control		
▩ ○ ○	Replace oil in splitterbox	17 Gal.	OM 5.12
○	Check mounting screws of engine and splitterbox for tightness		OM 6.4
	Replace primary element of air cleaner (if necessary or once a year)		OM 6.17
	Replace safety element of air cleaner (if necessary or once a year)		OM 6.17
	Check air intake hose for condition and leaks (at filter maintenance)		OM 6.17
	Every 1500 hours, perform a complete "C" Maintenance Check, as stated in Operation and Maintenance Manual for Cummins Engine		CU
	Every 6000 hours, perform a complete "D" Maintenance Check, as stated in Operation and Maintenance Manual for Cummins Engine		CU
	Yearly: - in autumn, perform checks listed in O.M.M. for Cummins Engine - in spring, perform checks listed in O.M.M. for Cummins Engine		CU
	HYDRAULIC SYSTEM		
○ ○ ○ ○	Clean hydraulic and splitterbox oil cooler (if necessary)		OM 6.10
▩ ○ ○ ○	Change element of pump bearings lubrication filter (first after 250 hrs.)		OM 6.11
▩ ○ ○ ○	Change servo filter element (first after 250 hrs.)		OM 6.11
▩ ○ ○ ○	Change replenishing oil filter element on swing pump (first at 250 hrs.)		OM 6.11
▩ ○ ○ ○	Change element of filter for leakage of hyd. pumps and motors (first after 250 hrs.)		OM 6.12
○ ○ ○ ○	Check hydraulic system for function and leaks		OM 6.13 / 6.14
○ ○ ○	Check mounting of components (pumps, motors, clamps, ...)		OM 6.24
▩ ○ ○	Change filter element of return filter (first after 500 hrs.)		OM 6.11
▩ ○ ○	Clean or change regulating oil filter elements on main pumps (first at 500 hrs.)		OM 6.12
○ ○ ○	Check and adjust primary and secondary pressure relief valves		
○ ○ ○	Check hydraulic cylinder rods for leaks and good condition		OM 6.15
○	Replace hydraulic oil	462 Gal.	OM 5.14
	Bleed servo system and hydr. pump (as necessary)		OM 6.14
	Clean high pressure filters (as necessary)		OM 6.12
	ELECTRICAL SYSTEM		
○ ○ ○	Check level and specific gravity of the electrolyte in the batteries		OM 6.18
○ ○ ○	Check and clean battery terminals		OM 6.18
○ ○ ○	Check system for function		
	▩ First and only maintenance interval		

MAINTENANCE SCHEDULE R 994

at delivery / at 250, 750, 1250, ...hrs. / at 500, 1500, 2500, ...hrs. / at 1000, 3000, 5000, ...hrs. / at 2000, 4000, 6000, ...hrs.	Work to be carried out	Adjustment Values, Quantities	For description refer to : - OM : Operation and maintenance manual LIEBHERR - CU : OMM for CUMMINS Engine
	AIR SYSTEM		
○ ○ ○ ○ ○	Check cut in and cut out pressures of air pressure regulator	6.2 - 7.2 bar	OM. 6.6
○ ○	Check hydraulic tank pressurisation	0.5 bar	
	Replace filter cartridge of air dryer (before cold season)		OM 6.7
	SWING GEAR		
○ ○ ○ ○ ○	Check for leaks. If gear is leaking, check oil level		OM 5.13
○ ○ ○ ○	Check brake fluid level (replace fluid yearly)	9 oz	OM 6.5
○ ○ ○	Check function and operation of swing brake		OM 4.13 - 6.6
○ ○ ○	Check mounting of gear and oil motor		OM 6.23
▩ ○ ○	Replace gear oil (first at 500 hrs.)	2×7 Gal.	OM 5.13
	SWING RING		
○ ○ ○ ○	Check and tighten mounting screws, if necessary	2450 ft.lbs.	OM 6.23
○ ○ ○ ○	Remove lube line and clean nozzle		OM 5.15
○ ○ ○ ○	Check pinion gear mesh		
	TRAVEL GEARS		
○ ○ ○ ○ ○	Check for leaks. If gear is leaking, check oil level		OM 5.13
○ ○ ○	Check function and operation of travel brakes		
○ ○ ○	Check mounting screws of gears, sprocket wheels and oil motors		OM 6.9
▩ ○	Replace gear oil (first at 1000 hrs.)	2 × 16 Gal.	OM 5.13
○ ○	Check the oil level in the travel brake housing (change the oil every 2000 hours)	2×0.4 Gal.	OM 5.13
	TRACKS		
○ ○ ○ ○	Check and tighten mounting screws of track pads	3170 ft.lbs.	OM 6.9
○ ○ ○ ○	Check and tighten mounting screws of side frames		OM 6.24
○ ○ ○	Clean and lubricate sliding surfaces of chain tensioners		OM 6.9
○ ○ ○	Check idler, carrier and track rollers for leaks		
	CAB, HEATER AND AIR CONDITIONER		
○ ○ ○ ○	Check function of air conditioner every two weeks for 10 minutes during winter		OM 6.21
○ ○ ○ ○	Check condenser unit, evaporator filter and compressor V-belt (in summer)		OM 6.21
○ ○ ○ ○	Check refrigerant, if necessary refill circuit		OM 6.22
○ ○	Check locks and hinges on doors and windows (lubricate if necessary)		
	Check heater for leaks, heat exchanger and heater filter (before cold season)		OM 6.21
	Yearly check condition of the refrigerant receiver, if necessary replace it		
	Replace the filter / drier every two years		
	UNDER/UPPERCARRIAGE, & ATTACHMENTS		
○ ○ ○ ○	Check and tighten mounting screws of counterweight and tanks		OM 6.23
○ ○ ○	Check lower speed of attachment	5 sec.	
○ ○	Check all parts for cracks		
○ ○	Check and lubricate cover hinges and locks		
○	Check sviwel bearings for play clearance		
○	Explain proper use and maintenance to the operator		
○	Ask the operator to lubricate the machine using the lube chart, explain defects and deficiencies.		
	▩ First and only maintenance interval		

TRAVELLING PROCEDURES FOR MINING MACHINE

The life expectancy of undercarriage components is based on standard working conditions with a maximum travel ratio of 5% per service meter unit. Working and / or travelling on uneven ground and / or abrasive material will influence the lifetime of the components and attract additional cost for the undercarriage components.

In general travel action has to be kept to the lowest level that is possible. Minimize travelling with turning through a narrow turning circle and long distance travel.

To minimize the travel ratio, professional mine planning with longfront winning sections is preferred. If digging operations at various spots are necessary, a proper short term and long term plan of winning operations has to be employed to guarantee long term use of the excavator at one place before moving to another location.

However, if frequent machine movement is necessary, the following set of procedures defined by LIEBHERR to minimize possible machine damage, downtime and wear have to be taken into consideration.

General

In order to move the machine forwards: with the excavator in standard forward position, depress travel pedals all the way forward with the toes. Direction of travel is in the direction of idlers.

In order to move the machine backwards: with the excavator in standard forward position, depress travel pedals all the way down with the heels. Direction of travel is in the direction of the drive sprockets.

Moving the machine during loading operations

Moving the machine during loading operations means adjustment of excavator digging and / or truck loading position of some meters.

Important procedures:

- Before moving the machine, empty the bucket and close up the attachment to a position as close as possible to the excavator undercarriage.
- The practice of placing the attachment on the ground and lifting the machine, then counter turning the undercarriage, is not allowed, because it could cause premature structural damage to the machine
- If there is a build up of material around the tracks where the machine will not turn, you must move the machine several meters forwards and / or backwards and attempt to turn again.
- If mine safety regulations allow, the operator can use the swing function to assist in turning the tracks, i.e. if turning to the right, swing upper deck to the left and vice versa.

Walking the machine over distance

Walking the machine distances means any movement of the machine of more than 100m or for a time period longer than 3 minutes, whatever comes first.
In addition to above mentioned guidelines, when moving the machine during loading operations, the following procedures apply:

- It is required to have somebody standby with a heat gun, to monitor the temperature of the drive components , including the track and carrier rollers.
- If temperature of any moving part is growing up about 20°C above ambiant temperature, interrupt travel and only commence again after parts have sufficiently cooled.
- To prevent overheating during travelling or to speed up cooling procedure it is advisable to have a water truck standby, to hose the heating components during travelling or cooling break.
- Move with idler and attachment forwards. Whenever possible, and not to contravene with mine safety regulations, swing whilst travelling to equally load track rollers. However, always ensure that clear forward vision is maintained.

Travelling the machine down grades or upgrades

In addition to above mentioned guidelines, when moving the machine during loading operations or when walking the machine distances, the following procedures apply :

- When travelling down grades greater than ten percent, it would be better to walk the machine down with the track motors first, i. e. the machine is moved backwards.
- When travelling up an incline, the final drives must be at the rear of the excavator.
- When walking down from a bench, firstly prepare a ramp, making it no more than a 30° slope (machine must be able to walk up unaided). When moving down the ramp never allow the machine to fall down on the attachment. When walking up the ramp never use attachment to assist the movement by pushing with the hydraulic power of the bucket, stick or boom.

Travelling the machine first time

The slide bearing (friction bearing) of the track rollers needs some time for running-in. If the bearing becomes hot at an early stage of machine life, this may cause lubrication problems during further life. Therefore when travelling the machine the first time aside from all above mentioned guidelines it is strongly recommended to move carefully and at reduced speed.

Note: Warranty may become void if failure to recognize and comply with the recommended travel operating procedures, as outlined in this document, is noted.

RESERVE SYSTEM FOR ENGINE OIL
(Optional Equipment)

DESCRIPTION AND PURPOSE

The reserve system mainly consists of an additional oil tank 1 (fig. 4) mounted to the upperframe inside the cab elevation of the machine.
The oil is in permanence sucked from engine oil sump 2 into the tank and returned to engine so to renew oil and maintain constant level in the engine sump.

Due to the increased (approx. doubled) oil quantity in the circuit, the engine oil and filters change intervalls can be raised to 500 working hours.

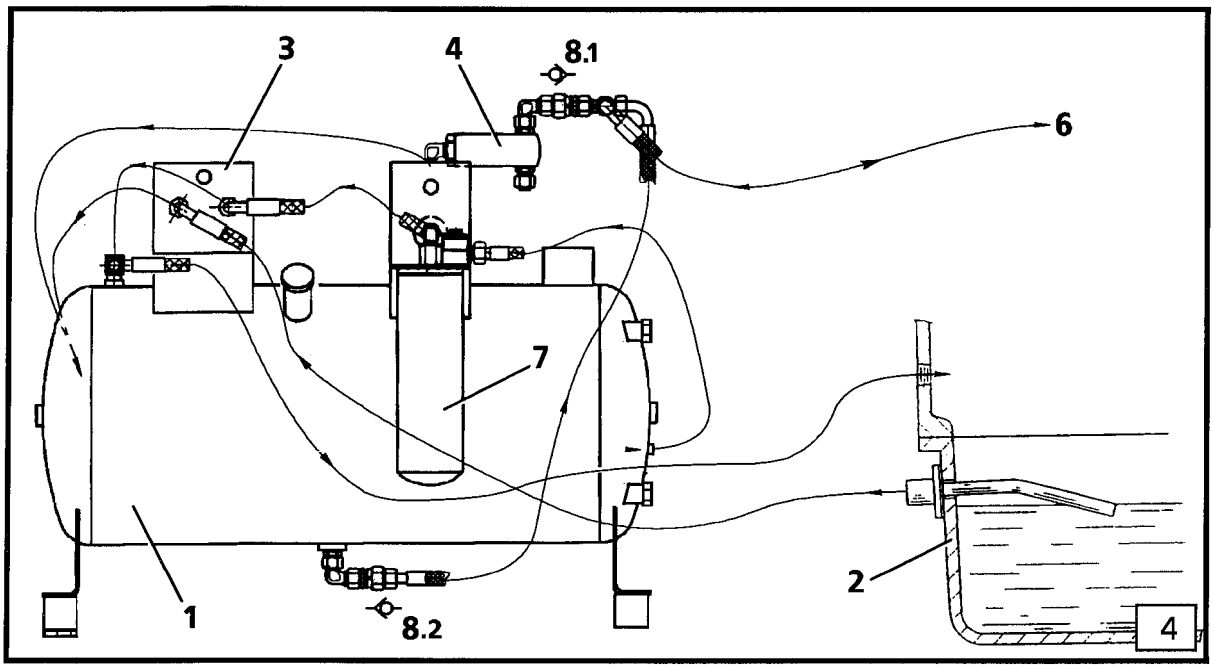
FUNCTION

Oil is circulated between the engine sump 2 and the supply tank 1 by two electrically driven pumps within a single pumping unit.

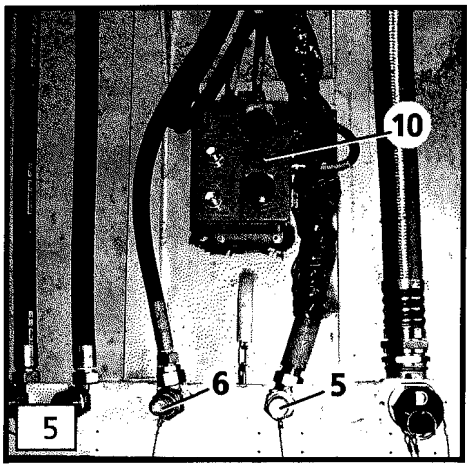
Pump P1 (fig. 7) draws from the sump at a preset control point. Oil above this point is withdrawn and transferred to the tank. This lowers the level in the sump until air is drawn.

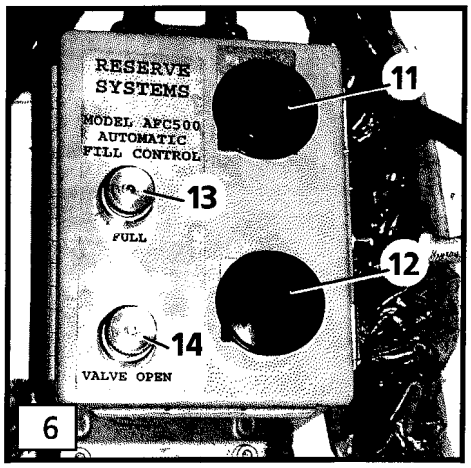
Air reaching the pumping unit activates pump P2, which returns oil from the tank and raises the sump level until air is no longer drawn by the pump P1. Pump P2 then goes off.

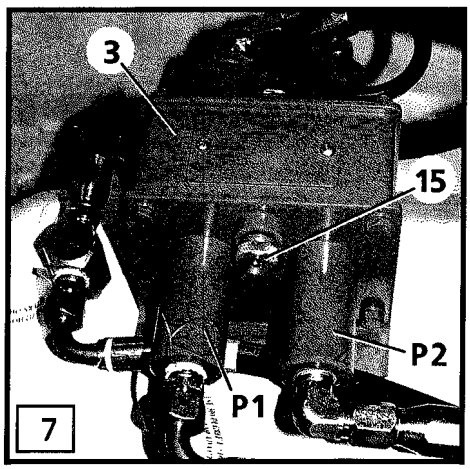
The running level is continuously adjusted at the control point by alternation between withdrawal and return of oil at the sump.



1 Supply tank
2 Engine oil sump
3 Pumping unit
4 Fill control valve
6 Quick coupling nozzle for supply tank
7 Filter element
8.1 Check valve refilling
8.2 Check valve draining







TO CHANGE THE ENGINE LUBE OIL

To drain the oil from the engine sump

Drain the oil from the sump using the quick coupling nozzle 5 (fig. 5) of the service flap.

To drain the oil from the supply tank

Drain the oil from the supply tank of the Reserve System using the quick coupling nozzle 6 of the service flap.
Prior to start draining the oil from the supply tank, pull out the top switch 11 (fig. 6) and then push the start switch 12 of the control box 10 to open the fill control valve 4 (fig. 4).

To refill the engine sump

Refill oil into the engine sump using the quick coupling nozzle 5 until the correct level is reached on the dipstick of the engine.
Change the filter element 7 mounted to the supply tank at every oil change.

To refill the supply tank

- Connect the pressure supply hose to the quick coupling nozzle 6.
- Turn on pressure.
- Energize the fill control valve 4 by pulling out the top switch 11 of the control box. Switch should light.
- Push start button 12. "VALVE OPEN" light 14 should come on and filling will begin.
- When tank is full, "VALVE OPEN" light will go out and "FULL" light 13 will come on.
- Turn off the pressure to the supply hose.
- Push button 12 for a couple of seconds to relieve pressure in the line between quick coupling connector and fill control valve.
- Disconnect the supply hose.
- Turn off power to the fill control valve while pushing in the top switch 11.

For oil quality, refer to lubrication chart.
The oil quantity in the supply tank is approximately 80 liters (21 US gal.)

TO CHECK OUT THE OIL CIRCULATION IN SUPPLY SYSTEM

The control light 15 (fig. 7) mounted to the pumping unit 3 signals the operating state of the supply system by responding to the state of pump P2. When only the pump P1 is running, the signal output at pump P2 is steady. This indicates that the running oil level is above the preset control point and is being drawn down by pump P1.
Regular pulsing indicates that the running level is low and that pump P2 is delivering oil from the supply tank to the sump.
When the running level is at the control point, either air or oil could be drawn as the system attempts to control an already correct level. In this case there is a frequent alternation between operation and non-operation of pump P2 and the signal of control light 15 is an irregular pulsing.
If engine is then shut down and after adequate time for oil drain in the engine sump, the oil level in the sump must be correct.

USE OF ENVIRONMENTALLY FRIENDLY HYDRAULIC FLUIDS IN LIEBHERR EARTHMOVING MACHINES

General

If specific applications require that even in the case of accidents or leakage there may be no damage caused to the environment, hydraulic excavators using environmentally friendly hydraulic fluids can be operated.

These lubricants are free of mineral oils, they are water-soluble in every proportion and meet the requirements for biodegradability.

Never mix them together or with lubricants based on mineral oils.

The following recommendations state how to proceed when using these biodegradable hydraulic fluids in LIEBHERR earthmoving machines.

Prescriptions for biodegradable hydraulic fluids

When using environmentally friendly hydraulic fluids, we exclusively recommend synthetic ester oils with a viscosity according to ISO VG46.

Note :

Due to their limited high temperature stability, **vegetable oils** cannot be used.

Polyglycols decompose various machine paints and should only be used in special cases. In this instance, the material compatibility in regard to seals, paints, etc..., has to be observed.

Due to the lack of experience with the various products, a **"Warranty Declaration"** has to be inquired from the **Oil Supplier** if LIEBHERR earthmoving machines are to be operated with environmentally friendly hydraulic fluids based on synthetic ester **upon "customer's demand".** The declaration applies for hydraulic components in the case of damage caused by the hydraulic fluid. This "warranty declaration" together with the completely filled out confirmation has to be sent to LIEBHERR.

Fundamentally, the supplier is responsible to maintain the standard of quality, standards and specifications of his product when environmentally friendly products are being used.

In order to avoid misunderstandings, **a distinct reference** must be made on the hydraulic tank, stating the fluid which the machine is operating with.

Attention :

Mixing various "environmentally friendly hydraulic fluids" together is prohibited.

The name "synthetic ester" for example does not mean, that all products carrying this name have the same contents. The lack of experience with biodegradable products does not allow a general statement.

Oil change intervals

The oil changes in preset intervals are not allowed for environmentally friendly hydraulic fluids.

The time for oil change must be determined by oil sample analysis and according to the laboratory reports. See page 5.8.

To take the oil samples, LIEBHERR offers its customers a complete **Analysis-Set for Wear Check Lubrication-Analysis** (Id. No. 7018368), which consists of 6 coded sample containers, 6 sample cover letters, 6 envelopes as well as a 3 mtr. silicon hose. Oil analysis and laboratory report are already included in the price for the set! Furthermore, only with the first command, a hand pump (Id.No. 8145666) or, as an alternative, an extraction valve (Id.No. 7019068) and a high pressure hose for pressure test-point (Id.No. 7002437), will be necessary only once.

Further oil analysis or oil change intervals have to be carried out according to the sample analysis in the laboratory report from Wear Check. The évaluation result has to be sent to LIEBHERR and the customer.

Oil filters change intervals

The **filters change intervals** as stated by LIEBHERR must be adhered to.

Use only **Original LIEBHERR Filters.** We recommend the use of special "bio oil filters" to reduce the percentage of zinc in the system (see also chart of return filters).

Water Condensation

Water Condensation must be drained from the hydraulic tank in regular intervals (drain plug on the tank). It is recommended to do this after the machine was stopped for a longer period of time, for exp. Monday morning.

The percentage of condense water is not allowed to exceed 0,1 wgt.%.

Changing to environmentally friendly hydraulic fluid

If machines **which used to operate with mineral oils or other hydraulic fluids** are modified to operate with **environmentally friendly hydraulic fluids,** it is imperative to observe **all LIEBHERR guidelines for modifications.** Flushing the system is absolutely necessary to ensure trouble-free operation.

Never install attachments from other machines without strictly adhering to all guidelines for modifications with regards to the interior coating of components (e.g. the hydraulic tank), and the procedure for flushing with flusher oil (to drain the mineral oil, ...).

The percentage of mineral oil, resulting from changing or mixing with other mineral oil based fluids, remaining within the system is not allowed to exceed 2 wgt.%.

If the changing guidelines stated by LIEBHERR are not adhered to, warranty will be refused in case of damage. In case of a doubt, first obtain these guidelines from your LIEBHERR representative.

Having changed to environmentally friendly hydraulic fluid or when initially filling the system a reference fresh oil sample must be taken **after initial warm-up** and sent to the laboratory for analysis. The sample must be taken while the machine is running using pressure test-point valve (Id.No. 7019068) or right after stopping the engine via the breather valve using the vacuum pump.

Particular precautions

- **When disposing of these fluids** make sure that this medium is not treated as a mineral oil, i.e. there are special regulations for the disposal of these fluids in individual countries.

  In case you have any questions please contact your representative waste oil recycler.

- **When handling** the medium simply use gloves and, in case there is a risk of spraying, use safety goggles as well.

  Wash your hands before taking a break and at the end of your shift. In case the fluids come into contact with skin, rinse with lots of water; in case of eye contact, rinse with water for 10 to 15 minutes.

- **After any fluid is spilled or runs out,** wash away any smaller amounts with lots of water; larger amounts must be properly collected and disposed of.

- **In case of fire,** the usual fire extinguishers may be used (like water vapor, $C0_2$, foam, dry ice extinguishers, ...).

  Never aim a stream of water directly at hot, burning material (risk of splattering).
  Thermal decomposition generates CO and/or $C0_2$.