

# Section F - MAINTENANCE

Operation and Maintenance Manual

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# F-1 GENERAL INFORMATION

Correct and safe operation of the top drive depends on its regular maintenance.

This section covers regular, scheduled maintenance activities, replacement of parts requiring renewal or scheduled maintenance or operating requirements.

Never try to solve a problem or carry out any type of maintenance without the necessary training and availability of special tools.

DRILLMEC will not assume any liability for damage caused due to non-compliance with the maintenance instructions.



Safety helmet



Safety gloves



Safety shoes



Face protective shield



Ear plugs or noise-protective headset



Safety goggles or glasses



Danger

### DANGER: INDIVIDUAL PROTECTION DEVICES

Before starting any set-up, maintenance and repair activities, the individual protection devices required by safety standards (such as goggles, gloves, helmet, non-slip safety footwear, etc. ....) must be made available to staff, and it is compulsory for staff to use them.



Danger

### ATTENTION WHEN WORKING IN INSUFFICIENTLY LIT ZONES

If you must operate the top drive in dark areas, you must have a portable lamp with magnet with you.

THE LAMP MUST COMPLY WITH LEGISLATION!





Danger



It is forbidden to remove the guards and safety devices.

### DANGER:

Any set-up, maintenance or repairs can only be carried out after the top drive is switched off (placed out of service) and not powered (voltage disconnected).

### F-1.1 MAINTENANCE INTERVALS

The frequency of the maintenance intervention is determined by the number of working hours (see hours counter) or the calendar deadline (daily, weekly activity, etc. ...). If maintenance is carried out based on the calendar expiries, these must approximately correspond to the number of working hours.



### **IMPORTANT**

In heavy working conditions, e.g. dust, more frequent maintenance must be required.

If, due to reduced use of the top drive, the maintenance intervals exceed 6 months, all the outer parts must be greased. If the top drive is not used for over three months, all the exposed parts must be protected against atmospheric agents. Pressure must be set at regular intervals by qualified staff.

### F-1.2 WELDING

If you have to weld the top drive, comply with the following precautions:

- welding on the important static parts can only be executed after the written approval of DRILLMEC.
- welding can only be carried out by qualified staff.

The earthing terminal of the welder must be directly connected to the parts to weld. The welding current must not be in any case conducted by deviating it through electronic parts.



### WARNING

Do not connect the earthing terminal of the welding machine to the assemblies (motor, gears, etc.) The welding current can provoke spark discharge at bearing points inside the assemblies. The structure alterations on the surface caused in contact points of the supports can distinctively be highlighted as new hardening points. This early wear can cause premature faults on the driving head. Do not touch the electronic components compartment (e.g. the control tools) and the electrical lines with the welding electrodes or the earthing terminal of the welder.

Welding must not be carried out:

- on parts with motors, gearboxes, etc. ...;
- on the main frame.

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### F-1.3 INTEGRATED NOTES ON THE MAINTENANCE MANUAL

On the following pages, the tables are outlined with the notes on how to carry out maintenance and the list of faults (hydraulic, mechanical or the control system).

A list of maintenance activities and faults is compulsory to find the causes and solutions.



### **IMPORTANT**

During the warranty period, warranty coverage also depends on the above.



# **MAINTENANCE TABLE**

Maintenance (Working hours)	Carried out by company/date/name	Notes

# **FAULTS SEARCH TABLE**

Progressive no.	Date/Working hours	Type of fault	Fault solution	Solved: Client/Date/ Name	Solved: DRILLMEC Date/Name

### F-1.4 BEFORE/DURING/AFTER MAINTENANCE

- Pressurised leaking oil can cause injuries.
- Never work with the top drive on.

### F-1.4.1 BEFORE MAINTENANCE

- Block the top drive and the equipment to avoid accidental movements and start-up
- Maintenance should only be carried out with technically perfect equipment suitable for the type of specific work.
- When working on the electrical system or parts of it, tools, etc...which are in contact with the electric system parts, isolate the power source.
- Open or remove the guards only when drives have stopped or they are blocked to avoid sudden startup.
- Before cleaning the top drive, for safety reasons cover or wrap all the openings with insulating tape so water, vapour or detergents cannot penetrate.
- Always keep the equipment, the workplace and the top drive clean. Before carrying out maintenance intervention, clean all the connections and the threaded joints of oil or grease. Do not use aggressive detergents.
   To clean, only use non-abrasive cloths.



### **WARNING**

The detergents must not damage the seals, etc. Before using detergents, check they are suitable for use.



### **HAZARD**

The electrical system can only resist sprays. When you clean the top drive with a high pressure cleaner, do not spray the electrical parts directly with a jet.

Water penetration can damage the electrical system on the winch. In extreme cases, this can also cause sudden and unexpected movement of the top drive. Never orientate the water jet on electrical modules or contacts.

- After cleaning, check all the tubing for any leaks, loose joints, abrasions or faults. Immediately eliminate any faults found.
- The re-used parts must be clean and then dried with a non-abrasive cloth or with compressed air (max. pressure 2 bar).

### F-1.4.2 DURING MAINTENANCE



### WARNING

Only the oils and lubricants specified by Drillmec and/or suitable for the purpose can be used. Non-compliance with this specification will make the warranty null and void.

- Check the oil levels
- Replace the oil.

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(i) IMPORTANT

Replace the oil in the gearbox at working temperature to enable any dirt in the oil to come out.



### **IMPORTANT**

Keep the oils and lubricants in a suitable container and dispose of as required.



### IMPORTANT

Clean the tubing with non-abrasive cloths only.

- If the oil leaks, determine the cause and immediately eliminate it.



### WARNING

During the oil change, synthetic oil must not be replaced with mineral oil.

- When assembling, replace the seals.
- Exchange defective hydraulic lines, pipes and hoses.
- Tighten the threaded joints only in the absence of pressure.



### **WARNING**

It is forbidden to change the values set on the pressure limiting valves without the prior authorisation of DRILLMEC.

- Check the fastening parts and replace with new ones, if necessary.
- Replace the faulty parts.
- Clean the filling holes and nozzles before filling. Once full, immediately close the holes with the specific
- Remove the guards and the protective plugs only before starting maintenance.
- When you remove the plugs, place dust-proof covers on the plugs and the machine.

### F-1.4.3 AFTER MAINTENANCE

- Check the seal on all lines, pipes and hoses.
- Restore all the protection devices and test top drive functioning.



### **IMPORTANT**

To dispose of detergents, components containing oil and waste oil, comply with legislation safeguarding the environment.



# F-2 PERIODIC MAINTENANCE SUMMARY

### F-2.1 LUBRICATION SCHEDULE

MAINTENANCE OPERATIONS -		Frequency						
LUBRICATION/GREASING	Daily	Weekly	3 months	6 months	Two years	Ref.		
Gear box - Check oil level	х					1		
Main drive unit (washpipe, gear box shafts, pins of counterbalance system links) - Centralized greasing	x					2		
Link tilt assembly -Greasing	х					4		
IBOP valve - Greasing	х					5		
Carriage (rollers, lateral pins) - Centralized greasing	x					3		
Gear wheel for adapter rotation - Greasing		х				6		
Link adapter - Greasing		х				7		
Oil filter gear box - Replacing			х			1		
Gear box - Replacing oil			х			1		



### **IMPORTANT**

The oil in the lubrication plant can be replaced with the frequency on the table, however, for better oil use control, analyses can be carried out on the oil parameters.



### **IMPORTANT**

For maintenance of the parts installed on the top drive not manufactured by Drillmec (electric motor, hydraulic control unit), refer to the manufacturer's manual.

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### F-2.2 INSPECTION PROGRAM



### **IMPORTANT**

The inspection intervals listed in the following table are based on normal working conditions. Some conditions (excess load, dusty or corrosive environment, extreme temperature, etc.) can justify more frequent maintenance intervals.

MAINTENANCE OPERATIONS -						
TESTING/CLEANING	Daily	Weekly	3 months	6 months	Two years	Ref.
Gear box magnetic rod - cleaning			x			1
IBOP valve - visual check	х					5
IBOP valve - functional test	х					5
Bolt tightening hold - check			х			
Top drive guides - check				х		
Gooseneck - check				х		8
Precharging the accumulators			х			9
Gear box - complete inspection					Х	1



### **IMPORTANT**

For maintenance of the parts installed on the top drive not manufactured by Drillmec (electric fan, hydraulic control unit), refer to the manufacturer's manual.



# F-2.3 MAINTENANCE LAYOUT

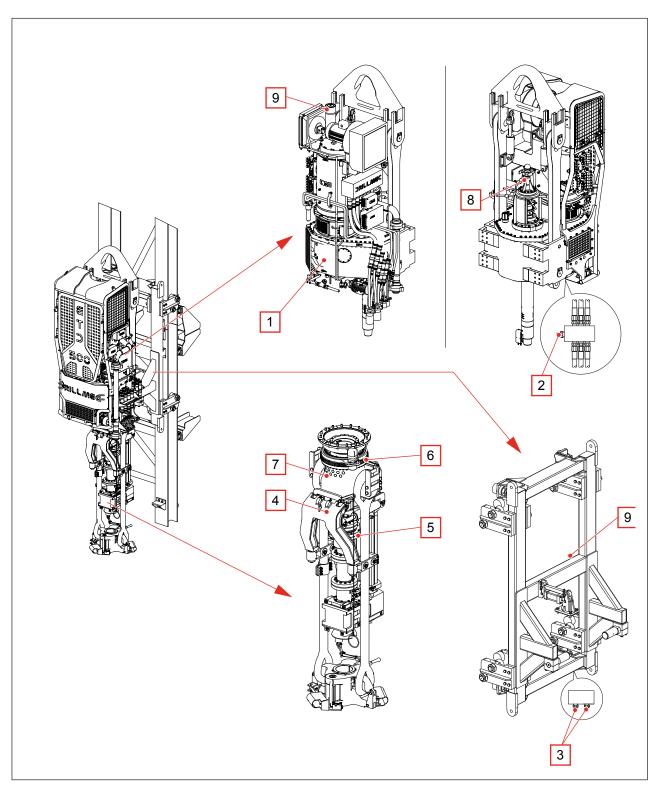


Fig. F-1

### F-2.4 OIL TYPES FOR TOP DRIVE

Component	Oil type	Quantity (I)
Gear box	SHELL SPIRAX S5 ATE 75W/90	173

### Typical physical characteristics

Property	Method	SHELL SPIRAX S5 ATE 75W/90
SAEViscosity	SAE J 306	75W-90
Density, kg/m³ at 15°C	ISO 12185	879
Kinematic Viscosity: cSt at 40°C mm²/s cSt at 100°C mm²/s	ISO 3104	81 14.9
Viscosity Index	ISO 2909	194
Dynamic Viscosity mPa s	ISO 9262	35000
Flash Point (COC) °C	ISO 5292	205
Pour Point °C	ISO 3016	-45



### **IMPORTANT**

For further information, refer to the technical data sheet for the oil, attached to this document.



### **IMPORTANT**

ALWAYS use oil suitable for environmental working conditions. The oil must freely drain at the minimum working temperatures.



### **IMPORTANT**

If you want to change the brand of oil, you are advised to empty and replace all the old oil. DRILLMEC S.p.A. suggests you avoid using equivalent oils.



### **IMPORTANT**

Do not mix mineral oil and synthetic oil when they don't have the same characteristics. This could cause FOAM which could have a negative influence on functioning of the various hydraulic components.



### **WARNING**

Do not mix oils with different characteristics!

This could cause malfunctioning or faults on the relevant mechanical units.



### F-2.5 GREASE TYPES FOR TOP DRIVE

For greasing use the SHELL GADUS S2 V220 2

Typical physical characteristics	
Consistency NLGI	2
Type of soap	Lithium
Type of base oil	Mineral
Kinematic viscosity: cSt a 40°C cSt a 100°C (IP 71/ASTM-D445)	220 19
Dropping point °C (IP 396)	180
Penetration worked @ 25°C 0.1 mm (IP 50/ASTM-D217)	265/295

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### **IMPORTANT**

For further information, refer to the technical data sheets for the grease, attached to this document.



### **WARNING**

Never mix different types of grease. Do not use low quality grease.

# F-3 LUBRICATION SYSTEM

The lubrication system is composed of an (1) independent circuit, specifically for lubrication of the entire gearbox and therefore the main shaft, of the intermediate shaft and motor shaft.

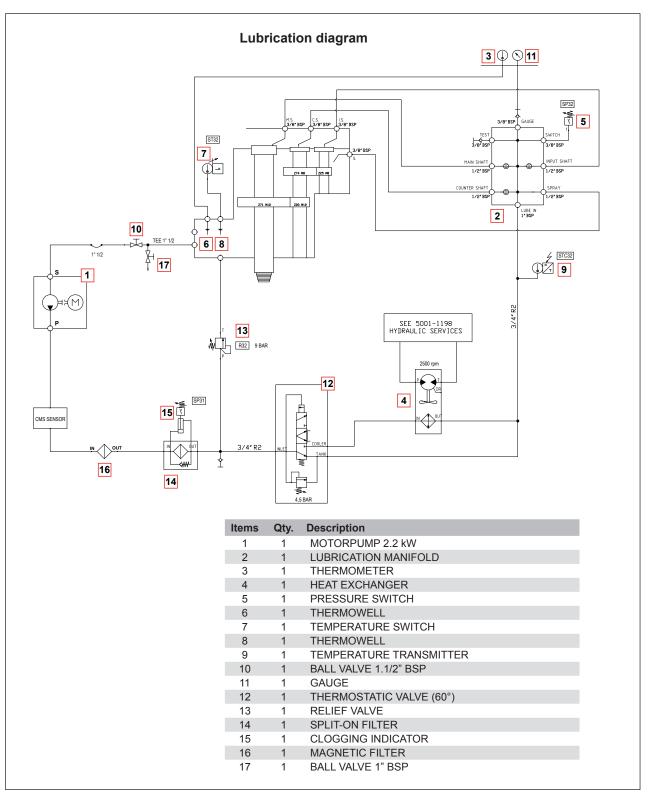


Fig. F-2



Isolate power and close all the lubrication and transmission system circuits and release pressure on the entire system when carrying out maintenance works on it.

Cleaning is highly important on all the systems and, to guarantee fault-free functioning, the maintenance time relating to the oil level control and replacement of the filter must be strictly met.

Maintenance of the lubrication system is mainly limited to the filters. The components of the system are not subject to maintenance; however a periodic visual check of pipe for leaks is required.

### F-4 **GEAR BOX OIL LEVEL** CHECK

To conduct an oil level control on the gear box, you need to place the machine in the working configuration, with the driving head in the easiest to access position. Check the oil level, possibly hot, using the specific oil level indicator A. The oil level must correspond to the halfway notch on the indicator. If necessary, top up.

Check the oil level every day to start the system.

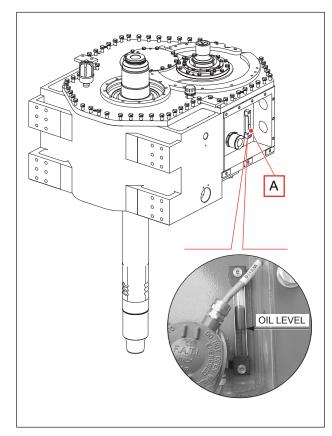


Fig. F-3

To change the oil, you need to place the machine in the working configuration, with the top drive in the easiest to access position.



### **IMPORTANT**

To facilitate oil drainage, you need to use warm oil. By doing so, you avoid depositing oily slime inside the box.

- Prepare an exhausted oil collection system to connect to the emptying plug C.
- Unscrew plug C and allow all the exhausted oil to flow out.



### **WARNING**

It is forbidden in any case to dispose of exhausted oil in the environment, since it poses a serious pollution threat.



### **IMPORTANT**

Carefully inspect, clean and dry the housing containing the oil before filling it again. It is of primary importance that there is no trace of water in the housing.

- Screw plug C back on and fill using the oil top-up
- Check the oil level using the level indicator A.

# **WARNING**

Never add oil beyond the maximum level.

### **WARNING**

During the operations described, it is good practice to work in maximum cleanliness, to avoid soil, dirt and impurities entering the housing and the circuit.

### **IMPORTANT**

Do not partially replace oil.

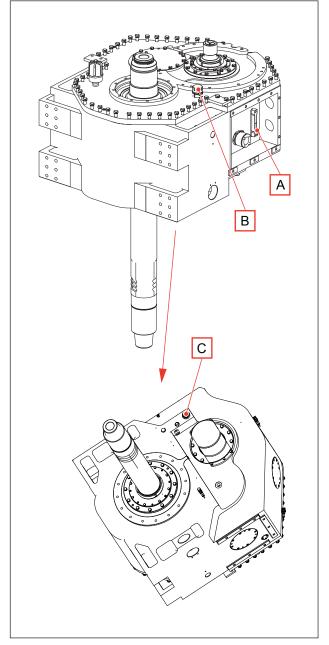
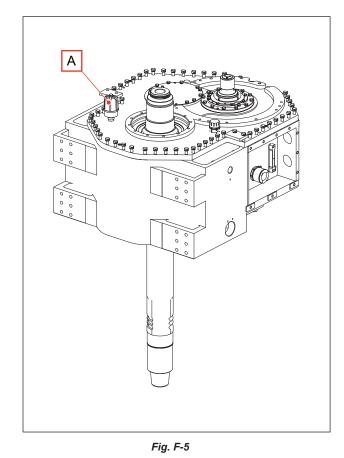


Fig. F-4

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### **GEAR BOX OIL FILTER** F-6 **REPLACEMENT**

Unscrew the filter positioned over the gear box. Drain the residual oil contained in the filter. Replace the filtering part.



### **GEAR BOX MAGNETIC ROD** F-7 **MAINTENANCE**

A magnetic rod is inserted on the bottom of the gearbox, to attract magnetic particles that could end up in the oil,

Clean the magnetic rod each time you replace the oil.



Allow sufficient cooling off time. Pipe work may also be hot.

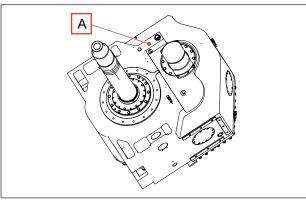


Fig. F-6

Washpipe 1 lubrication point

### F-8 **MAIN DRIVE UNIT -CENTRALIZED GREASING**

Use the block for centralized greasing for the components of the main drive unit.

Operation to execute with top drive into position more easily accessible.



Fig. F-7

Gear box shafts 3 lubrication points

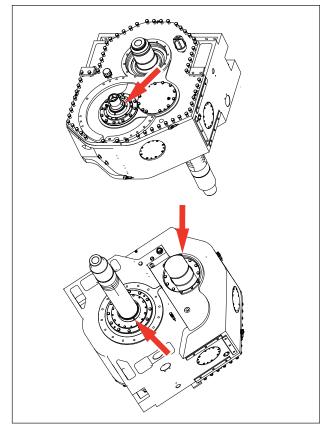
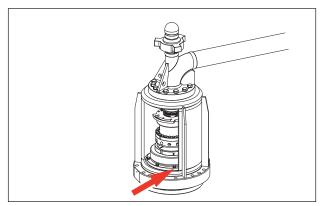


Fig. F-8



# Pins of counterbalance system links

2 lubrication points

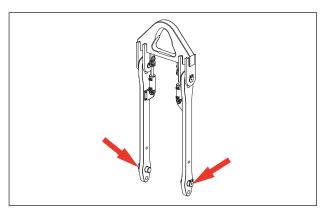


Fig. F-10

### **CARRIAGE - CENTRALIZED** F-9 **GREASING**

Use the block for centralized greasing for carriage. Operation to execute with top drive into position more easily accessible.



Fig. F-11

### Rollers and lateral pins

20 lubrication point for rollers and 2 lubrication pint for pins

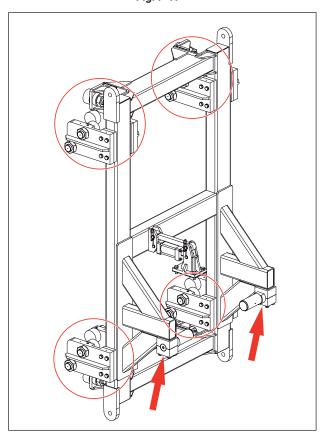
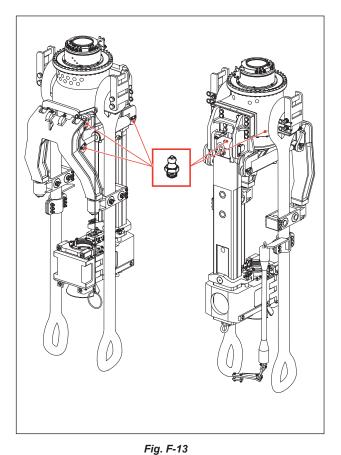


Fig. F-12

F-10 PIPE HANDLER GREASING

# Greasing of link tilt assembly

Grease the cylinders for the link tilt (4 lubricators, 2 for cylinder), the link adapter (2 lubricators) and the pin in the clamp.



### Greasing of link adapter

1 lubricator on the lower part of the link adapter.

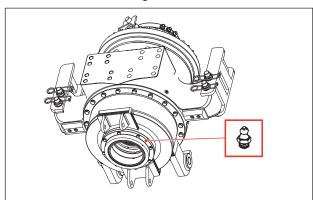
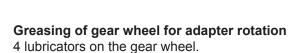


Fig. F-14



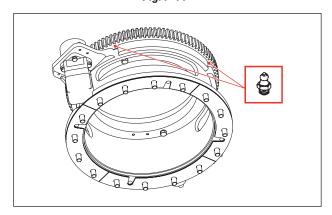


Fig. F-15



### IBOP valve greasing

Greasing of the automatic IBOP valve (2 lubricators, 1 for each leverage) and the connection bracket with the cylinders (2 lubricators).

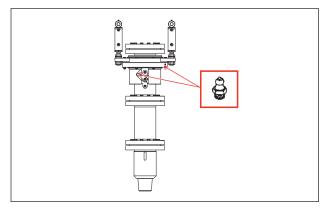
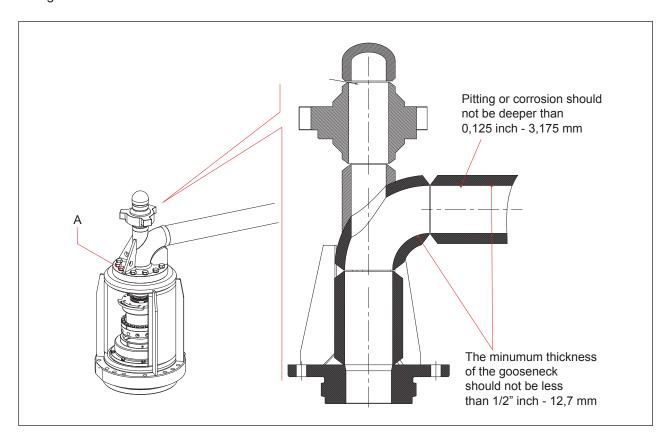


Fig. F-16

### F-11 TOP DRIVE INSPECTIONS

### F-11.1 GOOSENECK INSPECTION

- Unscrew the hammer lug connecting the flexible hose to the gooseneck.
- Unscrew the eleven bolts A connecting the gooseneck to the washpipe support
- Clean the bore of the gooseneck and inspect for visible signs of pitting, corrosion, or erosion.
- Remove and perform an ultrasonic inspection on the gooseneck if visual inspection indicates erosion or corrosion.
- Check condition of the seals.
- Apply pipe dope to the threads before re-installing.



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Fig. F-17

### F-11.2 PIPE HANDLER INSPECTION

Inspect the pipe handler installed on the lower part of the top drive, checking the pins and the holding systems are correctly installed.

Tighten the bolts if they are loose and replace each pin or safety latch that is missing or damaged.

The figure indicates the main parts of the pipe han-

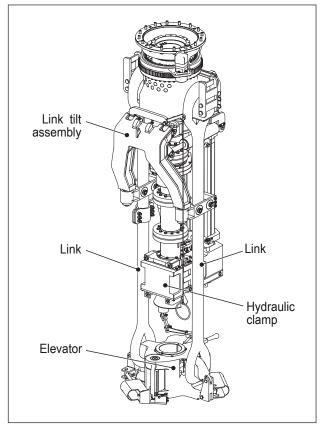


Fig. F-18

# F-11.3 TOP DRIVE GUIDES INSPECTIONS

Inspect the guides on the top drive, checking the pins and the supports are correctly installed. Tighten the bolts if they are loose and replace each pin or safety latch that is missing or damaged.

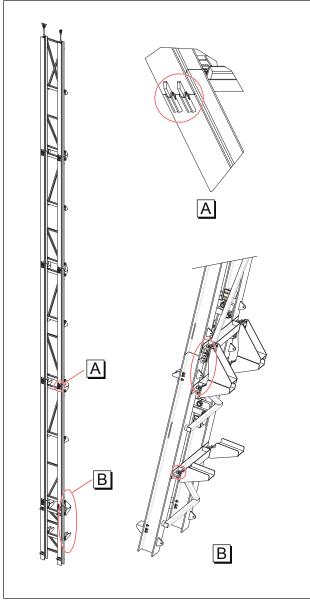


Fig. F-19



### **IMPORTANT**

Internal inspection must be carried out during the oil change, before filling.

Remove covers 1 and 2 placed on the side of the gear housing on the top drive and check the gear set backlash between the motor shaft and the intermediate shaft and then check the gear set backlash between the intermediate shaft and the main shaft (sleeve). Run a piece of solid wire solder through the primary and secondary gear meshes and measure the thickness of the two flat spots made by the gear teeth surfaces with a micrometer.

If the primary gear mesh backlash exceeds 0.030" or the secondary gear mesh backlash exceeds 0.040", excessive gear wear or bearing failure may be indicated.

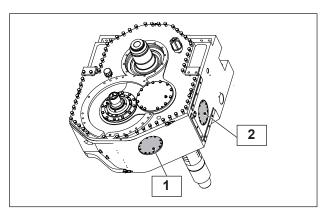


Fig. F-20

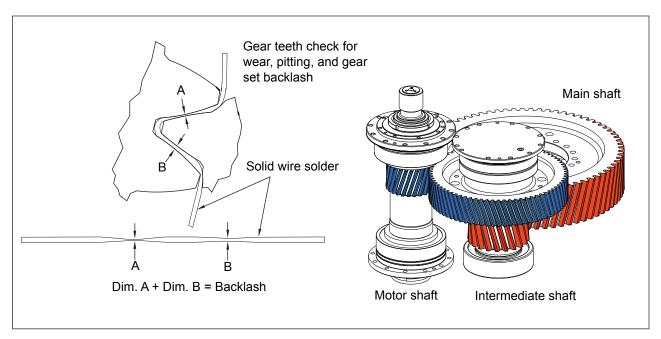


Fig. F-21

### **IMPORTANT**

Check the gear teeth for pitting or corrosive wear at the same time the gear set backlash is checked.

# **IMPORTANT**

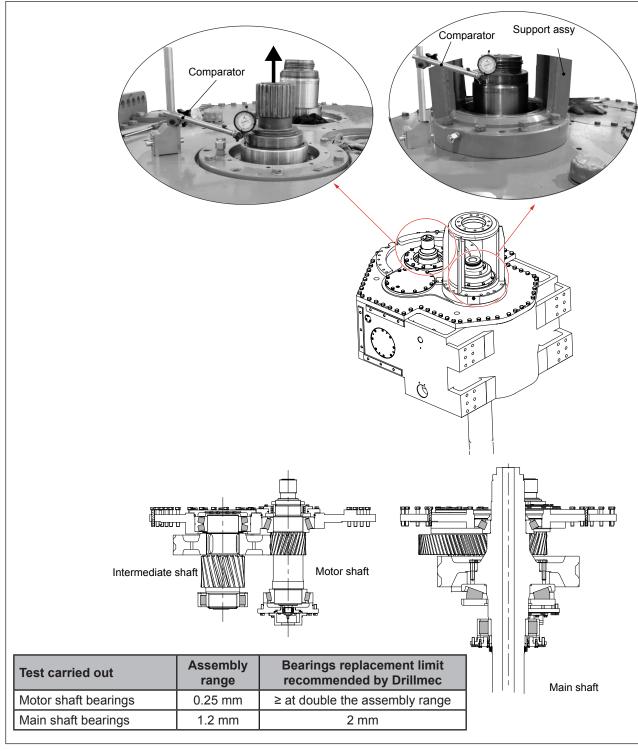
Record backlash data for future reference.

Once the inspection is complete, re-position the covers and fasten them with the specific screws.

# F-13 INSPECTING SHAFTS END PLAY

Check axial movement on the ends of the motor shaft by applying a force on the shaft upwards and measuring movement with a comparator.

Check axial movement on the ends of the main shaft by applying a force on the shaft upwards and measuring movement with a comparator.







You are advised to check axial movement of the main shaft after jarring operations.

# F-14 SHAFT BEARING REPLACEMENT

When you replace the bearings of the motor shaft, also check the bearings on the intermediate shaft and replace them, if necessary.

When replacing the main shaft bearings, axial movement of the shaft on assembly must be 1.2 mm. Before positioning the support assy and fastening it with the housing screws, insert the shims (as indicated in the figure) and measure the depth with a calliper. The bearing pre-loading pins in release exit the support assy flange by 1.5 mm.

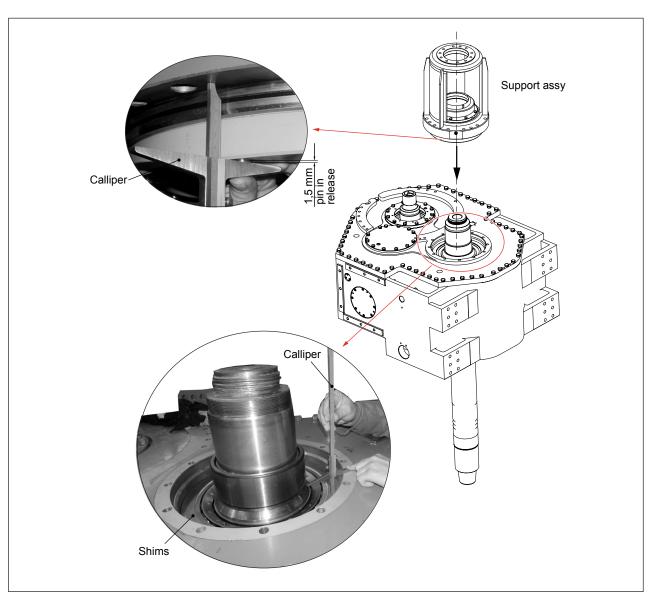


Fig. F-23

### F-15 HANDLING THE BEARINGS

Cylindrical and conical bearings are used on the top drive. The bearings are a precision part and require attentive management to guarantee a long working life and resistance to heavy loads, associated with antifriction bearings.

If the bearings are removed and must then be re-used, the innermost and outermost paths and the roller assemblies on each bearing must be held together and re-installed exactly as they were previously assembled.

It is always necessary to completely replace each faulty roller bearing, even if only part of the bearing is damaged. When the ranges of the stroke in these bearings is greatly reduced, an excessive range, worn or marked bearing rings, and any sign of damage or breakage on the parts means there is a fault and the entire bearing must be replaced as soon as possible.

Most of the roller bearings are assembled on their shaft through hot fitting. The damaged or worn bearings can be removed by guiding them out of the shaft with a bar or hammer. The bearings must always be heated in an oil bath or inductive heater with a temperature not exceeding 120 °C. Ensure the container and the oil are very clean. If the oil container comes in contact with fire, insert a container structure so the bearings don't stay on the bottom of it. Do not leave bearings in the oil bath for more than three minutes. Once the heated bearing is in position on the shaft, hold it still until it cools.



### Never use water or other liquids to cool a hot bearing.

Fast cooling can cause the surface of the paths and the rollers to loosen or break and the bearing becomes faulty.



### Never strike a roller bearing with a steel hammer.

If the bearing must be placed in position, use a copper or soft head hammer and gently strike.

If the innermost path of the bearing is positioned on a hydraulic press, use an assembly tube with an inner diameter slightly wider than the shaft and an external diameter that does not exceed the external diameter of the innermost path. The tube must have square faces on both ends, which must be extremely clean inside, and must be long enough to release the final part of the shaft after the bearing has been assembled.

If the outermost path of the bearing must be pressed into the compartment, the outermost diameter of the assembly tube must be slightly smaller than the compartment hole and the inner diameter not smaller than the inner diameter of the outermost path.

Always lubricate the shaft and the compartment before installing the bearing. The oil or an anti-galling mix is the best lubricant for this purpose.

Do not remove a new bearing from the box or packaging until it has to be installed. Protect from dirt and other foreign substances every time. If a bearing must be cleaned, use clean kerosene or another solvent.

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# F-16 PRECHARGING THE ACCUMULATORS

Accumulator	Setting	Port
Counterbalance accumulator	10 liter displacement (1261 psi/87 bar) precharge	AC
Cylinder alignment clamping block accumulator	2 liter displacement (536 psi/37 bar) precharge	PA



### **IMPORTANT**

Bleed the accumulator if the pressure is higher, or add nitrogen if the pressure is lower than specified above.

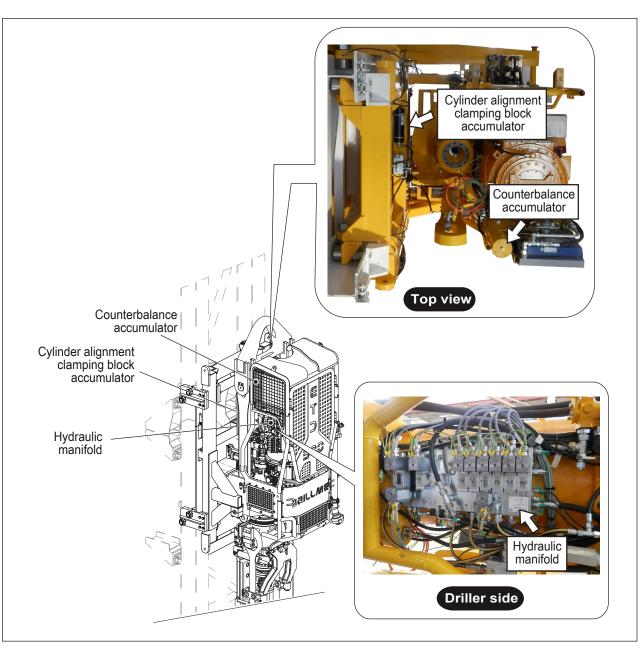


Fig. F-24

# **PROCEDURE**

- With the hydraulic system shut down test the hydraulic pressure at AC and PA on the hydraulic manifold, mounted to the driller side of the top drive.
- Verify that all two points measure 0 psi (0 bar).
- Disconnect the hydraulic lines to the accumulators and drain them of all hydraulic fluid.
- Test the precharge pressure on the following two nitrogen filled accumulators.

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# F-17 IBOP VALVE OPENING/ **CLOSING DEVICE ADJUSTMENT**

- Rotate the selector \$3 to "CLOSE" position to move the valve activation cylinders to end-of-stroke position (rod fully extended).
- The right and left IBOP mechanism must be rotated downward as illustrated in the figure F-26.
- Loosen the lock nuts (2) and the nuts (1) of both cylinders so that the sliding plate rests on the
- Place a spirit level over the sliding plate to verify its perfect horizontal position.
- While checking the perfect horizontal position of the flange, tighten the nuts (1) and the lock nuts (2) of both cylinders until locking the flange.



### **WARNING**

The sliding plate must be locked in perfect horizontal position.



### **IMPORTANT**

In case oil is lacking inside the hydraulic circuit, open the cylinders manually.

Test the mechanism multiple times to be sure that it works properly and check that the pressure inside the hydraulic cylinders is 30 bar (as indicated in the hydraulic diagram 5001-1198\_Y).

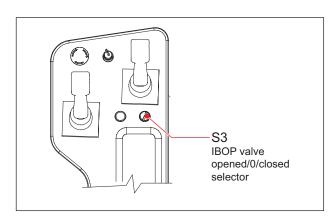


Fig. F-25

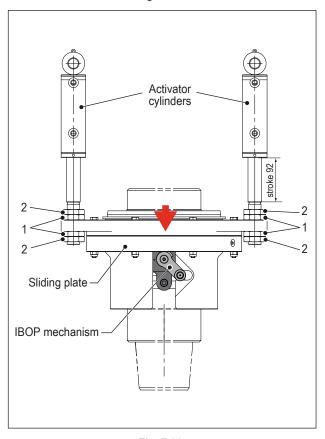


Fig. F-26



If one or both the IBOP mechanisms have to be replaced:

- Rotate the selector \$3 to "OPEN" position to close the valve activation cylinders (rod retracted) in such a way the sliding plate is positioned upward.
- Insert the body with the relevant lever (IBOP mechanism).
- Fasten the body using the screws (3).
- Proceed with mechanism calibration as per previous paragraph.



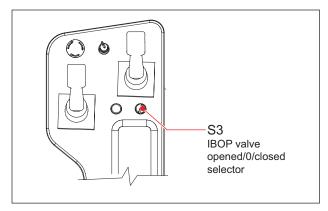
### **IMPORTANT**

In case oil is lacking inside the hydraulic circuit close the cylinders manually.

### F-17.1 IBOP VALVE FUNCTIONAL TEST

Verify that the IBOP valve closes within a time less than or equal to 3 seconds.

Rotating the selector **S3** to "CLOSE" position, verify that the cylinders move to the end-of-stroke position (rod fully extended) within a time less than or equal to 3 seconds.



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Fig. F-27

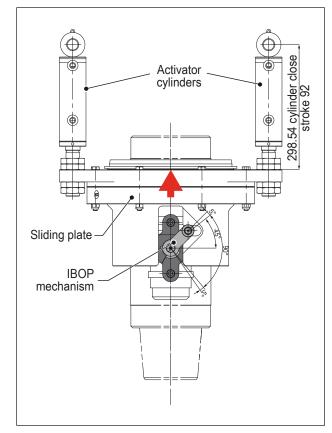


Fig. F-28

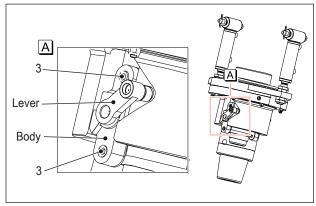


Fig. F-29

# F-18 ROTOR SEAL REPLACEMENT

If the rotor seal had to be replaced, it is necessary to:

- fill lines not used with hydraulic oil through a hand pump
- make the hydraulic connections as shown in the hydraulic diagram 5001-1198.

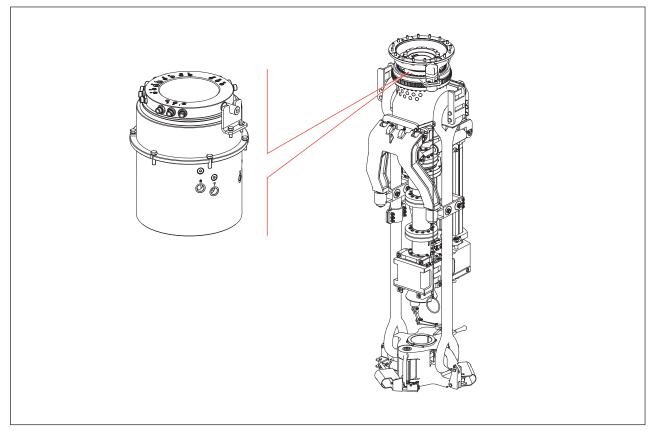


Fig. F-30



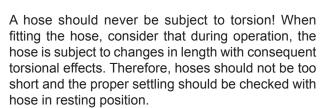
# F-19 BOLT TIGHTENING SPECIFICATIONS

	4.8	В	5.8	В	8.8	В	10.	9	12.	9
Diameter	0.7 Rs	= 224	0.7 Rs	= 280	0.7 Rs	= 448	0.7 Rs	= 630	0.7 Rs	= 756
x pitch	Pre- loaded	Torque								
mm	N	Nm	Ν	Nm	N	Nm	Ν	Nm	N	Nm
3 x 0.5	1130	0.67	1400	0.84	2550	1.5	3170	1.9	3800	2.3
4 x 0.7	1970	1.5	2500	1.9	3930	3.1	5530	4.3	6640	5.2
5 x 0.8	3180	3	4000	3.8	6360	6	8950	8.5	10700	10.1
6 x 1	4500	5.2	5600	6.5	9000	10.4	12700	14.6	15200	17.5
8 x 1.25	8200	12.3	10250	15.4	16400	24.6	23100	34.7	27700	41.6
8 x 1	8780	13	11000	16.3	17600	26	24700	36.6	29600	43.9
10 x 1.5	13000	25.1	16200	31.3	26000	50.1	36500	70.5	43900	84.6
10 x 1.25	13700	26.2	17100	32.7	27400	52.4	38500	73.6	46300	88.4
12 x 1.75	18900	42.4	23600	53	37800	84.4	53000	119	63700	143
12 x 1.25	20600	45.3	25800	56.6	41300	90.6	58000	127	69600	153
14 x 2	25800	67.4	32200	84.3	51500	135	72500	190	86900	228
14 x 1.5	28000	71.7	35000	89.6	56000	143	78800	202	94500	242
16 x 2	35200	102	44000	128	70300	205	98900	288	119000	346
16 x 1.5	27400	107	46800	134	74800	214	105000	302	126000	362
18 x 2.5	43000	142	53800	177	86000	283	121000	398	145000	478
18 x 1.5	48400	154	60500	193	96800	308	136000	434	163000	520
20 x 2.5	24900	200	68600	250	110000	400	154000	562	185000	674
20 x 1.5	60900	216	76200	270	122000	431	171000	607	206000	728
22 x 2.5	67900	266	84800	322	136000	532	191000	748	229000	897
22 x 1.5	74600	286	93200	357	149000	571	210000	803	252000	964
24 x 3	79100	345	98800	432	158000	691	222000	971	267000	1170
24 x 2	86000	365	108000	457	172000	731	242000	1030	290000	1230
27 x 3	10300	505	129000	631	206000	1010	289000	1420	347000	1700
27 x 2	111000	534	139000	667	222000	1070	312000	1500	375000	1800
30 x 3.5	126000	686	157000	854	251000	1370	353000	1930	424000	2310
30 x 2	139000	738	174000	923	278000	1480	391000	2080	469000	2490
33 x 3.5	155344	933	194180	1166	310688	1866	436905	2624	524286	3148
33 x 2	170240	994	212800	1243	340480	1989	478800	2797	574560	3356

# F-20 HOSE FITTING SPECIFICATIONS

For best operation of the hydraulic system, always keep in mind some important rules for hose fitting.

Hose fitting nuts shall be tighten until no leakage occurs through the coupling. Exceeding that point, does not improve tightness and damages the coupling!



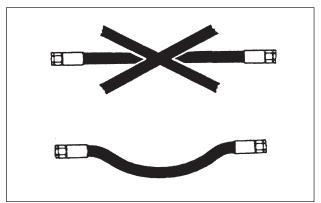


Fig. F-31

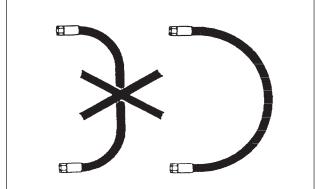


Fig. F-32

If hoses routing requires the hose to bend, make sure that the bending radius are correct.

A bending radius too small can cause restrictions in the section and therefore load losses. Moreover, these bends can cause torsional stress and even breakage of the hose!

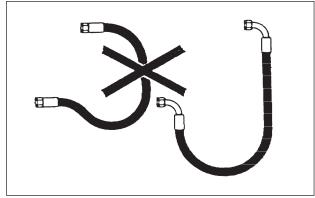


Fig. F-33

For correct fitting of hoses, elbow fitting can be used for installation in restricted space without impairing hose efficiency and life.

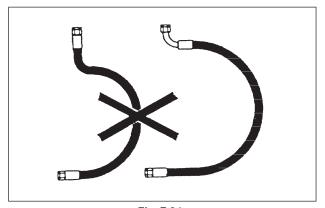


Fig. F-34



### F-20.1 STORING OF FLEXIBLE HOSES

### RECOMMENDATIONS FOR A CORRECT STORING

The rubber is subjected, by its nature, to changes in its physical properties. These changes, which normally take place in time, according to the used type of rubber, can be accelerated by a special factor or by a combination of factors. The reinforce materials are, in the same way, damaged by unproper storing conditions. The following recommendations contain some precautions to take in order to ensure the minimum wear of the stored goods.

Operation and Maintenance Manual

### STORING TIME

The storing time should be minimized by means of a scheduled rotation program. When it is not possible to avoid long storing times and when the following recommendations are not respected, it is necessary to accurately check the hose before using it.

### **TEMPERATURE AND HUMIDITY**

The best temperature for the storing of the rubber hoses is between 10 to 25 degrees centigrade. The hoses should not be hold stored with temperature higher than 40°C or lower than 0°C. When the temperature is under -15°C, it is necessary to keep precautions when handling the hoses. The hoses must not be stored near to heat sources nor in conditions of high or low humidity. A maximum level of humidity of 65% is recommended.

The hoses must be stored in obscured places, avoiding the direct exposition to the sunlight or to strong artificial lights. If the store has some glass windows or doors, these must be obscured.

### **OXYGEN AND NITROGEN**

The hoses must be protected against the air by a proper package or by storing them into airtight containers. As the nitrogen has a particularly aggressive action over all the rubber products, the storehouse must not contain materials that emit nitrogen, like equipment under high voltage, electrical motors or other materials which generate sparks or magnetic fields.

### **CONTACTS WITH OTHER MATERIALS**

The hoses must not be in contact with solvents, fuels, oils, greases, volatile chemical compounds, acids, disinfectants and other organic liquids in general. Moreover, the direct contact with some metals (for example manganese, iron, copper and its alloys) and relevant compounds causes harmful effects on some types of rubber. Contacts with PVC and wood or fabrics soaked of creosote must be avoided.

### **HEAT SOURCES**

When the temperature limits cannot be respected, it is necessary to use a thermal protection.

### **ELECTRIC OR MAGNETIC FIELDS**

The variations of the electric or magnetic fields must be removed in the storehouses because that could cause currents in the metallic connections, heating them. Similar fields could be caused by high-voltage wires or by high-frequency generators.

### STORING CONDITIONS

The hoses must be stored in easy conditions, free from stretches, compressions or other deformations and contacts must be avoided with objects that could cut or drill them.

It is preferable to store the hoses on special shelvings or dry surfaces.

The packaged hoses must be stored in horizontal position avoiding to stack them. When this is not possible, the height of the stacks must be such to avoid permanent deformations of the hoses placed at the bottom. The inner diameter of the package must never be lower than the double of the curvature radius declared by the manufacturer in compliance with the technical standards. It is suggested to avoid to store the packages of hoses on rods or hooks. It is suggested, moreover, to store the hoses, which are delivered straight, in horizontal position without bending them.

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### **RODENTS AND INSECTS**

The hoses must be protected against rodents and insects. When this risk is probable, proper precautions must be taken.

### F-20.2 NORMS AND METHODS OF USE OF THE FLEXIBLE HOSES

### PRE-ASSEMBLY CHECKS

Before the installation after a replacement, it is necessary to accurately check the hose characteristics to verify that type, diameter and length are in compliance with the required specifications. Moreover, a visual check must be executed in order to ensure that there are not obstructions, cuts, damaged cover or any other evident imperfections.

### **HANDLING**

The hoses must be handled with care avoiding shocks, draggings on abrasive surfaces and compressions. The hoses must not be pulled with violence when are twisted or contorted. The heavy hoses, generally delivered in horizontal straight position, must be placed over proper supports for the transport.

If wooden supports are used, these must not be treated with creasote or painted with substances which could damage the rubber.

### PRESSURE AND SEALING TEST

The operating pressure, generally marked on the hoses, must be respected. After the installation, when the air balls have been removed, gradually increase the pressure up to the operating pressure to test the assembly and check possible leaks.

### **TEMPERATURE**

The hoses must be always used within the generally pointed out temperature ranges. In case of doubts, call the manufacturer.

### TRANSPORTED PRODUCTS

The hoses must be used for the transport of substances, which they have been manufactured for. In case of doubts, call the manufacturer. As much as possible, the hoses must not be kept under pressure when they are not used.

### **ENVIRONMENTAL CONDITIONS**

The hoses must be used only in the environmental conditions which they have been manufactured for.

### **TORSION**

The hoses have not been manufactured to work in torsion, except for specific purpose.

### **STRETCH**

The stretch must be within the limits specified by the manufacturer.

### **VIBRATIONS**

The vibrations subject the hoses to the stress and to the heat, above all near the joints and premature explosions can occur. It is then suggested to check that the hoses have been manufactured to withstand these stresses.

### **CUSPS**

Some users blocks the passage of the liquid thought the hose creating cusps in it. This method is not suggested by the manufacturers, as the reinforcement is subjected to an excessive stress that could bring to explosion.

### F-20.3 MAINTENANCE OF THE FLEXIBLE HOSES

### **MAINTENANCE**

The frequency of the hose maintenance is determinated depending on the use of the hose. In the normal checks, special care must be taken on the connections and on the presence of the following irregularities that point out the deterioration of the hose:

- fissures, cuts, scraps, ungluing, tearings of the cover that make the reinforcement visible;
- deformations, balls, local bulges in pressure;
- hardened or too tender parts;
- leaks.

These irregularities justify the replacement of the hose.

When the cover reports the expiry date, this must be respected even if the hose does not show evident signs of deterioration.

### **REPAIRS**

The repairs are not suggested. However, if the deterioration is placed at one edge of the hose, this can be

### **CLEANING**

Clean, if necessary, by soap and water avoiding the use of solvents (petroleum, paraffin, etc) or detergents. Never use abrasive, sharpened or cutting tools (metallic brushes) for the cleaning.

# F-20.4 RECOMMENDED TEST SCOPE "VISUAL INSPECTION" (PRIOR TO INITIAL SETTING INTO OPERATION OR PUTTING BACK INTO OPERATION)

- Is all information for use available which is required for the safe operation of the hydraulic plant (e.g. hydraulic plan, parts list, description of the plant, drawings, operating / maintenance instructions, hydrostore documents, safety data sheets for the hydraulic fluid being used etc.)?
- Do the hydraulic hose assemblies correspond to the hydraulic plan and to the parts list and the description of the plant (including the hydraulic fluid being used)?
- Have safety measures been taken for the case of exceptionally high pressure impacts or pressure increases, such as for example, pressure control valves?
- Are the individual hoses of the hydraulic hose assembly marked with the name or a short designation of manufacturer, EN-number and type (pressure level), nominal diameter, quarter/year of manufacture? (s. DIN EN 982, [12])
- Are hydraulic hose assemblies individually marked on the fittings with the name or a short designation of the manufacturer, the max. admissible operating pressure, month and year of manufacture?
- Are hydraulic hose assemblies installed in such a way, that according to DIN 20066 [7]?
- The natural position does not obstruct the movement.
- A torsion of the hose, a tensile load due to a line which is too short, or a bending radius which is too low are all avoided.
- The hose is led by buckling protection (if applicable at the connection element);
- External mechanical influences or abrasion at the edges are avoided by sufficient distance;
- Damage by running over is avoided by means of hose bridges;
- Loosely installed hose assemblies are protected by hose guiding devices (such as hose brackets and
- A thermal protection (shielding) protects from high temperatures?
- With regard to their installation location, are the hydraulic hose assemblies designed and arranged in such a way, that they:
- Cannot be mixed-up and are unambiguously and durably marked;

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- Are protected against any foreseeable damage, e.g. mechanical or due to environmental influences such as cooling lubricants;
- Do not impair maintenance of the work equipment?
- Are hydraulic hose assemblies which are used in areas of high-level requirements, (e.g. holding up a load) protected against hose break?
- Are hydraulic hose assemblies which in case of failure may generate hazards due to whiplash or escape of hydraulic fluid provided with suitable protective measures, such as fastening, capturing device or shielding?
- Are the hydraulic hose assemblies installed in such a way that they cannot be used as a ladder or means for access?
- Do the hydraulic hose assemblies of the initially operated or reoperated machines already show damages? If damages have been detected
- Have the installed hydraulic hose assemblies or hoses exceeded the period of storage or use, recommended by the individual manufacturer
- Are the hydraulic hose assemblies over-lacquered (over painted)?
- Does the operating manual state testing intervals? If so, what?

Note: The hydraulic hose assemblies being installed shall not consist of hoses which have already been used as part of a hose assembly before! (s. DIN EN 982, no. 5.3.4.3).

# F-20.5 RECOMMENDED TEST SCOPE "FUNCTIONAL TESTING" (PRIOR TO INITIAL SETTING INTO OPERATION OR PUTTING BACK INTO OPERATION)

- Does the hydraulic control system fulfil the intended function and comply with the plant description?
- Is there an indication by acoustic signals or similar indicating extremely high pressure impact or pressure increase for the hydraulic hose assembly for all required machine functions during the intended machine operation?

All parts of the hydraulic plant shall be tested with the intended maximum operating pressure which can be reached in all intended applications:

Have measurable leakages been detected at the hydraulic hose assembly and connection elements? Did all hydraulic hose assemblies withstand the pressure?

Are there spots of abrasion due to hydraulic hose assemblies moving under operation conditions?

# F-20.6 RECOMMEND TEST SCOPE "FOR SAFE PROVISION AND USE" (RECURRENT OR EXTRAORDINARY TEST)

- Is the information for use (operating instructions, hydraulic plan, parts list etc.) from the manufacturer still complete and available?
- Do the conditions of use and environmental conditions of the machine still comply with the initial intended use of the machine?

(This requires consideration of for example: kind of product, cycle times, number of pieces produced, hydraulic pressures and volume / flows temperatures, hydraulic fluid(s) used, speeds/ stopping times of hazardous movements, moved/ upheld masses, loading and unloading method of workpieces, place of installation, external influences (e.g. vibration, humidity, pollution by oil, UV-radiation, mechanical influences, ambient temperature etc.), position of transport ways and kind of transport means being used (hazards of damage), location and access for operation and maintenance, arrangement and assembly of additional equipment, interaction/ link with other machinery).

Have the above mentioned preconditions changed, which previously formed the basis for specifying a defined duration of use of the hydraulic hose assembly? If so, have the testing periods and replacement intervals been considered accordingly and if necessary, been changed?

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- Are the markings at the hydraulic hose assemblies still existent and legible?
- Do the hydraulic hose assemblies show any deficiencies indicated?
- Are the safety measures against whiplash hazard and/or escape of hydraulic fluid at the relevant hydraulic hose assemblies still existent respectively installed?
- Have the periods for recurrent tests at the hydraulic hose assemblies been specified and kept? If required, the periods have to be specified by the user and the required tests have to be carried out or arranged for.
- Have the intervals for replacement recommended by the manufacturer respectively the maximum duration of use specified by the user for hydraulic hose assemblies been taken into account?
- Have shortened test intervals been established, e.g. to biannually or quarterly (instead of yearly or biannually) in case of intended prolonged duration of use of hydraulic hose assemblies?
- In case of modifications at the machine and in the hydraulic plant (control and equipment) as well as after extensive maintenance work, in particular if this involves the new installation of hydraulic hose assemblies, a relevant test for "proper assembly and safe function"
- Have those modifications been recorded and have they been considered in the machine documentation?

### F-20.7 RECOMMENDED TEST CRITERIA FOR HYDRAULIC HOSE ASSEMBLIES

- Damage at the outer layer to the reinforcement? (abrasion spots, cuts, cracks);
- Embrittlement of outer layer (crack formation of the hose material);
- Deformations, which do not correspond to the original shape of the hydraulic hose assembly, in the nonpressure state or in the pressurized state or in case of bending e.g. separation of layers, formation of bubbles, squeeze points, buckling points;
- Leakages at the hose, hose assembly or fittings;
- Disentanglement of the hose out of the fittings;
- Damaging or deformation of fittings which reduces the function and strength of the fittings or the connection of hose-fittings;
- Corrosion of fittings, reducing the function and strength;
- Do hydraulic hose assemblies have freedom of movement, or has there been formation of squeeze, shearing or abrasion points due to the assembly of new plant parts or aggregates?
- Do hydraulic hose assemblies protrude into traffic routes, even if the aggregates being coupled with the hydraulic hose assemblies are operated to the final position?
- Have hydraulic hose assemblies been over-lacquered (over painted (explanation: no detection of marks and cracks)?
- Have storage periods and durations of use been exceeded?
- Have all coverings been re-installed and are they active (after testing, relocation, rearrangement)?
- Are there additional tear-off protections existent or required?

### F-20.8 FACTORS INFLUENCING THE TEST PERIODS

- Hazards which may occur when using the work equipment for all relevant operation procedures (basis: hazard evaluation);
- Increased requirements for safety (such as holding of loads in particular gravity-loaded axes) e.g. due to the protection concept of the machinery manufacturer and provisions for shortened periods in the operation manual;
- Conditions of use of work equipment and hydraulic plant (e.g. particular loads, conditions with defined overload, operating times, operation parameters, influence of the hydraulic fluid being used);

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- Environmental conditions (damaging external influences such as vibration, humidity, pollution, mechanical influences, ozone generation by electric motors or welding transformers) and more, s. table 3);
- Comparison, whether the actual operating conditions / conditions of use comply with those conditions stated by the manufacturer at acquisition;
- General manufacturer's information (of machinery manufacturer or the manufacturer of the hydraulic hose assemblies) with regard to test intervals:
- Age respectively rate of wear of the work equipment or of the hydraulic hose assembly;
- Prolongation of replacement intervals;
- Kind and system by means of which the intended maintenance is carried out, in particular for safety relevant components and wear parts;
- Experience made by the users / set-up/ maintenance personnel with the work equipment and the hydraulic plant (with regard to failure behaviour, occurrence of defects, interruptions, increase of such events);
- Evaluation of results from the visual and function inspection prior to the daily use of the machine;
- Any known accidents at comparable machines or hydraulic plants;
- Evaluation of test results of recurrent tests at those hydraulic hose assemblies or those being operated under comparable conditions;
- Test results prior to commissioning.

### F-20.9 RECOMMENDED TEST PERIODS

Requirements for hydraulic hose assembly	Recommended test period
Normal requirements	12 months
Increased requirements for safety, e.g. due to: - increased operating times (e.g. multiple-shift operation); - strong external influences; - intended prolonged duration of use; - (replacement intervals, see. chapter 3.5) or - provisions stated by the machine manufacturer for particular gravity-loaded axes.	

# F-20.10 INFLUENCING FACTORS WITH REGARD TO THE REPLACEMENT **INTERVALS**

- Statements or instructions given by the manufacturer of the hydraulic hose assemblies or the machinery manufacturer, particularly provisions given by the manufacturer for gravity-loaded axes;
- Conditions of use and environment;
- Hazards due to hydraulic fluid, the pipe itself or a hazardous machine or load movement in case of damage or break of the hose assembly;
- Test and empirical values of the machinery manufacturer or the user;
- Secondary protective measures against hazards in case of failure of the hose assembly, e. g. covering, line break protection;
- Proper execution of tests with regard to the safe operational state in adequately determined time intervals, (if necessary shortened) by a competent person.

# F-20.11 RECOMMENDED REPLACEMENT INTERVALS

Requirements for the hydraulic hose assembly	Recommended replacement intervals
Normal requirements	6 years
<ul> <li>Increased requirements for safety, e.g. by:</li> <li>increased operating times (e. g. multiple-shift operation);</li> <li>strong external influences;</li> <li>provisions stated by the machine manufacturer for particular gravity-loaded axes.</li> </ul>	2 years

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