8.4 Types of malfunction

The following tables show an excerpt of possible malfunctions with the respective possible causes.

A measure in the remedies column is only specified if the cause itself does not explain the measure.

➡ Observe the following information:

- Chapter *Maintenance*.

8.4.1 Types of malfunctions, hydraulic systems

Source The contents of the following malfunction tables are to a large extent based on the specifications/recommendations taken from the "Information of the Employers' Liability Insurance Association on safety and health at the workplace" (BGI 5100).

Excessive noise		
Malfunction	**Possible cause**	**Remedy**
Mechanical drive components	Incorrectly aligned coupling	
	Coupling loose	
	Defective coupling	
	Loose motor and/or pump fastening	
	Other transmission elements defective (V-belt, toothed belt)	
	Wrong direction of rotation	
Suction conditions	Excessive resistance in suction line due to: ▪ Clogged hydraulic filter ▪ Stop cock in suction line closed or only partially open ▪ Clogged or leaking suction line ▪ Excessively low liquid level	Replace hydraulic filter cartridge

Troubleshooting and remedies

Excessive noise		
Malfunction	**Possible cause**	**Remedy**
Pump	Oscillating controller system	Replace regulator
	Excessive pump speed	Reduce rotational speed
	Feed pump defective	
	Defective shaft seals or seals on the suction side	
	Pump defective	
	Feed line and return line mixed up	
Pressure line	Pipe fastening missing or loose	
	Plant/machine not properly vented	
Return line	Clogged hydraulic filter	Replace hydraulic filter cartridge
	Pipe fastening missing or loose	
	Plant/machine not properly vented	
	Return line ends above the liquid level	
Pressure valves	Valve chatters due to contaminated/worn valve seat	Replace valve
Flow control valves	Valve vibrates and stimulates others to vibrate	Replace valve
Solenoid valves	Flow volume too high	Check settings according to diagram
	Control pressure fluctuations	Check accumulator, if applicable
	Valve chatters due to defective solenoid or voltage too low	
	Valve defective due to wear or dirt	
	Valves with adjustable dampening: Dampening not adjusted	
Hydraulic fluid	Foaming of fluid	Check fluid level
	Fluid contaminated, thus causing damage to/clogging of equipment	Take oil sample, replace hydraulic filter cartridges, recover purity class acc. to diagram

Excessive noise		
Malfunction	**Possible cause**	**Remedy**
	Suction issues due to insufficient fluid level	
	Suction problems as viscosity too high (temperature too low)	
Drive (motor, cylinder)	Wear of running surface	

Insufficient forces and torques at the output sides (insufficient pressure)		
Malfunction	**Possible cause**	**Remedy**
Mechanical drive components	Power transmission defective	
	Slipping of V-belt or toothed	
	Wrong direction of rotation	
	Key on pump or motor sheared off	
	Motor defective	
Suction conditions	Excessive resistance in suction line due to: ▪ Clogged hydraulic filter ▪ Stop cock in suction line closed or only partially open ▪ Clogged or leaking suction line ▪ Excessively low liquid level	Replace hydraulic filter cartridge
Pump	Inner leakage quantities due to wear	
	Pump defective	
	Limiting pressure set too low or controller device defective	
Pressure line	Excessive line resistance	Check temperature of the fluid
	Clogged hydraulic filter	Replace hydraulic filter cartridge
	Leaks	
Return line	Excessive resistor	Possibly excessive ambient temperature
	Clogged hydraulic filter	Replace hydraulic filter cartridge
Pressure valves	Operating pressure set at an exces-	

Troubleshooting and remedies

Insufficient forces and torques at the output sides (insufficient pressure)		
Malfunction	Possible cause	Remedy
	sively low value	
	Internal leakage due to wear	
	Valve seat contaminated or damaged	
	Spring broken	
Flow control valves	Pressure losses too high	
	Incorrect setting	
	Defective valve	
Solenoid valves	Incorrect switching position (e.g. pressureless circulation does not switch off)	Check valve (valve possibly blocked) or check electrical actuation
	Solenoid defective	
	Internal leakage due to wear	
	Slide valve jammed	
Hydraulic fluid	Foaming of fluid	Check fluid level
	Viscosity too low and therefore leakage too high	Check heating and cooling system
	Viscosity too high: excessive flow resistance	Check heating and cooling system
Drive (motor, cylinder)	Excessive internal friction (poor operating efficiency)	Replace seals
	Internal leakage (e.g. worn cylinder collars)	Replace seals
	Wear of running surface	Replace cylinder
Other	Errors in the closed- or open-loop control circuit of pressure control systems	
	Defective display instrument	

Jerky cylinder or motor movements (pressure and delivery volume fluctuations)		
Malfunction	**Possible cause**	**Remedy**
Mechanical drive components	Incorrectly aligned coupling	
	Coupling loose	
	Defective coupling	
	Loose motor and/or pump fastening	
	Other transmission elements defective (V-belt, toothed belt)	
	Pump or motor defective	
	Wrong direction of rotation	
Suction conditions	Excessive resistance in suction line due to: ▪ Clogged hydraulic filter ▪ Stop cock in suction line closed or only partially open ▪ Clogged or leaking suction line ▪ Excessively low liquid level	Replace hydraulic filter cartridge
Pump	Controller of variable pumps defective	
	Pump defective	
Pressure line	Plant/machine not properly vented	
Return line	Hydraulic filter clogged	Replace hydraulic filter cartridge
	Excessive line resistance	Possibly excessive ambient temperature
	Leaks	
Pressure valves	Valve chatters due to contaminated/worn valve seat	Replace valve
Flow control valves	Valve contaminated	
	Wrong direction of rotation	
Solenoid valves	Control pressure fluctuations	Check accumulator, if applicable
	Valve chatters due to defective solenoid or voltage too low	

Troubleshooting and remedies

Jerky cylinder or motor movements (pressure and delivery volume fluctuations)		
Malfunction	**Possible cause**	**Remedy**
	Valve defective due to wear or dirt	
	Valves with adjustable dampening: dampening not adjusted	
Hydraulic fluid	Foaming of hydraulic fluid	Check fluid level
	Hydraulic fluid contaminated	Take oil sample, replace hydraulic filter cartridges, recover purity class acc. to diagram
Drive (motor, cylinder)	Stick-slip effect	Check seals
	Required min. speed of hydraulic motor not reached	Check settings

Cylinder or motor does not run or runs too slowly (no or insufficient delivery volume)		
Malfunction	**Possible cause**	**Remedy**
Mechanical drive components	Incorrectly aligned coupling	
	Coupling loose	
	Defective coupling	
	Loose motor and/or pump fastening	
	Other transmission elements defective (V-belt, toothed belt)	
	Pump or motor defective	
	Wrong direction of rotation	
Suction conditions	Excessive resistance in suction line due to: ▪ Clogged hydraulic filter ▪ Stop cock in suction line closed or only partially open ▪ Clogged or leaking suction line ▪ Excessively low liquid level	Replace hydraulic filter cartridge

Cylinder or motor does not run or runs too slowly (no or insufficient delivery volume)		
Malfunction	**Possible cause**	**Remedy**
Pump	Inner leakage quantities due to wear	
	Pump defective	
	Feed line and return line mixed up	
Pressure line	Excessive line resistance	Check temperature of the fluid
	Clogged hydraulic filter	Replace hydraulic filter cartridge
	Leaks	
Return line	Hydraulic filter clogged	Replace hydraulic filter cartridge
	Excessive line resistance	Possibly excessive ambient temperature
Pressure valves	Operating pressure set at an excessively low value	
	Internal leakage due to wear	
	Valve seat contaminated or damaged	
	Spring broken	
	In sequence control: sequence valve set too high or defective	
Flow control valves	Set at excessively low flow rate	
	Valve clogged (contaminated)	
Solenoid valves	Incorrect switching position (e.g. depressurized circulation does not switch off)	Check valve (valve possibly blocked) or check electrical actuation
	Solenoid defective	
	Internal leakage due to wear	
	Slide valve jammed	

Troubleshooting and remedies

Cylinder or motor does not run or runs too slowly (no or insufficient delivery volume)		
Malfunction	**Possible cause**	**Remedy**
	Manually actuated valves (stop-cocks) not in straight-flow position	
Hydraulic fluid	Foaming of fluid	Check fluid level
	Viscosity too high: excessive flow resistance	Check heating and cooling system
	Viscosity too low and therefore leakage too high	Check heating and cooling system
Drive (motor, cylinder)	Excessive internal friction (poor operating efficiency)	Replace seals
	Internal leakage (e.g. worn cylinder collars)	Replace seals
	Wear of running surface	Replace cylinder
	Output blocked (e.g. binding of piston)	Replace cylinder
Other	Preconditions for starting not fulfilled (controller) defective. Electric control line (connector) interrupted. Signal elements (e.g. pressure switch incorrectly set or defective: limit switch is not approached)	

Excessive operating temperature		
Malfunction	**Possible cause**	**Remedy**
Pump	Efficiency losses due to wear	
	Controller of variable pumps defective	
	Excessive speed and/or delivery volume	
Pressure valves	Excessively high continuous delivery volume	Check settings
Flow control valves	Set at excessively low flow rate	
	Defective valve	

Excessive operating temperature		
Malfunction	**Possible cause**	**Remedy**
Flow control valves Flow control valves	Set at excessively low flow rate	
	Defective valve	
	Set at excessively low flow rate	
Hydraulic fluid	Foaming of fluid	Check fluid level
	Viscosity too low and therefore leakage too high	Check heating and cooling system
	Viscosity too high: excessive flow resistance	Check heating and cooling system
Drive (motor, cylinder)	Efficiency loss due to wear	
	Excessive internal friction (poor operating efficiency)	Replace seals
	Inner leakage losses	Replace seals
Other	Cooling water temperature too high	Check water supply and treatment system
	Deposits in the cooler	Clean cooler
	Inadequate hydraulic fluid in the plant/machine	
	Cooling water control valve does not switch	
	Thermostat set too high	
	Failure of cooling water supply or failure of the fan	
	Excessive ambient temperature	
	Insufficient heat radiation due to encapsulation	

Foaming of the hydraulic fluid		
Malfunction	**Possible cause**	**Remedy**
Suction conditions	Suction line leaking	
	Excessively low liquid level	

Troubleshooting and remedies

Foaming of the hydraulic fluid		
Malfunction	**Possible cause**	**Remedy**
Pump	Defective shaft seals or seals on the suction side	
	Leak oil line not below oil level	
Hydraulic fluid	Unsuited make	

Cylinder overtravel		
Malfunction	**Possible cause**	**Remedy**
Pressure line	Hoseline too flexible	
	Lines not vented	
Solenoid valves	Switching speed too slow	Check settings
	Solenoid defective, leakage quantities	
	Valve contaminated	
Drive (motor, cylinder)	Inner leakage quantities	
	Insufficient ventilation	
Hydraulic fluid	Pilot-operated check valve does not close immediately, due to ▪ Defective or soiled seat ▪ Switching/circuit error	
	Limit switch is overrun	

Lines hammering during switching operations		
Malfunction	**Possible cause**	**Remedy**
Pressure line	Pipe fastening missing or loose	
	Plant/machine not properly vented	
Return line	Lines are loose	
Pressure valves	Throttles or orifice plates are damaged	
Solenoid valve	Switching time set too fast	
Hydraulic fluid	Foaming of hydraulic fluid	Check fluid level, vent

Frequency of switching on and shutting off of the pump		
Malfunction	**Possible cause**	**Remedy**
Pressure valves	Sequence valve or shut-off valve incorrectly set or defective	
Other	With intermittently operated plants/machines with pressure accumulators: Gas pre-charge pressure too low	Check gas pressure

8.4.2 Types of malfunctions - water systems

Excessive noise		
Malfunction	**Possible cause**	**Remedy**
Pump stations	Incorrectly aligned coupling	
	Coupling loose	
	Defective coupling	
	Loose motor and/or pump fastening	
	Wrong direction of rotation	
Pump	Oscillating controller system	Replace regulator
	Excessive pump speed	
	Backfeed pump defective	
	Defective shaft seals or seals on the suction side	
	Pump defective	
	Feed line and return line mixed up	
Pipework	Pipe fastening missing or loose	
	Plant/machine not properly vented	Check ventilation devices if repeatedly occurred
Feed/return	Filter clogged	Clean/replace
	Return line ends above the liquid	

Troubleshooting and remedies

Excessive noise		
Malfunction	**Possible cause**	**Remedy**
	level (only collecting basins in open cooling circuits)	
Control valves	Valve chatters due to unfavorable control conditions or wear	Check operating point/replace valve Note: In the secondary cooling system, louder operating noise occurs in the lower flow volume range. This does not indicate valve malfunction.
Solenoid valves (valves and fittings with pneumatic auxiliary power)	Valve chatters due to defective solenoid or voltage too low	
	Valve defective due to wear or dirt	
	Valves with adjustable dampening: dampening not adjusted	
Cooling water	Water contaminated and therefore damage and clogging of devices	Take cooling water sample, replace filter elements, if necessary clean piping system, produce a cooling water quality in accordance with the specifications incl. chemical treatment

Insufficient pressure/flow rate		
Malfunction	**Possible cause**	**Remedy**
Supply data (TOP) are not acc. to specification requirements	Breakdown and/or malfunction of upstream plant parts	Checking/validating of the specification data in the flow diagram. Refer to the operating instructions of the upstream plant area.
Consumer/machine data not acc. to specification require-	Increased pressure loss	See Operating Instructions of the respective consumer/machine
	Deposits in consumer/machine	Clean

Insufficient pressure/flow rate		
Malfunction	**Possible cause**	**Remedy**
ments		
Shut-off valves	Not in operating position	Check position according to flow diagram
	Missing auxiliary power	Check power supply and compressed-air supply system
Pump	Power transmission defective	
	Wrong direction of rotation	
	Motor defective	
	Excessive resistance in suction line due to: ▪ valve in feed line closed or only partially open ▪ clogged or leaking suction line ▪ excessively low liquid level	
	Internal leakage due to wear	
	Limiting pressure set too low or controller device defective	
Pressure line	Filter clogged	Clean/replace
	Leaks	Seal
	Excessive resistor	
Pressure relief valves	Internal leakage due to wear	
	Valve seat contaminated or damaged	
	Spring broken	
	Pressure losses too high	
	Defective valve	
Solenoid valves (valves and fittings with pneumatic auxiliary power)	Valve defective due to wear or dirt	
	Valve chatters due to defective solenoid or voltage too low	
	Valves with adjustable dampening: dampening not adjusted	

Troubleshooting and remedies

Insufficient pressure/flow rate		
Malfunction	**Possible cause**	**Remedy**
Pressure compensating vessel (only closed circuits)	Feed pressure not correctly set	
	Compressed air supply defective	
Other	Display instrument (remote indication) defective	Check by means of local displays
	Local display instrument defective	Draw conclusions about other process parameters

Incorrect operating temperature		
Malfunction	**Possible cause**	**Remedy**
Pump	Efficiency losses due to wear	
	In case of controlled pumps controller is defective	
	Insufficient or excessive speed and/or delivery volume	
Control valves	Defective valve	
	Set at excessively high or low flow rate	Check flow-rate measurement/casting programs
Other	Recooling water temperature too high	Check water supply and treatment system, transfer point (TOP)
	Failure of cooling water supply	
	Deposits in the cooler	Clean cooler
	Inadequate flow of water in the plant/machine	Check pressure compensating vessel and feed line
	Heat flow of the equipment to be	If required, shut down plants to be

Incorrect operating temperature		
Malfunction	**Possible cause**	**Remedy**
	cooled exceeds design values	cooled or lower process-related load; leave to cool down
	Temperature control settings too high	
	Excessive ambient temperature	If required, shut down plants to be cooled or lower process-related load

Lines hammering during switching operations		
Malfunction	**Possible cause**	**Remedy**
Pump station	Soft start defective	
	Check valve on conveyor side defective	
Pressure line	Pipe fastening missing or loose	Pressure line
	Abrupt switching-on or switching-off of the upstream system	
	Plant/machine not properly vented	
Shut-off valves/solenoid valves	Switching time set too fast	If required, reset throttle

Troubleshooting and remedies

Other		
Malfunction	**Possible cause**	**Remedy**
Corrosion and/or layer formation (fouling)	Cooling water quality	Take cooling water samples, replace filter cartridges, clean pipework system, if necessary, produce a cooling water quality in accordance with the specifications/operating instructions incl. chemical treatment

8.4.3 Types of malfunctions, gas systems

Excessive noise		
Malfunction	**Possible cause**	**Remedy**
Generator stations / compressors	Defect	
Pipework	Pipe fastening missing or loose	
	Louder flow noise	Check consumer
	Vibrations introduced by brackets or units	
Filters	Filter clogged	Clean/replace
Control valves	Valve chatters due to unfavorable control conditions or wear	Check operating point/replace valve
Solenoid valves (valves and fittings with pneumatic auxiliary power)	Valve chatters due to defective solenoid or voltage too low	
	Valve defective due to wear or dirt	
	Valves with adjustable dampening: dampening not adjusted	
Gases	Gases contaminated, thus causing damage to/clogging of equipment	

Consumer /machine data		
Malfunction	**Possible cause**	**Remedy**
Supply data (TOP) are not acc. to specification requirements	Breakdown and/or malfunction of upstream plant parts	Checking/validating of the specification data in the flow diagram. Refer to the operating instructions of the upstream plant area.
Consumer/machine data not in accordance with specifications	Increased pressure loss	See Operating Instructions of the respective consumer/machine
Shut-off valves	Not in operating position	Check position according to flow diagram
	Missing auxiliary power	Check power supply and compressed-air supply system
Pressure line	Filter clogged	Clean/replace
	Leaks	Seal
	Excessive resistor	
Pressure relief valves	Internal leakage due to wear	
	Valve seat contaminated or damaged	
	Spring broken	
	Pressure losses too high	
	Defective valve	
Solenoid valves (valves and fittings with pneumatic auxiliary power)	Valve defective due to wear or dirt	
	Valve chatters due to defective solenoid or voltage too low	
	Valves with adjustable dampening: dampening not adjusted	

Troubleshooting and remedies

Consumer /machine data		
Malfunction	**Possible cause**	**Remedy**
Other	Display instrument (remote indication) defective	Check by means of local displays
	Local display instrument defective	Draw conclusions about other process parameters

Incorrect operating temperature		
Malfunction	**Possible cause**	**Remedy**
Supply data (TOP) are not acc. to specification requirements	Breakdown and/or malfunction of upstream plant parts	Checking/validating of the specification data in the flow diagram. Refer to the operating instructions of the upstream plant area.

Pressure hammers during switching operations		
Malfunction	**Possible cause**	**Remedy**
Pressure line	Abrupt switching-on or switching-off of the upstream system (Quick-acting valve)	Reduce adjusting speed

Other		
Malfunction	**Possible cause**	**Remedy**
Gas contaminated	Entrainment by damage	Flush system

8.5 Types of malfunction - grease systems

NOTICE	**Malfunctions in the centralized lubrication system**
	Due to the special relevance of the centralized lubrication system the plant/machine must be shut down in case of malfunctions in the centralized lubrication system prevailing for more than 4 hours.

Troubleshooting - Grease lubrication system		
Malfunction	**Possible cause**	**Remedy**
Guides/bearings are partly dry	Defective lubrication lines (interrupted and/or squeezed)	Check the lines, replace damaged lines
	Lubricant metering block defective or contaminated (clogged)	Check lubricant metering block and replace, if necessary
All guides/bearings are dry	Lubricant tank empty	Fill lubricant tank
	Lubricant metering block defective	Check lubricant metering block and replace, if necessary
	The lubricant pump is defective or is not energized	Check the lubricant pump Check the control system

8.6 Types of malfunction - oil lubrication systems

Excessive noise		
Malfunction	**Possible cause**	**Remedy**
Oil tank	Operating fluid too cold	Check setting of thermostat. Check the function of the heater.
	Fluid level too low	Top up oil in tank. Check oil lubrication system for leaks.
	Breather filter clogged	Clean/replace filter element.
Pump station	Direction of rotation of electric motor is incorrect	Reverse polarity of motor
	Shut-off valves in suction line closed or not completely open	Fully open shut-off valves
	Leaky suction line (air is sucked in)	Check flange gasket. Replace expansion joint.
	Coupling defective or not correctly aligned	Align/replace coupling
	Bearing damage on electric motor or pump	Replace/repair motor or pump
	Internal pump damage	Replace/repair pump
Control valves	Defective/incorrect adjustment on the	Check overflow regulating valve

Troubleshooting and remedies

Excessive noise		
Malfunction	**Possible cause**	**Remedy**
	overflow regulating valve	
Pipework system	Loose piping	Check/retighten fastenings
	Insufficient number of fastening points	Make further attachment points

Incorrect operating temperature		
Malfunction	**Possible cause**	**Remedy**
Oil temperature in tank too high or too low	Incorrect setting or switching failure of thermostat	Check/correctly adjust thermostat
	Heat exchanger contaminated	Clean heat exchanger
	Cooling water filter clogged	Clean/replace filter insert
	Heating system defective	Check/replace heater
	Cooling water too hot	Use cooler water
	Ambient temperature too high	Provide for better heat dissipation
Oil tempera-ture/housing temperature at the pumps too high	Pressure too low or fluctuating	Leakage losses too high. Safety valve settings too low. Shut-off valves in suction line closed or not completely open. Pressure gauge defective.
Oil temperature at the control valves too high	Incorrect setting of temperature con-troller or overflow regulating valve	Check temperature controller. Check overflow regulating valve.
Oil temperature at the measuring devices too high	Incorrect setting of temperature switch	Check temperature switch. Incorrect setting or switching failure of thermostat.

Pressure too low or fluctuating		
Malfunction	**Possible cause**	**Remedy**
Pump	Shut-off valves in suction line closed or not completely open	Fully open shut-off valves
	Leaky suction line (air is sucked in)	Check flange gasket. Replace expansion joint.
	Internal pump damage	Replace/repair pump
	Leakage losses too high	Find and eliminate leaks
	Pressure control valve settings too low	Correct/check setting
Filters	Filter element clogged	Clean/replace filter element. Check clogging indicator.
Heat exchangers	Clogging on oil side	Clean heat exchanger
Control valves	Incorrect setting of overflow regulating valve	Check/correct setting of overflow regulating valve
	Bypass valve closed	Open bypass valve

Flow rate too low or fluctuating		
Malfunction	**Possible cause**	**Remedy**
Pump	Shut-off valves in suction line closed or not completely open	Fully open shut-off valves
	Leaky suction line (air is sucked in)	Check flange gasket. Replace expansion joint.
	Internal pump damage	Replace/repair pump
	Leakage losses too high	Find and eliminate leaks
Filters	Filter transfer valve not completely switched-over	Check change-over
Control valves	Incorrect setting of overflow regulating valve	Check/correct setting of overflow regulating valve
	Bypass valve closed	Open bypass valve
Measuring instruments	Incorrectly set/defective flow meter devices	Check flow measuring instruments
Pipework	Pipeline/hoseline broken	Replace pipeline/hoseline
	Couplings/flanges leaky	Check/replace seals

Troubleshooting and remedies

Flow rate too low or fluctuating		
Malfunction	**Possible cause**	**Remedy**
	Air trapped in system	Vent the system
	Connections mixed up	Check connections, replace if necessary

Delayed switching		
Malfunction	**Possible cause**	**Remedy**
Switching delay of control valves	Valve jammed due to clogging or insufficient lubrication	Ensure sufficient lubrication. Clean valve.

Oil level in tank/pressure tank too high/too low		
Malfunction	**Possible cause**	**Remedy**
Oil level in tank too low	Leaks in the system	Find/eliminate leaks. Top up oil in tank.
Oil level in tank too high	Water ingress	Check/repair heat exchanger. Separate oil. Replace oil depending on water content.
Oil level in pressure tank too low/too high	Air pressure too high/too low	Check safety valve. Check the check valve in the drain line.

9 Maintenance

Target groups O, E, M, C

➡ Definition of the target groups:

- Chapter *Introduction/target groups*.

➡ Observe the following information:

- Chapter *Safety*,
- Operating Instructions *Equipment units*, Chapter *Maintenance*,
- *Subsuppliers'* Operating Instructions,
- *Electrical Equipment* Operating Instructions.

9.1 Safety

DANGER	Various hazards during maintenance work
	When performing maintenance work, various hazards may arise in a danger zone (e.g. crushing, shearing off, electrical hazards, hazards due to fluids). If required and especially when using tools, the following measures must be taken before any maintenance work is performed for all relevant functions, in the specified order: 1. Stop all relevant functions. 2. Interrupt the power supply 3. Secure against restarting. 4. Secure parts which could change their position without power supply. 5. Discharge or block residual energy. 6. Check effectiveness of the above measures.

Especially all those functions of the plant/machine shall be accounted for

- that belong to the danger zone which is entered.
- that may affect the danger zone that is entered.

If required, a warning sign must be installed at a suitable location, saying e.g. "Do not switch on – Maintenance work in progress".

For safe performance of the required work, observe the following instructions:

- Before taking up any maintenance work, the specialist personnel for mechanical and electrical equipment must inform themselves about all functions and hazards in the danger zone.
- All persons involved must be informed beforehand.
- For safety reasons, shutting off and securing against restarting may only be done by the person in charge previously appointed by the owner.
- Work may not be taken up until clearance by the person responsible for work performed in the danger zone has been given.
- Assign specialist personnel.
- Use appropriate tools.
- Ensure cleanliness at the workplace.
- Observe the instructions specified in the Operating Instructions.
- Select suitable operating mode.
- Comply with the relevant safety instructions.

⚠ WARNING	Danger of crushing when venting hydraulic cylinders
	During venting work on hydraulic cylinders during standstill there is danger of crushing from unintended movements. ▪ If protective devices are removed or taken out of operation, substitute protective actions must be defined: Emergency stop device within the reach of the banksman, visual contact if possible, voice contact, persons must stay only in permissible areas. ▪ A banksman shall observe from the local control desk. For observing, persons are allowed to stay at certain predetermined locations only. ▪ Specialist personnel must be familiar with the movements in the danger zone. Special caution is required at locations where there is danger of crushing.

⚠ WARNING	Danger of being burnt due to fluids
	There is the danger of being burnt by hot fluids that may escape from opened lines, hoselines and components for example. ▪ Make sure that the sealing elements are in a perfect condition and have been correctly positioned. ▪ Ensure that screwed pipe joints and flanged connections are properly installed. ▪ Working on pressurized systems during operation is prohibited. ▪ Visual check for leaks during operation required. ▪ Use hand protection.

⚠ CAUTION	Danger of slipping on oily/greasy or wet floors
	Danger of slipping on oily/greasy or wet floors. ▪ Collect escaping fluids and clean dirty/greasy or wet floors carefully. ▪ If necessary, set up information signs.

9.2 General information

Maintenance is, in addition to inspection and repair, part of the servicing. This chapter Maintenance also comprises Inspection.

The Operating Instructions provide approximate values for the intervals of the work to be performed on the basis of a three-shift production and under consideration of the annual production according to the technical data.

The inspection work to be performed by the specialist personnel concerns predominantly checks and inspections of the plant/machine with regard to:

- tightness,
- function,
- settings and
- wear.

Any defects found during these checks and inspections must be rectified.

Maintenance work should be recorded in writing.

9.3 Maintenance work

Bolted connections are to be checked in accordance with the specifications in the maintenance tables. The values for the tightening torques are included in the drawings (see technical documentation). If no values are indicated there, the values specified in the table below shall apply.

If the drawings do not contain information on the securing of screws/bolts, the screwed/bolted connections are secured with Loctite 243 (or equivalent).

Pre-tensioning forces for bolts of property class 8.8			
	Tightening by turning		Tightening by stretching
Bolt size	Pretensioning force [kN]	Tightening torque [Nm]	Pretensioning force [kN]
M 8x1	7	7	-
M 8x1.25	13	18	-
M 10x1.5	20	35	-
M 12x1.75	29	61	-
M 16x2	55	149	-
M 20x2.5	86	290	-
M 24x3	124	500	158
M 30x3.5	199	1004	251
M 36x4	291	1749	366
M 42x4.5	401	2806	502
M 48x5	529	4236	660
M 56x5.5	732	6791	909
M 64x6	969	10147	1199
M 72x6	1265	14689	1551
M 80x6	1597	20388	1946
M 90x6	2069	29492	2504
M 100x6	2605	41122	3136
M 110x6	3198	54799	3835

Pre-tensioning forces for bolts of property class 8.8			
	Tightening by turning		Tightening by stretching
Bolt size	Pretensioning force [kN]	Tightening torque [Nm]	Pretensioning force [kN]
M 125x6	4205	80284	5018
M 140x6	5352	113326	6362
M 160x6	7073	171027	8378

The above values apply for bolted connections with bolts of property class 8.8. The following table shows the conversion values for bolted connections of other property classes.

Conversion factors for property classes							
Property class	3.6	4.6	5.6	10.9	12.9	A2-70	A2-80
Calculation factor	0.28	0.375	0.47	1.41	1.69	0.71	0.94

Pretensioning forces for T-head and stone bolts [kN]			
	Tightening by turning		Tightening by stretching
Bolt size	T-head bolts of property class 5.6	T-head bolts of property class 8.8	Stone bolts
M 8x1	-	-	-
M 8x1.25	-	-	2.8
M 10x1.5	-	-	4.5
M 12x1.75	-	-	7
M 16x2	-	-	14
M 20x2.5	-	-	22.5
M 24x3	66	138	33
M 30x3.5	111	217	53
M 36x4	159	336	79
M 42x4.5	226	424	110
M 48x5	291	547	145
M 56x5.5	396	799	203
M 64x6	536	1050	271
M 72x6	697	1330	-
M 80x6	879	1820	-
M 90x6	1140	2270	-
M 100x6	1430	2840	-
M 110x6	1750	3300	-
M 125x6	2300	4240	-
M 140x6	2920	5090	-
M 160x6	3860	6550	-

The admissible pre-tensioning forces for T-head bolts shall be applied only with a tool for pre-tensioning by stretching.

9.3.1 Maintenance of components exposed to dynamic loads

Components with screwed/bolted connections exposed to dynamic loads and/or shocks must be inspected and the screwed/bolted connections retightened. Unless otherwise specified in the *Equipment units* Operating Instructions, the following intervals must be adhered to:

- First check one week after installation and/or commissioning,
- second check after two months,
- third check after one year and
- then checks once per year.

9.3.2 Maintenance of bearings/bearing units

Bearing damage is prevented by correct maintenance according to the instructions provided by the bearing manufacturer.

Cleaning of bearings

All bearings have to be cleaned thoroughly and packed with grease as specified in the pertinent lubrication instructions before they are reassembled.

When equipment units are spray-cleaned, ingress of water or cleaning agent in the bearings must be avoided. After all bearing parts have been cleaned with petroleum ether, acid-free kerosene or another suitable cleaning agent, the bearings must be immediately protected against corrosion by thorough oiling or greasing. If compressed air is used for drying the bearing, it must be free from water.

Formation of vacuums in bearings

When the process is finished, the cooling-down of the plant/machine may lead to the formation of a vacuum in the bearings, which may cause water to be drawn into the bearings.

To prevent water ingress and/or to remove ingressed water, the bearings must be relubricated for a sufficiently long time after the end of

the process by means of the centralized lubrication system to ensure sufficient sealing of the bearings against water ingress. This is normally the case when grease emerges from the bearing assembly.

9.3.3 Maintenance of electrical equipment

Maintenance work on electrical equipment of the plant/machine may be carried out by specialist personnel for electrical equipment only.

9.3.4 Maintenance of fluid systems

Any changes in the chemical and physical properties and thus in the further usability of the operating fluid largely depend on the operating conditions prevailing within the hydraulic system, i.e. temperature, pressure, frequency of recirculation and velocity of flow. It is not possible, therefore, to generally specify applicable guidance values for fluid change intervals.

Chemical analyses reveal how these properties change.

Observe the information and instructions in the safety data sheets of the fluids.

The limit values or criteria for a necessary change of fluid have to be specified by the fluid supplier.

The degree of contamination and thus the purity class are ascertained either under a microscope by manual counting of the number of particles on an appropriate filter (monitor) through which a 100 cm^3 fluid sample has flowed, or by means of an appropriate particle counter which is directly connected to the system.

Maintenance

Hydraulics

The degree of contamination affecting hydraulic systems must not exceed ISO classification as per hydraulic diagram. When the admissible degree of contamination is exceeded, the hydraulic fluid must be changed.

When changing the hydraulic fluid, make sure that neither the tank nor other parts of the hydraulic circuit are contaminated.

In order to obtain the desired purity class, even newly delivered hydraulic oil must be filtered before or while filling it into the hydraulic circuit. It is not allowed to use the breather filters for this purpose.

The service lives of the components depend directly on the cleanliness of the hydraulic system.

Due to the lubricating properties of the fluids, there is an increased danger of slipping in and around the hydraulic and grease facilities.

Tanks/containers during operation

During operation tanks/vessels must be checked for:

- Damage,
- leaks,
- optical filling level indicator,
- optical temperature indicator,
- cabling and plugs and
- external corrosion.

Tanks/containers during standstill

During standstill tanks/vessels must be checked for:

- Functioning of the level switch,
- functioning of the overfill protection,
- functioning of the thermostat,
- function of the heating elements,
- clogging of the air filters and
- internal corrosion.

Pumps/units

The pumps must be used alternately as service pumps and standby pumps with switch-over at regular intervals so that they all have approximately the same number of operating hours.

During a production standstill the recirculating pump should continue to run so as to improve the quality of the operating fluid.

Check the preconditions for operation of the pumps according to the interlocking conditions (level switches, shut-off valves in the intake line).

During operation pumps/units must be checked for:

- Damage and leaks,
- electric motor current consumption,
- cabling, connections,
- pump running noises,
- housing temperature and
- pressure setting.

Never start the pumps with the suction-side shut-off valves closed

During and after work on equipment the condition and position of the seals must be checked.

Checks for leaks must be carried out according to the instructions provided by the manufacturer.

Maintenance

Filters

Filters equipped with a visual and/or electrical clogging indicator must be replaced as soon as clogging indicator (electrical/visual) responds. The only situation in which immediate replacement is not necessary is system start-up with cold operating fluid after a prolonged standstill period. In this case, the clogging indicator may respond for a short time.

A clogged filter cartridge must be replaced immediately.

Depending on the filter material, the elements can be cleaned (metal fabric) or are disposable elements (non-woven material).

Usually, filter elements

- for water can be cleaned (stainless-steel fabrics) and
- for hydraulic fluids cannot be cleaned, i.e. these are disposable elements.

Observe the correct mesh sizes of the respective filter elements.

Vent the filters during filling.

Check the proper functioning of the differential pressure indicators (electric/visual).

Check air filter on tank.

Bladder-type/piston-type accumulators during operation

Check bladder/piston-type accumulators as follows:

- External corrosion and
- leaks.

If installed, check the switching operation of the accumulator shut-off valves and/or pressure relief valves.

Bladder-type/piston-type accumulators during standstill

Check bladder/piston-type accumulators as follows:

1. Connect a pressure gauge to the accumulator safety and shut-off block at the point provided for this purpose.
2. Close shut-off valve in the pressure line.
3. Slowly open shut-off valves leading to the leak oil line/tank line. The pressure gauge indicates a slow, uniform pressure drop which turns into an abrupt drop when the hydraulic side of the accumulator is fully drained.
4. Connect a charging and testing device on the gas side and check the nitrogen pressure.

The accumulator bladder/piston seal is in proper condition if a continuous escaping noise can be heard during slow opening of the leak oil/tank-line shut-off valve and the gas has the specified pressure.

In case of major deviations from the specified value:

- Refill or drain nitrogen as required and
- check gas valve.

If there is only a short escaping noise during slow opening and the nitrogen filling pressure p0 is 0, the accumulator bladder or the piston seals are defective. In this case, the accumulator bladder/seals must be replaced immediately.

Only nitrogen may be used as charging gas.

No welding, soldering, brazing or mechanical work may be performed on pressure accumulators.

Maintenance

Diaphragm accumulator

Diaphragm accumulators are checked as follows:

- Close shut-off valve in the pressure line and relieve pressure on the liquid side.
- Connect a charging and testing device on the gas side and check the nitrogen pressure.
- Correct in case of deviations.

Only nitrogen may be used as charging gas.

No welding, soldering, brazing or mechanical work may be performed on pressure accumulators.

Continuously adjustable valves/control valves

In areas where large quantities of dirt and water arise, the continuously adjustable valves/control valves are installed in protective housings.

The temperature in these protective housings must not exceed 80°C.

To prevent disturbance of heat transfer to the ambient air, the protective cases/housings must be kept free of any deposits of dirt.

In areas where high temperature rises occur, additional air is blown through these protective housings.

The air pressure/air flow rate setting must be neither too low (temperature rise) nor too high (risk of injury when opening the protecting housing).

Pressure control valves and pressure switches

Setting and testing the pressure control valves and pressure switches according to the setting values specified in the diagram and/or in the functional description of the electrical equipment.

Electronic pressure switches and transducers and their hydraulic connections must be vented completely after longer standstill periods to avoid that the measuring cell is destroyed by the entrapped air.

During operation, pressure control valves and pressure switches must be checked for:

- Damage,
- signal output and
- setting values according to control circuit diagram.

Directional control valves

During operation, directional control valves must be checked for:

- Damage,
- switching operation (mech. valves),
- electrical function (solenoid valves) and
- cabling and plugs (damage, tight fit).

Proportional valves

During operation, proportional valves must be checked for:

- Damage,
- setting values according to control circuit diagram (speeds, ramp times),
- electrical functioning and
- cabling and plugs (damage, tight fit).

Maintenance

Servo valves

During operation, servo valves must be checked for:

- Damage,
- control deviations,
- electrical functioning,
- cabling and plugs (damage, tight fit),
- housing/protective case temperature and
- leak oil rate.

Pressure valves

During operation, pressure valves must be checked for:

- Damage and
- setting values according to control circuit diagram.

Throttle valves/ flow control valves

During operation, throttle valves/flow control valves must be checked for:

- Damage and
- setting values according to control circuit diagram.

Pipeline system/ hoses

During operation, pipeline systems and hoses must be checked for:

- Damage,
- leaks,
- external corrosion and
- fastening.

Retightening of screwed/bolted connections during operation is prohibited!

Rubber expansion joints

Experience has shown that ageing of materials limits the service lives of the rubber expansion joints to max. 5 years (incl. 2 years storage) for this application. For this reason the rubber expansion joints should be replaced after this period, even if they are apparently without external damage. If, during operation, the service lives of the rubber expansion joints are found to be shorter, the replacement intervals must be adapted accordingly.

During operation, rubber expansion joints must be checked for:

- Damage,
- chafe marks,
- proper attachment/fastenings,
- embrittlement and
- flexibility.

Cylinders/hydraulic and pneumatic motors

During operation, cylinders/hydraulic and pneumatic motors must be checked for:

- Damage,
- collars, wipers (leak-tightness),
- rotary shaft seals (leak-tightness),
- piston rods and
- setting of cushioning.

Leak oil troughs, retention systems, leak oil warning systems

During operation, leak oil trays, retention systems, leak oil warning systems must be checked for:

- Damage,
- corrosion,
- leak-tightness and
- function.

Further components

Further maintenance procedures/instructions for specific Equipment units can be found in the respective section of the Operating Instructions *Equipment units* or in the Subsuppliers' section.

9.4 Maintenance schedule

The maintenance plan lists the necessary maintenance work.

The specified operating status is the condition of the system / machine in which the test is performed.

The time interval refers to the interval between two maintenances. At the end of the time interval, the required tests must be carried out at the latest.

Intervals combined with numbers denote for example:

- 2W = every two weeks, or
- 3M= every three months

The measures must be carried out if the test has not been passed.

Operating condition (OC)	
N	Normal operation (production)
Z	Enabling mode
S	Special operating mode (roll change)
P	Stop (maintenance, troubleshooting)
R	Repair
X	In all operating condition

The time interval, see chapter *Lubrication interval*.

9.5 Lubrication instructions

Where required, the lubrication instructions refer to the respective lubrication charts.

Grease lubrication system

For all equipment units the following instructions shall apply. They are the basic principles for a trouble-free and safe operation.

- The types of grease specified in the lubrication instructions must be used and the greasing cycles observed.
- Greases with different types of saponification must not be mixed.

Adjustment of the centralized grease lubrication system

For economical lubricant consumption, the centralized grease lubrication systems are set during commissioning of the plant/machine such as required by the plant's/machine's operating conditions.

This setting refers to the following activities:

- Checking of the lubrication intervals for the individual grease lubrication systems via the relays of the pump control systems.
- Setting of the grease volume per lubrication point at the respective lubricant metering block.

Initial grease fills

For nipple and centralized lubrication, grease for the initial filling shall be filled in sufficiently until it escapes at the bearing points.

Danger of contamination

Cleanliness is the major requirement when handling greases, for instance during storage (keep containers hermetically sealed at all times) and refilling.

Oil lubrication

It is mandatory to use the oil grades specified in the lubrication instructions. The specified quantities must be checked during operation and adjusted as necessary.

Change of oil

Used oil is to be drained at operating temperature. Closed gear casings must be cleaned by flushing.

High-viscosity oils

High-viscosity oils must be heated before use.

Signs/terms

Detailed explanations are contained in SN 180 and SN 181.

A number in a rectangle indicates a manual lubrication point.
Example: Manual lubrication point number 9

A number in a hexagon indicates a centralized lubrication point.
Example: Central lubrication point number 9

A number in a hexagon in brackets indicates a centralized lubrication point which is not visible (hidden) in a figure.

Example: Hidden centralized lubrication point number 99

The same applies to the non-visible, hidden manual lubrication point.

9.6 Operating materials and auxiliaries

In the following, the descriptive tables of the lubrication instructions are listed.

9.6.1 Type of lubrication

Type of lubrication	
S	Lubricating nipple
Z	Centralized grease lubrication pump
ZHp	Centralized grease lubrication pump, manual
O	Surface lubrication
F	Oil or grease fills
U	Oil circulation lubrication system
Sp	Spray lubrication
Fe	Solid lubricant
M	Morgoil lubrication system
Hp	Hand-operated grease pump
Ön	Oil mist lubrication
Hy	Hydraulic oil
E	Hydraulic emulsion
Hs	Hydrostatic
K	Corrosion protection
OL	Oil-air lubrication
Sg	Lubricant metering block
OV	Oil-loss lubrication
Sd	Spray can lubrication
Wf	Maintenance-free lubrication point

9.6.2 Lubrication interval

Time interval (TI)	
**)H	Every hour
S	Every shift (8 hours)
**)D	Every day (24 hours)
**)W	Every week
**)M	Every month
**)Y	Every year
ED	Lubrication activated with equipment
L	Service-life lubrication
WW	During roll change
GW	During stand change
B1	According to supplier's specifications
B2	Check
B3	Check/top up every 6 months
B4	Change after 3 000 operating hours or after 18 months, whichever occurs first
B5	Oil change after every 10 000 operating hours
B6	First oil change after 500 operating hours
B7	▪ First oil change after 500 operating hours ▪ Second oil change after 2 000 operating hours ▪ Further oil changes after 4 000 operating hours but at least once a year
B8	▪ First oil change after 200 operating hours ▪ Second oil change after 1 500 operating hours ▪ Further oil changes 4 000 - 5 000 operating hours
B9	Weekly check, note oil level on dipstick
B10	Lubricate chain links as required
B11	20 double strokes
B12	Lubrication intervals: every 30 minutes
B13	Lubrication intervals: every 4 hours
B14	Lubrication intervals: every minute
B15	Lubrication intervals: every 1.5 minutes

Time interval (TI)	
B16	Lubrication intervals: every 20 minutes
**) Intervals combined with numbers signify for example: 2D= every two days or 3M= every three months	

9.6.3 Indication of quantity units

Indication of quantity units	
FA	Until grease escapes
cm^3	w/o indication
dm^3	with indication
m^3	with indication

9.7 Lubricants and specifications

9.7.1 Grease

Lubricant number acc. to lubrication instructions	Types of grease according to DIN 51502	Typical application
1	KP0K-20, KP00K-20	Gear couplings
2	KPK2K-20	Antifriction and plain bearings
3	K2N-30	Antifriction and plain bearings, max. 250°C in case of frequent automatic relubrication
4	Paste	Sliding faces, gear racks
5	KMC2K	Eccentric bushings for CL stands

The definition for the specification of lubricants according to DIN 51825 is composed as follows:

Example KP2K-20

K Code letter (type of grease)

P Lubricant

2 Consistency code (NLGI class)

K Supplementary code letter

-20 Supplementary code

Type K lubricating greases

Type K lubricating greases are consistent greases for the lubrication of antifriction bearings, plain bearings and sliding faces; they consist of mineral oil and/or synthetic oil and a thickening agent. Addition of additives and/or solid lubricants is admissible. The short designations are the same as those in DIN 51502.

Type KP lubricating greases

Type K lubricating greases which contain additives to reduce friction and wear in the mixed friction zone and/or to increase the load bearing capacity and which have passed the relevant examination according to DIN 51350-5 (see table 4) are designated with the supplementary code letter P (type KP). Such greases are used e.g. for the lubrication of antifriction bearings the dynamic equivalent load rating P of which exceeds 10% of the dynamic equivalent radial load C. (Observe instructions by the antifriction bearing manufacturers)

Consistency number 1

Worked penetration 310-340 units

Consistency number 2

Worked penetration 265-295 units

Supplementary code letter K

K max. operating temperature +120°C,
behavior in the presence of water: Rating 0-90 or 1-90 according to DIN 51807

N max. operating temperature +140°C,
behavior in the presence of water: to be agreed upon

Supplementary code

-20 min. operating temperature -20°C

-30 min. operating temperature -30°C

9.7.2 Oil

The **letter code** acc. to DIN 51502 is specified in the following, as far as applicable, according to the substance type, e.g. lubricating oils **B**.

Substance group 1 - mineral oils, lubricating oils & special oils
Lubricating oils B (e.g. bituminous) acc. to DIN 51513

SMS group lubricant No.	Short designation acc. to DIN 51502	Typical application
24	BC-V	Gear racks

Substance group 1 - mineral oils, lubricating oils & special oils
Lubricating oils C (circulation lubricating oils) acc. to DIN 51517-1 to 2 and DIN 51517-3

SMS group lubricant No.	Short designation acc. to DIN 51502	Typical application
10	CLP 100	Centralized-oil lubrication systems
11	CLP 150	Gear unit
12	CLP 220	Centralized oil lubrication systems, CL-millstands, gear units, cold shears
13	CLP 320	Centralized oil lubrication systems, CL-millstands, gear units
14	CLP 460	Centralized oil lubrication systems, CL-millstands, gear units, gear couplings
15	CLP 680	Worm gear units and gear couplings, main drives
20	ISO VG 100	Centralized oil lubrication systems, wire rod finishing blocks
26	CL 46	Flushing oil for centralized-oil lubrication systems

Substance group 1 - mineral oils, lubricating oils & special oils
Lubricating oils V (air compressor oils) acc. to DIN 51506

SMS group lubricant No.	Short designation acc. to DIN 51502	Typical application
17	VDL 100	High-pressure compressors

Substance group 1 - Mineral oils, lubricating oils & special oils
Oils S (cooling lubricants)

SMS group lubricant No.	Short designation acc. to DIN 51502	Typical application
18	SE	5% oil-in-water emulsion

Substance group 1 - mineral oils, lubricating oils & special oils
Hydraulic oils H acc. to DIN 51524

SMS group lubricant No.	Short designation acc. to DIN 51502	Typical application
19	HLP 46	Hydraulic systems
25	HL 22/32	Air conditioning units
	HLP 22/32	
	CL 22/32	
	CLP 22/32	

Substance group 1 - Mineral oils, lubricating oils & special oils
Lubricating oils

SMS group lubricant No.	Short designation acc. to DIN 51502	Typical application
23	-	Chains

Substance group 2 - hydraulic fluid, hardly flammable
Aqueous polymer solutions HFC

SMS group lubricant No.	Short designation acc. to DIN 51502	Typical application
27	HFC	Hydraulic systems on water-glycol basis

Substance group 3 - Synthetic or semisynthetic fluids

Ester, organic

SMS group lubricant No.	Short designation acc. to DIN 51502	Typical application
21	ELPF 100	Loop cooling conveyor chains

Substance group 3 - Synthetic or semisynthetic fluids

Polyglycol oils PG

SMS group lubricant No.	Short designation acc. to DIN 51502	Typical application
22	CLP PG 150	Pedestal bearings

9.8 Sampling from water circuits

For the performance of water analyses, observe the following steps and instructions:

Sampling containers

As containers, clean plastic (no PET) or glass bottles with a capacity of 1 liter must be used.

NOTICE	Caution
	Cleaning agent bottles must not be used as they may falsify the measuring result. The analysis of the sample must be performed within three days after sampling because otherwise the measuring result could be falsified.

⚠ CAUTION	Danger of injury due to bursting glass bottles
	If water is stored in closed glass containers at temperatures below 0°C, the glass may burst due to freezing water. There is danger of injury from glass splinters. ▪ Do not store water in glass bottles in case of temperatures of around 0°C or below.

Maintenance

⚠ WARNING	Danger of being burnt due to hot components/systems
	Fluid-carrying components/systems (pipelines, hoses, valves and fittings, etc.) may be hot. ▪ Allow to cool down sufficiently. ▪ Use hand protection. ▪ Observe the safety instructions and measures specified in the safety data sheet of the respective fluid.

⚠ WARNING	Danger of injury during sampling
	Danger of injury when taking water samples due to pressurized piping systems and components as well as due to escaping fluid mist when opening the sampling point. ▪ Sampling must only be performed when the plant is at standstill. ▪ Samples may only be taken at the points intended for this purpose. ▪ Open the valve of the sampling point slowly. ▪ Observe the safety data sheet of the respective fluid as required (e.g. additive). ▪ Upon completion of the work, clean and/or dry any soiled floors and surfaces. ▪ Use hand protection.

Action

1. Open the valve at the sampling point just far enough for the water to flow out smoothly.
2. Insert the hose at the sampling point. Flush the clean hose with sampling water.
3. Rinse out the sampling bottles and caps three times with the water to be analyzed.
4. Push the hose into the bottle until it reaches the bottom in order to prevent the contained gases (carbon dioxide, oxygen, etc.) from outgassing (required in the case of additional analysis of the gas content).
5. Fill up the bottle to above the neck.
6. Withdraw the hose from the sampling cock.
7. Slowly close the sampling cock.
8. Withdraw the hose from the bottle.
9. When using glass bottles, tilt the bottle so that a little water flows out to ensure that an air bubble remains under the cap (plastic bottles remain filled up to right below the cap).
10. Close the bottle tightly.

Taking samples

Water samples for water analysis. The specifications in the sampling record ensure that origin and composition can be analyzed in a reproducible way.

The specifications on the sampling point and the type of water are of special importance for the origin of the water sample as well as the allocation and analysis of the sample.

Maintenance

WBS element			Country	
Name			Date	
System description of the water circuit				
Sampling point				
	Between water softener and metering station			
	Feed water tank			
	Cooling circuit	Pipeline identification marking:		
	Marked in the enclosed flow chart			
	Other			
Type of water				
	Boiler water		Production water	
	Feed water		Town water	
	Condensate		Water upstream of the treatment system	
	Cooling water circulation water		Cooling water make-up water	
	Well water		Softened water	
	Ground water		Other	
Pretreatment of the water				
	Types of chemicals		Amount of chemicals	
	Other			
Description of the damage or complaint				

9.9 Completion of maintenance work

Upon completion of the maintenance work, all functions and all protective measures which have been rendered inoperative must be taken into operation again and checked for proper functioning.

Before restarting, remove all tools and foreign parts from the plant/machine.

Only then production operation may be enabled.