

Operating manual

Turbine

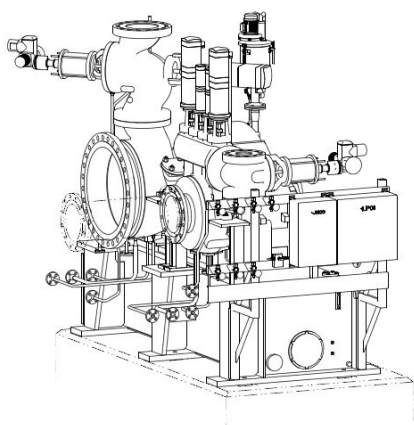
Customer: Columbia Pulp, LLC

Machine type: TWIN-CA 56 GT7

Year of construction: 2018

Output date: 27.04.2018

Machine number: 4.756.125



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Table of contents

1	Operating instructions.....	13
1.1	User information	21
1.1.1	General.....	21
1.1.2	Using the operating manual.....	21
1.1.3	Recommended settings to simplify navigation	23
1.1.4	Contact with Howden.....	24
1.1.5	Copyright	24
1.2	Safety information.....	25
1.2.1	General.....	25
1.2.2	Laws and regulations.....	25
1.2.3	Intended use.....	26
1.2.4	Personnel	26
1.2.5	Safety notes in the operating instructions.....	27
1.2.6	Safety notes on the machine.....	28
1.2.7	Safety notes for operation	29
1.2.8	Safety notes for maintenance.....	30
1.2.9	Safety information in safety data sheets.....	30
1.2.10	Instructions how to handle a trip.....	30
1.2.11	Safety instructions for machines with hot surfaces.....	31
1.2.12	Safety instructions for machines with steam (turbines) or hot operating fluids.....	31
1.2.13	Functional safety	31
1.2.13.1	Overspeed protection trip circuit: Electromechanical overspeed trip (EMSS)	32
1.2.13.2	Windage protection trip circuit.....	42
1.3	Technical data	50
1.3.1	Turbine operating data	50
1.3.1.1	Tuning the turbine to the plant unit	50
1.3.1.2	Operating limits	50
1.3.1.2.1	Operating limits 4756125 CFR5 GT7.....	50
1.3.1.2.2	Operating limits AFA6 GT7	52
1.3.1.3	Turbine steam flow diagram.....	52

1.3.1.4	Limitation of turbine operating data.....	61
1.3.2	Operating fluid of the turbine	62
1.3.2.1	Steam requirements.....	62
1.3.3	Acoustic data	62
1.3.4	Settings and switching values	62
1.3.5	Vibration velocity	63
1.3.6	Shaft vibration.....	64
1.3.7	Oil and bearing data	64
1.3.8	Monitoring of turbine oils	66
1.3.9	Steam quality.....	68
1.3.10	Screw tightening torques	69
1.3.11	Electrical technology.....	69
1.3.12	Sealing fluid for turbine shaft seal	70
1.4	Description.....	71
1.4.1	Functional description of turbine 1.....	71
1.4.2	Functional description of turbine 2.....	71
1.4.3	Structure of turbine	71
1.4.4	Crossover line (Turbine 1 to 2).....	72
1.4.5	Turbine rotor	72
1.4.6	Turbine impeller.....	72
1.4.7	Turbine shaft blank.....	72
1.4.8	Shaft-hub connection.....	72
1.4.9	Turbine casing	73
1.4.10	Nozzles.....	73
1.4.11	Shaft seal.....	73
1.4.12	Gearbox.....	73
1.4.13	Gearbox casing	73
1.4.14	Bearings	74
1.4.15	Bull gear shaft.....	74
1.4.16	Baseframe	74
1.4.17	Oil supply unit.....	74
1.4.18	Mechanically driven main oil pump.....	74

1.4.19	Auxiliary oil pump	75
1.4.20	Controllers	75
1.4.21	Control valves.....	75
1.4.22	Valve seal	75
1.4.23	Control actuator	76
1.4.24	Overspeed device.....	76
1.4.25	Monitoring.....	77
1.5	Transport and storage	79
1.5.1	Safety	79
1.5.2	Packaging.....	79
1.5.2.1	Labelling and information	79
1.5.2.2	Plugs	79
1.5.3	Transport	80
1.5.3.1	Lifting and lowering	80
1.5.3.2	Transporting.....	80
1.5.4	Checking delivery	80
1.5.5	Storage	81
1.5.6	Duration of packaging protection.....	81
1.5.7	Parts made of corrosion-resistant steel.....	82
1.5.8	Disposal of packaging material.....	82
1.6	Assembly and disassembly	83
1.6.1	Safety	83
1.6.2	Personnel qualifications.....	86
1.6.2.1	Installation list	86
1.6.3	Installation of turbine	87
1.6.3.1	Checking delivery.....	87
1.6.3.2	Assembly planning and provision of assembly equipment	88
1.6.3.3	Checking the connection points	88
1.6.3.4	Turbine assembly.....	88
1.6.3.5	Cleaning of main steam line.....	89
1.6.3.6	Connecting the turbine.....	91
1.6.3.7	Piping erection	91

1.6.3.8	Acid-cleaning and neutralizing of lube oil piping	92
1.6.3.9	Flushing of lube oil lines.....	92
1.6.3.10	Installing accessories.....	93
1.6.3.11	Filling the oil tank with lube oil	93
1.6.3.12	Clearing up the jobsite	93
1.6.3.13	Checks	94
1.6.4	Installation report.....	94
1.6.5	Electrical connection and interlocks	95
1.6.6	Test run	95
1.6.7	Preservation	95
1.6.8	Replacing spare parts.....	95
1.6.8.1	Checking of spare parts.....	96
1.6.8.2	Rotor	96
1.6.8.3	Impeller	96
1.6.8.4	Shaft seal	96
1.6.8.5	Turbine bearings	98
1.6.8.6	Coupling.....	99
1.6.8.7	Spare parts accessories	100
1.6.8.8	Seals and wear parts	100
1.6.8.9	Maintenance Manual.....	100
1.6.8.10	Corrosion protection.....	100
1.6.8.10.1	Parts made of stainless steel.....	100
1.6.9	Test run	101
1.7	Initial commissioning and operation	103
1.7.1	Turbine and plant.....	103
1.7.2	Mode of operation.....	103
1.7.3	Influence of the plant	103
1.7.4	Requirements for initial commissioning or recommissioning following overhaul.....	103
1.7.4.1	Preparation for initial commissioning without LCP.....	104
1.7.4.2	Commissioning of oil supply unit.....	105
1.7.4.3	Turbine.....	106
1.7.4.4	Shutdown with emergency stop switch	106
1.7.5	Initial commissioning or recommissioning following overhaul	107

1.7.6	Report following initial commissioning.....	109
1.7.7	Commissioning.....	110
1.7.7.1	Prerequisites.....	110
1.7.7.2	Startup of the turbine via LP.....	110
1.7.7.3	Startup of the turbine via control room.....	111
1.7.7.4	During operation.....	111
1.7.7.5	Turbine startup.....	112
1.7.7.6	Automatic synchronization:.....	113
1.7.7.7	Manual synchronization.....	113
1.7.7.8	Monitoring.....	113
1.7.7.9	Turbine shutdown.....	114
1.7.7.10	Trip test.....	115
1.7.7.11	Testing of trip function – trip simulation.....	116
1.8	Maintenance.....	117
1.8.1	Safety.....	117
1.8.2	Maintenance activities.....	119
1.8.3	Automatic monitoring.....	120
1.8.4	Inspection and maintenance intervals.....	120
1.8.5	Inspection and maintenance intervals.....	121
1.8.6	Inspection intervals.....	122
1.8.7	Adjusting the intervals.....	122
1.8.8	Personnel qualifications.....	123
1.8.9	Inspection and maintenance lists.....	124
1.8.9.1	Machine periphery and machine connections.....	124
1.8.9.2	Instrumentation.....	124
1.8.9.3	Machine.....	125
1.8.9.4	Gearbox.....	127
1.8.9.5	Oil supply system.....	128
1.8.9.6	Oil specification.....	130
1.8.9.6.1	Monitoring the oil condition.....	130
1.8.9.6.2	Oil maintenance.....	130
1.8.9.6.3	Oil sampling.....	130
1.8.9.6.4	Changing the oil.....	132

1.8.9.7	Safety inspection.....	132
1.8.9.8	Protective equipment.....	133
1.8.10	Instructions.....	133
1.8.10.1	Cleaning.....	133
1.8.10.2	Lubricants and assembly compounds.....	134
1.8.10.3	Supply systems.....	135
1.8.10.4	Condensate drainage.....	136
1.8.11	Maintenance of accessories.....	137
1.8.12	Preserving.....	137
1.8.13	Repair.....	137
1.8.14	Maintenance manual.....	138
1.9	Trouble shooting.....	139
1.9.1	Handling of faults.....	139
1.9.2	Personnel qualifications.....	139
1.9.3	Defective measuring instruments.....	140
1.9.4	Documentation.....	140
1.9.5	Fault tables.....	140
1.9.5.1	Sound.....	141
1.9.5.2	Vibration.....	142
1.9.5.3	Noise.....	143
1.9.5.4	Corrosion/Wear/Deposits.....	143
1.9.5.5	Bearing temperature.....	144
1.9.5.6	Bearing tightness.....	145
1.9.5.7	Shaft seal tightness.....	145
1.9.5.8	Coupling.....	146
1.9.5.9	Gearbox.....	146
1.9.5.10	Control system / control equipment.....	146
1.9.5.11	Oil temperature.....	148
1.9.5.12	Oil pressure.....	149
1.9.5.13	Oil flow rate.....	149
1.9.5.14	Oil level in tank / bearing housing.....	150
1.9.5.15	Oil condition.....	150
1.9.5.16	Seal gas supply.....	151

1.9.5.17	Electrical equipment.....	151
1.9.5.18	Monitoring	151
1.9.5.19	Leaktightness of gearbox.....	152
1.9.5.20	Generator	152
1.10	Spare parts	153
1.10.1	Stocking of spare parts.....	153
1.10.2	Identification	153
1.10.3	Ordering.....	153
1.10.4	Storage	154
1.11	Disposal.....	155
1.11.1	Replacement of parts	155
1.11.2	Changing lubricants.....	155
1.11.3	Dismantling of machines	156
1.11.4	Laws and regulations.....	156
1.11.5	Accompanying information	157
1.11.6	Packaging material and preservatives.....	157
1.12	Revision index	159
2	Drawings and Schemes.....	163
2.1	Drawings and Parts Lists.....	165
2.1.1	Plant	165
2.1.1.1	General Arrangement	165
2.1.2	Machine	170
2.1.2.1	Drawings and Parts Lists	170
2.1.3	Schemes and Lists	226
2.1.3.1	P & I Diagram.....	226
2.1.3.2	Interlock Diagram.....	229
2.1.4	Electrical Engineering	231
2.1.4.1	Electrical documentation.....	231
2.1.5	Guidelines.....	265
2.1.5.1	External electrical installation.....	265
2.1.5.2	Surrounding area for turbines	277

2.1.5.3	Installation instructions for flanged joints	310
3	Documentation on Accessories	315
3.1	Documentation on Accessories	317
3.2	Main steam drain with steam trap 5.1-2; 6.1-2; 7.1-4	319
3.3	Electro mechanical emergency trip 14.1-2	330
3.4	Control valve 12.2; 15.1-4	409
3.5	Main steam strainer - Y-type for fast maintenance 11.1	852
3.6	Magnetic actuator 19.1-2	859
3.7	Electronic speed controller 24	889
3.8	Vibration probe housing 34.1	980
3.9	Speed transmitter 36.1-3	1008
3.10	Overspeed protection system 39	1016
3.11	Oil level indicator 54	1039
3.12	Level sensor in oil tank 55	1287
3.13	Oil mist separator 56	1290
3.14	Mechanical oil pump 58	1371
3.15	Aquasensor for oil water content 65	1374
3.16	Resistance thermometer for turbine bearings 84.1-10	1397
3.17	Resistance thermometer for turbine wheel temperature 85	1429

Operating instructions

Turbine

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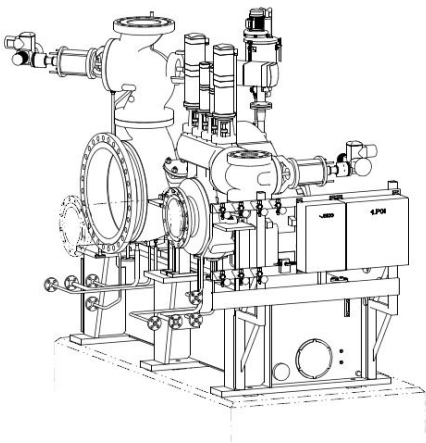
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Original operating Instructions according to EC directive 2006/42/EG



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1 Operating instructions

Table of contents

1.1	User information	21
1.1.1	General	21
1.1.2	Using the operating manual	21
1.1.3	Recommended settings to simplify navigation.....	23
1.1.4	Contact with Howden	24
1.1.5	Copyright	24
1.2	Safety information	25
1.2.1	General	25
1.2.2	Laws and regulations	25
1.2.3	Intended use	26
1.2.4	Personnel.....	26
1.2.5	Safety notes in the operating instructions	27
1.2.6	Safety notes on the machine	28
1.2.7	Safety notes for operation.....	29
1.2.8	Safety notes for maintenance	30
1.2.9	Safety information in safety data sheets	30
1.2.10	Instructions how to handle a trip	30
1.2.11	Safety instructions for machines with hot surfaces.....	31
1.2.12	Safety instructions for machines with steam (turbines) or hot operating fluids.....	31
1.2.13	Functional safety.....	31
1.2.13.1	Overspeed protection trip circuit: Electromechanical overspeed trip (EMSS).. 32	
1.2.13.2	Windage protection trip circuit	42
1.3	Technical data	50
1.3.1	Turbine operating data.....	50

1.3.1.1	Tuning the turbine to the plant unit.....	50
1.3.1.2	Operating limits.....	50
1.3.1.2.1	Operating limits 4756125 CFR5 GT7	50
1.3.1.2.2	Operating limits AFA6 GT7.....	52
1.3.1.3	Turbine steam flow diagram	52
1.3.1.4	Limitation of turbine operating data	61
1.3.2	Operating fluid of the turbine	62
1.3.2.1	Steam requirements	62
1.3.3	Acoustic data	62
1.3.4	Settings and switching values.....	62
1.3.5	Vibration velocity.....	63
1.3.6	Shaft vibration	64
1.3.7	Oil and bearing data	64
1.3.8	Monitoring of turbine oils.....	66
1.3.9	Steam quality	68
1.3.10	Screw tightening torques	69
1.3.11	Electrical technology.....	69
1.3.12	Sealing fluid for turbine shaft seal.....	70
1.4	Description.....	71
1.4.1	Functional description of turbine 1	71
1.4.2	Functional description of turbine 2.....	71
1.4.3	Structure of turbine	71
1.4.4	Crossover line (Turbine 1 to 2)	72
1.4.5	Turbine rotor	72
1.4.6	Turbine impeller	72
1.4.7	Turbine shaft blank	72
1.4.8	Shaft-hub connection.....	72
1.4.9	Turbine casing	73

1.4.10	Nozzles	73
1.4.11	Shaft seal	73
1.4.12	Gearbox	73
1.4.13	Gearbox casing.....	73
1.4.14	Bearings.....	74
1.4.15	Bull gear shaft.....	74
1.4.16	Baseframe	74
1.4.17	Oil supply unit	74
1.4.18	Mechanically driven main oil pump.....	74
1.4.19	Auxiliary oil pump.....	75
1.4.20	Controllers	75
1.4.21	Control valves	75
1.4.22	Valve seal	75
1.4.23	Control actuator	76
1.4.24	Overspeed device.....	76
1.4.25	Monitoring.....	77
1.5	Transport and storage	79
1.5.1	Safety.....	79
1.5.2	Packaging	79
1.5.2.1	Labelling and information	79
1.5.2.2	Plugs.....	79
1.5.3	Transport	80
1.5.3.1	Lifting and lowering	80
1.5.3.2	Transporting	80
1.5.4	Checking delivery	80
1.5.5	Storage	81
1.5.6	Duration of packaging protection	81
1.5.7	Parts made of corrosion-resistant steel	82

1.5.8	Disposal of packaging material.....	82
1.6	Assembly and disassembly	83
1.6.1	Safety.....	83
1.6.2	Personnel qualifications.....	86
1.6.2.1	Installation list.....	86
1.6.3	Installation of turbine.....	87
1.6.3.1	Checking delivery	87
1.6.3.2	Assembly planning and provision of assembly equipment.....	88
1.6.3.3	Checking the connection points	88
1.6.3.4	Turbine assembly	88
1.6.3.5	Cleaning of main steam line	89
1.6.3.6	Connecting the turbine	91
1.6.3.7	Piping erection.....	91
1.6.3.8	Acid-cleaning and neutralizing of lube oil piping	92
1.6.3.9	Flushing of lube oil lines	92
1.6.3.10	Installing accessories	93
1.6.3.11	Filling the oil tank with lube oil.....	93
1.6.3.12	Clearing up the jobsite.....	93
1.6.3.13	Checks.....	94
1.6.4	Installation report	94
1.6.5	Electrical connection and interlocks.....	95
1.6.6	Test run.....	95
1.6.7	Preservation.....	95
1.6.8	Replacing spare parts	95
1.6.8.1	Checking of spare parts.....	96
1.6.8.2	Rotor.....	96
1.6.8.3	Impeller.....	96
1.6.8.4	Shaft seal.....	96
1.6.8.5	Turbine bearings.....	98

1.6.8.6	Coupling	99
1.6.8.7	Spare parts accessories	100
1.6.8.8	Seals and wear parts	100
1.6.8.9	Maintenance Manual	100
1.6.8.10	Corrosion protection	100
1.6.8.10.1	Parts made of stainless steel.....	100
1.6.9	Test run.....	101
1.7	Initial commissioning and operation.....	103
1.7.1	Turbine and plant	103
1.7.2	Mode of operation	103
1.7.3	Influence of the plant	103
1.7.4	Requirements for initial commissioning or recommissioning following overhaul	103
1.7.4.1	Preparation for initial commissioning without LCP	104
1.7.4.2	Commissioning of oil supply unit	105
1.7.4.3	Turbine	106
1.7.4.4	Shutdown with emergency stop switch	106
1.7.5	Initial commissioning or recommissioning following overhaul.....	107
1.7.6	Report following initial commissioning	109
1.7.7	Commissioning	110
1.7.7.1	Prerequisites.....	110
1.7.7.2	Startup of the turbine via LP	110
1.7.7.3	Startup of the turbine via control room	111
1.7.7.4	During operation	111
1.7.7.5	Turbine startup	112
1.7.7.6	Automatic synchronization:.....	113
1.7.7.7	Manual synchronization.....	113
1.7.7.8	Monitoring.....	113
1.7.7.9	Turbine shutdown	114

1.7.7.10	Trip test.....	115
1.7.7.11	Testing of trip function – trip simulation	116
1.8	Maintenance	117
1.8.1	Safety.....	117
1.8.2	Maintenance activities	119
1.8.3	Automatic monitoring	120
1.8.4	Inspection and maintenance intervals	120
1.8.5	Inspection and maintenance intervals	121
1.8.6	Inspection intervals	122
1.8.7	Adjusting the intervals.....	122
1.8.8	Personnel qualifications	123
1.8.9	Inspection and maintenance lists.....	124
1.8.9.1	Machine periphery and machine connections	124
1.8.9.2	Instrumentation.....	124
1.8.9.3	Machine	125
1.8.9.4	Gearbox.....	127
1.8.9.5	Oil supply system	128
1.8.9.6	Oil specification	130
1.8.9.6.1	Monitoring the oil condition.....	130
1.8.9.6.2	Oil maintenance.....	130
1.8.9.6.3	Oil sampling.....	130
1.8.9.6.4	Changing the oil	132
1.8.9.7	Safety inspection	132
1.8.9.8	Protective equipment.....	133
1.8.10	Instructions	133
1.8.10.1	Cleaning	133
1.8.10.2	Lubricants and assembly compounds	134
1.8.10.3	Supply systems	135
1.8.10.4	Condensate drainage	136

1.8.11	Maintenance of accessories	137
1.8.12	Preserving.....	137
1.8.13	Repair	137
1.8.14	Maintenance manual	138
1.9	Trouble shooting	139
1.9.1	Handling of faults	139
1.9.2	Personnel qualifications	139
1.9.3	Defective measuring instruments	140
1.9.4	Documentation.....	140
1.9.5	Fault tables	140
1.9.5.1	Sound	141
1.9.5.2	Vibration	142
1.9.5.3	Noise	143
1.9.5.4	Corrosion/Wear/Deposits	143
1.9.5.5	Bearing temperature.....	144
1.9.5.6	Bearing tightness.....	145
1.9.5.7	Shaft seal tightness	145
1.9.5.8	Coupling	146
1.9.5.9	Gearbox.....	146
1.9.5.10	Control system / control equipment.....	146
1.9.5.11	Oil temperature.....	148
1.9.5.12	Oil pressure	149
1.9.5.13	Oil flow rate.....	149
1.9.5.14	Oil level in tank / bearing housing	150
1.9.5.15	Oil condition.....	150
1.9.5.16	Seal gas supply	151
1.9.5.17	Electrical equipment	151
1.9.5.18	Monitoring.....	151
1.9.5.19	Leaktightness of gearbox	152

1.9.5.20	Generator	152
1.10	Spare parts	153
1.10.1	Stocking of spare parts	153
1.10.2	Identification.....	153
1.10.3	Ordering.....	153
1.10.4	Storage	154
1.11	Disposal	155
1.11.1	Replacement of parts.....	155
1.11.2	Changing lubricants	155
1.11.3	Dismantling of machines.....	156
1.11.4	Laws and regulations	156
1.11.5	Accompanying information	157
1.11.6	Packaging material and preservatives	157
1.12	Revision index	159

1.8 Maintenance

1.8.1 Safety



DANGER

Unexpected start of the machine

A machine that is not secured against restart can start up any time.

- If the machine is shut down for assembly or maintenance work it must be secured against restart!

Set the main switch to "OFF" and install a safety lock.



DANGER

Rotating machine parts

Touching rotating machine parts may cause severe injuries.

- Only carry out maintenance work if the machine is equipped with the required protective devices.



DANGER

Escaping steam

Steam that escapes from leaking or opened components can lead to serious injuries or death.

1. Note that escaping steam can be invisible.
2. Stay out of areas where there may be a possibility of escaped or escaping steam.
3. Report leaks from steam-conveying components to the responsible person immediately.
4. Perform work on steam-conveying components with utmost care.
5. Ensure that steam-conveying components are drained, cooled down and at atmospheric pressure when working on them.
6. Ensure that the steam supply is permanently and securely shut off when performing work on steam-conveying components.
7. Ensure that only qualified and authorized personnel perform work on steam-conveying components.



WARNING!

Pressure in hydraulic systems

Careless work on pressurized hydraulic systems can lead to serious injuries.

1. Ensure that only suitably qualified personnel perform work on hydraulic systems.
2. Prior to working on hydraulic systems, ensure that these are at atmospheric pressure.
3. Secure the hydraulic systems against accidental startup by other persons for the duration of the work.

 **WARNING!**

Hot surfaces

Touching hot machine parts may cause severe burns.

- Touch hot machine parts only with safety gloves or wait until the parts have cooled down sufficiently.

 **CAUTION**

Noise caused by running machine

The noise of the running machine may damage your hearing.

- Wear ear protection when near the running machine.

1.8.2 Maintenance activities

Maintenance ensures that the turbine remains operational. Maintenance includes inspection, service and repair.

- Inspection
 - Asses actual condition by
 - Checks
 - Measurements
- Service
 - Prevent wear by
 - Cleaning
 - Draining
 - Lubricating
 - Readjusting (restoration of specified condition)
 - Making up (operating fluids)
 - Changing (operating fluids)
 - Preserving
- Repair
 - Restore operational condition by

- Adjusting (setting new setpoint or specified condition)
- Replacing (spare parts)
- Repairing

1.8.3 Automatic monitoring

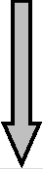
Turbines are typically monitored automatically. This may include:

- Operating data
 - Intake pressure
 - Intake temperature
 - Operating point
- Instrumentation and control variables
 - Speed
 - Casing vibration
 - Shaft vibration
 - Temperatures of bearings, lube oil, seal fluid, cooling water
 - Pressure of lube oil, seal fluid, seal gas
 - Differential pressure filter
 - Fill level of lube oil, seal fluid

1.8.4 Inspection and maintenance intervals



Note! The inspection and maintenance intervals differ as a function of operating time and operating hours.

Time	Interval	Operating hours	Operating time
	A	500 hours	-
	B	3500 hours	-
	C	24,000 hours	3 years
	D	100,000 hours	12 years

Interval C continues in a three-year cycle.

Intervals A and B are one-off intervals and completed after the stated *operating hours*.

Intervals C and D are completed after the stated *operating hours* or the *operating time*, depending on which event occurs first.

Interval D, *Safety inspection*, is continued in a three-year cycle after 100,000 hours.

1.8.5 Inspection and maintenance intervals

Inspection and maintenance must be performed within the intervals indicated in the inspection and maintenance lists. The first inspection and maintenance is always scheduled at the beginning of a new interval.

Abbreviation	Interval
1	according to condition
2	according to lubrication instruction
3	once at the beginning of the time interval
d	Daily
w	Weekly
m	Monthly
3 m	every 3 months
6 m	every 6 months
36 m	every 36 months
R	during an inspection and overhaul

1.8.6 Inspection intervals

The unit is shut down during inspections and overhauls. This allows comprehensive inspection and maintenance, and, if necessary, repair of the turbine. Preventive maintenance is also possible.

The interval for an inspection and overhaul depends on

- the required reliability and operating safety
- the unit
 - operating temperature
 - operating fluid
- operating frequency
- experience gained from inspection and maintenance

In case of continuous operation, we recommend an inspection and overhaul

- once during interval C
- at least every 3 years



Contact the Howden field services department if you wish to determine specific inspection and overhaul intervals for your turbine.

An inspection and overhaul ensures reliable operation for the next operating period.

Have Howden carry out inspections and overhauls in good time.

1.8.7 Adjusting the intervals

The intervals for the turbine and its accessories can be reduced to bring them in line with intervals of the overall plant.

1.8.8 Personnel qualifications



Attention! Work on the electrical power supply system may only be performed by qualified electricians.

Electrical equipment shall be secured against unexpected restarting (lock main switch and remove key, apply warning lock against restart).

Attention! Compliance must be ensured with national and international codes and standards for accident prevention and environmental protection as well as with the recognized rules for safe work in line with accepted engineering standards.

Maintenance personnel for maintenance must have the following training and qualifications:

Abbreviation PQ	Training	Personnel qualification
L	Simple	Qualified and instructed
C	Competent	With special qualification and instructed
Q	Qualified	With special qualification, specifically trained and instructed
E	Electrician	Professional electrical engineering training
S	Specialist	Howden technical supervisor
I	Inspector	Howden technical supervisor
M	Specialist	Specialist from the equipment manufacturer or specialized company
A	Authorized	Persons that have been approved and authorized by Howden to perform the required tasks

1.8.9 Inspection and maintenance lists

1.8.9.1 Machine periphery and machine connections

Work	Interval			PQ	Note
	A	B	C		
Machine periphery					-
Cleaning: General	1	1	1	L	-
Machine foundation and machine attachment					-
Cleaning: General	1	1	1	L	-
Checking: Condition, attachments, corrosion	w	m	3m	C	-
Piping connections and expansion joints					-
Cleaning: General	1	1	1	L	-
Checking: Condition, attachments, corrosion	w	m	3m	Q	-



Note! Have nonreturn valves and full-lift safety valves checked by qualified personnel at the intervals specified in the manufacturer documentation.

1.8.9.2 Instrumentation

Work	Interval			PQ	Note
	A	B	C		
Instrumentation					-
Cleaning: Scales, displays	1	1	1	C	-
Checking/measuring: All values of local displays	d	d	w	C	Local displays are marked with the letter "I" in the piping and instrument diagram.
Checking: Oil tightness, damage, vibrations	d	d	w	C	-
Checking: Function	-	-	R	S	-

1.8.9.3 Machine

Activities	Interval			PQ	Remarks
	A	B	C		
Machine					
Clean: General	1	1	1	L	-
Check: Noise	d	d	w	C	-
Check: condition, attachments, piping connections, rating plate, warning signs	w	m	3m	C	-
Measure: vibration analysis	1	1	1	I	"Technical Data" sec.
Measure: vibration velocity	d	d	w	Q	"Technical Data" sec.
Measure: alignment of drive train	-	-	R	S/A	"Technical Data" sec.
Protective equipment					
Check: attachment, deformation, vibrations	w	w	m	Q	-
Turbine casing					
Check: steam tightness	d	d	w	C	-
Clean drains, check passage	1	1	R	S/A	-
Turbine casing interior (flow chamber)					
Clean: deposits	-	-	R	C	-
Check: Condition, corrosion, wear	-	-	R	S	-
Impeller					
Clean: deposits	-	-	R	C	-
Check: Condition, corrosion, wear, cracks	-	-	R	S/A	-
Impeller/casing (impeller seal)					
Checking/adjusting: Gap	-	-	R	S	Drawings and diagrams
Rotor shaft					
Clean: General	-	-	R	C	-

Check: Corrosion, wear	-	-	R	S	
Shaft seal					
Clean: General	-	-	R	C	-
Check: Leaktightness	w	w	m	Q	-
Check: Corrosion, wear	-	-	R	S	-
Bearings					
Check: condition, bearing clearance, contact pattern	-	-	R	S/A	-
Oil					
Check: coating, odor	w	w	m	Q	-
Check/drain: water content	-	-	R	Q	Separate lube oil
Replace: Lube oil	1	1	R	Q	"Technical Data" sec.
MPC test (ASTM D 7843) Ruler test (ASTM D 6971)	-	-	6m	Q	Test must also be performed when refilling or topping up the oil
Coupling					
Check: condition, wear	-	-	R	S	-
Control equipment and trip gear					
Check	-	-	R	S	-
Steam strainer					
Check	-	-	R	S	-
Steam lines, seals					
Check	-	-	R	S	-
Function test (automatic start)					
Immediate standby	-	-	2m	Q	-



DANGER

Safe closing of electromechanical control valves in the event of power failure

In order to ensure safe closing of electromechanical control valves in the event of a power failure, the Dynamic Energy Units (Moog component) must be replaced at the latest after 10 years, taking into account the manufacturer-specific safety instructions.


- Ensure that the Moog component is replaced according to schedule.
- ⇒ If the Dynamic Energy Units are not replaced, safe closing of the electromechanical control valves in the event of a power failure is no longer ensured!



[Technical data \[▶ 50\]](#)

1.8.9.4


Gearbox

Activities	Interval			PQ	Note
	A	B	C		
Gearbox					-
Clean: in general	1	1	1	L	-
Check: noise, smooth running	d	d	w	C	-
Check: condition, attachments, piping connections, rating plate, warning signs	w	m	3m	C	-
Measure: alignment of drive train	-	-	R	S	-
Measure: vibration analysis	1	1	1	I	 Technical data
Protective equipment					-
Check: attachment, deformation, vibration	w	w	m	Q	-
Gearbox					-
Clean: ventilation filter	1	1	1	C	-
Check: oil tightness	d	d	w	C	-
Gearbox bearings					-

Check: condition, bearing clearance, contact pattern	-	-	R	S	-
Gearwheels, gear teeth					-
Check: condition, cracks, fatigue (pitting), contact pattern	-	-	R	S	-
Mechanically driven oil pump					-
Check: attachment, noise	w	m	3m	C	-
Check: condition	-	-	R	S	-
Coupling					-
Check: condition, wear	-	-	R	S	-
Piping, instruments					-
Check: oil tightness, damage, vibration	d	d	w	C	-

1.8.9.5 Oil supply system

Activities	Interval			PQ	Note
	A	B	C		
Oil supply system					-
Clean: in general	1	1	1	C	-
Check: oil tightness	d	d	w	C	-
Check: Condition, attachments, settings, piping connections, electrical connections, rating plate, warning signs	w	m	3m	C/E	-
Tank					-
Clean: filling nozzle	1	1	1	C	-
Clean: ventilation filter	d	d	w	C	-
Replace: filter, ventilation filter	1	1	1	C	-
Check: oil level	d	d	w	C	-
Top up: lube oil	1	1	1	C	-
Oil pump(s)					-
Check: noise, smooth running	d	d	w	C	-

Activities	Interval			PQ	Note
	A	B	C		
Check: Attachment, direction of rotation	w	m	3m	C	-
Valves					-
Check: noise, vibration	d	d	w	C	-
Check: attachment, settings	w	m	3m	C	-
Oil filter					-
Check: Attachment, fouling	d	d	w	C	-
Clean: Filter	1	1	1	C	-
Replace: Filter	1	1	1	C	-
Units, general					-
Check: oil tightness	d	d	w	C	-
Check: attachment	w	m	3m	C	-
Oil cooler					-
Clean: deposits	-	-	R	C	-
Check: oil tightness, water tightness	d	d	w	C	-
Tanks and vessels, interior					-
Clean: deposits	-	-	R	C	-
Check: coating	-	-	R	C	-
Piping, hoses					-
Check: oil tightness, damage, vibration	d	d	w	C	-
Lube oil					-
Check: water content at oil supply unit of oil tank, coating, odor	w	w	m	Q	-
Check/drain: water content	1	1	1	Q	Separate lube oil
Replace: lube oil	1	1	R	C	 Technical data

1.8.9.6 Oil specification

Only the oil specified in the "Technical Data" section may be used for the turbine.



[Technical data \[▶ 50\]](#)

See also

 [Technical data \[▶ 50\]](#)

1.8.9.6.1 Monitoring the oil condition



Danger! In the event that water is detected in the oil, the turbine must be shut down.

1. Drain water and oil from the lowest point of the oil tank until only clear oil is discharged.
2. If provided, use an oil separator to remove any water.
3. Determine and eliminate the cause for the ingress of water.

1.8.9.6.2 Oil maintenance



Note! We recommend having oil analyzed by the technical service of the oil supplier or by an independent laboratory.

These examinations contribute significantly to the operating safety and reliability.

1.8.9.6.3 Oil sampling

Removing samples from the oil line

Note! Required accessories: clean bucket, sampling container.

Only use adequate sampling containers made of glass or plastic to sample oil. Ensure that the sample containers are clean and free of any residue.

1. Place bucket underneath the sampling drain valve in the oil line.
2. Open the sampling container.
3. Open sampling drain valve.
4. Drain 1-2 liters of oil into the bucket.
5. Immerse and rinse sampling container in oil and empty it.
6. Fill sampling container from the sampling drain valve (90 % of max. filling level).

7. Close sampling drain valve.
8. Seal sample and label.
9. Dispose of excess oil in the bucket.

Sampling oil from the oil tank

1. Place bucket underneath the drain valve in the oil tank.
2. Open the sampling container.
3. Open oil drain valve.
4. Drain 2-3 liters of oil into the bucket.
5. Immerse and rinse sampling container in oil and empty it.
6. Fill sampling container from the drain valve (90% of max. filling level).
7. Close oil drain valve.
8. Seal sample and label.
9. Dispose of excess oil in the bucket.

Labeling the sample

To ensure unambiguous identification, label the sample as follows.

Machine number

Type and manufacturer of the oil

Date and place of the sampling

Changing the oil filter:

The filter cartridge must be cleaned or replaced if the differential pressure across the filter exceeds the maximum allowable limit. Follow the procedure specified in the operating instructions of the filter manufacturer.



DANGER

Fire hazard due to escaping oil during filter cleaning

When cleaning the filters of the duplex oil filter, oil may escape due to improper handling or negligence.

- When changing the filter, ensure that the active filter is not opened.
Single oil filters may only be replaced when the unit is shut down.

1.8.9.6.4 Changing the oil



Note! The oil must be changed when the oil analysis has determined that it is no longer adequate for continued use.

Cleaning the oil lines

All oil lines and the oil tank must be absolutely clean. Solid particles such as sand, flyash, dust, cotton fibers absolutely must not remain in the oil-conducting parts (mechanical cleaning). New connecting lines to the oil tank must be free of corrosion and absolutely clean.

Filling the oil system



Note! Do not fill in oil that does not meet the specified quality. Do not fill in the oil directly, but through a fine-mesh strainer. If provided, use an oil separator when replenishing oil.

Keep remaining oil quantity in the original container for comparison.

Record filled oil type, manufacturer, quantity and filling date in the maintenance manual.

1.8.9.7 Safety inspection

The tasks described here are required in addition to the tasks detailed in other maintenance and inspection lists.

Activities	Interval	PQ	Note
Valve body, turbine casing, exhaust steam casing Check: condition, pressure tightness, cracks	D	S	-
Compressor impeller, turbine wheel Check: condition, cracks	D	S	-

Activities	Interval	PQ	Note
Shaft, impeller-shaft connections Check: condition, cracks	D	S	-
Control equipment and trip gear Check: condition, function	D	S	-

1.8.9.8 Protective equipment

Activities	Interval			PQ	Note
	A	B	C		
EMERGENCY STOP					-
Check: Function	-	-	R	Q	-
Turbine trip					-
Check: Function (trip simulation)	-	3m	3m	Q	Initial commissioning (trip simulation) sec.
Check: function (trip test)	-	-	36m	Q	Initial commissioning (trip test) sec.
Trip test	-	-	R/C	S/A	-

1.8.10 Instructions

1.8.10.1 Cleaning

 **CAUTION**

Fire risk caused by dirt

Dirt, dust deposits, lube oil and other substances may ignite.

- Clean the machine surfaces at regular intervals.



NOTICE

Functional impairment caused by lint

Lint may endanger the functioning of sensitive parts such as bearings, seals and supply units.

- Clean only with lint-free cleaning rags.



NOTICE

Incorrect cleaning

High-pressure cleaners may spray water into the inside of the machine and damage sensitive parts.

- Do not use high-pressure cleaners for cleaning of the machine.

Only a clean machine can be serviced in accordance with the specified instructions. Dirt is also a safety hazard.

1.8.10.2 Lubricants and assembly compounds



CAUTION

Contact with lubricants or installation materials

Contact with lubricants or installation materials may be harmful to your health.

1. Avoid direct contact with lubricants or installation materials.
2. Wear safety gloves and goggles.
3. Read the safety data sheets of the products; they provide information on health and safety, accident prevention and environmental protection.
Howden will send you the safety data sheets upon request.

 **NOTICE**

Use of wrong lubricants

Only the specified lubricants are suitable for use.

Mixing different lubricants may adversely affect their properties.

1. Use only the specified lubricants.
2. Do not use any lubricant of different quality.

 **NOTICE**

Use of lube oil additives

Lube oil additives may adversely affect the oil properties and thus damage machine components.

- Do not add any additives to the lube oil.

 **NOTICE**

Dirty lube oil

Water or solid matter in the lube oil may damage bearings, oil pipes or the oil supply system.

- Establish and eliminate the cause of the dirt.

 **NOTICE**

Environmental hazards caused by lube oil and grease

1. Lube oil and grease may not ingress in the soil or sewage system.
2. Have used oil and grease disposed of by an authorized and specialized company.

1.8.10.3 Supply systems

Oil supply systems and other supply system are a prerequisite for the safe and reliable operation of the machine.



NOTICE

Unauthorized adjustment of devices

The machine may be damaged if valves, throttles and shutoff valves are adjusted or control actuators are operated.

1. The settings of the devices may not be changed without authorization.
2. Have Howden check if the changes are allowable before making them.



Note! Please contact Howden, if you want to change the switching values.



NOTICE

Dirty lube oil

Water or solid matter in the lube oil may damage bearings, oil pipes or the oil supply system.

- Establish and eliminate the cause of the dirt.



NOTICE

Dirty sealing fluids

Dirt in sealing fluids may damage shaft seals, supply lines or supply systems.

- Establish and eliminate the cause of the dirt.

1.8.10.4 Condensate drainage

Condensate in the casing must be drained from the drain connections.



DANGER

Damage to the impeller/wheel due to startup in condensate

The impeller may be destroyed if it is immersed in accumulated condensate in the casing during turbine startup.

- Thoroughly drain the turbine prior to startup.

1.8.11 Maintenance of accessories

Separate operating instructions apply to accessories. They contain the necessary maintenance instructions.



[Documentation on Accessories \[► 317\]](#)

1.8.12 Preserving

Preservation measures must be performed when the machine is at standstill if

- operation is not commenced immediately following assembly or commissioning
- the turbine will be shut down for a prolonged period of time

1.8.13 Repair

The results of inspections show whether repairs are required. We recommend having repairs carried out by Howden specialist personnel.

Repair list

Component/damage	Activity	PQ
Non-rotating parts, seals, parts without alignment	Replacement of parts	Q
Rotating parts, parts with alignment, components conveying steam, valve gland packings	Replacement of parts	S/A
	Measurement/readjustment of clearances, gaps, alignment, retightening, replacement	S/A
Pressure valves	Adjustment of pressure values	Q
Switches for pressure, temperature, volumetric flow rate	Adjustment of switching values	Q
Transducers	Adjustment of measured values, switching values	Q/E
Minor damage	Repair (place of installation / workshop)	Q
Major damage, rotating parts	Repair (workshop / Howden)	S
Damage to accessory	Repair (at manufacturer's site)	M



Assembly and disassembly

[Documentation on Accessories \[► 317\]](#)

1.8.14 Maintenance manual

The operator documents all work in a maintenance manual. The book provides proof of maintenance and should include the following information:

- Howden machine number
- Date
- Name
- Operating hours
- Work performed
- Date of lube oil change / lube oil type
- Date of lubrication / lubricating grease type
- Replacement of spare parts
- Modification of settings
- Faults and damage

1.9 Trouble shooting

1.9.1 Handling of faults

Faults must be eliminated to avoid machine damage.



DANGER

Failure to observe fault messages

Violation of specified limit values can result in machine damage.

1. In the event of an ALARM, establish the root cause of the fault and eliminate it.
2. Do not restart the machine following display of an EMERGENCY STOP message by the interlock or an actual EMERGENCY STOP until the root cause of the fault has been established and remedied.



NOTICE

Manipulated switch signals

Modified or bridged switch signals no longer ensure protection of the machine.

1. The settings of the equipment must not be changed without authorization.
2. Bridging switch signals is strictly prohibited.

The following tables list possible faults, their causes and remedial actions for all sub-assemblies and variants. The table may list subassemblies and variants that are not part of your machine.

1.9.2 Personnel qualifications



NOTICE

Incorrect fault analysis

Incorrect fault analysis results in the wrong measures being taken.

Faults may only be analyzed by qualified, authorized personnel.

Depending on the type of fault, the personnel deployed for fault analysis must be qualified as shown in the following table.

Training	Personnel qualification	Abbreviation PQ
Qualified	Special qualification, specially trained and instructed	Q
Authorized	Authorized by Howden and qualified to perform required tasks	A
Electrician	Professional electrical engineering training	E
Specialist	Howden technical supervisor	S

We recommend that fault analysis and repairs be performed by specialist personnel from Howden.

1.9.3 Defective measuring instruments

Defective measuring instruments may indicate faults that do not actually exist. This applies in particular to installed transmitters with measuring transducers and to portable measuring instruments. Therefore, it must first be checked whether the measuring instruments are operating correctly.

1.9.4 Documentation

The operator must document faults and damage in a maintenance log.



Maintenance

1.9.5 Fault tables

For variants equipped a VF1.6 turbine-driven auxiliary oil pump, the information given for the turbine shall apply except where special requirements are defined.

1.9.5.1 Sound

Fault	Cause	Action
Sound power level too high	Acoustic insulation not in line with accepted engineering practice	Repair acoustic insulation

1.9.5.2 Vibration

	Cause	Action
Elevated vibration levels, noisy running behavior	Unbalance through deposits/spalling on impeller	Table Corrosion/Wear/Deposits
	Speed within no-hold speed range	Only allow speed outside the no-hold speed ranges
	Bearing clearance too large	Install bearing with correct bearing clearance
	Bearing unstable due to incorrect oil viscosity	Change lube oil, use specified lube oil
	Bearing damaged	Replace bearing
	Coupling alignment incorrect or modified	Re-align coupling
	Foundation has yielded	Repair foundation, re-align machine
	Impeller is immersed in condensate	Check drain and clean it
	Unbalance through deposits/spalling on impeller	Table Corrosion/Wear/Deposits
	Imbalance due to wear on the impeller	Balance, measure and evaluate wear

The cause of elevated vibration levels can often only be determined by special measurements. For such measurements, the connection between vibration pickup and bearing must be rigid and as short as possible. Measurement direction is horizontal, in some cases also vertical and axial.

A frequency analysis allows the cause of vibration to be established. If a frequency analysis is not possible, you should

- measure selectively: overall (∞) and rotational frequency vibrations (1xn)
- measure the vibration displacement (μm) and vibration velocity (mm/s).

We recommend that vibration issues be resolved by qualified and authorized personnel from Howden.

1.9.5.3 Noise

Fault	Cause	Action
Noise in area of installed operating oil pump	Pump defective, worn	Check pump, replace
Noisy, rough running behavior of gearbox	Gearing damage	Check gearing and repair

1.9.5.4 Corrosion/Wear/Deposits

Fault	Cause	Action
Erosion, corrosion on the impeller, nozzles and casing interior	Excessive steam moisture	In case of increased steam moisture, operate turbine in specific range
	Steam quality (boiler water treatment), not according to Howden specification	Check water treatment, analyze condensate, compare with Howden specification
Deposits on the impeller	Steam quality (boiler water treatment), not according to Howden specification	Check water treatment, analyze condensate, compare with Howden specification
Deposits on the casing interior	Steam quality (boiler water treatment), not according to Howden specification	Check water treatment, analyze condensate, compare with Howden specification

1.9.5.5 Bearing temperature

Fault	Cause	Action
Bearing temperature too high	Bearing clearance too small	Install bearing with sufficient clearance
	Oil temperature too high	Table Oil temperature
	Oil viscosity too high	Change lube oil, use specified lube oil
	Oil pressure too low	Oil quantity table
	Oil quantity too low	Oil quantity table
	Bearing(s) damaged	Install new bearing
	Bearing worn	Install new bearing
	Incorrect bearing	Install correct bearing

The bearing temperature limit values can often only be determined after commissioning and initial operating experience.

1.9.5.6 Bearing tightness

Fault	Cause	Action
Leaking gearbox	Seal rings worn	Replace seal rings
	Leaking joint	Reseal joint
	Excessive pressure in bearing housing	Clean ventilation filter
	Excessive pressure from adjacent assemblies (compressor/turbo blower, cooling disc, coupling)	Ensure pressure balance and ventilation
	Oil level too high	Ensure compliance with specified max. oil level when lubricating in the future; if necessary drain lube oil
	Oil quantity too high	📖 Table Oil quantity
	Defective oil supply system	📖 Table Lube oil supply
Leaking shaft seal	Shaft seal defective (negative pressure may cause lube oil to be drawn from the bearing)	📖 Table Tightness of shaft seal

1.9.5.7 Shaft seal tightness

Fault	Cause	Action
Leaking shaft seal	Carbon rings worn	Replace carbon rings
	Defective extraction	Check and repair extraction system
	Defective seal gas supply*	📖 Table Sealing gas supply

* only applies for gas expansion turbines

1.9.5.8 Coupling

Fault	Cause	Action
Noise and/or vibration	Incorrect or changed alignment	Establish cause, realign
	Wear	Replace worn parts of coupling

1.9.5.9 Gearbox

Fault	Cause	Action
Noises	Defective oil supply system	Table Oil pressure
	Damaged gear teeth	Check and repair gearbox
Vibration	Excitation by compressor/turboblower	Table Vibration
Galling on tooth flanks	Lube oil with incorrect failure load stage	Use specified lube oil
Damaged tooth flanks	Overloading, also localized overloading	Inspection of current load, service limit (contact pattern test)
Incorrect contact pattern	Foundation has yielded	Repair foundation, realign machine, check contact pattern

1.9.5.10 Control system / control equipment

Fault	Cause	Action
Turbine does not start	Valve stem is jammed tight, deposits on valve stem	Clean valve stem, replace seal

Fault	Cause	Action
Turbine does not stop	Valve stem is jammed tight, deposits on valve stem	Clean valve stem, replace seal
Speed fluctuates	Valve stem is jammed tight	Clean internals of the actuator
Speed fluctuates	Actuator contaminated on the inside	Clean valve stem, replace seal
Specified speed/output is not achieved	Valve stem is jammed tight, deposits on valve stem	Clean valve stem, replace seal
Oil leaking from actuator	Seal rings worn	Replace seal rings
Steam leakage at steam valve	Wear	Replace packing



Attention! Gland packings at steam valves must not be retightened during operation of the turbine or when the machine is hot. Freedom of movement on the part of the stem must be ensured at all times!

1.9.5.11 Oil temperature

Fault	Cause	Action
Oil temperature too high	Ambient temperature too high	Protect oil supply system against heat
	Cooler fouled	Clean cooler
	Inadequate cooling water flow rate	Increase cooling water flow rate
	Cooling water temperature too high	Increase cooling water flow rate
	Water connections at cooler switched	Correct water connections
	Heater does not switch off	Check and repair oil heater and temperature controller
	Controller incorrectly set or defective	Correct controller settings or replace controller
Oil temperature too low	Heater does not switch on	Check and repair heater and temperature controller
	Cooling water flow rate too high	Reduce cooling water flow rate
	Cooling water temperature too low	Reduce cooling water flow rate

1.9.5.12 Oil pressure

Fault	Cause	Action
Oil pressure too low	Soiled filter	Clean / replace filter
	Pressure relief valve soiled, incorrectly set or defective	Clean, readjust or repair pressure relief valve
	Clogged suction line	Clean suction line
	Defective oil pump	Repair oil pump
	Mechanical pump drive unit defective	Repair drive unit
	Lube oil foams	☞ Table Oil condition
	Leakage	Eliminate leakage
Oil pressure too high	Soiled filter	Clean / replace filter
	Pressure relief valve soiled or incorrectly set	Clean or readjust pressure relief valve
	Cooler fouled	Clean cooler

1.9.5.13 Oil flow rate

Fault	Cause	Action
Oil pump does not pump lube oil	Pump is rotating in the wrong direction	Wire up motor correctly
	Mechanical pump drive unit defective	Repair drive unit
	Defective oil pump	Repair oil pump
	Oil level too low	Replenish lube oil, check level indicator
Oil pump pumps too little lube oil	Oil pump sucks in air	Check and repair oil pump seal

1.9.5.14 Oil level in tank / bearing housing

Fault	Cause	Action
Oil level too low	Lube oil has not been replenished	Replenish lube oil
	Leaking bearing	📖 Table Tightness of bearing
	Leakage	Eliminate leakage

1.9.5.15 Oil condition

Fault	Cause	Action
Dirt in the lube oil	Lube oil has not been changed	Change lube oil
	Oil filter defective or filter mesh size too large	Repair filter, replace filter strainer
Metal particles in lube oil	Bearing wear	Check bearing
Water in lube oil	Ingress of rainwater or cleaning water	Protect against water ingress
	Cleaning was performed with high-pressure cleaner	Do not use high-pressure cleaner
	Leak in cooler	Repair cooler
	Water not drained from oil tank	Drain water at regular intervals, eliminate cause
	Leaking turbine shaft seal	Replace shaft seal
Lube oil displays dark discoloration	Lube oil has not been changed	Analyze oil and change lube oil
Lube oil foams	Lube oil has not been changed	Analyze lube oil, change lube oil
	Incorrect lube oil	Flush system, change lube oil

Fault	Cause	Action
Brown precipitation from the oil, deposits	Aged oil, degraded antioxidants	Analyze oil, change oil, clean oil system

1.9.5.16 Seal gas supply

The described faults and their causes are specific in some cases to the measuring point.



Documentation on Accessories

1.9.5.17 Electrical equipment

Power supply

Fault	Cause	Action
No power	Power supply interrupted	Check and restore power supply
	Overload switch triggered	Restart after a certain period, establish cause

1.9.5.18 Monitoring

Fault	Cause	Action
No measured value	Measuring fault	Check 4...20mA signal, check, replace or repair cables
	Defective measuring transmitter	Repair measuring transmitter
Incorrect measured value	Measuring transmitter not set correctly	Reset measuring transmitter

1.9.5.19 Leaktightness of gearbox

Fault	Cause	Action
Leaking gearbox	Seal rings worn	Replace seal rings
	Leaking joint	Reseal joint
	Excessive pressure in bearing housing	Clean ventilation filter
	Oil level too high	Ensure compliance with specified max. oil level when lubricating in the future; if necessary drain lube oil
	Oil quantity too high	Oil quantity table
	Defective oil supply system	Lube oil supply table
	Shaft seal defective (negative pressure may cause lube oil to be drawn from the bearing)	Shaft seal tightness table

1.9.5.20 Generator

Fault	Cause	Action
Short circuit	Surge	Check: coupling (elastomer sleeves, possibly replace them)
		Shaft ends - coupling hubs (visible deformation / twisting)
		Gear teeth (visible deformation, possibly crack examination, depending on load)