

Commissioning protocol Steam Turbo-Set RoCa

1 Overhaul works summary

The following scope of works was executed in the steam turbo set overhaul 2022,

- Full Turbine Valve Revision (Hp, IP, Admission, LP)
- Full Turbine and Generator bearing inspection
- Revision of HP Turbine
- Revision of IP Turbine
- Revision of Auxiliary Systems (Lube Lift Oil Pumps, Control Oil Pumps, Drains System, Seal Steam System)

This Annex 1 contains the general Uniper requirements on the commissioning procedure, its milestone and activities as well as documentation. The yellow marked text passages and KKS are not RoCa specific and the Contractor shall change prior to commissioning using the Annex 1 as a minimum requirement and template

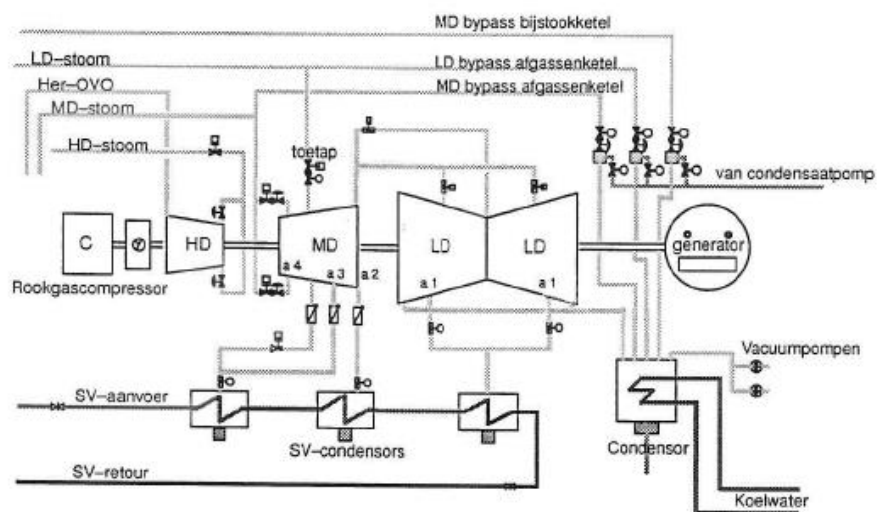
2 Milestones / steps of commissioning

No.	Activities	Date of exec.
1		
2		
3		
4		
n		

3 Technical Data

Steam Turbine

Model	ABB, D4Y441AZ (LP last stage blade RS41A)
Serial number of turbine generator set	GM 00359
Type	Condensing turbine downward exhaust
Reheat system	single reheat
Number of steam extractions	5
Shaft trains / casings / exhaust steam flows	1 / 4 / 2
Turbine designed for driving a generator	
Nominal capacity	104 MW
Speed	3,000 rpm
Live steam mass flow	70 kg/s
Live steam parameters (upstream of valve block)	112 bar / 520°C
Reheat steam mass flow	75 kg/s
Reheat steam parameters (upstream of valve block)	41 bar / 520°C
Exhaust steam pressure	0.018 bar



Overzicht Stoomturbine-installatie



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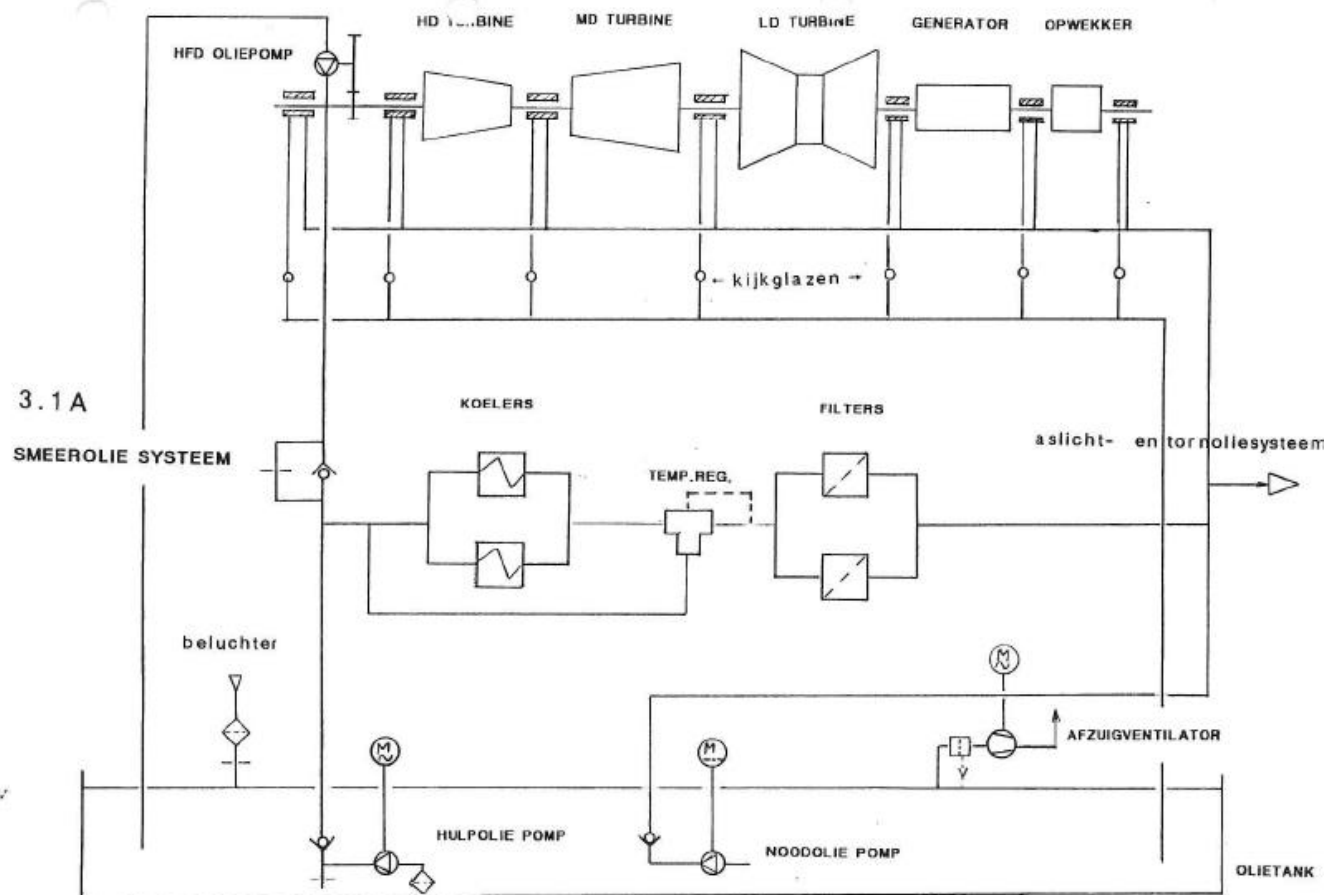
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Generator / Exciter

Model	ABB 50WT23E-114
Serial number of turbine generator set	GM 206 359
Nominal capacity	687,5 MVA / 550 MW
$\cos \varphi$	0,8
Nominal voltage	21 kV
Nominal current	18,9 kA
H2 pressure	5,0 bar
Exciter (nominal)	520V / 5.949A

4 Commissioning works oil, tuning gear and auxiliary systems

4.1 Bearing oil system



- Check if Shaft oil pump suction line needs to be filled (primed) prior to operation
- Check for tightness and readiness for operation
- Check reinstallation and settings of orifices/throttles
- Check correct oil filter operation, perform switch over
- Check correct cooler operation, perform switch over
- Adjust oil pressure and check oil pressure stability
- Check and adjust negative pressure in bearing housings during turning gear and @ full load
- Check tightness of bearing housings
- Check oil pressure during auxiliary and emergency pump operation
- Check "switch on pressure" of auxiliary pump
- Check "switch-on pressure" of the emergency pump
- Check working of functional group "lube/lift/bearing oil"



Diameter orifices :

Name	Orifices diameter in mm	Tightness "Straub" yes/no
Bearing 11		
Bearing 12		
Bearing 21		
Bearing 31		
Bearing 41 (Gen)		
Bearing 51 (Gen)		
Bearing 61 (Gen)		

Check emergency oil pump "on" successfully :

Switching point emergency pump on/off ::

Functionality check and adjustment of bearing oil temperature control valve :

Check pressure oil tank in mmWS:



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Recording of data **cold** commissioning,

Name	Date/Time	Date/Time	Date/Time
Oil-Pump	MAV 21 AP011	MAV 21 AP012	MAV 21 AP022
Turbine revolutions [1/min]	0	0	Turning gear
P bearing oil {bar]			
T bearing oil [°C]			
P before bearing No 11 [bar]			
P before bearing No 12 [bar]			
P before bearing No 21 [bar]			
P before bearing No 31 [bar]			
P before bearing No 41 [bar]			
P before bearing No 51 [bar]			
P before bearing No XX [bar]			

Check vacuum pressure oil tank in mmWS :

Remarks :



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Recording of data **hot** commissioning,

Name	Date/Time	Date/Time	Date/Time
Oil-Pump	MAV 21 AP002	MAV 21 AP002	MAV 21 AP001
Turbine revolutions [1/min]	0	Turning gear	3000
P bearing oil {bar]			
T bearing oil [°C]			
P before bearing No 11 [bar]			
P before bearing No 12 [bar]			
P before bearing No 21 [bar]			
P before bearing No 31 [bar]			
P before bearing No 41 [bar]			
P before bearing No 51 [bar]			
P before bearing No XX [bar]			

Switching point lift oil pumps off/on :

Switching points MAV 21 AP 002 off/on :

Functionality check bearing oil pressure control valve MAV 22 pressure fluctuation in bar in the switching point MAV 21 AP002 / MAV 21 AP001:

Check vacuum pressure oil tank in mmWS :

Remarks:



4.2 Lift oil system

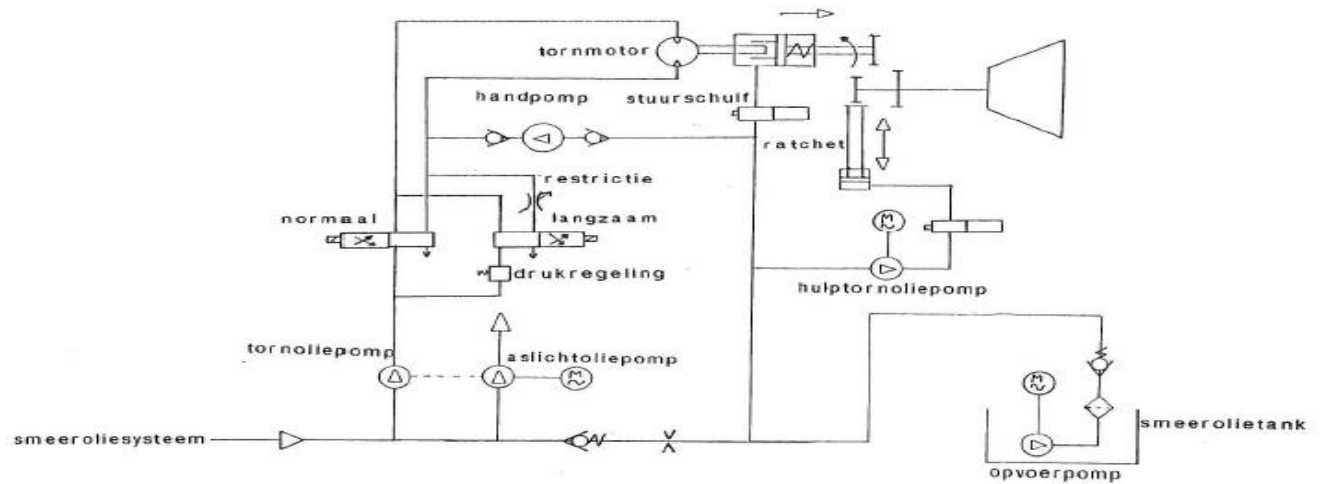
- Check for tightness and readiness for operation
- Protocol lift oil pressure and shaft lift
- Check switch over of the pumps, if applicable
- Check working of functional group “on and off”

Name		Date/Time	Date/Time
Turbine revolutions [1/min]		0	Turning gear
P bearing oil {bar}			
T bearing oil [°C]			
	Shaft lift [mm]	Oil pressure [bar]	Oil pressure [bar]
P lift oil, bearing 11	--	--	--
P lift oil, bearing 12			
P lift oil, bearing 21			
P lift oil, bearing 31			
P lift oil, bearing 41			
P lift oil, bearing 51			

Switching point lift oil pumps off/on :

Remarks :

4.3 Turning gears



- Turn shaft by hand and check smooth running of the shaft
- Check functioning of the auxiliary turning gear
- Check functioning of the main turning gear MAK 80 AE 001 and protocol start-up and run out time
- Record Motor Current consumption of turning gear
- Check working of functional group “on and off”

Name	Date/Time	Date/Time	Date/Time
Starting current MAK 80 [A]			
Operating current MAK 80 [A]			
Run-down time			

Overcurrent protective **MAK 80 AE 001** in A :

Functionality check auxiliary turning gear :

Remarks :

4.4 Non-return valves

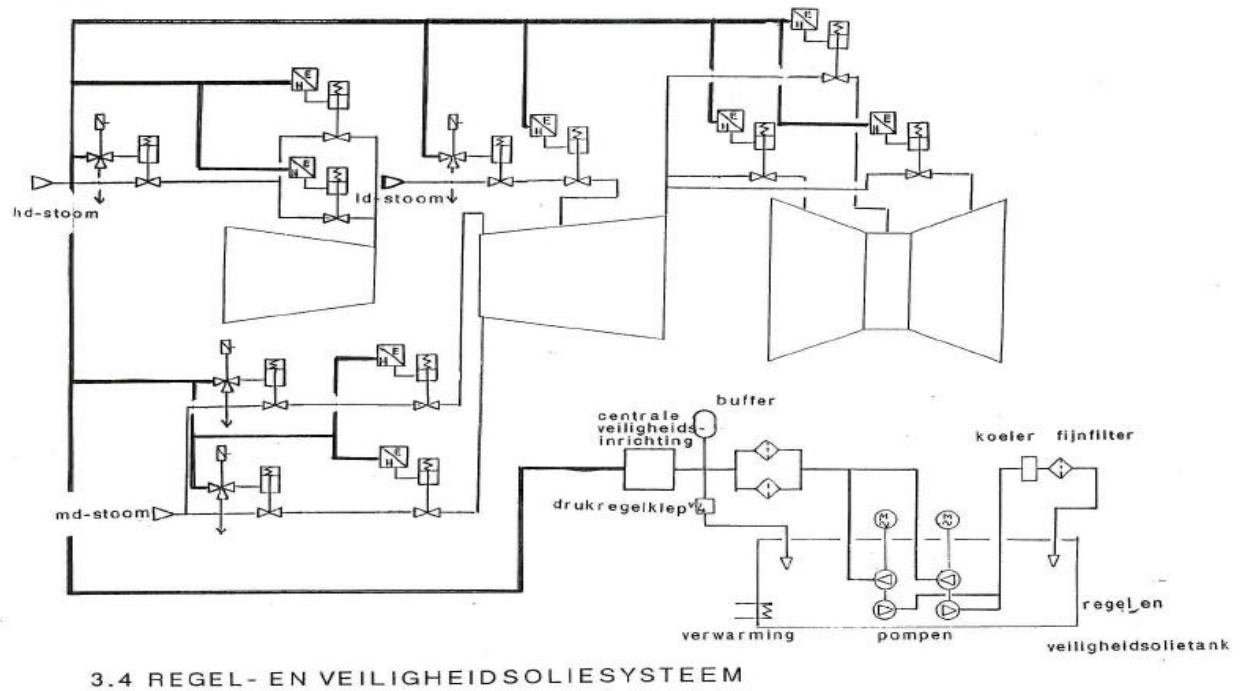
- Check for tightness and readiness for operation
- Check function of non-return valves pneumatic actuator
- Adjust control pressure of the pneumatic actuators

Functional test of the pneumatic actuators :

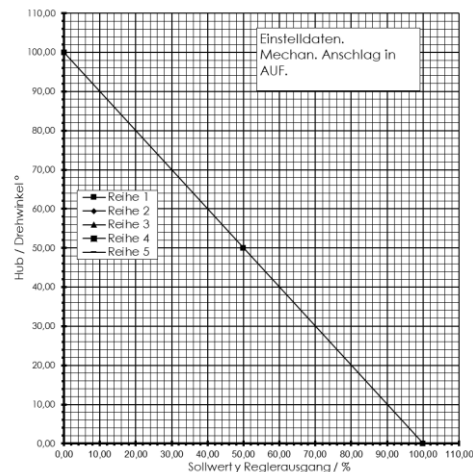
Name	KKS	Date/Time
Cold reheat non-return valve (CRNRV) 1	LBC 10	
Cold reheat non-return valve (CRNRV) 2	LBC 20	
Non-return valve , DN 500, PN 16; A4	LBS 40 AA 001	
Non-return valve , DN 400, PN 40; A5	LBS 50 AA 001	
Non-return valve , DN 400, PN 40; A5	LBS 50 AA 002	
Non-return valve , DN 600, PN 16; Heizer 3	NAA 31 AA 001	
Non-return valve , DN 600, PN 16; Heizer 3	NAA 32 AA 001	
Non-return valve , DN 250, PN 40; A6	LBQ 60 AA 001	
Non-return valve , DN 250, PN 40; A6	LBQ 60 AA 002	

Remarks :

4.5 Control Oil System – MAX system



- Check for tightness and readiness for operation
- Check oil pressure pump operation
- Check pump switching
- Check pressure accumulator
- Record characteristic curve valve opening too set point of the butterfly control valves LBS 30, LBS 40, LBS 50, NAA 31 and NAA 32



Examples for characteristic curve valve opening



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Functional test LBX 11 AP 001 and LBX 11 AP 002 pressure in bar :

Functional test pump switching :

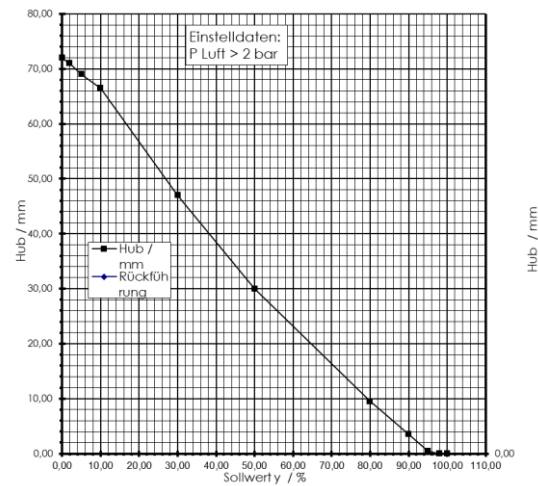
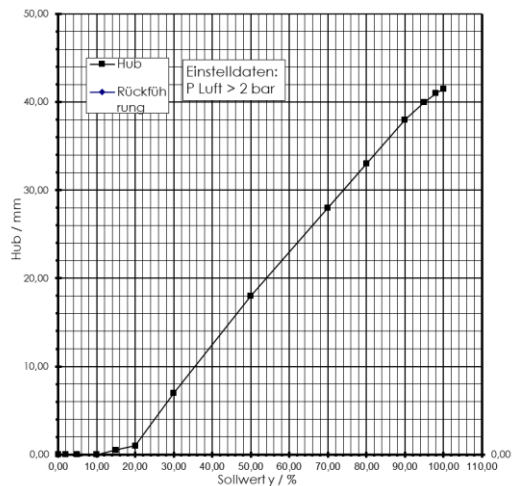
Functional test pressure accumulator, N₂ pressure in bar :

Functional test of the hydraulic actuators :

Name	KKS	Date/Time
Control butterfly valve, DN 700, PN 16; A3	LBS 30 AA 051	
Control butterfly valve, DN 500, PN 16; A4	LBS 40 AA 051	
Control butterfly valve, DN 500, PN 25; Spw. Beh.	LBS 50 AA 051	
Control butterfly valve, DN 600, PN 16; Heizer 3	NAA 31 AA 051	
Control butterfly valve, DN 600, PN 16; Heizer 3	NAA 32 AA 051	

4.6 Sealing steam system

- Check readiness for operation
- Check and adjust operating characteristics
- Record characteristic curve valve stroke too set point of the control valves MAW 10 AA 051, MAW 10 AA 055 and LCE 20 AA 051
- Check working of functional group “Sealing Steam”



Examples for characteristic curve valve stroke

Control air pressure in bar :

Functional test control valve MAW 10 AA 051 :

Functional test control valve LCE 20 AA 051 :

Functional test control valve MAW 10 AA 055 :

Functional test exhaust steam condenser, „Hannemann“ control valve and exhaust steam fan :

Remarks :



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4.7 Vacuum breaker flaps

- Check readiness for operation
- Check controlled turbine vacuum reduction

Functional test MAC 10 AA 021 and MAC 20 AA 021 :

Record set points controlled turbine vacuum reduction during shut down :

Record operational curve turbine vacuum pressure in mbar too turbine revolutions in 1/min during shut down :

Remarks :

4.8 Turbine drain system

- Check readiness for operation
- Check working of functional group "Drains"

Functional test FG MAL 10 EA 100 :

Remarks :

5 Commissioning works fire protection “Brandschutz” Turbosatz

- Check readiness for operation
- Inform PP RoCa about checking of the button “Fire Prot” in control room and wait until the commitment for the test is given.
- Protocol the results and compare with logic

Date/Time	operational state before	operational state afterwards	Remark
GC Lube Oil	on		
MAV 21 AP 002	on		
MAV 21 AP 005	off		
GC Turning Gear	on		
MAK 80 AS 001	on		
FG Hydr-Versorgung	on		
MAX 11 AP 001	on		
MAX 11 AP 002	on		
GC Lift Oil	on		
Lift Oil Pumps 2-6	on		
VaCuumbreacker MAC 10/20 AA 021	closed / closed		

Remarks :



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6 Commissioning turbine and LP- bypass protection

- Check readiness for operation
- Functional test turbine protection according **GMD 4 681 009**
- Functional test LP bypass protection according **GMD 4 681 009**
- Target setting of the specific limit values via the instrument transformer
- Check signal processing within C&I system
- Protocol the checks

Functional test turbine protection according **GMD 4 681 009** executed and documented yes/no :

Name / Date :

Document :

Functional test LP bypass protection according **GMD 4 681 009** executed and documented yes/no :

Name / Date :

Document :

Remarks :

6.1 TRIP - Block

- Functional test "Trip" – operation via manual release "in situ"

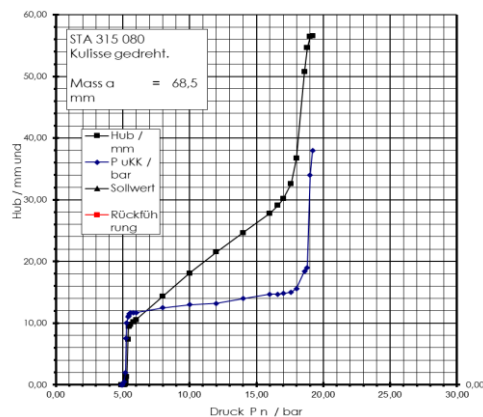
Functional test Trip executed – "Channel 1-3 pressureless" :

Remarks :

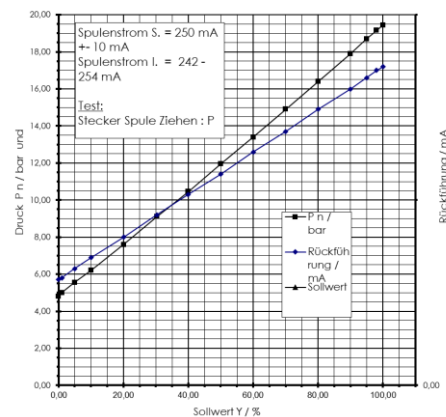
7 Commissioning turbine control system "S74"

7.1 Setting of the hydraulic control valve actuators MAA, MAB and MAN

- Check hydraulic control valve actuators for proper coupling
- Adjust the control oil pressure valve MAX 12 DP 001 and check oil pressure stability
- Adjust mechanical feedback resp. the cam plate of the hydraulic control valve actuators MAA, MAB and MAN
- Adjust the characteristic curve valve stroke too hydraulic pressure P_n and P_{uKK} , protocol the characteristic curve and create the corresponding data sheets for MAA, MAB and MAN
- Adjust the electro hydraulic converter, protocol the characteristic curve and create the corresponding data sheets for MAX
- Adapt the LT 5410 I&C cards to the characteristic curves
- Adapt the position indicator of the control valves
- Check the correct functioning of the control valve positioning by activation from the turbine controller



Example for characteristic curve valve stroke



Example for characteristic curve electro hydraulic converter & LT 5410

Name	Date/Time	Remark
MAX 26 AU 001		
MAA 11/12 AA 051		
MAX 28 AU 028		
MAA 11/12 AA 051		
MAX 71 AU 001		
MAN 11/12 AA 051		
MAN 11/12 AU 051		

7.2 Setting of the emergency stop valves

- Check hydraulic emergency stop valve actuators for proper coupling
- Functional test of the emergency stop valves (ESV)
- Check and measure full and partial valve stroke emergency stop valves (ESV)
- Check functioning of the partial stroke governing valve for the ESV
- Measuring and protocol the closing time of the emergency stop valves (ESV) and the control valves (CV)

Name	full / partial stroke in mm	closing time measurement in ms	Remarks
HP ESV MAA 11 AA 001			
HP ESV MAA 12 AA 001			
IP ESV MAB 11 AA 001			
IP ESV MAB 12 AA 001			
BP ESV MAN 11 AA 001			
BP ESV MAN 12 AA 001			
IP CV MAA 11 AA 051	--		
IP CV MAA 12 AA 051	--		
IP CV MAB 11 AA 051	--		
IP CV MAB 12 AA 051	--		
BP CV MAN 11 AA 051	--		
BP CV MAN 12 AA 051	--		

Check of emergency stop valves and control valves closing time successfully yes/no :

8 Operation monitoring

8.1 Relative elongations

- Check measurement for proper installation
- Adjust elongation measurement
- Check “Alarm” and “Trip” values

Name	negative Trip in mm	negative Alarm in mm	positive Alarm in mm	positive Trip in mm
relative elongation HPT MAA 10 CY 901				
relative elongation IPT MAB 10 CY 901				
relative elongation LPT 2 MAC 20 CY 901				

Adjustment and check of relative elongation measurements successfully yes/no :

8.2 Axial shaft position

- Check measurement for proper installation
- Adjust elongation measurement
- Check “Alarm” and “Trip” values

Name	negative Trip in mm	negative Alarm in mm	positive Alarm in mm	positive Trip in mm
axial shaft position MAD 20 CY 911				

Adjustment and check of relative elongation measurements successfully yes/no :



8.3 Absolut elongations

- Check measurement for proper installation
- Adjust absolute elongation measurement MAA 10 CY 010 and MAD 20 CY 010

Adjustment of absolute elongation measurements successfully yes/no :

8.4 Basic monitoring

- Check that the integrity of measurements (revolution, key phasor, temperature, pressure, position, displacement, level, vibration, etc.) is given
- Check that the availability of installed VIB 3000-System is given
- Check that the function of the LP turbine hood spray is given

Remarks :



9 Hot commissioning

9.1 Check-up vacuum functionality

- Ensure operation of the oil system and the turning gear
- Check-up the operational functionality of the sealing steam system
- Check-up the operational functionality of the vacuum pumps MAJ 10/20/30 AN 001
- Check the “Trip” values of the turbine protection and LP bypass protection

LP bypass protection

Name	Trip value in bara	Switch back value in bara	Remark
Condenser pressure			

Turbine protection trip

Name	Trip value in bara	Switch back value in bara	Remark
Condenser pressure			

Turbine protection alarm

Name	Alarm value in bara	Switch back value in bara	Remark
Condenser pressure			

Switching point vacuum pumps in bar absolute :

Sealing steam pressure in bar :

Condition at the steam inlet valve (ESV and CV) bushings :

9.2 Check-up turbine drain functionality

- Check- up turbine drain system functionality
- Check during test of vacuum functionality and during start up sequence
- Check working of functional group “Drains”
- Perform temperature checks on the drain valves

Name	Date/Time	Date/Time	Date/Time
	Position of valve open/ closed & t in °C	Position of valve open/ closed & t in °C	Position of valve open/ closed & t in °C
MAL11 AA404			
LBS51 AA401			
LBS41 AA401			
MAL11 AA401			
NAA31 AA401			
MAL11 AA405			
LBS51 AA403			
NAA22 AA401			
NAA32 AA401			
LBQ61 AA401			
NAA21 AA401			
LBQ61 AA403			
LBS31 AA401			
LBC21 AA402			
LBC11 AA402			

Remarks :

9.3 Check the tightness of the turbine steam inlet valves MAA and MAB

- Check- up the tightness of the turbine steam inlet valves MAA and MAB during start up
- Execute tightness test in close cooperation with C&I department Staudinger
- Protocol tightness test results

Steam parameters upfront valve blocks

Name	acceptable pre-condition values	Test values	Remark
P live steam in bar	80		
T live steam in °C	400		
P reheat steam in bar	12		
T reheat	380		

Tightness test of emergency valves

Name	ESV position in %	CV position in %	Remark
HP ESV MAA 11 AA 001	closed		
HP ESV MAA 12 AA 001	closed		
IP ESV MAB 11 AA 001	closed		
IP ESV MAB 12 AA 001	closed		
IP CV MAA 11 AA 051		ca. 20 %	
IP CV MAA 12 AA 051		ca. 20 %	
IP CV MAB 11 AA 051		ca. 20 %	
IP CV MAB 12 AA 051		ca. 20 %	

Change of turbine revolutions noticed :



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Tightness test of control valves

Name	ESV position in %	CV position in %	Remark
HP ESV MAA 11 AA 001	open		
HP ESV MAA 12 AA 001	open		
IP ESV MAB 11 AA 001	open		
IP ESV MAB 12 AA 001	open		
IP CV MAA 11 AA 051		closed	
IP CV MAA 12 AA 051		closed	
IP CV MAB 11 AA 051		closed	
IP CV MAB 12 AA 051		closed	

Change of turbine revolutions noticed :

9.4 Check the functional group “Safety Installations“

- Ensure correct and successful working of functional group “Test Sich Einr Turb” subfunctions,
 - AW Test Überdrehzahl-Schutz
 - AW Test HW Turbinen-Schutz
 - AW Test HilfÖIPumpe
 - AW SW-Test NotOelPpe
 - AW SW-Test Anhebe-NotOelPpe
 - AW Test Anzapf RSKL
- Ensure correct and successful working of functional group “FG Prüfen Ventile”
- Protocol the test results

Test FG Sich Einr Turb

Name	Function	Remark
AW Test Überdrehzahl-Schutz		
AW Test HW Turbinen-Schutz		
AW Test HilfÖIPumpe		
AW SW-Test NotOelPpe		
AW SW-Test Anhebe-NotOelPpe		
AW Test Anzapf RSKL		

Check of “FG Sich Einr Turb” successfully yes/no :



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Test FG Prüfen Ventile

Name	Impact / Function	Remark
FG Prüfen FD SSV/RV Li MAA 11 AA 051 (RV) MAA 11 AA 001 (ESV)		
FG Prüfen FD SSV/RV Re MAA 12 AA 051 (RV) MAA 12 AA 001 (ESV)		
FG Prüfen ABFG SSV/RV Li MAB 11 AA 051 (RV) MAB 11 AA 001 (ESV)		
FG Prüfen ABFG SSV/RV Re MAB 12 AA 051 (RV) MAB 12 AA 001 (ESV)		
ND Bypass Schutz – push button in the control room		

Check of “FG Prüfen Ventile” successfully yes/no :



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9.5 Check the Vacuum drop during operation

- Check- up the drop of turbine vacuum during turbine operation
- Ensure tightness of shut-off valve upfront Elmo pumps
-
- Protocol test results

Name	Date		Remark
	Time:	Time:	
Turbine load in MW			
Colling water mass flow in m ³ /h			
Cooling water inlet temperature in °C			
Cooling water outlet temperature in °C			
P absolute condenser in bara			

Change of vacuum noticed :



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9.6 Bearing oil system

Recording of data **hot** commissioning / turbine load,

Name	Date/Time	Date/Time	Date/Time
Oil-Pump	MAV 21 AP001	MAV 21 AP001	MAV 21 AP001
Turbine load (100 / 300 / 550) [MW]			
P bearing oil {bar}			
T bearing oil [°C]			
P before bearing No 1 [bar]			
P before bearing No 2 [bar]			
P before bearing No 3 [bar]			
P before bearing No 4 [bar]			
P before bearing No 5 [bar]			
P before bearing No 6 [bar]			
P before bearing No 7 [bar]			

Remarks: