DM--AV-TBSIDD----SPECIFICATIONS CENTRAL PROCESS SYSTEM 3 MW BEAM ON TARGET.DOCX

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1. INTRODUCTION

This document describes design parameters for the Central Process System (CPS). It is an agreement between ESS and the supplier E.ON of what the CPS shall deliver and when it is operational.

Most of the ESS installations are planned and built for a final capacity of 5 MW Beam on Target and this should be the maximum capacity seen over a very long time to come, maybe 20-40 years.

In spite the fact that the long-term future Beam on Target can reach 5 MW it´s decided that the CPS shall be designed only for 3 MW Beam on Target, with the following additions:

- The main spine pipe systems in CUB shall be designed to allow up to 5 MW Beam on Target.
- E.ON shall, as far as possible, allocate space in the CUB to enable future expansion up to 5 MW Beam on Target.

The table below shows differences in duty between the both:

Table 1 Differences in supply temperatures between 5 MW and 3 MW Beam on Target

Duty MW for different systems	**CWL**	**CWM**	**CWH 45**	**CWH 50**	**DHL**
5 MW Beam on Target, MW	6,3	7,5	8,4	6,1	4,2
3 MW Beam on Target, MW	**6,0**	**6,1**	**6,0**	**4,8**	**4,2**

1.1. Applicability

This document is a development of the earlier document ESS Central Process Systems Technical Description ESS-0068371, dated January 22, 2018. Also referred to as Appendix 1.1.72 Technical requirements in the DBFOM Agreement between E.ON and ESS.

Information in this document is collaborated together with E.ON in order to provide increased understanding and clarity between E.ON and ESS.

Information in this document overrules information in the document described above.

2. TECHNICAL SPECIFICATIONS

2.1. Cooling water

The cooling water system is divided into 4 circuits CWL, CWM, CWH45 and CWH50.

The CWH45 system is for Klystron cooling serving 3 shunt circuits in the ESS G02 building.

The level of 45°C is set to provide a maximum 55°C outlet temperature from Klystons at a Δt 5°C over the Klystrons. As long as the functionality max Δt 5°C and 55°C outlet temperature from Klystrons can be guaranteed E.ON can connect the CWH45 circuit to the CWH50 circuit in the CPS system, and also deliver a higher temperature <50°C.

Table 2 Supply/return temperatures and capacity.

System	Supply temp	Return temp	Max cooling capacity in 2025	Comment
CWL [1]	8°C	16°C	3,0 MW	For HVAC cooling.
			3,0 MW	For Process and Rack cooling.
CWM	25°C	31°C	6,1 MW	For Klystrons, Kryo and Target.
CWH45	45°C	55°C	6,0 MW	For Klystrons.
CWH50	50°C	>80°C	4,8 MW	For Kryo and Target.

Table 3 Cooling Water System Design Data

Design data:	CWL	CWM	CWH45	CWH50
Design temperature	110^0 C	110^0 C	80^0 C	110^0 C
Design pressure	10 bar	10 bar	10 bar	10 bar
Quality	DC [2]	De-ionized	De-ionized	De-ionized
Filtration Full Flow	1 mm	1 mm	1 mm	1 mm
Filtration Slip Flow 5%	0,1 mm	-	-	-
Supply temp	+/- 1°C	+/- 1°C	+/- 2°C	+/- 2°C
Pressurization	4 bar	4 bar	4 bar	4 bar
Minimum Diff. pressure[3]	3 bar	4 bar	2 bar	4 bar
Pressure variation	+/- 0,2 bar	+/- 0,2 bar	+/- 0,2 bar	+/- 0,2 bar

[1] Temperature curve can be adapted to outside temperatures.
[2] DC = Normal District Cooling / District heating Water quality.
[3] Diff. pressure measured at consumers.

The values relate to stable operation with no load changes, temperature stability at start and stop may vary above the values.

Operation time according to chapter 3, Design Case Matrix. Planned total shutdowns, max one (1) per 5 years

2.2. District Heating

Table 4 District Heating System Design Data

Design data:	DH to Kraftringen	DHL to ESS
Design capacity, MW	E.ON[4]	4,2
Design temperature	120^0 C	120^0 C
Design pressure	16 bar	16 bar
Quality	DH [5]	DH
Filtration Full Flow	1 mm	1 mm
Supply temp from CUB winter / summer	>=80^0 C	55 / 35^0 C
Return temp to CUB winter / summer	< 60^0 C [6]	35 / 25^0 C
Supply pressure	< 10 bar	< 10 bar
Diff. pressure	2 - 4 bar	1,5 - 2 bar

2.3. Instrument air

The instrument air from CUB will be used across the site for control valves, lifting equipment, tool operations, etc. See technical specifications for detailed requirements. ESS has installed air compressors in substations in G02 and G04 buildings. ESS compressors shall be integrated with main headers together with E.ON:s equipment to act as redundancy.

Capacity:	3000 Nm3/h
Solids:	ISO 8573 class 1
Dew point:	ISO 8573 class 2 (-40°C)
Oil:	ISO 8573 class 0 (oil free)
Pressure:	7 bar g
Design pressure:	10 bar g

[4] Designed by E.ON
[5] DH = Normal District Heating water quality.
[6] The return temperature from DH is normally below 50^0 C. The CUB must be able to handle short periods (hours) when temperature can be up to 60^0 C.

Operation time:	100% capacity > 6000 hours/year. 50% capacity rest of year Redundancy from ESS
Planned total shutdowns:	Max one (1) per 5 years

2.4. De-ionized water for taps

The de-ionized water from CUB will be used across the site for laboratory use and other general uses. See technical specifications for detailed requirements.

Capacity:	2 m3/h
Supply pressure:	8 bar g
Design pressure:	10 bar g
Oxygen:	< 15 ppb
Conductivity:	ISO 3696 Grade 1 (<0,1 µS/cm)
Purity:	RO filtered + polishing
Operation time:	100% capacity > 6000 hours/year. 50% capacity rest of year
Planned total shutdowns:	Max one (1) per 5 years

2.5. Noise requirements for Air Cooler, ESS building H01

The Contractor guarantees that the total noise level outdoors, caused by sound from cooler, will not under any normal operational conditions exceed the following levels:

- Equivalent sound power level of 93 dBA, dB re 10^{-12} W.

This maximum permissible sound power level is equivalent with a sound pressure level of 45 dBA, dB re 2 x 10^{-5} Pa, measured in free field conditions at 100 m distance. The cooler mounted as intended and in operation at maximum load.

The Contractor shall state if noise hood or silencer is required to fulfil this noise level and in case also specify the actual noise level achievable without a Noise hood.

2.1. Control & Monitoring

E.ON is responsible for all control and monitoring required for the utilities services in CUB. Communication with the ESS control system is required for acquisition of instruments readings as well as control of set-points. Details will be specified during E.ON detailed design work.

2.2. Power supply

ESS will supply 20 kV electrical power including transformers to CUB for all E.ON requirements. E.ON shall install necessary switchgears for distribution to E.ON equipment. The electrical consumption of E.ON equipment will be measured. This

electricity cost will be part of the operational cost of the CUB and it will be accounted for in the computation of the “Heat recovery yield”.

2.1. Interface: Responsibility ESS and E.ON

Please see Appendix 1: DM--AV-TBSIDDH01-H01 RESPONSIBILITY INTERFACE MATRIX CF – EON. Chess: ESS-0401641, Dated Feb 19, 2018. Revision 3.

2.2. Availability

When at operation the utility requirements will vary during the year, with large reduction during periods of maintenance and modifications of the Accelerator and other advanced equipment.

Information on supply of utilities can be found in Milestones in this document.

2.3. Installations

All installations in the Central Utility Building shall be according to relevant system design codes, Swedish laws and regulations. Present permits for operation includes restricted levels of ammonia to be used in Heat Pumps.

Installations according to Appendix 2 SI Process, ESS-0043566 dated July 4, 2017, with the following clarification:

- 1.4404 or similar includes all stainless steel within the 316 and 316L “family”.

3. DESIGN CASE MATRIX

Table 5 Design case matrix

From 2025, 3 MW BoT		Estimated medium capacity per case, MW						Estimated need of energy, GWh
		HVAC		Process				
Case	Hours	DHL	CWL		CWM	CWH45	CWH50	
Full operation in summer	1000	0,4	3,0	3,0	4,8	4,8	3,8	19,9
Shutdown in summer	1300	0,4	2,4	0,9	1,8	1,2	1,0	10,0
Full operation in spring&autumn	4000	2,1	1,5	3,0	4,8	4,8	3,8	80,2
Shutdown in spring/autumn	360	2,1	1,5	0,9	1,8	1,2	1,0	3,0
Full operation in winter	1400	3,4	0,3	3,0	4,8	4,8	3,8	28,2
Shutdown in winter	700	3,4	0,3	0,9	1,8	1,2	1,0	6,0
	8760							**147,3**

4. MILESTONES

Actions E.ON	**Time**[7]	**Comment**
Preliminary Design Review (PDR)	Feb, 12-13, 2019	
Circulation in CWL from CUB. DHL new heat exchanger upgrade 2 MW (the goal is to supply DHL in October 2019). De-Ionized water 100%. Instrument air 100%.	Dec 31, 2019.	Final pumps on low capacity. Cooling supplied by existing ESS 0,5 + 0,5 MW machines. E.ON to take over operation on ESS Site and equipment.
CWL 2,4 MW.	June 1, 2020	
Circulation from CUB in CWM, CWH45, CWH50.	June 30, 2020	Cooling supplied by existing ESS cooling equipment.
DHL 3,4 MW.	Dec 31, 2021	
CWL 4,5 MW. CWM 2,4 MW. CWH45 2,5 MW. CWH50 3,0 MW.	June 1, 2022	
CWL, CWM, CWH45, CWH50, DHL full capacity.	Dec 31, 2024	CUB in operation at full capacity.

[7] Milestones stating the latest date for system in operation, including test and commissioning.

5. GLOSSARY

Term	Definition
CPS	Central Process System (Inside CUB)
CUB	Central Utility Building
C&M	Control and Monitoring
ELV	Extra Low Voltage
CWL	Cooling Water Low (Temperature)
CWM	Cooling Water Medium (Temperature)
CWH	Cooling Water High (Temperature)
DH	District Heating
DHL	District Heating Low (Temperature)
RO	Reverse Osmosis

6. APPENDICES

Appendix 1: DM--AV-TBSIDDH01-H01 RESPONSIBILITY INTERFACE MATRIX CF – EON. Chess: ESS-0401641, Dated Feb 19, 2018. Revision 3.

Appendix 2: SI Process, ESS-0043566 dated July 4, 2017

DOCUMENT REVISION HISTORY

Revision	Reason for and description of change	Author	Date
1	First issue	Roy Ericsson	-