BEER - Sub-System Design Description – Auxiliary System

Revision (1)

Components included in Revision (1): Control Hutch, Sample Preparation Area

	Name	Role/Title
Owner	Premysl Beran	BEER Lead Scientist (ESS, NPI)
Authors	Jan Saroun[a], Radim Svejda[b], Jiri Petru[c], Jakub Vyvadil[c], Tomas Rovensky[c], Martin Rojdl[c], Filip Dufek[c], Lukas Pavlicek[c], Milan Vojir[c], Martin Vankat[c], Mathieu Reungoat[c], Jaroslav Soltes[c], Martin Schulc[c], Evzen Losa[c]	[a]Nuclear Physics Institute [b]NUVIA [c]UJV Rez
Reviewer	Ken Andersen Peter Sångberg	Head of Neutron Instruments Division Systems Engineer
Approver	Gabor Laszlo	NSS Lead Instrument Engineer

The list of contributors to the feedback of each components, can be found at the end of this document.

CONTENT

CONTENT 2
LIST OF FIGURES 4
LIST OF TABLES 4
1. SCOPE 5
2. ISSUING ORGANISATION 5
3. CONTEXT 5
4. SUB-SYSTEM DESCRIPTION 5
4.1. Control Hutch (PBS 13.6.6.6) and Sample Preparation Area (PBS 13.6.6.7) 6
4.1.1. Civil part 6
4.1.1.1. Bearing structure and outer cladding 7
4.1.1.2. Ceilings, roof and floors 7
4.1.1.3. Staircase 7
4.1.1.4. Insulation 7
4.1.1.5. Surface finishes 8
4.1.2. Electrical part 8
4.1.2.1. Power supplying of Instrument BEER facilities 10
4.1.2.2. Cables and cable trays of Instrument BEER 11
4.1.2.3. Lightning and sockets 14
4.1.2.4. Grounding system 15
4.1.2.5. EPLAN output 16
4.1.2.6. Missing inputs, expert estimates 16
4.1.3. Ventilation (HVAC) 16
4.1.3.1. System G02 – Ventilation for operators 17
4.1.4. Chilled water 18
4.1.4.1. SYSTEM W01 – WATER CIRCUITS FOR HVAC 19
4.1.4.2. SYSTEM W02 – WATER CIRCUITS FOR SES 20
4.1.5. Compressed air 21
4.1.6. Socket boxes for Sample Environmental System (SES) 22
5. TECHNICAL RISK EVALUATION 22
5.1. Service pipelines 23
5.2. HVAC 23
5.3. Control Hutch and Sample preparation area 24
6. BEER TG2 REQUIREMENTS & SOLUTIONS 25

6.1. High level requirements 25
6.2. Low level requirements 25
7. ESS REQUIREMENTS 26
7.1. Installation 26
7.2. HVAC 27
7.3. Materials 27
8. GLOSSARY 28
9. REFERENCES 28
DOCUMENT REVISION HISTORY 30

LIST OF FIGURES

Figure 1: Layout of FBSname0 9

Figure 2: Layout of FBSname0.WC01 board and UPS source FBSname0.WC01.RB01 10

Figure 3: Layout of FBSname0.WC02 11

Figure 4: Chicanes into Control hutch 12

Figure 5: Main cable trays in Sample preparation area (room No. 1.01a) 13

Figure 6: Main cable trays in Control room (room No.2.02) 13

Figure 7: Location of Socket boxes in Sample preparation area (room No. 1.02) 14

Figure 8: Ventilation of room r. no. 1.01a and r. no. 2.02 17

Figure 9: Battery limit of chilled water for water circuits 19

Figure 10: System W01 – Water circuits for HVAC 20

Figure 11: Utilities in room no. 1.01a 21

Figure 12: Location of Socket boxes 22

LIST OF TABLES

Table 1: Room / area marking of CO 101 BEER Experimental Cave and Control Hutch area 6

Table 2: Table of built up area / enclosed space 6

Table 3: Level of illumination in rooms of Control hutch 15

Table 4: Main parameters of HVAC system G02 (room No. 1.01a) 17

Table 5: Main parameters of HVAC system G02 (room No.2.02) 18

Table 6: Technical risks of service pipelines 23

Table 7: Technical risks of HVAC - Ventilation part 23

Table 8: Technical risks of HVAC – Water circuits part 24

Table 9: Technical risks of Control Hutch and Sample preparation area 24

Table 10: Table of high-level requirements 25

Table 11: Table of low-level requirements 25

1. SCOPE

The scope of this document is to describe the design of the sub-system of the BEER instrument related to the auxiliary systems. The fulfilment of high- [1] and low-level [2] BEER instrument requirements are verified.

A description of parts made in this document are in a level sufficient to understand the main functionality of the sub-system. Detailed descriptions are provided in the referenced annexes.

This document will be updated throughout the process of the detail design of the whole instrument and will be freeze by the time of the final TG3.

In the Rev1 it contains the design description of the following PBS sub-systems:

- 13.6.6.6 – Control Hutch
- 13.6.6.7 – Sample Preparation Area

2. ISSUING ORGANISATION

Nuclear Physics Institute (NPI) and NUVIA

3. CONTEXT

The BEER instrument is the engineering instrument dedicated for the in-situ and in-operando studies in the field of material science under real conditions. The novel technique of the pulse modulation will allow the fast strain scanning of even real shape engineering samples.

The auxiliary systems document describes the design of supporting sub-systems of the BEER instrument like a control hutch, sample preparation area, etc.

All auxiliary sub-systems have a lot of interfaces between each other or with external ESS sub-systems which need to be properly defined to allow the expected functionality. These interfaces are described in separated document *BEER – Interface document* [3].

4. SUB-SYSTEM DESCRIPTION

The control hutch (CH) and sample preparation area (SPA) on the BEER instrument are located further downstream just after the experimental cave in the two-floor adjacent building. The lower floor is occupied by the sample preparation area and the upper floor by control hutch.

For the engineering design purposes, we use the internal numbering which is also reflected in this document and is mainly used in the referenced detail design report documents. The numbering is following:

Table 1: Room / area marking of CO 101 BEER Experimental Cave and Control Hutch area

Mark	Room name	Part of	TCS Floor level [m]
1.00	Service Area	EC	-3.000
1.01a	Sample Preparation Area	CH	-3.000
1.01b	HVAC engine room	CH	-3.000
1.02	Experimental Cave	EC	-1.500
2.01	Staircase	CH	-3.000 to -1.500/+0.600
2.02	Control Hutch	CH	+0.600

The sample preparation area serves as the space for additional sample handling, preliminary sample adjustment and installation in a sample environment as well as its alignment. From SPA, there is a close connection to the experimental cave via main door for the transport of the prepared sample environment or samples. SPA provide enough space for run also off-site experiments or test sample environment. A connection from SPA to CH is envisaged to allow control of off-site experiments from the control hutch.

The control hutch serves as the space where the instrument scientist and users are able to control the functionality of the instrument. The area is considered as temporary office. The control hutch is connected with the experimental cave personal access via stairs. The cave personal access is suited for frequent cave entry for the experiment adjustment.

4.1. Control Hutch (PBS 13.6.6.6) and Sample Preparation Area (PBS 13.6.6.7)

Because both SPA and HC are in one building, it is hard to fully separate the design description of each part. For this reason, we describe bellow the two-floor level building as one sub-system. Description is divided by functional properties.

4.1.1. Civil part

The article describes design of the Control Hutch (CH) and Sample Preparation Area (SPA) structure (two-storey enclosure near EC). The CH and SPA are designed on the E01 floor level (TCS -3.000 m). There is a space in the 1st floor (SPA) for the experiment preparation (preparatory lab – room no. 1.01a) and HVAC engine (room no. 1.01b). In the 2nd floor at TCS +0.600 m, there is a Control room no. 2.02. Personal entrance to the 2nd floor is secured from the staircase (room 2.01).

The supporting structure is designed as a steel frame structure with two floors. The steel columns are laid on the floor in hall E01 and are attached to it by chemical anchors. For more details of the design solution see documents of construction part – static analysis and technical report [4], [19], drawings of ground plans [5], [8], [11], [12] sections with material compositions [6], [9], [10], details [7] and views [18], bill of quantities [42].

Table 2: Table of built up area / enclosed space

Built up area of enclosure (control hutch):	45.60 m^2

Enclosed area of enclosure (control hutch):	296.40 m^3

4.1.1.1. Bearing structure and outer cladding

The two-storey enclosure is designed as mounted with a steel bearing structure. Columns are designed from profile HEB 140. Longitudinal beams on second floor and on the roof, are from profile IPE 160. Cross beams are designed from IPE 140 and the outer beam will be from UPE 140 profile.

Outside dimensions are 9.5×4.8 m, h=6.5 m.

The outer cladding is made of plasterboard wall th=100 mm, composed of: 2× plasterboard plate th=12.5 mm with vinyl foil (Durafort) anchored to thin-walled sheet metal profiles, with acoustic insulation of mineral wool th=60 mm. The facade of ground floor is based and anchored directly on the floor of Experimental hall 3 (E01). The optimum depth of anchorage is set to 70 mm.

Fixed windows are designed in the outer cladding on both floors.

4.1.1.2. Ceilings, roof and floors

The ceiling structures above 1st floor and 2nd floor are made of steel beams, trapezoidal metal sheet and suspended plasterboard ceiling. The floor in the sample preparation area consists of the E01 hall floor covered with an epoxy screed. The floor in the control room consist of chipboards, acoustic insulation, OSB boards and PVC strips. The roof above the control room is made of chipboards and trapezoidal steel sheets with galvanized (Zn) surface finish.

For appropriate drawings see documents for cassette ceiling [14] and roof drawing [13].

4.1.1.3. Staircase

The entrance to the control room on the 2nd floor of enclosure (cabin) is by the steel staircase, following the outer steel staircase to enter the experimental cave. The staircase will be covered with plasterboard with the same surface as the walls from the bottom side of the HVAC engine room.

For appropriate drawings see documents for staircase [15] and [16].

4.1.1.4. Insulation

The outer cladding, partitions and floor in control room will be fitted with mineral wool acoustic insulation doors and windows.

A door 800x2000 mm is designed for the access to the control room from the staircase area. The door is fixed to an aluminium doorframe, the door wing is laminated. A door 900x2200 mm is designed for access to the sample preparation area. The door is fixed to an aluminium doorframe, the door wing is made of aluminium with comaxit finish. The door wing is partially glazed. A sectional gate door 3500×2200 mm (with integrated door for personal access) is designed for the arrival of samples and equipment to/from the sample preparation area (SPA).

Windows are designed into the facade to allow partial illumination of the interior. However, main illumination of the interior is provided by artificial lighting.

For appropriate drawings see document list of doors and windows [17].

4.1.1.5. Surface finishes

The outer cladding, walls and partitions walls will be made of plasterboards with vinyl foil, colour white. Aluminium profiles, doors and window frames will be covered by comaxit finish, - gray colour.

For appropriate drawings of sections [9], [10] and external views [18].

4.1.2. Electrical part

The utility distribution in the Control hutch includes electrical power, chilled water, compressed air and HVAC systems. Chilled water, compressed air and HVAC system are described in Chapter 4.1.3, 4.1.4 and 4.1.5.

Power system for the Instrument BEER

As main power supply source for BEER Instrument, which was determined by ESS, is ESS LV main cabinet. The marking of the cabinet is FBSname0 and is situated in Guide hall E02 next to the BEER instrument.

The main cabinet FBSname0 is basic connection point for power supply and grounding of the BEER instrument and its technology for all partners – NPI, HZG and ESS.

The design of electrical parts respects the requirements of all partners that have been announced until its completion. If not, expert estimates of possible future solution were made (see chapter 4.1.2.6).

Estimated basic parameters of ESS LV main cabinet:

- FBS name: FBSname0
- Voltage system: 3NPE ~ 50Hz 400 V/TN-S, protection by automatic disconnection from the source
- Importance of appliance: powered by GP (Grid Power)

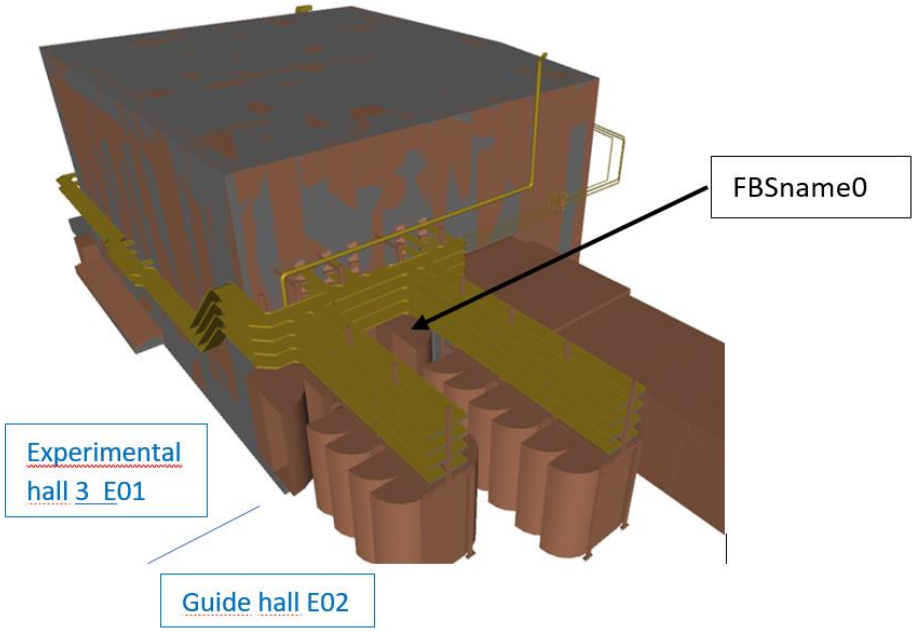

Figure 1: Layout of FBSname0

The following boards / cabinets for BEER technology, in scope of the NPI, are supplied by the LV main distribution board FBSname0:

- Two Low voltage (LV) distribution boards for lighting and sockets in the BEER instrument (marking FBSname0.WC01, WC02)
- The cabinet for bridge crane in the BEER instrument (marking FBSname0.WC03)
- The cabinet for heavy sliding door in the BEER instrument (marking FBSname0.WC04)
- The board for HVAC equipment in the BEER instrument (marking FBSname0.WC05)

Individual technological equipment's are supplied from these boards / cabinets.

To ensure selectivity between protections in the outlets of FBSname0 to distribution boards and outlets from distribution boards is issued document [26] (Fuse list) with recommendation of protections types and their parameters on FBSname0 outputs.

For more detail see the following documents of Detail Design:

Documents for overall coordination of all cooperating partners on the BEER instrument cooperating parties on NIK 6.6#3

[21] ESS-0461580 – Block diagram of electrical part, part 1

[22] ESS-0461581 – Block diagram of electrical part, part 2

Electrical scheme overview NIK 6.6

[29] ESS-0461588 – Electrical scheme overview NIK 6.6

List of electric consumers

[23] ESS-0461582 – List of electric consumers of NIK 6.6

Coordination of electrical protection with superior electrical diagram

[26] ESS-0461585 – Fuse list of NIK 6.6

4.1.2.1. Power supplying of Instrument BEER facilities

This electric power supplying system includes installations for feed the technical and safety facilities (lighting systems, socket circuits, air-conditioning equipment etc.) in Control hutch (CH).

Power supplying of facilities in CH is ensured from LV distribution boards. There are solved as compact enclosures, wall mounting. Installed instrumentation inside enclosures is solved mostly by miniature circuits breakers. The solution of enclosure and instrumentation respect ESS request in ESS-0102876 “ESS Approved Electrical Standard Components”.

LV distribution board FBSname0.WC01, situated in Control Hutch – Control room (room 2.02), is designed for power supplying of electrical circuits (lighting and socket circuits) of first floor of Control hutch and for power supplying of lighting system of Experimental cave.

Due to missing ESS back-up sources for Instrument BEER was added local UPS source FBSname0.WC01.RB01 for power supplying of Emergency lighting system. Basic parameters of UPS source are 1-phase, 10kVA with autonomy time min. 10 minutes. There is fed from FBSname0.WC01. There is situated under LV distribution board FBSname0.WC01, on the support structure.

LV distribution board FBSname0.WC02, situated in Control Hutch – Sample preparation area (room 1.01a), is designed for power supplying of electrical circuits (lighting and socket circuits) of ground floor of Control hutch and for power supplying of socket circuits of Experimental cave.

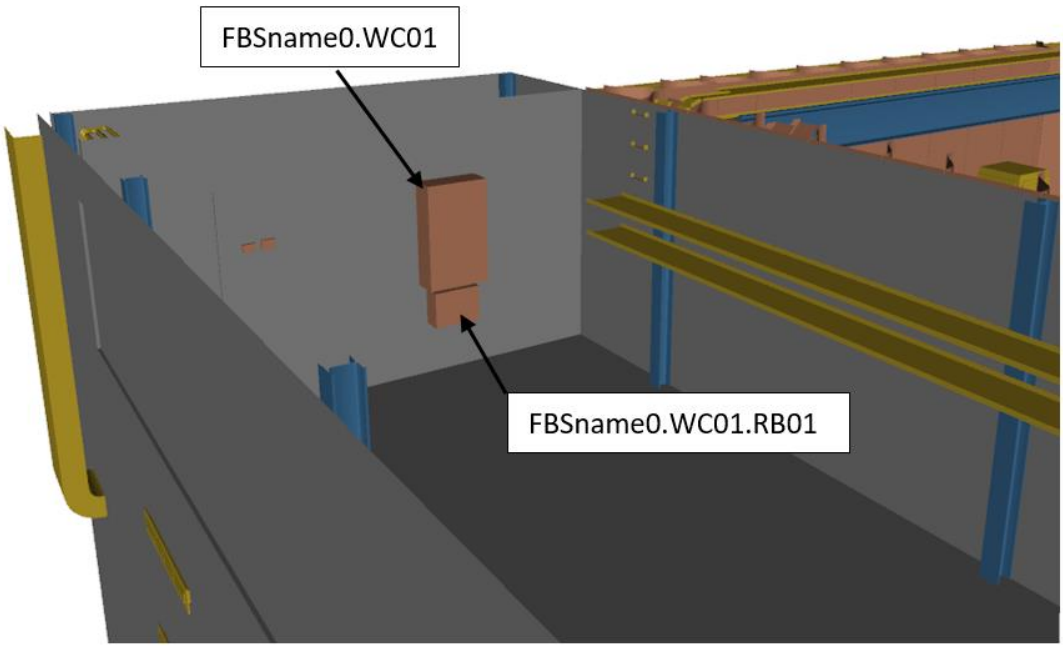

Figure 2: Layout of FBSname0.WC01 board and UPS source FBSname0.WC01.RB01

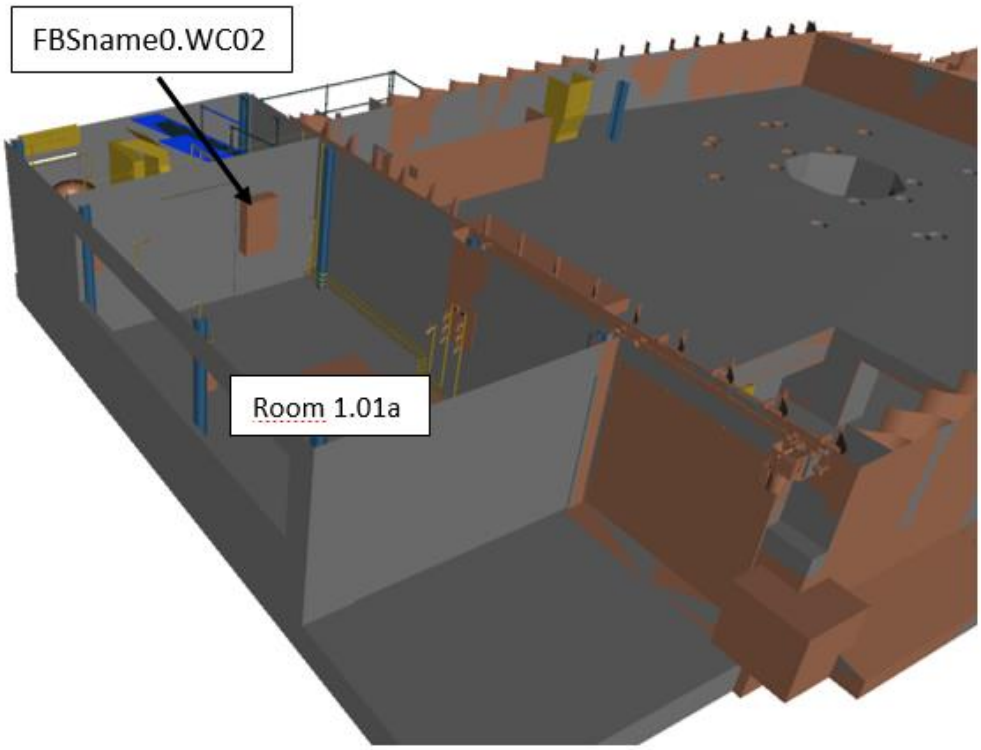

Figure 3: Layout of FBSname0.WC02

For more detail see the following documents of Detail Design:

Single line diagrams of power supply boards

[39] ESS-0461598 – FBSname0.WC01 - Single line diagram

[40] ESS-0461599 – FBSname0.WC02 - Single line diagram

4.1.2.2. Cables and cable trays of Instrument BEER

The cables needed for supplying of Instrument BEER technology, in scope of the NPI, were designed in accordance with ESS recommendation in ESS document ESS-0034035 - “ESS rules for the selection of material in cables”.

All needed cables are filled into ESS database form – [24] (*Cable overview list*). Sizing of power cables was performed - [25] (*Cable sizing list*). More detailed description in [20] (*Technical report*, Chapter 3.4.3).

The main cable trays have been designed in full scope in accordance with ESS requirements (ESS-010066). Each cable tray consists of four trays to ensure of cable separation (for power supply cables, auxiliary circuits, information cables and sensitive circuits). In accordance with conclusions of working meetings between all participants on Instrument BEER the range and size of cable

trays is enough. But still final inputs about number of needed cables for Instrument BEER as whole is not available - see [20] *Technical report of Electrical part*, ANNEX 3.

Main cable trays in Control hutch (CH) follow:

- cable trays outside of Instrument BEER (under ceiling of Sample preparation area – room No. 1.01a)
- cable trays from Experimental cave (through the chicanes) into Control room (room No. 2.02)

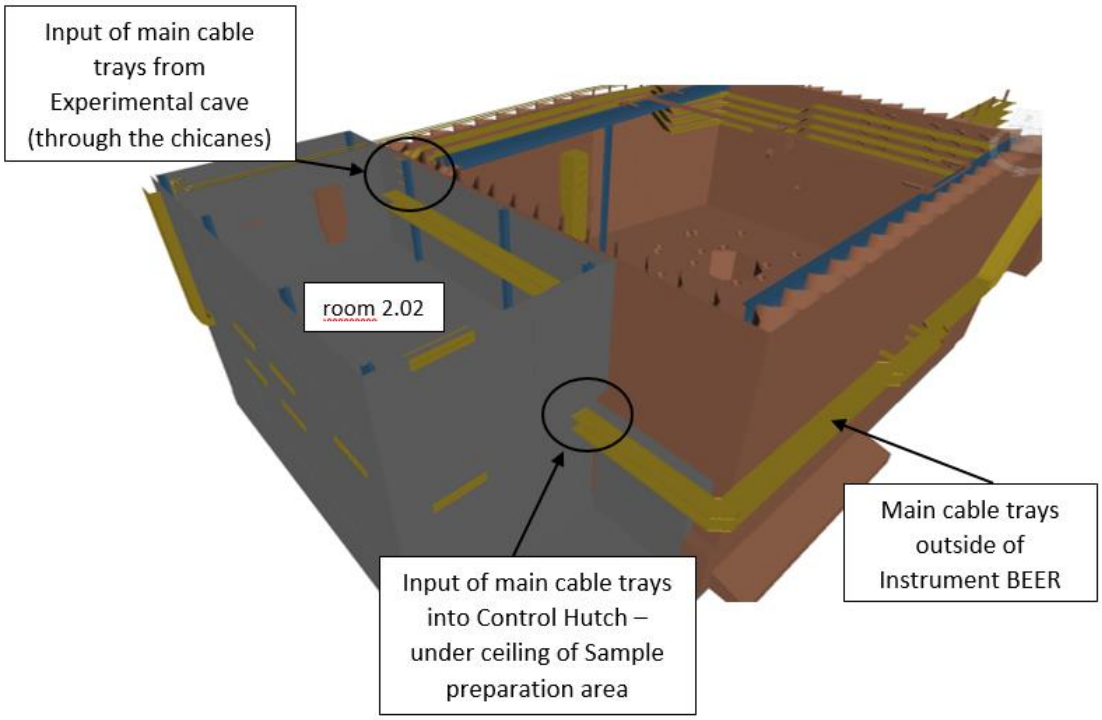

Figure 4: Chicanes into Control hutch

For cable connection between Control room and Sample preparation area are prepared chicanes in Sample preparation area ceiling. Main cable trays in Control hutch are led under ceiling and they are “wiring type” for comfortable cable routing. Field cable trays are led under plasterboard. In Control room are preliminary prepared couple cable tray (mounted on the wall, Surface finish - epoxy powder varnish) above working tables.

Main cable trays are divided into several sections and basic routing of cables, in scope of the NPI, is processed. Main cable trays mean including structures, support construction, mounting material see [28] (*List of equipment*).

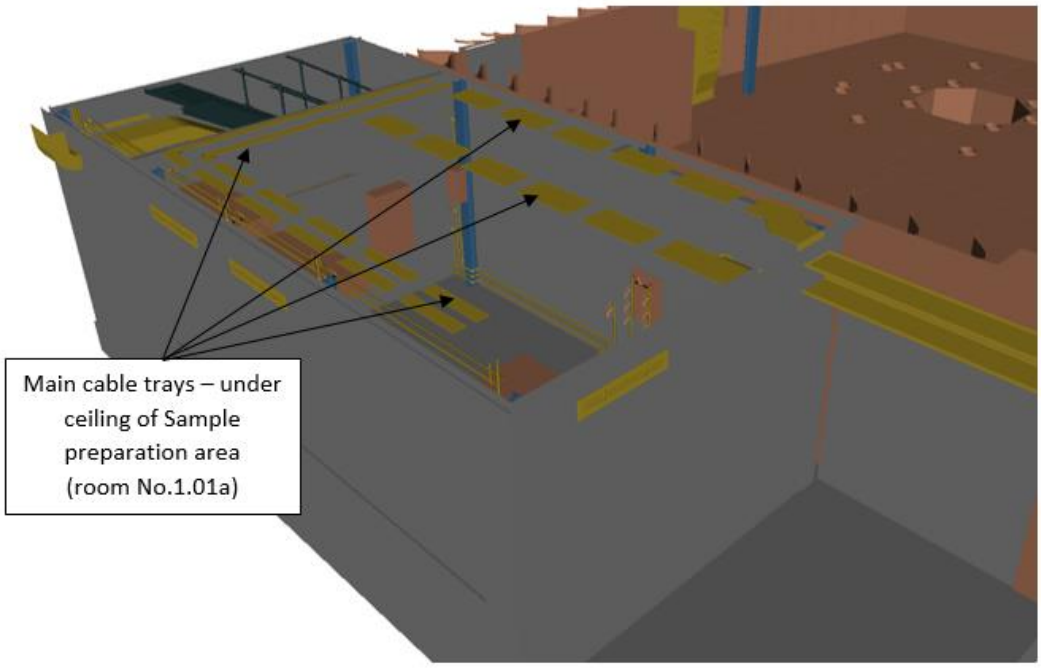

Figure 5: Main cable trays in Sample preparation area (room No. 1.01a)

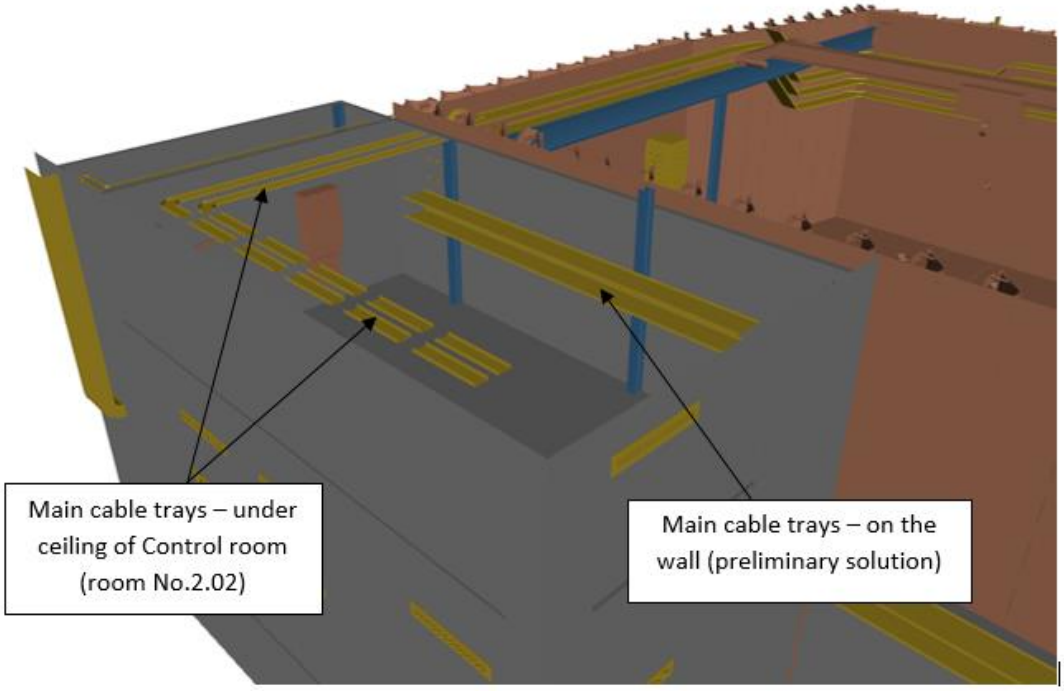

Figure 6: Main cable trays in Control room (room No.2.02)

For more detail see the following documents of Detail Design:

[30] ESS-0461589 – Main cable trays NIK 6.6 – power cables

[31] ESS-0461590 – Main cable trays NIK 6.6 – sections

[24] ESS-0461583 – Cable (overview) list of NIK 6.6

[25] ESS-0461584 – Cable (sizing) list of NIK 6.6

[28] ESS-0461587 – List of equipment of NIK 6.6

4.1.2.3. Lightning and sockets

This chapter includes Socket distribution and Lighting system, including power cables.

Socket Distributions means Socket boxes for the needs of the Instrument BEER and Socket boxes required from SES (see Chapter **Error! Reference source not found.**). Power supply of all Socket b oxes is ensured from LV distribution board of civil part FBSname0.WC02, located in the Sample preparation area (room No.1.01a).

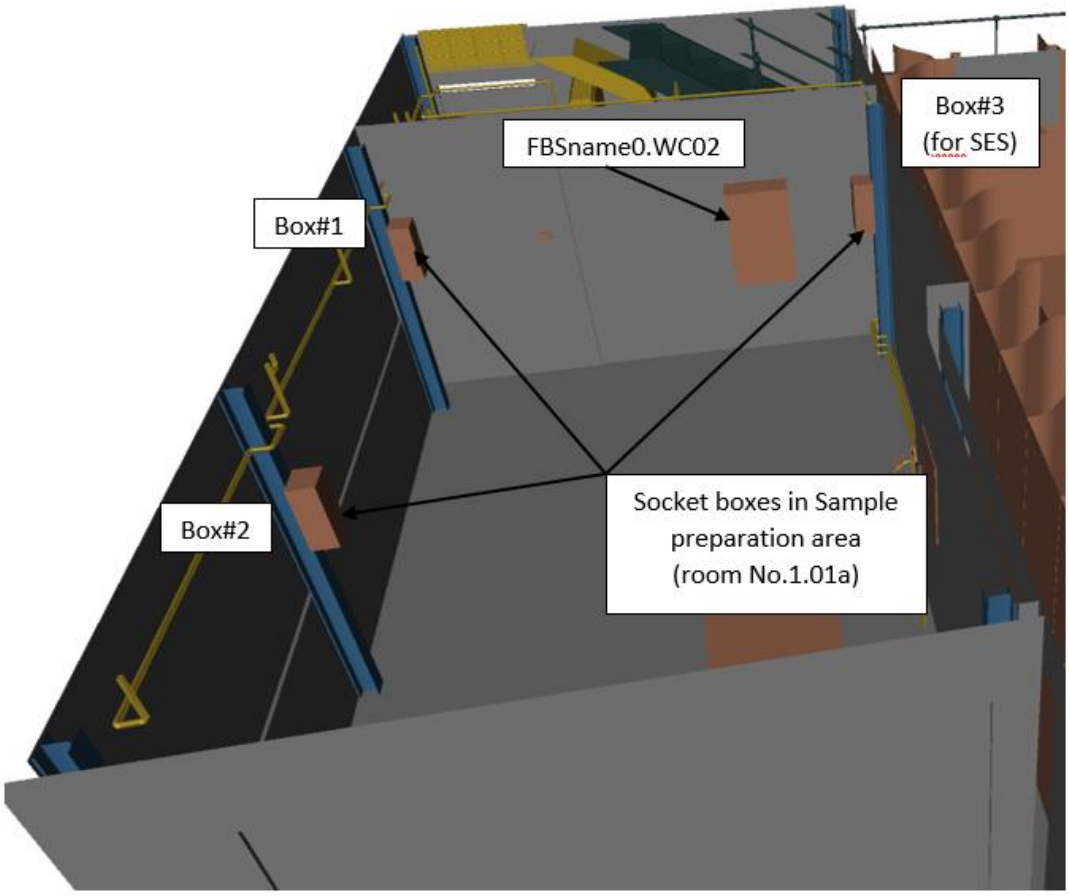

Figure 7: Location of Socket boxes in Sample preparation area (room No. 1.02)

Socket circuits intended for electrical facilities in Control room and Sample preparation area are solved by variable Bus bar system. This one is located above working tables and allows to connect needs number of sockets.

General lightning system is fed from board FBSname0.WC01 situated in Control Hutch – Sample preparation area (room 1.01a). Emergency and Guidance lightning system is fed from board FBSname0.WC02 situated in Control Hutch – Control room (room 2.02).

Internal general lighting system will be solved in accordance with standard EN 12464-1 by LED luminaires. This one is feed by normal power supply. Level of illumination in each rooms of Control hutch is shown in table below.

Table 3: Level of illumination in rooms of Control hutch

Control hutch	Room No.	Illumination level (lx)
Stairs	2.01	150
Control room	2.02	750
Sample preparation area	1.01a	750
HVAC engine room	1.01b	200

Emergency lighting system is solved in accordance with standard SS-EN 1838 by LED luminaires with minimum illumination level of 15 lx. This one is feed by local UPS source and is enable automatically in the event of an interruption in the normal power supply. Local UPS source is situated in Control room (room No. 2.02).

The Guidance lighting system will be solved in accordance with standard SS-EN 1838 by LED luminaires with self-battery kit with minimum illumination level of 1 lx.

Lighting calculations are content in [20] (Technical report of Electrical part - ANNEX 4,6).

For more detail see the following documents of Detail Design:

[35] ESS-0461594 – Building installation, socket circuits, level -1,500m

[36] ESS-0461595 – Building installation, socket circuits, level +0,600m

[37] ESS-0461596 – Building installation, light circuits, level -1,500m

[38] ESS-0461597 – Building installation, light circuits, level +0,600m

4.1.2.4. Grounding system

ESS LV main cabinet FBSname0 is main connection point for grounding of BEER technology. Grounding network of Instrument BEER consists grounding points, equipotential bonding bars and grounding strip. The ground connections will be attached radially to ESS LV main cabinet of Central grounding point and will be separated between sensitive and standard equipment.

For more detail see the following documents of Detail Design:

[32] ESS-0461591 – Grounding system, level -1,500m

[33] ESS-0461592 – Grounding system, level +0,600m

[34] ESS-0461593 – Grounding system, single line diagram

[27] ESS-0461586 – Internal grounding list of NIK 6.6

4.1.2.5. EPLAN output

Electrical part of Detail design documentation has been implemented into ESS ePLAN design. Due to the absence of some ePLAN software data in ESS area (see [20] Technical report of Electrical part - ANNEX 3), so once they have been submitted / added there will be necessary to elaborate ePLAN design update.

For more detail see the following documents of Detail Design:

[54] ESS-1406854 – NIK 6.6 EPLAN documentation

4.1.2.6. Missing inputs, expert estimates

Documentation of electrical part was compiled without the knowledge of some specific necessary inputs and without final confirmation of proposed types of NPI electrical part deliveries. Some parts of electrical design had to be based on experts estimates because of missing inputs from partners ESS and HZG. The list and description of these expert estimates is in ANNEX 3 of Technical report of Electrical part [20].

[20] ESS-0461579 – Technical report for electrical part of NIK 6.6

4.1.3. Ventilation (HVAC)

Designed HVAC equipment ensures required environment parameters for installed technological equipment located in the Experimental Cave, Control Hutch and Sample Preparation Area and provides appropriate environmental conditions for operational staff.

HVAC systems for the Experimental Cave, Control Hutch and Sample Preparation Area consists of the following subsystems:

Ventilation systems for experimental cave:

- SYSTEM G01 – Ventilation for experimental cave (convention)
- SYSTEM G03 – Containment ventilation (radiological waste)

Ventilation system for control hutch and sample preparation area:

- SYSTEM G02 – Ventilation for operators

The SYSTEM G01 and G03 is in detail described in BEER - Sub-System Design Description – Experimental Cave .

Water circuits:

- SYSTEM W01 – Water circuits for HVAC (supply chilled water +8°C for Air handling unit; fancoils and cooling HZG and PSS rack)
- SYSTEM W02 – Water circuits for SES (supply chilled water +15°C for Sample Environmental System)

Water circuits are in detail described in chapter 4.1.4 (Chilled water).

For more detail see the following documents of Detail Design:

[45] Technical report DPS 01.01 – HVAC

[47], [48] Systems G01, G02, G03, W01 and W02 diagrams solution are provided on the diagrams

[49], [50], [51] Systems G01, G02, G03, W01 and W02 layouts solution are provided on the drawings

4.1.3.1. System G02 – Ventilation for operators

The system is shown in the P&ID scheme [47].

Indoor environment ensures system G02 – Ventilation for operators.

Cooling in rooms is ensured by fan coil units. Fan coils are provided with suction of air from EXPERIMETAL HALL 03. Experimental hall 03 is heated in winter period (+20 °C is guaranteed) and equipped by free cooling in summer period (assumption +26 °C but it is not guaranteed). Heating exchanger is not included. Fan coils supply conditioned (cooled) air to mentioned rooms.

Fan coils units are connected to chilled water source (System W01) and ensure required temperature inside particular area. Circulation units are equipped by own autonomous control system.

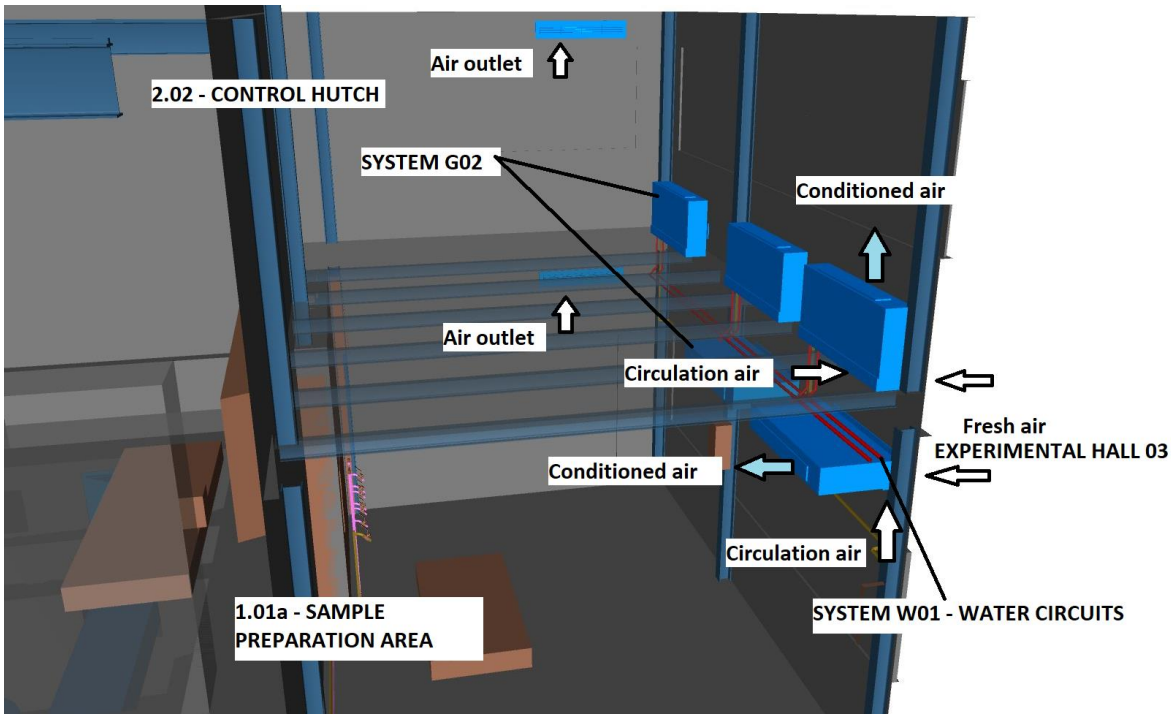

Figure 8: Ventilation of room r. no. 1.01a and r. no. 2.02

Table 4: Main parameters of HVAC system G02 (room No. 1.01a)

Indoor temperature (Sample preparation area Room No. 1.01a)	22±0.5°C
Min. fresh air flow (from E01)	400 m^3/h
Total cooling capacity (chilled water 8/18°C)	4.5 kW
Filtration	G3

Power supply	230V, 50Hz (0.4 kW)
AHU is equipped by autonomous control system: • performance control of cooler by HVAC water cooler control valve in order to maintain temperature in room +22±0.5°C during summer periods • set the fan speed (low, medium, high or auto fan) • set the operation mode (fan only, cooling). • time setting. • weekly ON/OFF program.	

Table 5: Main parameters of HVAC system G02 (room No.2.02)

Indoor temperature (Control room No. 2.02)	22±0.5°C
Min. fresh air flow (from E01)	600 m^3/h
Total cooling capacity (chilled water 8/18°C)	7,0 kW
Filtration	G3
Power supply	230V, 50Hz (0.6 kW)
AHU is equipped by autonomous control system: • performance control of cooler by HVAC water cooler control valve in order to maintain temperature in room +22±0.5°C during summer periods • set the fan speed (low, medium, high or auto fan) • set the operation mode (fan only, cooling). • time setting. • weekly ON/OFF program.	

Supply of chilled water is part DPS 01.01 too – SYSTEM W01 – Water circuits. The systems are shown in the P&ID scheme [48].

4.1.4. Chilled water

Supply of chilled water is needed for ventilation (cooling) systems, Sample Environmental System and cooling of HZG and PSS racks.

Chilled water is obtained from the central cooling water distribution system. The connection point (battery limit) is located in the E01.100.1001 – Experimental Hall 3 with technical parameters:

- Cooling capacity / average instrument: 27 kW
- Supply +8°C/7 bar
- Back <+60°C

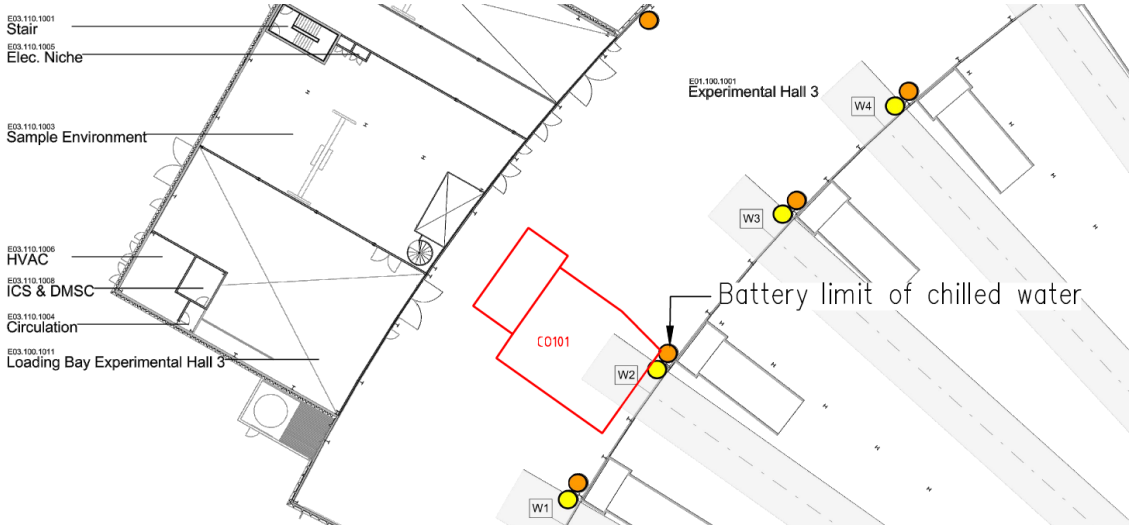

Figure 9: Battery limit of chilled water for water circuits

ESS - Instrument Technical Interfaces are described in [43].

Water circuits are divided to individual systems:

- SYSTEM W01 – Water circuits for HVAC (supply chilled water +8°C for Air handling unit; fancoils and cooling HZG and PSS rack)
- SYSTEM W02 – Water circuits for SES (supply chilled water +15°C for Sample Environmental System)

For more detail see the following documents of Detail Design:

[45]	Technical report DPS 01.01 – HVAC
[47], [48]	Systems G01, G02, G03, W01 and W02 diagrams solution are provided on the diagrams
[49], [50], [51]	Systems G01, G02, G03, W01 and W02 layouts solution are provided on the drawings

4.1.4.1. SYSTEM W01 – WATER CIRCUITS FOR HVAC

The system is shown in the P&ID scheme [48]

The system ensures supply cooling water 8°C for:

- SYSTEM G01 – Ventilation for experimental cave
- SYSTEM G02 – Ventilation for operators
- SYSTEM W02 – Water circuits for SES

Cooling water for mentioned systems shall be provided by ESS central distribution system.

- chilled water demands 31.0 kW (8/18°C)

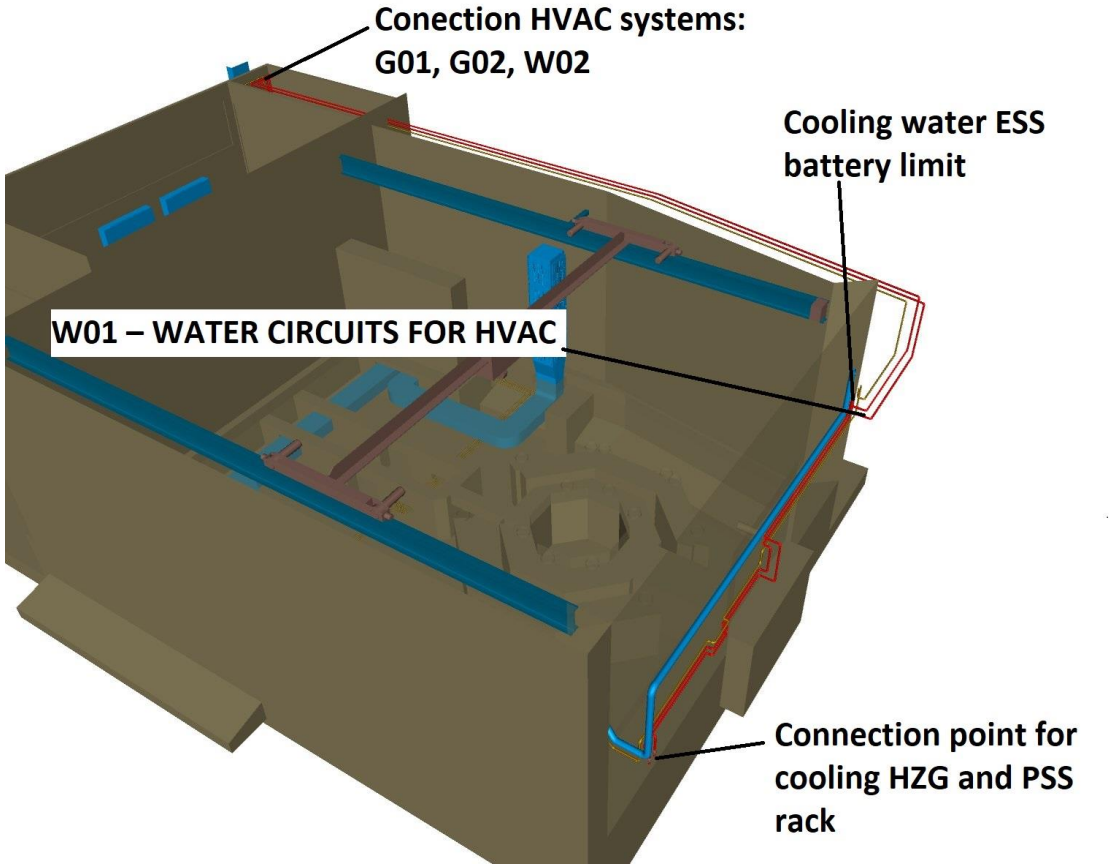

Figure 10: System W01 – Water circuits for HVAC

4.1.4.2. SYSTEM W02 – WATER CIRCUITS FOR SES

The system is shown in the diagram [48].

The system W02 is filled from system W01. Connection point (battery limit) between W02 and W01 is in room 1.01b – HVAC engine room. Distribution panel with cooling water for SES is placed in room 1.02 – Experimental cave and in room 1.01a – Sample preparation area. Circulation circuit ensure supply cooling water +15°C (temperature above environmental dew point). Water temperature in circuits will be kept by hand thermostatic mixing valve (set range 10 - 30°C). All pipeline is made from stainless steel.

PLC (NEUS-PLC) system must ensure these functions (out of scope system W02):

- Start/stop of circulation pump
- Inputs for circulation pump (operate, false)
- close/open solenoid valves
- inputs measured values (flow-supply/back, temperature-supply/back, pressure-supply-back)

More information about PLC (NEUS-PLC) see [55].

Connectors for SES in distribution panel are type:

- Male - Walther-Precision LP-007-2-WR021-01-2
- Female - Walther-Precision LP-007-0-WR021-01-2

Cooling water is mainly required to remove excessive heat from the SES. Examples of SES requiring cooling water are listed below. It is not an exhaustive list, however the items are also found on the list of common pool SES, motivating this supply as a requirement.

- Electromagnets
- Furnaces
- Compressors for Close Cycle Refrigerators (CCR, PTR)
- Electronic Racks, pumps

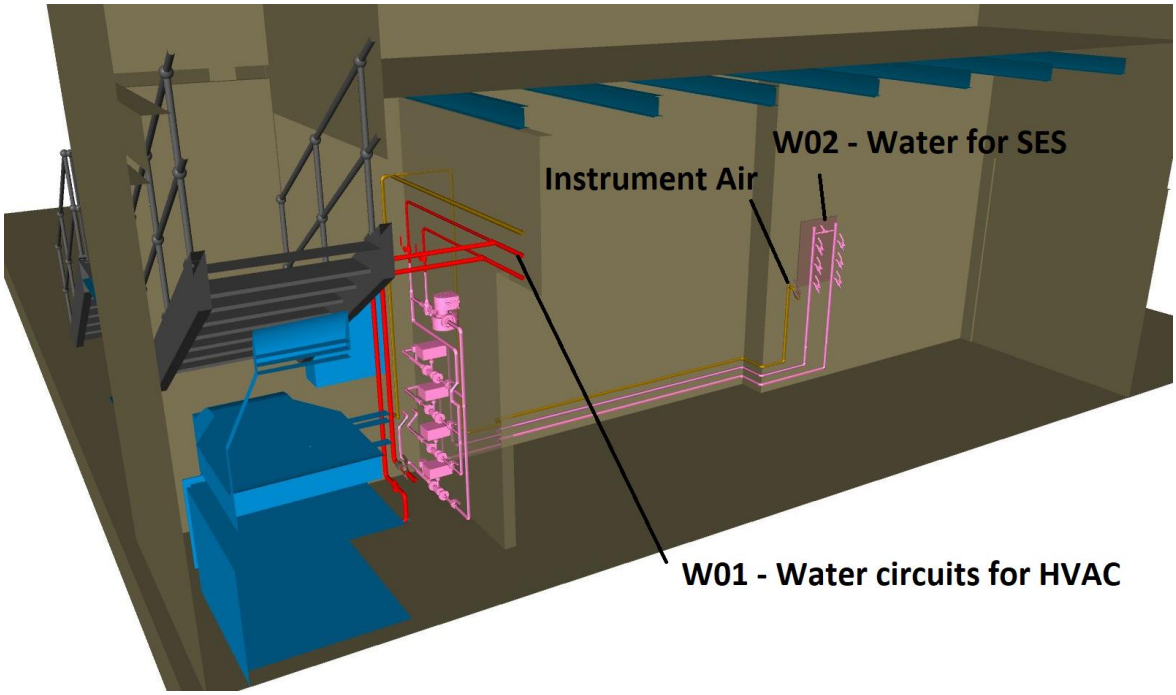

Figure 11: Utilities in room no. 1.01a

4.1.5. Compressed air

The system is shown in the P&ID scheme [48]. As per [44] the air flow available is 0.01 kg/s.

Compressed air will be supplied from central distribution lines along the cave to the room 1.01b, into buffer tank and further into Experimental Cave. Compressed air will be used as supply for air cushion.

Compressed air parameters:

- Solids : ISO 8573 class 1
- Dew point : ISO 8573 class 2 (-40°C)
- Oil : ISO 8573 class 0 (oil free)
- Operating pressure 6-7 bar g (the pressure level is adjustable)

The piping of compressed air will be equipped by set of shut-off valve and pressure measurement.

4.1.6. Socket boxes for Sample Environmental System (SES)

Inside Sample preparation area (room No. 1.01a) is installed Socket box "BOX#3" in accordance with ESS requirement in ESS-0038163 – *ESS Sample Environment Utility Supplies*.

For BOX#3 is requirement for the Uninterruptable Power Supply (UPS). Due to that is not clear question of UPS source yet (Central UPS source for Instrument or Local UPS source for BOX#3 only) is BOX#3 fed temporarily from LV distribution board FBSname0.WC02 Control Hutch – Sample preparation area (room 1.01a). Detailed in [20] (*Technical report of Electrical part* – Annex 3).

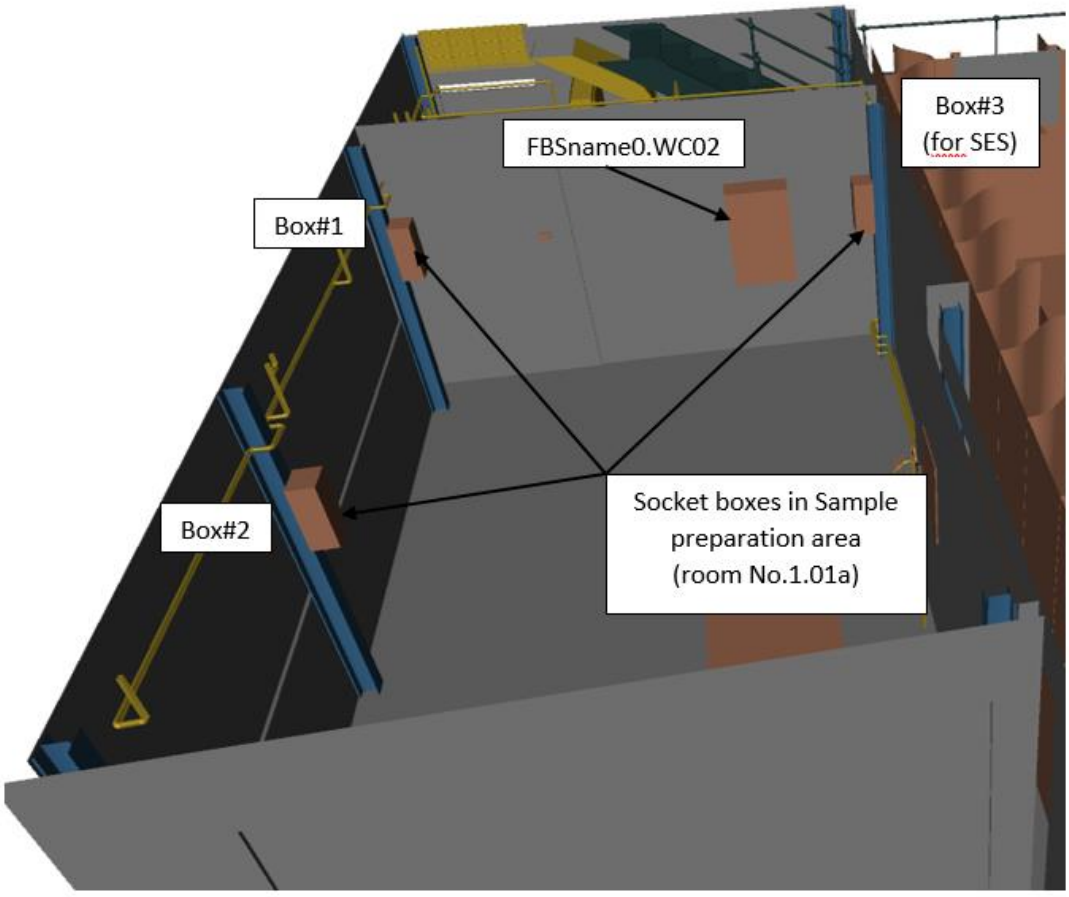

Figure 12: Location of Socket boxes

5. TECHNICAL RISK EVALUATION

Chapter 5 describes possible technical risks within Auxiliary systems, both during construction process and operation phase.

5.1. Service pipelines

Table 6: Technical risks of service pipelines

Source of Hazard	Cause	Event	Consequence	Prevention
Malfunctioning valves on supply points	Stiffened valve	Impossible to open supply point	Service media not available	Perform scheduled maintenance and check of valves
Wrong design of safety valve	Incorrect inputs for operational pressure	Compressed air release at operating pressure	Loss of air volume	Correct design of safety valve provided by supplier and approved by NoBo
Non-compliant quick connectors at supply point	Different types of quick connectors.	Not possible to connect consumers	In-operable consumers.	Check

5.2. HVAC

Table 7: Technical risks of HVAC - Ventilation part

Source of Hazard	Cause	Event	Consequence	Prevention
Dimension of rectangular duct	Incorrect dimension of ventilation duct supplied	Ventilation duct it is not possible place into under the staircase and penetration in Cave foundations	Ventilation cannot be operated	Check
Dimension of Air Handling Unit	Incorrect dimension of Air Handling Unit	AHU is not possible place under the staircase in HVAC engine room.	Ventilation cannot be operated	Check
Dust and impurity in ventilated Area	Unsuitable technological operations in ventilated areas	Clogged Air filters.	Reduced ventilation air flow, reduced cooling capacity. High temperature in ventilated areas	Avoid dust in Cave. Filters check.
AHU performance	Incorrect design or incorrect delivery of AHU	Insufficient AHU performance	High temperature in ventilated	Check delivery, periodic

Source of Hazard	Cause	Event	Consequence	Prevention
			areas, not enough of air in ventilated areas	inspection during operation

Table 8: Technical risks of HVAC – Water circuits part

Source of Hazard	Cause	Event	Consequence	Prevention
Malfunctioning valves on supply points	Stiffened valve	Impossible to open supply point	Service media not available	Perform scheduled maintenance and check of valves
Non-compliant quick connectors at supply point	Different types of quick connectors.	Not possible to connect consumers	In-operable consumers.	Check
Impurity in water circuits	Unsuitable technological operations connected to water circuits	Clogged filters.	Reduced chilled water flow, reduced cooling capacity.	Avoid impurity in water circuits. Periodic inspection during operation
Pump performance	Incorrect design or incorrect delivery of pumps	Insufficient pumps performance	High temperature of water in water circuit, not enough cooling capacity in water circuits for experiments.	Check delivery.

5.3. Control Hutch and Sample preparation area

Table 9: Technical risks of Control Hutch and Sample preparation area

Source of Hazard	Cause	Event	Consequence	Prevention
Positions of the anchor holes in the steel structure are not positionally accurate.	Preparation mistake / Inappropriate position of the element relative to the built-in elements.	Neighboring items do not fit together.	Need to drill holes.	Checking the accuracy of elements according to the manufacturer's production documentation.

6. BEER TG2 REQUIREMENTS & SOLUTIONS

The following description tries to summarize the influence of the high- [1] and low-level [2] requirements on the design of the auxiliary systems. Any design restrictions that result the modification or adaptation of the requirement are marked and explained, and the system requirements specification document is adequately updated.

6.1. High level requirements

Table 10: Table of high-level requirements

Req. # 13.6.6.1	Description	Design solution
R5	The experimental cave design of BEER as well as the design of the adjacent laboratory shall allow the access-on-the-beam of ex-situ-running long-term experiments for occasional measurement.	The requirement is fulfilled. There are two preparatory laboratories. One just close to the entrance to the experimental cave which will be equipped for the additional sample handling, sample alignment and run of one or two long-term experiment. Additional preparation area will be in the SLIM laboratory which is located 25 m from the experimental cave. There will be over-head crane and large space for the manipulation and preparation of the samples and/or sample environment. The equipment of the SLIM laboratory will be part of the instrument upgrade.

6.2. Low level requirements

Table 11: Table of low-level requirements

Req. # 13.6.6.1	Description	Design and description
R53	Instrument control terminal	The connections in the control hutch allow the installation of terminals for the instrument control.
R54	Data reduction terminal	The connections in the control hutch allow the installation of terminals for the data reduction.
R55	Working space	The requirement fulfilled, working space in the control hutch is sufficient for up to 6 persons.
R56	Comfort	The equipment and working space are designed to fulfil this requirement.
R57	Access to instrument	The requirement is fulfilled by design of an easy access from the control hutch to the cave throughout stairs and a cave personal entry.

Req. # 13.6.6.1	Description	Design and description
R58	Laboratory	The preparatory are is designed just near by the experimental cave what fulfil the requirement.
R59	Laboratory crane	*The space restrictions in the E01 not allow in the sample preparatory area near by the experimental cave to have 5 m hook-height crane. In this area manual crane system will be installed. The manipulation with the big sample environment or huge samples can be done in the SLIM laboratory located approx. 25 m away from the experimental cave where the required equipment and space will be available*.
R60	Instrument area	*The sample preparation area below the control hutch will have a space for a storage of only one or two sample environments for long-term experiments. The more additional space will be available in the SLIM laboratory located approx. 25 m away from the preparatory area.*

7. ESS REQUIREMENTS

7.1. Installation

The two-storey enclosure (CH and SPA with other associated rooms in CH area) is designed as mounted with a steel bearing structure – see Chapter 4.1.1.

The wall of ground floor is based and anchored directly on the floor of Experimental hall 3 - E01. The optimum depth of anchorage is set to 70 mm.

The anchoring of the column of the CH steel structure must be done non-conducting so as not to interfere with the ground circuit of Experimental hall 3 - E01. The anchors will be drilled out of the existing reinforcement of E01 floor slab so that the anchors are not in contact with the reinforcement.

The anticipated procedure of Electro part (DPS 01.03):

- Installation of main cable trays and support structures in accordance with appropriate documents of DPS 01.03
- Installation of grounding network
- Installation of field cable trays in accordance with requirement of technology of PS01 (cabinets of HVAC, Crane and Heavy shielding gate)
- Installation of power supply cables for power supply of technology of PS01
- Installation of lighting systems into CO101 (distribution boards of civil part, UPS, luminaires, switches, sensors, cables, …)
- Connection to ESS connection point of power supply and grounding (ESS LV main cabinet – FBSname0)

7.2. HVAC

The HVAC includes:

- SYSTEM G01 – Ventilation for experimental cave
- SYSTEM G02 – Ventilation for operators
- SYSTEM G03 – Containment ventilation (Radiological waste)
- SYSTEM W01 – Water circuits for HVAC
- SYSTEM W02 – Water circuits for SES

Chilled water consumption (from ESS central distribution system):

- Total chilled water demands 31.0 kW (8/18°C)

Note: Cooling water for AHU (system G01), fan coils (System G02) and SES (System W02) is ensured by system W01 – Water circuits for HVAC

Electric consumption for HVAC:

- Total electric power for HVAC 3.2 kW

7.3. Materials

For the material inventory used within the sub-systems *BEER - Material inventory for activation analysis* [57].

8. GLOSSARY

Term	Definition
NPI	Nuclear Physics Institute
CH	Control Hutch
EC	Experimental cave
CR	Control room (room No. 2.02)
CO101	Experimental Cave and Control Hutch area
LV	Low voltage
SPA	Sample preparation area
DD	Detail Design
HVAC	Heating, ventilation and air condition
AHU	Air handling unit
SES	Sample Environmental System
PS01	Process system – BEER
DPS 01.01	Detail Process system - HVAC System
DPS 01.02	Detail Process system - Manipulation and transportation part
DPS 01.03	Detail Process system - Electrical part
DPS 01.06	Detail Process system - Shutter
DPS 01.07	Detail Process system - Sliding door

9. REFERENCES

[1] BEER – Concept of operation (ESS-0124310)
[2] BEER – System Requirements Document (ESS-0124328)
[3] BEER – Interface Description (ESS-0432366)
[4] Static analysis and technical report - Steel structures (ESS-0461612)
[5] Ground plan (ESS-0462066)
[6] Sections 1-1' (ESS-0462067)
[7] Details (ESS-0462068)
[8] Ground plan level -3,000 m (ESS-0461613)
[9] Sections 1-1', 2-2', 6-6’ (ESS-0461614)
[10] Sections 3-3', 4-4’, 5-5' (ESS-0461615)
[11] Ground plan level -1,500 m (ESS-0461617)
[12] Ground plan level +0,600 m (ESS-0461618)
[13] Ground plan of the roof (ESS-0461619)
[14] Cassette ceiling (ESS-0461628)
[15] Staircase 8/Z – section, ground plan (ESS-0461622)
[16] Staircase 8/Z – section, detail 1,2 (ESS-0461623)

[17] List of doors and windows (ESS-0461629)
[18] Views (ESS-0461626)
[19] Technical report (ESS-0461627)
[20] Technical report for electrical part of NIK 6.6 (ESS-0461579)
[21] Block diagram of electrical part, part 1 (ESS-0461580)
[22] Block diagram of electrical part, part 2 (ESS-0461581)
[23] List of electric consumers of NIK 6.6 (ESS-0461582)
[24] Cable (overview) list of NIK 6.6 (ESS-0461583)
[25] Cable (sizing) list of NIK 6.6 (ESS-0461584)
[26] Fuse list of NIK 6.6 (ESS-0461585)
[27] Internal grounding list of NIK 6.6 (ESS-0461586)
[28] List of equipment of NIK 6.6 (ESS-0461587)
[29] Electrical scheme overview NIK 6.6 (ESS-0461588)
[30] Main cable trays NIK 6.6 – power cables (ESS-0461589)
[31] Main cable trays NIK 6.6 – sections (ESS-0461590)
[32] Grounding system, level -1,500m (ESS-0461591)
[33] Grounding system, level +0,600m (ESS-0461592)
[34] Grounding system, single line diagram (ESS-0461593)
[35] Building installation, socket circuits, level -1,500m (ESS-0461594)
[36] Building installation, socket circuits, level +0,600m (ESS-0461595)
[37] Building installation, light circuits, level -1,500m (ESS-0461596)
[38] Building installation, light circuits, level +0,600m (ESS-0461597)
[39] FBSname0.WC01-Single line diagram (ESS-0461598)
[40] FBSname0.WC02-Single line diagram (ESS-0461599)
[41] Bill of quantities (ESS-1415778)
[42] Bill of quantities (ESS-1408067)
[43] ESS - Instrument Technical Interfaces (ESS-0403282)
[44] Process flow chart (ESS-0046901)
[45] DPS 01.01 - Technical report (ESS-0461604)
[46] DPS 01.01 - List of equipment's and material (ESS-0461605)
[47] DPS 01.01 - PFD (P&ID) - systems G01, G02 and G03 (Ventilation) (ESS-0461606)
[48] DPS 01.01 - PFD (P&ID) - systems W01 and W02 (Water circuits) (ESS-0461607)
[49] DPS 01.01 - GR. LEVEL -3.000 m; +0,600 m (ESS-0461608)
[50] DPS 01.01 - SECTION 1-1; 2-2; 3-3; 4-4 (ESS-0461609)
[51] DPS 01.01 - SECTION A-A; B-B; C-C (ESS-0461610)
[52] PID System R09 and W09 (ESS-1407593)
[53] Building installation, light circuits, level roof (ESS-1400037)
[54] NIK 6.6 EPLAN documentation (ESS-1406854)
[55] ESS sample Environmental Utility Supplies Reference Document for WBS 13.6.X. 5.6 (ESS-0038163)
[56] BEER- Sub-system design description – Experimental Cave (ESS-0432351)
[57] BEER – Material inventory for activation analysis (ESS-1416976)

DOCUMENT REVISION HISTORY

Revision	Reason for and description of change	Author	Date
1	First issue	Jiri Petru	2018-11-08
1	Second issue	Jiri Petru	2019-07-31

BEER - Sub-System Design Description – Auxiliary System

Revision (1)

Components included in Revision (1): Control Hutch, Sample Preparation Area

List of PBS included in Revision (1):

13.6.6.6 – Control Hutch

13.6.6.7 – Sample Preparation Area

List of revisions: ESS-0506957

ESS contributors for the document review:

For the components from SSDD for Experimental Cave included in the Sub-TG3, feedback contributors are: Phillip Bentley, Stuart Birch, Paul Barron, Peter Sångberg