BEER INSTRUMENT

Control Hutch – Technical requirements and design description

Nuclear Physics Institute, CAS
BEER instrument

CONTENT

FIGURES

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LIST OF ABBREVIATIONS

ESS	European Spallation Source
BEER	Beamline for European Engineering Materials Research
CBS	Cost Breakdown Structure
CDR	Comprehensive Design Review
CH	BEER Instrument Experimental Control Hutch
CTV	Call for Tender Verification
EC	BEER Instrument Experimental CAVE
ESS	European Spallation Source ERIC
FAT	Factory Acceptance Test
IRR	Installation Readiness Review
KOM	Kick Off Meeting
NPI	Nuclear Physics Institute of the CAS, v.v.i.
NSS	Neutron Scattering Systems
RFI	Ready For Installation
SAT	Site Acceptance Test
Supplier	Party that is awarded the contract
TA	Technical Annex
TG	Tollgate
PSS	Personal Safety System
TCS	Technical Coordination System

1. Introduction

1.1. ESS – European Spallation Source

The European Spallation Source (ESS) ERIC (European Research Infrastructure Consortium) is a multi-disciplinary research facility based on the world's most powerful neutron source with a vision to enable scientific breakthroughs in research related to materials, energy, health and the environment, and address some of the most important societal challenges of our time. ESS is currently under construction in Lund, Sweden. The initial suite of neutron instruments will consist of 15 instruments and a test beamline with further integration of instruments following to complete the projected suite of 22 instruments. Instruments will include hardware and software necessary to conduct neutron scattering experiments, collect data and distribute them to users and archive all necessary information related to the experiments. In addition, ESS or other partner laboratories will support specific experimental conditions or preparations required by the experimental programs.

Details about the ESS project can be found on https://europeanspallationsource.se/.

1.2. BEER instrument

The BEER instrument is one of the instruments built at ESS dedicated to engineering-related research. The main area of research lies in the study of advanced materials under the real processing or application conditions to develop new or adapt existing materials for particular purposes. In addition, BEER will also address the studies dedicated to understanding the internal microstructure of the materials or their change during or after processing. More about the driving ideas behind BEER design can be found in *BEER – Concept of Operations* [1] or on the instrument webpage[1].

The integral part of the instrument is also the control hutch which serves the users as the base space where they can control the instrument parts, analyse and discuss the experiment and the obtained data and use it as a temporary office. It can be also considered as the space where the preparation of the samples for measurement would be performed together with the setting up and alignment of the sample environments. The purpose of this document is to summarise the technical specifications and requirements of the control hutch based on the conceptual design provided in accordance and agreement with ESS standards and technical policies, which were approved by ESS authorities.

1.3. Requirement level interpretation

The keywords "must", "shall", and "should" in this document are to be interpreted as follows:

1. "must", "shall", or "has/have to" is an absolute requirement of the specification.
2. "should" means that there may exist valid reasons in certain circumstances to ignore a particular item or ease a requirement, but the full implications should be understood and carefully weighed and mutually agreed upon before choosing a different course.

[1] https://europeanspallationsource.se/instruments/beer

2. Control hutch

2.1. General description

The control hutch is a part of the BEER instrument. It is located in the E01 hall at a distance of about 158 m from the source, and it is adjusted to the instrument cave structure in the downstream direction. The full-length layout of the BEER instrument is depicted in Figure 1, where the experimental cave and the control hutch are highlighted.

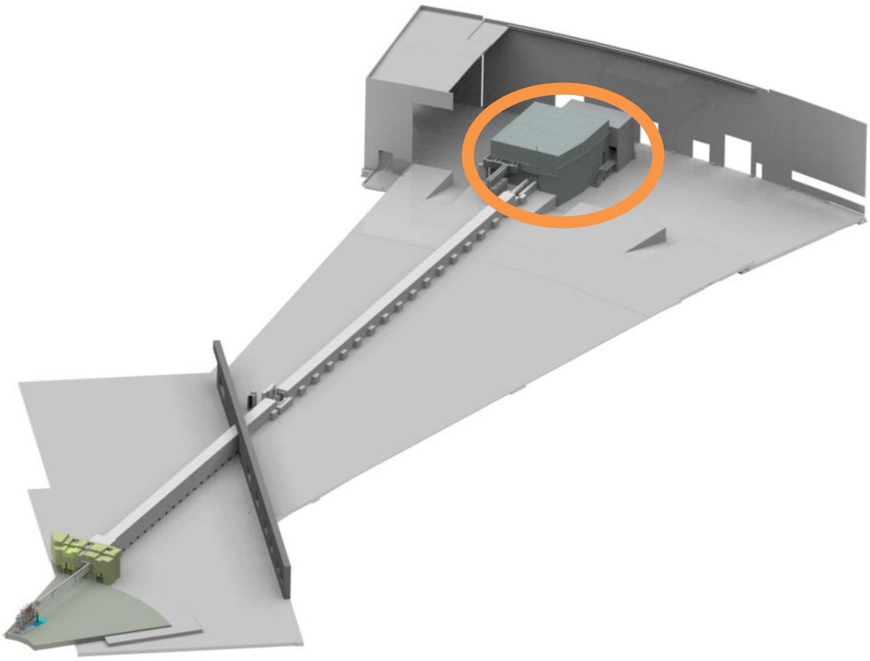

Figure 1 - The layout of the whole BEER instrument across different buildings. The experimental cave and adjacent control hutch are marked by the oval.

The main functions of the control hutch can be summarised as follows:

- Provide a space for the temporary office where the instrument and experiment control can take place – the control room[2]
- Provide a space for the sample and sample environments preparation as well as execution of the off-beam experiments – the sample preparation area
- Provide a separated space for auxiliary systems for an HVAC, water cooling skids, etc. – the auxiliary room
- Allow easy access from the control room to the personal entry of the cave
- Allow simple access from the sample preparation area to the sliding door of the experimental cave for voluminous samples or sample environments
- Allow a power and signal cable connection between the sample preparation area and the control room

[2] Note that on some pictures within this text the control room is named as the control hutch (CH)

To fulfil the above-mentioned requirements, the control hutch is designed as a two-floor structure. The upper floor consists of the control room (CR), and the ground floor has the sample preparation area (SPA) and the auxiliary room (AR).

The control room is connected with the experimental-cave-personal-access via stairs. The experimental cave personal access is suited for frequent cave entry for the experiment adjustment as it is located 1.5 m above the floor of E01.

From SPA, there is a close connection to the experimental cave via the main door for the transport of the prepared sample environment or samples. SPA provides enough space for running off-beam experiments or test sample environments. A connection using dedicated patch panels from SPA to CR is envisaged to allow control of off-beam experiments from the control room.

A 3D view of the conceptual design of the control hutch structure from the downstream and from the cave-personal-entry side is shown in Figure 2 and

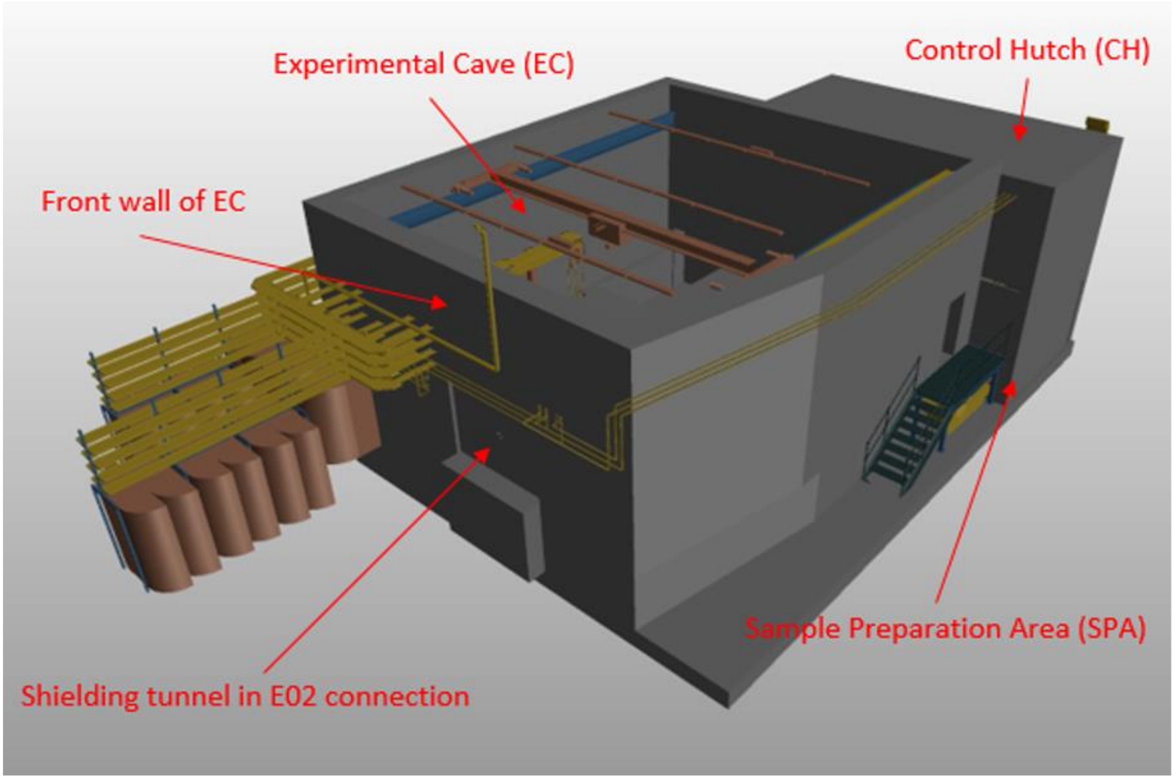

Figure 3.

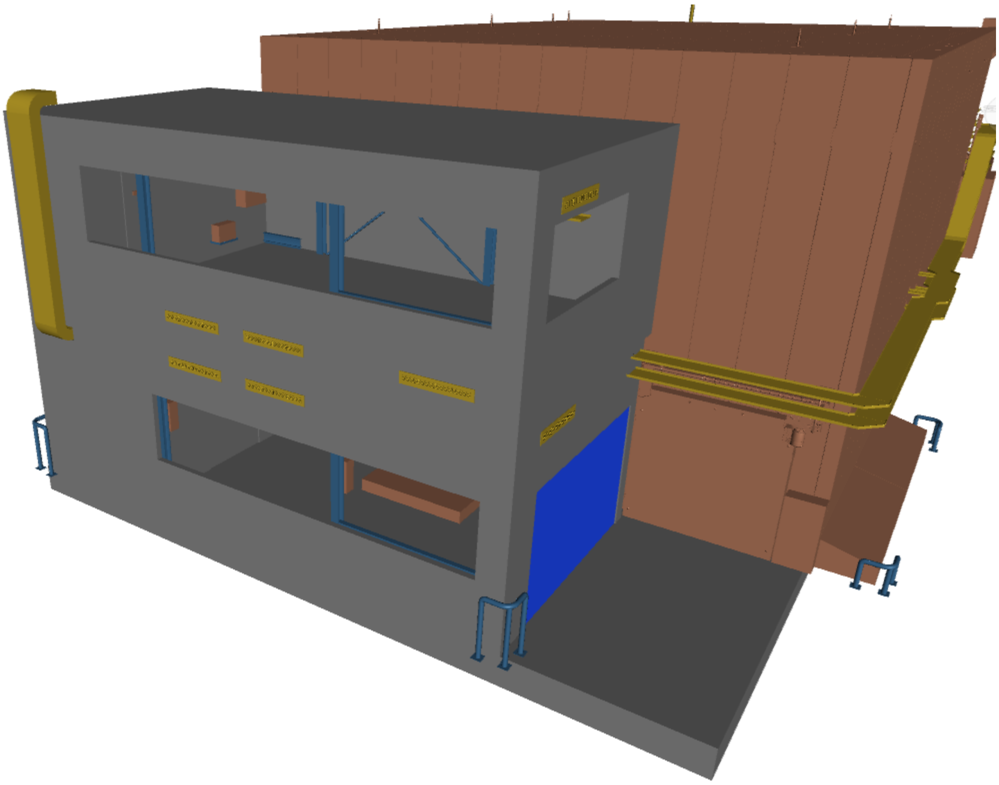

Figure 2: The structure of the control hutch located behind the experimental cave

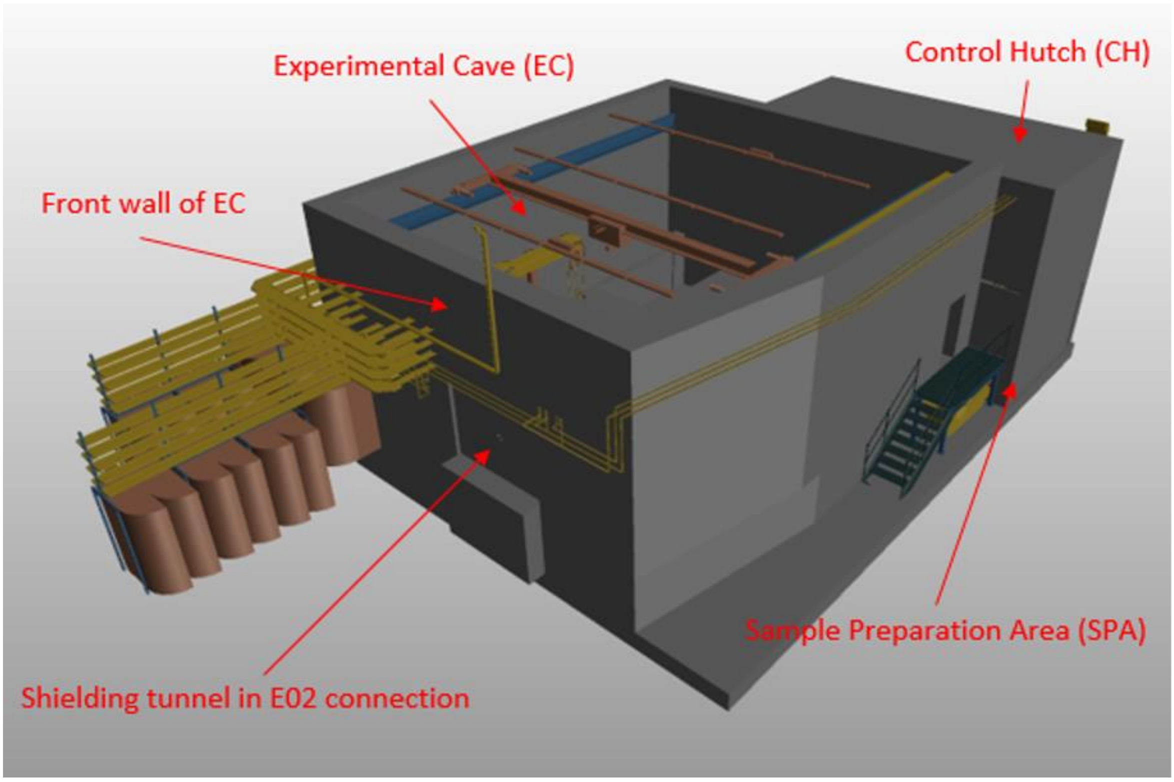

Figure 3 – The structure of the experimental cave and the control hutch from the cave-personal-entry side.

2.2. Interfaces

The main interfaces of the control hutch with other systems are described below in Table 1.

Table 1: Control hutch structure – interfaces

Number	Interface	To component
1	Control hutch structure	E01 hall floor
2	Control hutch roof	Overhead crane in E01
3	Control room/SPA	Cable trays from outside
4	Control room	Cable trays from SPA
5	To-cave wall	Experimental cave - sliding door
6	Control room staircase	Experimental cave - personal entry

The control hutch sub-system has the following external interfaces to the subsystems managed mainly by ESS and provided by its partners and suppliers:

1. E01 hall floor and its structures as crane, etc. (ESS) – interfaces 1 and 2
2. Utility connection of power, compressed air and other media (ESS) – interface 3

The internal interfaces of the control hutch structure are linked to other internal sub-systems of the BEER instrument, and they are following:

3. Signal and control connections from SPA to CR (Hereon) – interface 4
4. The sliding door of the experimental cave (NPI) – interface 5
5. The connecting staircase from CR to the cave personal entry (NPI) – interface 6

2.2.1. External limitations

There is a number of limitations related to the external interfaces. Below is the list of the main limitations or obstacles related to the experimental cave structure, which have to be taken into account during design. Other relevant information about the ESS interfaces can be found in *ESS – Instrument Technical Interfaces* [2].

- E01 floor load capacity: 20 t/m^2 (see Chapters 4.3.2.2 and 4.3.2.3 in [2])
- E01 overhead crane capacity and coverage: 10 tons (see Chapter 4.4.27 in [2])
- E01 overhead crane max. hook height: 10 m (TCS+7 m)
- E01 maximal structure height 7 m (TCS+4 m)
- E01/E02 support beams, wall structures, ramps and passage clearances

3. Specifications and requirements

3.1. Overview layout

The BEER control hutch is located in the E01 experimental hall on the beam port W02. There are two neighbouring instruments. On the south side, there is NMX, and on the north side, there is C-SPEC. The general layout of the BEER instrument within E01 and adjustment E02 hall is presented in Figure 4.

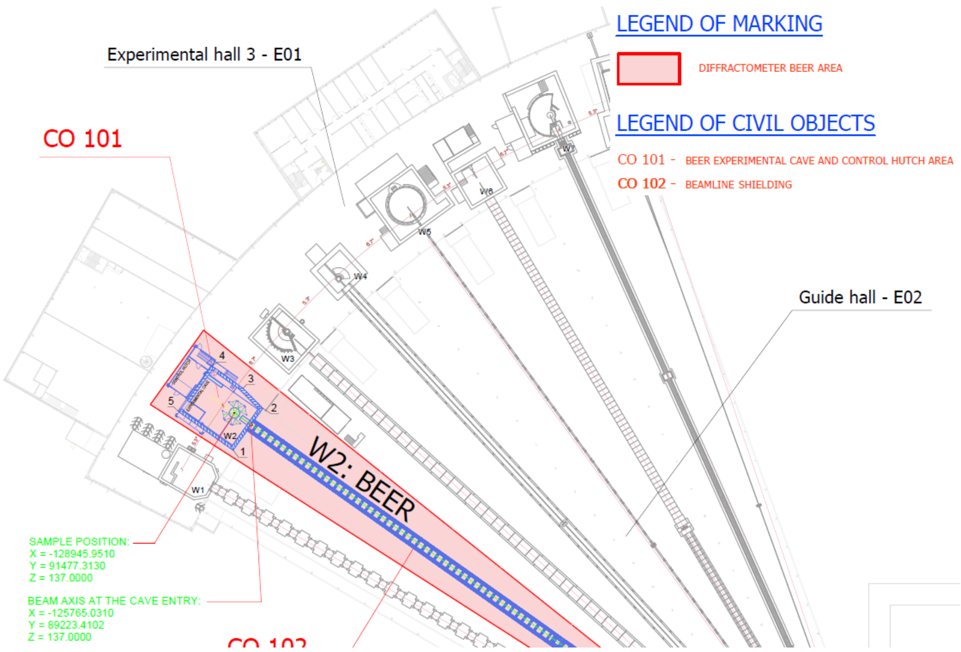

Figure 4: General layout of BEER instrument.

3.2. Requirements

The basic outer dimension requirements for the control hutch structure are listed below:

- **R1.** The external dimensions of the hutch shall not exceed 9.5 x 5 m^2 (L x W)
- **R2.** The height of the control hutch shall not exceed 7 m
- **R3.** The enclosed area of the control hutch should be at least 300 m^3
- **R4.** The structure shall be designed as a two-floor enclosure
- **R5.** The first floor shall have the status of the temporary office – control room
- **R6.** The ground floor shall have the status of the laboratory/workshop - SPA
- **R7.** The SPA shall have a door with dimensions of at least 3.5 x 2.2 m^2 (W x H) nearby the heavy sliding door of the cave entry bay.
- **R8.** The SPA shall have a door for personal access from the E01 near the experimental cave personal entry
- **R9.** The SPA should have a separate space for support systems – an auxiliary room
- **R10.** The control hutch shall allow easy access from the upper floor to the experimental cave personal entry and the E01 floor
- **R11.** The control room shall have a door for personal access nearby the experimental cave personal entry
- **R12.** The ground floor shall have a smooth surface allowing the usage of the air cushion or wheel platform for the transportation of heavy equipment between SPA, the E01 hall and the cave entry bay.
- **R13.** The control hutch shall have windows on both floors, allowing a view of the E01 hall
- **R14.** The structure has to be rigid and able to handle all hazards related to the area
- **R15.** Shall comply with the fire resistance class R30 defined in the Swedish fire standards mentioned in BFS 2011:10 with amendments up to BFS 2019:1 (EKS 11)[#]

R16. The control hutch shall be designed, leaving the free corridor of 4 m between its structure and the E01 downstream inner wall.

R17. The control hutch structure shall provide a cable pathway between the SPA and the control-room.

R18. The control hutch design shall include preparations for the installation of the socket box for sample environment equipment, a patch panel for connection between the hutch and the cave, and the media (compressed air, cooling water, etc.) distribution.

The fire safety indicates the following: the ceiling material in general of the class B-s1,d0 attached to material in the class not lower than A2-s1,d0 (non-combustible material) or a combustible material protected by ignition protected coating $K_2$10/B-s1,d0 (fire protective cladding), and the walls within the internal and external surfaces in general of the class C-s2,d0 [3].

3.3. Conceptual design

The detailed description of the conceptual design is summarised in the *Technical report for Civil part* [3] and the documents linked within. The above-mentioned report can be used as the template and guidance for the further analysis needed in the final design. Below is the extract of the design description related to the control hutch design.

3.3.1. Civil part

The CR and SPA are designed on the E01 floor level (TCS -3.000 m). The ground floor is separated into two parts. One is dedicated to the experiment preparation (real SPA) (in [3] noted as *room no. 1.01a*), and the second one is the auxiliary room located below the staircase and can be used for supported technologies such as HVAC, cooling water skids, etc. (in [3] noted as *room no. 1.01b*). On the 2nd floor at TCS +0.600 m, there is a control room (in [3] noted as room no. 2.02). The 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 the E01 hall and are attached to it by chemical anchors. For more details of the design solution, see the following documents:

Civil part drawings
ESS-0462066 Ground plan
ESS-0462067 Sections 1-1'
ESS-0462068 Details
ESS-0461613 Ground plan level -3,000 m
ESS-0461614 Sections 1-1', 2-2', 6-6'

[3] Building product classes to DIN EN 13501
A2=Products will contribute in the fire to an extremely limited extent
B=Products will contribute in the fire to a very limited extent
C=Products will contribute in the fire to a limited extent
s1=The smoke production is very limited.
s2=The smoke production is limited
d0=No flaming droplets or particles occur
$K_2$10=covering possible used on all substrates allowing fire protection for 10 minutes

ESS-0461615 Sections 3-3', 4-4', 5-5'
ESS-0461617 Ground plan level -1,500 m
ESS-0461618 Ground plan level +0,600 m
ESS-0461626 Views 1

3.3.2. Bearing structure and outer cladding

The control hutch enclosure is designed as mounted with a steel bearing structure. Columns are designed from profile HEB 140. Longitudinal beams on the 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^2, the height is 6.5 m.

The outer cladding is made of a plasterboard wall with a thickness of 100 mm, composed of a 2× plasterboard plate with a thickness of 12.5 mm with vinyl foil (Durafort) anchored to thin-walled sheet metal profiles, with acoustic insulation of mineral wool with a thickness of 60 mm. The facade of the ground floor is based and anchored directly on the floor of the E01 hall. The optimum depth of anchorage is set to 70 mm. Fixed windows are designed in the outer cladding on both floors.

3.3.3. Ceilings, roof and floors

The ceiling structures above the 1st floor and 2nd floor are made of steel beams, trapezoidal metal sheets and suspended plasterboard ceiling. The floor in the sample preparation area consists of the E01 hall floor covered with an epoxy screed. The floor load capacity for the E01 is 20 t/m^2. The floor in the control room consists of chipboards, acoustic insulation and PVC strips. The roof above the control room is made of chipboards and trapezoidal steel sheets with galvanised (Zn) surface finish.

For the appropriate drawings, see the following documents:

Ceilings, roof and floors drawings
ESS-0461619 Ground plan of the roof
ESS-0461628 Cassette ceiling

3.3.4. Staircase

The entrance to the control room on the 2nd floor of the control hutch 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 auxiliary room.

For the appropriate drawings, see the following documents:

Staircase drawings
ESS-0461622 Staircase 8/Z – section, ground plan
ESS-0461623 Staircase 8/Z – section, detail 1,2

3.3.5. Insulation

The outer cladding, partitions and floor in the control room will be fitted with mineral wool acoustic insulation doors and windows. Noise isolation equivalent sound pressure level should be 52 dB.

A door 800 x 2000 mm^2 (W x H) is designed for access to the control room from the staircase area. The door is fixed to an aluminium doorframe; the door wing is laminated. A door 900 x 2200 mm^2 (W x H) is designed to access the sample preparation area. The door is fixed to an aluminium doorframe; the door wing is made of aluminium with a comaxit finish. The door wing is partially glazed. A sectional gate door 3500 × 2200 mm^2 (W x H) (with an 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, the main illumination of the interior is provided by artificial lighting.

For the appropriate drawings, see the following documents:

Insulation drawings
ESS-0461629 List of doors and windows

3.3.6. Surface finishes

The outer cladding with walls and partitions walls will be made of plasterboards with vinyl foil, colour white (RAL 9010). Aluminium profiles, doors and window frames will be covered by a comaxit finish - grey colour.

For the appropriate drawings, see the following documents:

Surface finishes drawings
ESS-0461614 Sections 1-1', 2-2', 6-6’
ESS-0461615 Sections 3-3', 4-4’, 5-5'
ESS-0461626 Views 2

3.3.7. Materials & Fire rating

Materials shall be appropriate to ensure a pleasant and safe working environment. A fire suppression system will be a future installation for the hutch space (not in the scope of this tender), so the design should consider retrofitting a sprinkler system, for example, allowing voids for the installation of water pipework.

3.3.8. Lightning and sockets

The power supply of all socket boxes in the control hutch is ensured by the low voltage distribution boards located on each floor (see Figure 5). Socket circuits intended for electrical facilities in the control room and SPA are solved by variable BUS bar systems. Those ones are located at the height above working tables and allow to connect of a needed number of sockets.

The general lighting system is fed from board FBSname0.WC01 (see Figure 5), which is situated in the control room. The emergency and guidance lightning systems are fed from board FBSname0.WC02 (see Figure 5), which is situated in SPA.

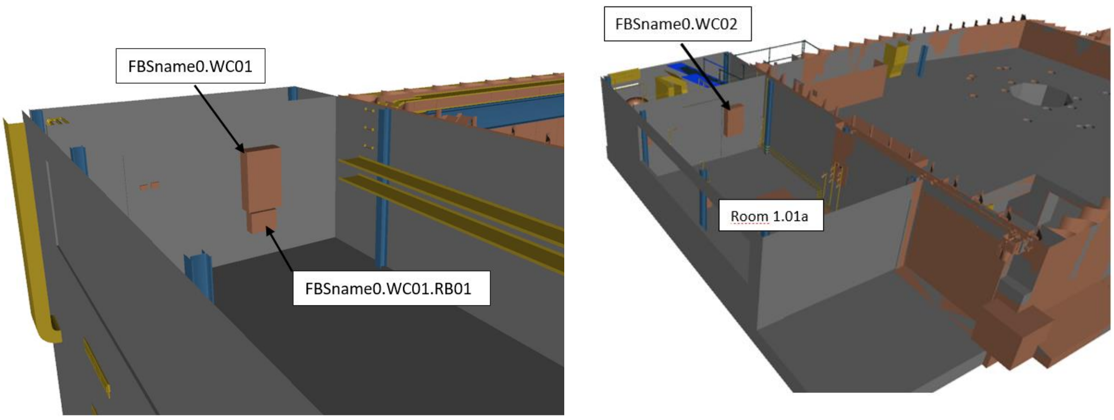

Figure 5: Location of socket boxes in the control room and SAP.

The internal general lighting system will be solved in accordance with standard EN 12464-1 by LED luminaires. This one is fed by the normal power supply. The level of illumination in each room of the control hutch is shown in Table 2.

Table 2: The level of illumination in rooms of the control hutch

Control hutch	Illumination level (lx)
Stairs	150
Control room	750
Sample preparation area	750
Auxiliary room	200

The emergency lighting system is solved in accordance with standard SS-EN 1838 by LED luminaires with a minimum illumination level of 15 lx. This one is fed by a local UPS source and is enabled automatically in the event of an interruption in the normal power supply. The local UPS source is situated in the control room.

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

For the appropriate drawings, see the following documents:

Lighting and socket drawings
ESS-0461594 Building installation, socket circuits, level -1,500m
ESS-0461595 Building installation, socket circuits, level +0,600m
ESS-0461596 Building installation, light circuits, level -1,500m
ESS-0461597 Building installation, light circuits, level +0,600m

3.4. Additional information

The conceptual design reports and drawings are available on request. The summarized list of the available documents is presented in Table 3.

Table 3: The list of available documents and drawings from the conceptual design of the control hutch

Reports
ESS-0461612 Static analysis and technical report - Steel structures
ESS-0461627 Technical report
ESS-1408067 Bill of quantities
Civil part drawings
ESS-0462066 Ground plan
ESS-0462067 Sections 1-1'
ESS-0462068 Details
ESS-0461613 Ground plan level -3,000 m
ESS-0461614 Sections 1-1', 2-2', 6-6'
ESS-0461615 Sections 3-3', 4-4', 5-5'
ESS-0461617 Ground plan level -1,500 m
ESS-0461618 Ground plan level +0,600 m
ESS-0461626 Views 1
Ceilings, roof and floors drawings

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ESS-0461629 List of doors and windows
Surface finishes drawings
ESS-0461614 Sections 1-1', 2-2', 6-6'
ESS-0461615 Sections 3-3', 4-4', 5-5'
ESS-0461626 Views 2
Lighting and socket drawings
ESS-0461594 Building installation, socket circuits, level -1,500m
ESS-0461595 Building installation, socket circuits, level +0,600m
ESS-0461596 Building installation, light circuits, level -1,500m
ESS-0461597 Building installation, light circuits, level +0,600m

4. References

[1] BEER – Concept of Operation (ESS-0124310)
[2] ESS – Instrument Technical Interfaces (ESS-0403282)
[3] Technical report for Civil part (ESS-0461627)