NUCLEAR PHYSICS INSTITUTE CAS
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EUROPEAN SPALLATION SOURCE

EXPERIMENTAL CAVE FOR THE BEER INSTRUMENT AT ESS

PROJECT SPECIFICATIONS AND REQUIREMENTS

Status: Draft
Revision: 1.7
Date: 2023-05-28

Annexes:

Annexe 1: BEER – Experimental cave technical requirements and design description

CONTENT

1. TERMS OF REFERENCE

1.1. SCOPE OF THIS DOCUMENT

This document, in conjunction with referenced annexes, establishes the requirements for the tendering, procurement, manufacturing, delivery and installation of the BEER Instrument Experimental Cave to be installed at the European Spallation Source in Lund, Sweden.

1.2. TERMS

Herein, the term "contractor" shall refer to the parties responsible for providing the scope of work defined below. The term "customer" shall refer to the purchaser and its representatives, including the ESS.

The contractor is responsible for manufacturing, installation, inspection, integration and testing, packaging, shipping, and other stipulated services in accordance with the requirements of this specification.

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.

1.3. EXCEPTIONS

Any exceptions to the specifications in this document shall be clearly noted as such in the contractor's proposal documentation. If the contractor proposes exceptions from this specification, alternative solutions shall be presented. The customer shall form a validation team to examine the feasibility of the proposed alternatives. Conditions for design modifications are described in Section 4.5.

1.4. APPLICABLE DOCUMENTS

The delivered assembly, including accessories, shall follow:

- European directives
- Swedish laws and standards
- Relevant Europeans and ISO standards
- ESS standards and regulations

The list of applicable documents is provided in Section 11.

2. INFORMATION

2.1. INTRODUCTION TO THE EUROPEAN SPALLATION SOURCE

The European Spallation Source ERIC (ESS) is a European Research Infrastructure Consortium (ERIC), 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. 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 it to users and archive all necessary information related to the experiments. Specific experimental conditions or preparations that may be required by the experimental programs will be supported by ESS laboratories or other partner laboratories.

Details about the project can be found under:

https://europeanspallationsource.se/ess-mandate

The facility will host several neutron beamlines that are being constructed by so-called in-kind partner institutes. The Nuclear Physics Institute of the CAS, V. V. I. (NPI) from the Czech Republic, participates in the design and construction of the BEER instrument, together with Helmholtz-Zentrum Hereon in Geesthacht, Germany.

2.2. INTRODUCTION TO THE BEER INSTRUMENT

The BEER project (Beamline for European Engineering Materials Research) is realised as a part of a multidisciplinary complex of international research centre ESS – European Spallation Source constructed in Lund in Sweden. 17 European partner countries participate in its construction mainly in the form of in-kind contributions, thus the development and supplement of individual scientific and technological units.

The diffractometer BEER (see Figure 1) is an experimental device focused on the research of advanced materials for a wide field of applications - i.e. research in engineering materials with various degrees of complexity, for example, in-situ and in-operando experiments for material characterisation, thermo-mechanical processing or joining of materials. The continuous development of advanced structural materials and novel manufacturing processes are key for the European manufacturing industry to stay competitive and ensure clean transport and clean energy generation. This includes the development of sustainable material and processing solutions protecting natural resources. More about BEER instrument can be found here:

https://europeanspallationsource.se/instruments/beer

Please refer to *BEER - Concept of Operation* [ESS-0124310] for further information.

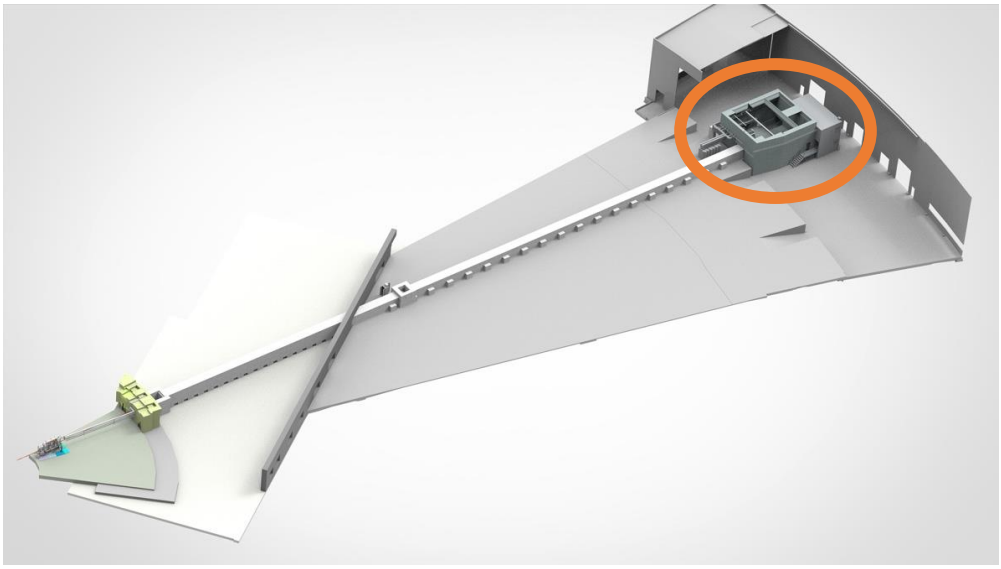

Figure 1 - The layout of the whole BEER instrument across the different halls. The experimental cave and control hutch are marked with the oval.

2.3. INTRODUCTION TO THE EXPERIMENTAL CAVE

The experimental cave (EC) of the BEER instrument is located in experimental hall E01 adjacent to guide hall E02, around 158 m from the target. Together with the control hutch (not described in this document), they form the end station of the instrument. The purpose of the instrument cave is to provide the shielded space for the scientific experiments performed on BEER. The "shielded space" is required in order to prevent the radiation from escaping the cave interior and endangering the users or visitors. On the other hand, the cave has to be easily accessible from the control room, as well as from the E01 hall. It must allow the installation of voluminous samples or sample environments in the sample area. Based on functional, radiation safety requirements, and spatial constraints, a conceptual design of the experimental cave and control hutch was made. Detailed information about the requirements and proposed solutions can be found in Annexe 1 *BEER – Experimental cave technical requirements and design description*.

The 3D view of the instrument cave and control hutch conceptual design is shown in Figure 2.

NOTE: the control hutch is not part of this project's scope.

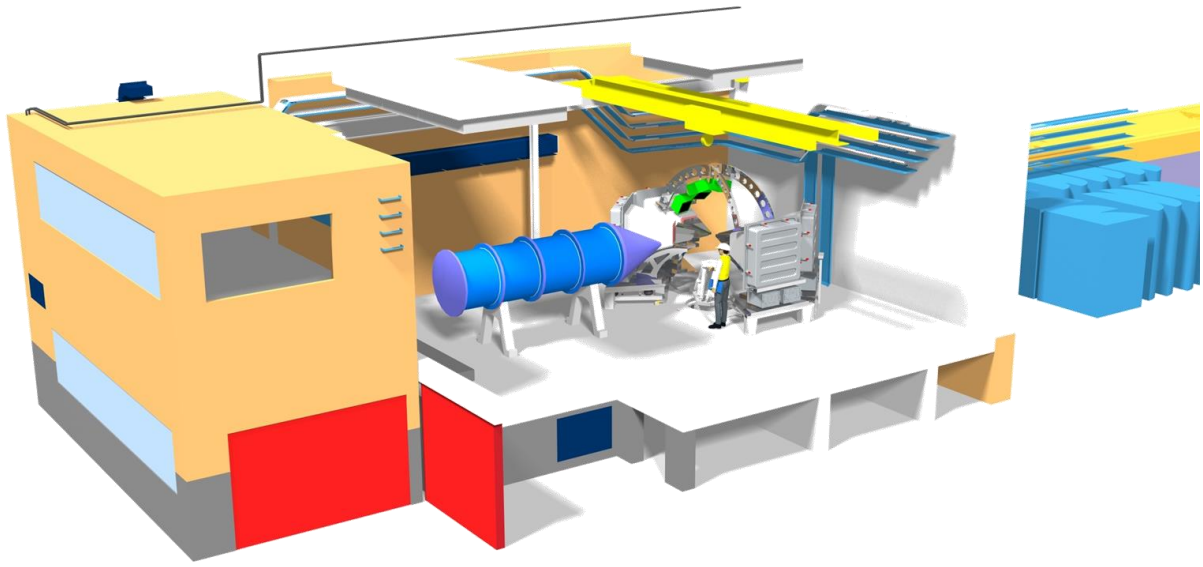

Figure 2 - 3D view of the BEER instrument cave interior and the adjacent hutch

2.4. CONSTRUCTION PHASES AND REVIEW PROCESS

The ESS instrument construction is divided into three phases, which are concluded by an acceptance process called Tollgate reviews (TG):

- Phase 2 – Detailed Design (TG3)
- Phase 3 - Manufacturing and procurement (TG4)
- Phase 4 - Installation and integration (TG5)

This contract concerns the finalisation of Phase 2 and execution of Phases 3 and 4 for the experimental cave.

2.5. CURRENT STATUS AND OPTIONS FOR MODIFICATIONS

The BEER instrument is in the design phase, except for the neutron optics system (neutron guides), which is already in production. The detailed design documentation for the experimental cave has been finished and evaluated by ESS within the TG3 review. The

contractor may propose modifications or alternative solutions in the offer under the conditions described in Section 4.5. The client will provide a CAD model of the conceptual design and basic drawings. Further TG3 design documents and reports will be provided by the Client upon request.

3. SCOPE OF WORK

The contractor shall be responsible for the procurements, manufacturing, delivery, installation, integration and commissioning of the complete BEER experimental cave to ESS. The following deliverables and services are expected to be delivered with the experimental cave:

Physical deliverables

The experimental cave project has been split into the following units:

- Unit 1 – Cave Shielding
- Unit 2 – Cave Sliding Door
- Unit 3 – Cave Internal Crane
- Unit 4 – Beam Stop

For a detailed description of the individual unit, see Annexe 1 *BEER – Experimental cave technical requirements and design description*.

Services

- Update and verification the design according to the design specification
- Preparation of detailed design documents for CDR (TG3)
- Factory acceptance tests (FAT)
- Delivery to ESS storage facility
- Transport to ESS site and installation
- Cold commissioning of all the units at the ESS facility (SAT)
- Training of operating staff at ESS premises

Documentation

- Documentation is described in Section 5

Excluded parts

The following components are explicitly excluded from the scope of work:

- Utilities distribution, including HVAC within the cave (described in *BEER - Sub-System Design Description – Experimental Cave* [ESS-0432123])
- Electrical distribution within the cave (described in *BEER - Sub-System Design Description – Experimental Cave* [ESS-0432123])
- PSS switches for the doors (will be supplied by PSS technical group)

4. SPECIFICATIONS

4.1. GENERAL REQUIREMENTS

The system has to be designed and manufactured according to the ESS and European standards. A selection of documents describing the ESS standards and requirements and the conceptual design documents which are relevant for this contract is given in Sections 11.1 (BEER project documents) and 11.2 (ESS Guidelines and regulations). These documents will be

provided to the contractor upon request. In case of uncertainty or need for additional information, the contractor shall contact the customer and/or representatives of the relevant ESS technical groups.

The delivered sub-systems have to comply with European standards (see Section 11.3). The EU declaration of conformity will be required as a part of the final System documentation.

4.2. COORDINATE SYSTEMS

The primary coordinate system at the ESS is the Target Coordinate System (TCS). The position of TCS within the Swedish National Reference System and also other coordinate systems used at the ESS and their position with respect to the TCS are described in the *Main Coordinate Systems at the ESS* [ESS-0035090].

4.3. SYSTEM REQUIREMENTS

The list of system requirements for the current design is provided in Annexe 1.

4.4. A DETAILED DESCRIPTION OF THE EXPERIMENTAL CAVE

The detailed technical description with drawings, material specifications and interface description is provided in **Annexe 1** (*BEER – Experimental cave technical requirements and design description*) and references therein, which makes an integral part of the system specifications.

4.5. DESIGN CHANGES

Modifications of the design details given in Annex 1 are possible under the following conditions:

Before CDR:

The contractor may propose modifications or alternative solutions which have to comply with the system requirements (Section 4.3). In such a case, the contractor shall describe the concept of the proposed modifications in a technical report as a part of the offer documents. The level of detail of this description must allow for evaluating the feasibility and compliance of the proposed modifications with the system requirements. If accepted, the contractor shall implement these modifications in the detailed design documents to be submitted for CDR in the project's first stage. These documents must prove that the modifications do not negatively affect the functional and safety properties of the system and comply with interfaces to the other system, such as the neutron guide tunnel, neutron optics, control hutch, sample tower and detectors.

In particular, changes in the dimensions and material composition of the radiation shielding components (walls, roof, sliding door and beam-stop) shall be avoided. If necessary for technical, safety or economic reasons, such design modifications must be accompanied by a radiation safety analysis carried out by the contractor, which proves that the modified design does not have a negative impact on the radiation safety parameters of the cave (see *BEER - Radiation Safety Analysis* [ESS-0432365]). An updated Bill of Materials for Activation Inventory must also be provided.

Specific component types proposed in the design description (Annexe 1) can be replaced by other types with equivalent parameters unless this option is explicitly excluded.

All changes must be accompanied by fire resistance safety analysis proving that the modified design meets the safety requirements according to EKS 11 standard, Code of Statutes of the

Swedish National Board of Housing, Building and Planning (Boverket) with fire classification for structural elements R30.

After CDR:

Any changes are possible only through the formal procedure, starting with submitting a "Design Changes Request" with reasoning and analysis of consequences for cost, performance and safety and compatibility (interfaces) with other sub-systems. The proposed changes must be evaluated and approved by both the customer and ESS before any further steps in their implementation are taken. The changes are only possible if necessary due to (i) physical constraints, (ii) conflicts with interfaces to other sub-systems, (iii) ESS safety and operational requirements or (iv) on request of the customer.

4.6. REQUESTED DESIGN MODIFICATIONS

In addition to the design changes proposed by the contractor according to Section 4.5, the client requests modifications with respect to the conceptual design described in Annexe 1. The following list provides further clarification (marked as "**Clarification**") to the selected requirements from Annexe 1. The changes requested by the client are explicitly marked as "**Change request**".

R4. The cave shall comply with the radiological calculation in terms of the material, structure, shape and dimensions.

Clarification: The radiological calculations are described in the report ESS-0432365. Modifications of the shielding parameters are possible only if they cannot negatively affect the shielding properties, while respecting other constrains such as maximum floor load. The radiation safety requirements also imply that the cave structure must allow for dust-free disassembling method during future decommissioning. Therefore, the cave should be constructed from detachable blocks with maximum weight of 10 t corresponding to the maximum E01 crane payload.

R6. The wall foundations and floor support structures should use normal concrete with a density of 2.35 g/cm3.

Change request: In addition, density homogeneity of the standard concrete shall not vary by more than 5%. The same holds for **R25**.

R10. The material of the walls shall be heavy concrete with a density of at least 3.8 g/cm3.

Change request: In addition, density homogeneity of the heavy concrete shall not vary by more than 5%.

R11. The walls shall be covered with a boron-containing layer with the equivalent of 3 kg of pure B4C per 1 m2.

Change request: Actual amount of B4C depends on the uniformity of B4C distribution, grain size, and properties of the matrix material. The requirement is better expressed as a layer with shielding properties equivalent to 1 mm of pure B4C. The layer has to protect the material of all heavy concrete walls in order to suppress prompt gamma emission and activation. Mixing

B4C powder with heavy concrete is, therefore, not allowed. The supplier will be required to provide samples of the B4C-containing material for verification.

R16. The front wall shall be compatible with the common shielding blocks.

Clarification: The front wall of the cave has to be modified to satisfy the interface with the guide system shielding (interface 5 and requirement R16 in Annex 1). The conceptual design works with intrusion of the last guide shielding block into the front cave wall, but the final design of the shielding expects an extrusion from the cave wall to facilitate the guide shielding installation. The client shall provide the drawings of the interface at the kick-off meeting.

R17. The front wall shall accommodate the guide system feedthrough.

Clarification: The guide system feedthrough (interface 8 and 9, and requirement R17 in Annex 1) design is not fully developed. The redesign of the simple hole to properly accommodate and enable the installation of the guide system feedthrough is necessary. The client shall provide the drawings of the interface at the kick-off meeting.

R9. The floor support structures should allow the service access and routing of cables/pipes or HVAC system utilities.

R19. The front wall shall accommodate the cable and pipes feedthrough chicanes with an overall area of at least 24 dm2.

R20. The back wall shall accommodate the cable feedthrough chicanes with an overall area of at least 9.6 dm2.

Change request: The feedthrough positions for cables/pipes should be redesigned. The access routes for the cables/pipes shall use the openings in the wall support structures (below the false-floor level/shielding part of the wall) and enter the cave's inner space via the false-floor opening. The false-floor load in the area of the feedthrough opening will be relaxed and can be covered with the walk-over barrier. Simple cable/pipes maintenance shall be allowed. In total, six feedthroughs are planned: five in the front wall (on both sides of the guide shielding tunnel) and one in the back wall (connecting the cave with the preparatory lab in user hutch). The total area should be 47 dm2 and 9 dm2 for the front and back wall, respectively. Further communication during the design with the common electrical/utility project from ESS and the Hereon in-kind partner responsible for the cabling/piping will be needed.

R24. The chicane wall (interior) located 120 cm in front of the service/personal entry shall be 55 cm thick, 340 cm in length and 250 cm in height, covered on the front end with a steel plate of thickness of 5 cm.

Change request: The chicane should include a ceiling made of standard concrete with a thickness of at least 20 cm, covered by a boron shielding layer from the top (1 mm of pure B4C equivalent). The chicane wall length shall be enlarged to 395 cm (including the 5 cm steel plate).

R26. The cave floor and ceiling shall be covered with a boron-containing layer with the equivalent of 3 kg of pure B4C per 1 m2.

Change request: The floor and ceiling can be without the B4C layer unless cheap and functional solution is found. Note that the final 3 mm epoxy surface proposed in Annex 1 would

make the B4C on the floor inefficient. If the B4C layer on the floor and ceiling is not provided, the change request for R24 (chicane ceiling with the B4C layer) is mandatory.

R29. The cave floor shall have a load capacity of 4 t/m2 everywhere with reinforcement to 5 t/m2 under the incoming beam in the width of at least 1 m.

Clarification: However, the floor load capacity can be relaxed at the throughputs for cables and pipes near the walls (see the comment at R20).

R31. The elevated platform shall accommodate the embedded jars for the kinematics mounts of the detector support structures (design and positions provided by Hereon).

Change request: The interface changed, and there are 6 trapezoidal-shape baseplates embedded in the floor, in contrast to Annex 1 (Figure 9), showing 6x3 kinematic jars. However, the design is not fixed yet. The kinematics mounts of the detector support structures (interface 12 and requirement R31) shall be designed and provided by the ESS in-kind partner (Hereon), together with the tools and guidance for precise integration in the cave floor.

R40. The personal entry shall contain a fence or door-like system to prevent entry.

Clarification: A light sliding door covering the whole opening (approx. 1-2 cm bigger than the opening), protected by a B4C shielding (same specification as the chicane ceiling R24) layer, is the preferred solution for radiation safety and spatial constraints reasons.

R50. The gap between the door and the E01 floor should be as small as technically feasible, but it shall be smaller than 4 cm.

Change request: The gap below the sliding door should be reduced to maximum 1 cm.

R56. The beam-stop shall cover the active area of at least 25 x 40 cm (W x H) of the maximally diverged neutron beam.

R58. The beam-stop active area shall contain a 2 cm thick boron-containing plate (material with a minimum of 80% of pure B4C).

R59. The active area of the beam-stop shall be embedded in a lead dousing with a thickness of at least 3 cm towards the rear wall and at least 1 cm in the lateral directions.

Change request: The beam-stop should be a sandwich of at least 1 cm Pb covered by a plate containing boron, with shielding properties equivalent to 1 cm of pure B4C equivalent (R58, R59). The dimensions of the beam-stop sandwich (R56) shall be increased to 30 x 45 cm (W x H). Unlike R59, the Pb part should be fully covered by B4C.

Additional requirement on surface finishing

All surfaces must be finished with paint protecting them against corrosion and weathering. Epoxy based sealant (example: Amerlock 400, Sigmacover 400 or equivalent) should be applied to all concrete elements to protect them for short exposure time to outdoor environment.

5. DOCUMENTATION REQUIREMENTS

5.1. DOCUMENTATION IN THE TENDER RESPONSE

The contractor shall provide the following information as part of the offer in the tender response:

- A technical report describing the offered system with a focus on any proposed modifications and alternative solutions, including those requested by the Client in Section 4.6, with respect to the description in Annex 1. The level of detail of the report should be sufficient to assess the offer's compliance with tender requirements.
- Costing of all items, services and documentation described in this document
- Project schedule
- Documented history of delivering similar systems (concrete shielding structures of a total weight of more than 20 t) by the Contractor (or subcontractor if specified in the offer), especially:
    - Design and construction of radiation shielding from cast concrete or pre-cast blocks using the technology proposed for the BEER cave which satisfies the requirements on accuracy, particularly the maximum allowed gaps (Annex 1, Section 3.2.1)
    - Manufacturing of radiation shielding structures from heavy concrete.
    - Design and construction of neutron shielding

5.2. DESIGN AND MANUFACTURING DOCUMENTATION

The customer will provide the present detailed design documentation (see Annexe 1) with drawings. The contractor is expected to implement any changes to this design (see Section 4.5) and provide:

- 3D model in .stp or CATIA v6 format
- Detailed production drawings in .pdf
- Updated bill of materials for activation inventory

5.3. SYSTEM DOCUMENTATION

- Detailed design description
- Interface description
- System integration and verification plan, including
    - FAT and SAT procedures description
    - Installation plan
    - Requirements on resources (heavy equipment, special tools, staff etc.) required for installation, integration and verification of the System.
- System Operation & Maintenance Manual, including, but not limited to:
    - Maintenance periods and lifetime assessment
    - List of recommended spare parts
    - Required test equipment
    - Requirements for storage, transportation, handling and packaging

5.4. SHIPMENT DOCUMENTS

See Section 8.6. for details

5.5. PROJECT DOCUMENTS

- Project Quality Plan (PQP)
- FAT reports, including measurements qualifying key dimensions and functionality
- Inspection and test plans
- Non-conformance and deviation reports
- Parts list and drawings
- Materials certificates/data sheets
- Material traceability report
- Welders qualification acc. to ISO 9606 / ISO 14732 / certificates of welders
- Dimensional reports
- Visual inspection report
- Risk assessment and Method Statement (RAMS)
- EU declaration of conformity for CE marking according to DIN EN ISO/IEC 17050-1

6. QUALITY ASSURANCE REQUIREMENTS

6.1. QUALITY MANAGEMENT SYSTEM

The contractor must maintain and apply a quality management system compliant with ISO-9001 for all processes and services needed to make the product.

6.2. PROJECT QUALITY PLAN (PQP)

The contractor must create and apply a PQP. The PQP lists, in the correct order, all critical tasks, processes, inspections, and tests of the phases "manufacturing" and "assembly". The PQP must be released at the CDR with defined witness points, hold points, and report indications. A template for a PQP is shown in ESS Template for Project Quality Plan [ESS-0037830].

6.3. DECLARATION OF CONFORMITY

The Contractor shall provide an EU declaration of conformity for CE marking according to DIN EN ISO/IEC 17050-1.

6.4. SUB-CONTRACTORS AND/OR SUPPLIERS

The contractor must apply the same project management and quality assurance requirements of this requirements specification for its subcontractors and suppliers. The customer reserves the right to visit the supplier's or subsupplier's premises upon prior notice to perform an audit or review the progress of the contractually agreed deliverables.

7. PROJECT MANAGEMENT

7.1. PROJECT STAGES AND MILESTONES

The execution of the contract scope of work is expected in the following stages:

Stage 1: Design: Verification and (if necessary) update of the detailed design documentation described in Annexe 1. Presentation of the detailed design at the Critical Design Review (CDR) at ESS. The documentation and CDR shall cover all modifications with respect to the existing

experimental cave design. Transition to the Stage 2 is subject to the ESS approval of manufacturing readiness (RFM).

Stage 2: Production: Manufacturing and assembly of the experimental cave components at the contractor's premises. The production phase is completed by FAT and delivered to the ESS site. Transition to the Stage 3 is subject to the ESS approval of installation readiness (RFI).

Stage 3: Installation: The experimental cave shall be installed in accordance with the installation plan for the Neutron Scattering Systems (NSS) of ESS. The project is completed by site acceptance tests (SAT).

Completion of one stage and transition to another is conditioned by ESS approval through the review procedures as indicated in the list above. Close cooperation between the contractor, customer and ESS teams is therefore necessary for the successful and timely completion of the project.

7.2. PROJECT SCHEDULE

The contractor must set up a project schedule, and this shall be set before the contract is signed. The project schedule starts with the kick-off meeting and ends with the final acceptance. The planning must indicate:

- All defined milestones
- Delivery dates for review documents to the customer
- The time needed to approve review documents by the customer (~10 working days)
- Dates of customer's deliverables to contractor's site (if applicable)
- All main tasks
- Actual timeline
- Delivery dates of the ordered products/batches to ESS
- FAT and SAT dates

7.3. ACCEPTANCE TESTS AND REVIEWS

The reviews are organised as meetings or carried out by email communication. The form and location of the reviews may be changed in mutual agreement. The list of expected reviews is given in Table 1.

The contractor should provide all necessary documentation for each review at least 2 weeks before the review date. For details about the reviews and tests, see Section 8.

Table 1 - Review meetings approvals and tests to be performed

ID	Name of Meeting / Review	Form
KOM	Kick-off Meeting	meeting
CDR	Critical Design Review	meeting
RFM	Ready for Manufacturing	e-mail
FAT	Factory Acceptance Test	meeting
RFD	Ready for Delivery	e-mail
SAI	Site arrival inspection	e-mail
RFI	Ready for Installation	meeting

ID	Name of Meeting / Review	Form
SAT	Site Acceptance Test	meeting

7.4. COMMUNICATION

The delivery of relevant data between the contractor and customer, such as review documents, data files or open issues, must be formally transferred via email and should be done by the persons defined for communication.

The contractor shall inform the customer about the project progress and issues of concern at least once per month in progress reports.

Meetings can be held online via videoconference tools if agreed by both parties. The inviting party shall prepare an agenda and meeting minutes. The actions resulting from these meetings shall be clearly defined and distributed, along with the minutes themselves, to all responsible persons. Open issues shall be recorded in an open issue list maintained by the contractor.

All communication, drawings, material certificates, and related documentation must be in English.

7.4.1.POINT OF CONTACT

The principal point of contact for the project execution and coordination between the contractor and ESS is the Lead Instrument Scientist for BEER nominated by the customer:

Premysl Beran (Premysl.Beran@ess.eu), tel. +46721792504, ESS Technical Directorate, Instrument Scientists Group

The customer can nominate other contacts for communication for particular project stages or tasks.

8. EXECUTION OF THE PROJECT

8.1. KICK-OFF MEETING (KOM)

The "project kick-off meeting" should be held within 2 weeks after the contract is signed. The list below summarises the minimum that shall be discussed:

- Project Schedule
- Communication Strategy
- Requirements for design modifications and CDR

8.2. CRITICAL DESIGN REVIEW (CDR)

All modifications of the detailed design implemented by the contractor shall be reviewed by the customer and by ESS representatives at the CDR. For this review, the contractor shall provide

- A production version of the detailed technical design, as specified in section 5.2
- A preliminary version of the system integration and verification plan as specified in section 5.3

8.3. READY FOR MANUFACTURING (RFM)

Manufacturing readiness shall be approved by ESS and confirmed by the customer on the basis of CDR output. The approved CDR documentation and released Project Quality Plan are required for the RFM review.

8.4. FACTORY ACCEPTANCE TEST (FAT)

Representatives of the customer and ESS (if required) shall be present during the FAT. The contractor shall inform the customer team at least 20 working days before the tests. A report shall be sent to the customer at the end of the tests for validation.

The content of the FAT and required equipment shall be described in the Quality Plan (Section 6.2). The FAT shall include, but is not limited to:

- Measurement of critical dimensions
- Test of the crane's gradually acceleration and other parameters
- Test of the cave sliding door
- A representative set of samples of concrete used to manufacture cave structure blocks shall be evaluated to verify the requirements on density, homogeneity, strength and composition. I the case of on-site concrete casting, such samples should be collected and evaluated during the casting process.

The contractor shall provide the measurement tools required for FAT.

8.5. READY FOR DELIVERY (RFD)

Readiness for delivery must be approved by the ESS and confirmed by the customer. Necessary documents to be provided by the Contractor include:

- Approved FAT protocol (see Section 8.4).
- Design documentation in the "as manufactured" state (see Section 5.2)
- Materials and components certificates/data sheets (see Section 5.5)
- Shipment documents (see Section 5.3)
- Detailed installation and alignment plan
- Requirements for resources required for handling and storage

8.6. DELIVERY

All tangible deliverables shall be delivered in accordance with DAP (2010 Incoterms), at the ESS premises in Lund, Sweden or such other final destination defined by ESS.

All deliveries shall be pre-advised 48h prior to the arrival at the destination via email to logistics@esss.se. A confirmation with a time slot for unloading will be sent to the notifier.

All deliverables shall be executed in accordance with the Logistics Guidelines [ESS-0042559] (i.e. technical guidelines regarding transportation further specifying: delivery notice time, minimum packaging specs, delivery notes, opening hours of receiving at ESS ERIC or warehouse, time of storage at Partner premises without charge after FAT, etc.)

All deliveries shall also be accompanied by an appropriate proforma invoice (evidencing the replacement value of the delivered equipment) and such other delivery documentation to enable ESS ERIC to store and insure the equipment properly.

For goods/material/equipment purchased by ESS ERIC and delivered to the Supplier for use in the execution of this scope of work that is expected to be returned to ESS ERIC, the Supplier shall consult the ESS ERIC procedure for the Off-site Lending of Hardware [ESS-0048868]. The

procedure describes the responsibilities, routines and processes in regard to the lending of equipment.

8.6.1.DELIVERY ADDRESS

Delivery location: Transportgatan 5 F03 / Gate E, 224 84 Lund, Sweden

Site location: Partikelgatan 2, 224 84 Lund, Sweden

Site owner: European Spallation Source ERIC, Address: Box 176, S-221 00 Lund, Sweden.

8.6.2.SHIPMENT

The start of the shipment will be communicated to ESS by email at least **14 days** prior to shipment and confirmed once the shipment is sent.

Prior to shipment, the Contractor must inform ESS about the delivery dates, quantity, size and weight of the packaging, resources required for unloading and storage, as well as requirements for safe handling and storage of all packages.

No shipment can be made without a previous agreement by ESS.

The components delivered to ESS must be accompanied by

- Parts list for all replaceable parts with appropriate identification and specifications
- Materials certificates/data sheets (if not included in FAT)

8.6.3.HANDLING AND PACKING

- The packing must have the means to use classical handling tools. The packed parts must be protected during transport and storage against possible harms such as weather elements, mechanical shocks, strain, and rubbing, which can damage surfaces.
- Packing cases must be of a stout and robust nature, suitable for lifting and transportation without damage using a forklift truck or crane.
- The contractor must inform ESS about the amount and size of packages.
- Each package must contain a packing list indicating at least:
    - Serial number
    - Item description
    - Quantity ordered
    - Quantity shipped
    - Packed in a sub-package number
- The package must be marked with:
    - The customer's and ESS contact email addresses and phone numbers
    - Weight of the package
    - Support points for transport and lifting

ESS will supply the local handling tools for unloading the goods at ESS.

8.6.4.IDENTIFICATION AND MARKING OF COMPONENTS

In order to provide traceability of the components, any loose or pre-assembled component should have an identification marking. Where this is not feasible, exceptions shall be communicated and agreed upon. The marking should be permanently fixed on an exposed surface showing at least:

- Weight of the element,
- ESS Identifier (provided by the customer)
- Part number
- Drawing number

8.7. SITE ARRIVAL INSPECTION (SAI)

Upon arrival at the ESS site, staff appointed by the customer shall inspect the experimental cave elements to ensure the integrity of the transport. The inspection should include, at minimum, document control, visual inspection and metrology on critical parts. If the SAI fulfils the requirements, the customer shall accept provisional reception.

8.8. READY FOR INSTALLATION (RFI)

For the RFI to be concluded, the contractor shall provide a detailed installation and integration plan, including:

- Clear assembly plans
- Updated installation schedule
- Risk assessments and method statements (RAMS)
- Installation procedures
- Information on any temporary services needed

8.9. INSTALLATION

Installation works at the ESS site will be coordinated by the Installation Package Leader appointed by the customer. ESS shall be responsible for the operation of the forklift or crane, but the contractor is responsible for the delivery, integration, and commissioning of the final assembly. Any external resources (services, personnel, tools) required by the contractor from the customer or ESS must be specified and agreed upon in advance (see RFI).

For the activities performed by the contractor's staff at the ESS site, the contractor must fill in the RAMS (Risk assessment and Method Statement) according to the ESS template [ESS-2071941]. The staff of the contractor working on site is subject to ESS regulations [ESS-0093892]. The contractor is responsible for necessary work permits and training of its staff. The contractor must ensure the presence of an English-speaking person during all activities carried out at the construction site. Likewise, the contractor's activities at the ESS site must be performed by the staff with qualification adequate for given type of work.

8.10. SITE ACCEPTANCE TEST (SAT)

The preliminary plan for SAT is described in the BEER System Integration and Verification Plan [ESS-0432367]. The SAT shall include, but is not limited to:

- Check that all experimental cave components are installed on site according to the documentation package
- Visual check of main components and their finishing
- Check all functional dimensions according to the documentation package
- Check parameters of the crane
- Check the operation and parameters of the sliding door
- Check the position of the embedded baseplates for the detector's kinematic mounts

- Check the dimension of the sample tower shaft (octagon pit)

After the SAT, the experimental cave shall be ready for accepting the installation of further components such as a guide system, detectors, sample tower parts, etc.

8.11. FINAL PROJECT ACCEPTANCE

The project shall be deemed complete upon signing of the SAT report and all final documentation, including:

- As built technical drawings
- Performed FAT Protocol
- Recommended spare parts list
- Materials certificates/data sheets
- Certificates of welders
- Main equipment data sheets
- Instruments calibration certificates
- Maintenance and User's manual
- Certificate of compliance with the requirements
- EU declaration of conformity

9. WARRANTY

The warranty on workmanship and stability of the experimental cave components shall be 5 years from the SAT. Rights to request services under the warranty period shall be transferred to ESS.

10. SUGGESTED MILESTONES AND PAYMENTS

The main milestones with tentative completion dates and proposed payments are given in the following Table 2.

Table 2 - Tentative milestones, schedule and payments

ID	Milestone	Tentative date	Payment
WP01.1.2	Procurement contract signed	D	5%
WP01.1.3	Detailed design approved (RFM)	D + 6 month	25%
WP01.1.4	Delivered to site, start of the installation (SAI, RFI)	D + 11 months	20%
WP01.1.5	Access for installation of equipment (SAT)	D + 14 months	50%

The time schedule shall be studied so that it is compatible with the installation of the common shielding project and the E02 neutron transport guide.

11. REFERENCES

The documents marked as *ESS-xxxxxxx* are documents from the ESS repository. Their current versions can be found in the ESS CHESS repository. If the contractor does not have access rights to this repository or additional documents such as review templates etc., the customer will provide the necessary documents upon request.

11.1. BEER PROJECT DOCUMENTS

Design	
BEER - Sub-System Design Description – Experimental Cave	ESS-0432123
BEER – Concept of Operation	ESS-0124310
BEER - Interface Description	ESS-0432366
BEER - Radiation Safety Analysis	ESS-0432365
BEER - Complete 3D Model of the instrument	ESS-0432373
Quality management	
BEER - System Validation Plan	ESS-0432370
BEER - System integration and verification plan	ESS-0432367
BEER - System Operations and Maintenance Manual	ESS-0432372
BEER - Instrument Hazard Analysis	ESS-0432364
BEER - Project Quality Plan	ESS-0432363

11.2. ESS GUIDELINES AND REGULATIONS

Design and construction	
Main coordinate systems at the ESS	ESS-0035090
ESS Instrument Technical Interfaces	ESS-0403282
Safety requirements	
Risk assessment and Method Statement (RAMS)	ESS-2071941
Project management	
ESS Procedure for Change Control of ESS Facility	ESS-0001879
Guideline for Shipping	ESS-0042559
Information to contractors working on site	ESS-0093892
Checklist for Installation Readiness Review (IRR)	ESS-0398509
Quality management	
ESS Guideline for Factory Acceptance Test (FAT) and Site Acceptance Test (SAT)	ESS-0094204

11.3. EU DIRECTIVES, STANDARDS AND REGULATIONS

Norm	Description
2006/42/EC	Machine Directive
Eurocode 0 (EN 1990)	Basis of structural design
Eurocode 1 (EN 1991)	Actions on structures
Eurocode 2 (EN 1992)	Design of concrete structures
Eurocode 3 (EN 1993)	Design of steel structures
EN 1090	Execution of Steel Structures and Aluminium Structures
EN 13670	Execution of Concrete Structures
EN ISO 13849	Safety of machinery — Safety-related parts of control systems

Norm	Description
EKS 11	Boverket mandatory provisions amending the board's mandatory provisions and general recommendations (2011:10) on the application of European design standards (Eurocodes)

12. GLOSSARY

CDR	Critical Design Review
EC	Experimental Cave
ESS	European Spallation Source ERIC
FAT	Factory acceptance test
KOM	Kick-off meeting
NSS	Neutron Scattering Systems
PQP	Project quality plan
PQP	Project Quality Plan
RAMS	Risk assessment and Method Statement
RFD	Ready for delivery
RFI	Ready for installation
RFM	Ready for manufacturing
SAI	Site acceptance inspection
SAT	Site acceptance test
TCS	Technical Coordination System
TGn	Tollgate review *n*