Critical Design Review-1 (CDR-1) for ESS Superconducting RF Distribution systems
June 7, 2016
Charge for the CDR

Meeting place: ESS, Lund

References:
Purpose of this CDR

A CDR is scheduled as a milestone event for approving the transition from detailed design to manufacture, or to material or component procurement, or to software coding, or to assembly and construction. At this milestone, the outputs of design such as CAD models, supporting calculations and analysis reports, and procurement and manufacturing specifications are compared and reviewed against the inputs of design, including technical and interface requirements or input specifications.

A successful CDR gives confidence that the proposed design will meet all technical requirements and that its interfaces with all relevant accelerator subsystems are understood and defined. The completion of a CDR freezes the Baseline design of the system(s) or component(s) being reviewed.

The purpose of this CDR is to confirm that the design status and the specification and statement of work are in such a state that our partner Huddersfield University can start procurement of the RF distribution systems, Tender 1 and Tender 2 (waveguides, dual directional couplers, bellows, elbows).

The CDR should confirm that the detailed design outputs for the RF distribution system are traceable to design inputs from ESS. It is important to confirm that requirements and specifications are understood and agreed inside ESS. The design for the RF distribution systems should demonstrate that these agreed design inputs have been used and fulfilled or achieved, that is, that these requirements are verified by the design. The inputs for detailed design may include the following, where applicable and agreed by:

- Product Breakdown Structure (PBS) requirements for Level 2 (L2) Accelerator, L3 RF section, relevant L4 disciplines and L5 components, including interface requirements applicable for the RF distribution systems at various PBS Levels. These requirements are managed in the IBM® Rational® DOORS® database, implemented for ESS products;
- any conceptual or preliminary design descriptions or other inputs provided during previous reviews, workshops, or other technical meetings that have been agreed and accepted as applicable input to detailed design for the RF distribution systems.

In general terms, the expected outputs of detailed design that should be presented and reviewed in the CDR are:

- Specifications for the RF distribution systems standard components (waveguides, bellows, elbows, directional couplers, shutter switches);
- Integration layouts;
- reports from calculations, analysis, simulation, prototype testing and other design verification activities

The specific information that should be reviewed in the CDR is listed as Deliverables. See Appendix 1.

Charge to the Committee
The Review Committee is composed of the Chairman and members as identified in Appendix 2. This list also shows reviewers, who provide comments and review but are not on the formal committee and presenters.

In the context of the Scope of Works, the Review Committee is asked to:

1. REVIEW: Scrutinize and assess the deliverables listed in Appendix 1 and presented via the talks at the CDR. Note that the presentations themselves are means of communication only, and it is the design which must be reviewed.

2. ANSWER: Answer each question listed in Appendix 3.

3. DECIDE: The Review Committee is to decide whether the RFDS for cold linac is ready to move to the procurement stage and deliver at the conclusion of this CDR, a clear recommendation to ESS. Suggested forms for the decision are:
   - Approved, without qualifying comments or further actions.
   - Approved, but with recommendations and/or actions to be completed.
   - Not approved, but with recommendations, actions, further inputs and activities required, and a proposal for a follow-on review.

4. REPORT: The Review Committee is to document in a short report to be delivered as soon as possible after the CDR, its recommendation and any specific actions for Work Package (WP) for BD system identifying any further design necessary, and other guidance for assisting planning and future success of the WP in for its scope and deliverables.
Appendix 1
Scope and Deliverables for Review

Scope for Work Unit RFDS
ACCSYS WBS 11.8.6 Work Unit (WU) RF distribution systems is led by Rutambhara Yogi of ESS. The systems will be supplied as an in-kind contribution from UK, by Huddersfield University, led by Rob Edgecock. This CDR is to ascertain that the specifications are agreed and detailed enough to allow HU to go for tender for the standard components.

The WU is responsible for the following scope relevant for this CDR

- Layout input
- Requirements

The partner (HU) is responsible to execute the contribution. Following this CDR, the relevant part is to go for tender for the standard waveguide components and the standard DDCs, bellows, and elbows needed to start the procurement.

Deliverables for CDR - Information to be reviewed

1. Technical Data Package

WU RF distribution systems is requested to deliver a technical data package consisting of the following documents and data to the Chairman for distribution to the Review Committee no later than 7 days prior to the CDR.

- Requirements. Agreed list of RF Level 3 requirements, and also lists of Level 4 requirements. For each requirement, please indicate that the requirement is understood and accepted, or not, by WU RF distribution systems;
- RF distribution System Description;
- List of components to be procured;
- Procurement Specifications;

2. CDR Presentation

WU RF distribution systems is requested to prepare and present at the CDR, PowerPoint presentation(s) with hardcopy supporting documents and data hand-Outs as deemed necessary. These presentations should address the following:

- Functional description and description of the equipment: provide a general description of the individual systems and equipment as well as its breakdown into
sub-systems. It should be coherent with and linked to the ESS Product Breakdown structure (PBS);

- Summarise and highlight key points from the deliverables of the Technical Data Package; identified above
- Safety; see below
- Quality; see below
- Reliability, Availability, Maintainability, Inspectability (RAMI); see below
- Interfaces; see below

WU RF distribution systems is requested to deliver an advanced draft of the CDR presentation(s) to the Chairman for distribution to the Review Committee no later than five (7) days prior to the CDR.

Safety

Conventional Hazards

WU RF distribution systems should present on any identified modes of installation, operation or maintenance tasks for RF distribution systems which could expose personnel to conventional hazards (e.g. high voltage hazards, discharge of gas in the tunnel, etc.).

Quality

Quality Planning

Describe planning for Quality, or provide a Quality Plan for RFDS systems scope. Use ISO 10005:2005 as guidance (not mandatory) for the planning of activities for Quality assurance and control. This especially is relevant to ensure quality assurance of the deliveries of components.

Standards

WU RF distribution systems is requested to list the standards used for engineering design, construction and verification of BD systems. Note that ESS-000151S Operating Procedure “Standards & Norms applicable for ESS” identifies radiation protection Standards, namely ICRP, IAEA, Erratum standards, and also more general engineering Standards, such as SIS, CEN and ISO, which ESS considers would be applicable for the design and construction of ESS systems and components. The ESS vacuum handbook also makes specific reference to applicable standards.

RAMI

Random failures
List the most frequent failures during normal operation (steady state operation). Related maintenance actions, times to repair and to restart the system should be provided.

**Lifetime issues**
List the components for which wear-out or degradation to failure will occur within 20 years of operation of the machine. For these components please provide maintenance actions, times-to-repair (hours) and the actions needed for restarting after repair.

**Catastrophic events**
List the failures with catastrophic consequences in downtime or cost. Please include an estimation of the probabilities, cost and downtime (hours) as well as the mitigation to avoid such failures.

**Integrated Control System (ICS)**
Descriptions or other identification of systems and components — for Integrated Control Systems (ICS) and including Machine Protection Systems (MPS) and Personnel Safety Systems (PSS):

- a list of protection functions required for the local protection system
- a list of the process variables to be monitored in the controls system, archiving rates and alarm limits (when applicable) for the control system and local protection system.
- to assist hazard identification for the Personnel Safety System. Please provide a table stating such hazards and its mitigation. Identify which devices WU RF distribution systems considers are hazardous for PSS design and other mitigation.

**Interfaces**
WU RF distribution systems is asked to provide descriptions/requirements of other interfaces between the RF distribution systems that will be procured now and other subsystems of the facility. This may include water cooling systems, LLRF systems, Interlock systems, and high power amplifiers, superconducting cavities, PSS systems etc.
Appendix 2

Review Committee and other Reviewers, Presenters and Observers

List to be finalised and names confirmed prior to CDR

<table>
<thead>
<tr>
<th>Name</th>
<th>Organisation</th>
<th>Appointment for CDR</th>
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<tbody>
<tr>
<td>John Weisend</td>
<td>ESS, ACCSYS Deputy Project Leader, and Group Leader, Specialised Technical Services (STS)</td>
<td>Chairman of the Review Committee</td>
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<tr>
<td>Anders Sunesson</td>
<td>ESS, RF group leader</td>
<td>Review Committee member</td>
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<tr>
<td>Matthew Conlon (tbd)</td>
<td>ESS, QA</td>
<td>Review Committee member</td>
</tr>
<tr>
<td>Lali Tchelidze</td>
<td>ESS, Safety and reliability</td>
<td>Review Committee member</td>
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<tr>
<td>Inigo Alonso</td>
<td>ESS, Linac group</td>
<td>Review Committee member</td>
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<tr>
<td>Timo Korhonen</td>
<td>ESS ICS/PSS</td>
<td>Review Committee member</td>
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<td></td>
<td>ESS, RF distribution work unit leader</td>
<td>Presenter</td>
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<td></td>
<td>Huddersfield University, UK</td>
<td>Presenter</td>
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<td>STFC, UK</td>
<td>Presenter</td>
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<tr>
<td>Morten Jensen</td>
<td>ESS RF section leader</td>
<td>Reviewer</td>
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<td>Anton Lundmark</td>
<td>ESS Water Cooling</td>
<td>Reviewer</td>
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<tr>
<td>Carlos Martins</td>
<td>ESS Power converter section leader</td>
<td>Reviewer</td>
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<tr>
<td>Stevo Calic</td>
<td>ESS RF group</td>
<td>Reviewer</td>
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<tr>
<td>Chiara Marrelli</td>
<td>ESS RF group</td>
<td>Reviewer</td>
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<tr>
<td>Anders J Johansson</td>
<td>Lund University</td>
<td>Reviewer</td>
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<tr>
<td>Rafael Montano</td>
<td>ESS RF group</td>
<td>Reviewer</td>
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<tr>
<td>Rihua Zeng</td>
<td>ESS RF group</td>
<td>Reviewer</td>
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<tr>
<td>Enric Bargalló</td>
<td>ESS, Safety and reliability</td>
<td>Reviewer</td>
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The CDR Committee conducts this review of design with the authority of ACCSYS Project Leader, Mats Lindroos, and ESS Chief Executive Officer, Jim Yeck.

The Committee serves in an advisory capacity to:

- the ACCSYS WP6 (Beam Delivery) Leader and deputy, and
• the ACCSYS management team.
Appendix 3

Questions

1. Has design and supporting activity for RF distribution systems progressed and reached a level of technical maturity in accordance with the activities and milestones for this Work Unit recorded in the ESS ACCSYS Project and been documented sufficiently and presented in a suitable format to enable review at this CDR?

2. Are all or a sufficient coverage of requirements and specifications for the RF distribution systems, including for its interfaces with other systems, documented by ESS, communicated to and understood by the Partner?

3. Does the design/documentation meet these requirements and specifications?

4. Have safety issues and technical risks been identified and eliminated or otherwise mitigated for in the detailed design or identified for managing for manufacture, assembly, installation or operation?

5. What quality assurance and quality control activities have been planned and how will these be conducted and documented or reported?

6. Are there sufficient staff resources assigned to the Work Unit team to allow to progress with work in accordance with activities, durations and milestone dates shown in the ESS ACCSYS Project plan?

7. Is the design information and information on procedures required for the operation of the RF distribution system delivered and presented at CDR sufficient to define the controls interfaces and allow the start of the controls system design?

8. Are the strategy, policies and regulations for procurement, manufacture and assembly sufficiently identified, defined, documented and understood by the Work Unit team, including supplier source(s) and pre-procurement activities and progressed to a sufficient stage?

9. Is the schedule for delivery of materials, components and for the manufacture of RF distribution system sufficiently understood and in accordance with activities, durations and milestone dates shown in the ACCSYS project plan?

10. Does the work unit team require additional input from ESS or its other partners, or seek additional review, decision or approval from ESS to proceed with all work planned?

11. Are there any outstanding agreements to be made or other actions necessary to allow the work unit to achieve the Plan?