Critical Design Review (CDR) for ESS Beam Delivery System

8 October 2015

Charge for the CDR

Meeting place: ESS, Lund

References:

A. ESS-0039290 *appendix to agreement ESS / Aarhus University*
Appendix A: Scope of Works for Work Package 6: Beam Delivery Systems

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 for Beam Delivery (BD) system is likely to meet all requirements and is specified in sufficient detail for production (including material purchase for manufacture, procurement of manufacture services and in-house manufacture) and assembly. It is understood that this procurement and manufacture will be managed by Aarhus University with components procured or manufactured and integrated into the BD system by venders.

The CDR should confirm that the detailed design outputs for the BD system are traceable to design inputs from ESS. It is important to confirm that requirements and specifications have been received, understood and agreed by Aarhus University. Aarhus University's design for the BD 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 ESS and Aarhus University:

- the scope of work described in the HoA for BD technical appendix;
- Product Breakdown Structure (PBS) requirements for Level 2 (L2) Accelerator, L3 BD section, relevant L4 disciplines and L5 components, including interface requirements applicable for the BD at various PBS Levels. These requirements are managed in the IBM® Rational® DOORS® database, implemented for ESS products;
- any specifications agreed as inputs for the detailed design of the BD;
- 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 BD.

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

- CAD models, prototypes, mock-ups and simulations;
- specifications and other descriptions resulting from detailed design activities;
- 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, Reference A, 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 deliberate and deliver at the conclusion of this CDR, a clear recommendation to ESS and to Aarhus University about proceeding with material procurement for manufacture, procurement of manufacture services, and the manufacturing itself of the BD system. 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 Package BD

ACCSYS WBS 11.6 Work Package (WP) BD is led by Søren Pape Møller of Aarhus University.

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

- detailed design
- prototyping
- procurement
- the construction, assembly, testing and other verification, and delivery of a complete Beam Delivery System

Deliverables for CDR - Information to be reviewed

1. Technical Data Package

Aarhus University 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 10 working days prior to the CDR.

- **Requirements.** Agreed list of HEBT Level 3 requirements, and also lists of Level 4 requirements proposed by Aarhus University The Level 4's use inputs from ESS such as vacuum diagram, vac system wiring diagram, and ESS vacuum handbook. For each requirement, please make indicate that the requirement is understood and accepted, or not, by the Aarhus University.
- **BD system optics design report**;
- **BD system engineering design report**;
- **Evaluation report** confirming the design configuration for the prototype, cabling options and the need for coating of the ceramic vacuum beam pipe for the raster scanning system;
- **CAD.** 3D CAD model, or 2D CAD files of the mechanical layouts of the BD systems within Aarhus and its vendors scope;
- **Technical specifications** for the procurement of major components of the raster scanning system,
- **Verification Planning.** Factory Acceptance Test (FAT) plans and other planning for verifying the major components of the raster scanning system meet requirements, specifications and design.

2. CDR Presentation

Aarhus University is requested to prepare and present at 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*
- Beam Physics; *see below*
- Integrated Control Systems (ICS)*; see below*

Aarhus 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 (5) working days prior to the CDR.

Safety

Conventional Hazards

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

Radiation Hazards regarding Gamma Ray Blockers

Aarhus should present any results to date of the evaluation of the need for gamma blockers in the beam line from the targets (main target and tuning dump) to facilitate hands-on maintenance by reducing back shine radiation from the target, and tuning beam dump.

Aarhus should present design criteria / requirements and any conceptual design for the gamma blocker if it is demonstrated that gamma blocker will be needed.

Quality

Quality Planning

Describe planning for Quality, or provide a Quality Plan for BD systems scope. Use ISO 10005:2005 as guidance (not mandatory) for the planning of activities for Quality assurance and control.

Standards

Aarhus University is requested to list the standards used for engineering design, construction and verification of BD systems. Note that ESS-0001515 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.

Beam Physics

Reviewers should assess the choices made in the BD design and also validity and usability of the results for the end-to-end simulations, for setting the tolerances and for fine-tuning of the linac.

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 the devices, that could be sent offsite from Aarhus University to allow controls development and test, and tentative dates for when each device would be available at Aarhus University and could be sent offsite.
- a list of the chosen power supplies that need to be controlled, including BD system corrector PS, controls interface connectors and protocols, Interlock in/out signals (when applicable) and programming documentation. Please identify the preferred / chosen protocol when several possibilities for protocol exist.
- a list of the vacuum devices on Ground (Primary Pumps, Turbo molecular Pumps, gauges, valves, gas dosing valve, residual gas analyser….) controls interface connectors and protocols, signal types.
- a list of the sensors (flow meters, PT100 and pressure sensors) and the signal type produced by them.
- a list of the procedures required from the control system for the BD system and their vacuum systems
- a list of protection functions required for the local protection system
- a list of the process variables that want to be monitored in the controls system, archiving rates and alarm limits (when applicable) for the control system, vacuum control system and local protection system.
- specifications for the feedback procedure and the automatic start-up of the BD system
- to assist hazard identification for the PSS, please provide a table showing the voltages and estimated current outputs onto each device in the BD system and identify which devices Aarhus University considers are hazards for PSS design and other mitigation.

Appendix 2

Review Committee and other Reviewers, Presenters and Observers

List to be finalised and names confirmed prior to CDR

Name	Organisation	Appointment for CDR
John Weisend II	ESS, ACCSYS Deputy Project Leader	Chairman of the Review Committee
Lali Tchelidze	ESS, ACCSYS Safety Manager	Review Committee member
Matthew Conlon	ESS, ACCSYS Quality Assurance Manager	Review Committee member
Stephen Molloy	ESS, ACCSYS Section Leader	Review Committee member
Thomas Shea	ESS, ACCSYS Beam Instrumentation	Review Committee member
Daniel Piso Fernandez	ESS, Integrated Control Systems	Review Committee member
Marcelo Ferreira	ESS, ACCSYS Vacuum Systems	Reviewer
Eugene Tanke	ESS, ACCSYS Systems Engineer	Reviewer
Enric Bargalló	ESS, ACCSYS RAMI Engineer	Reviewer
Mohammad Eshraqi	ESS, ACCSYS beam physics	Reviewer
Carlos Martins	ESS, ACCSYS power converters incl. supplies	Reviewer
Inigo Alonso	ESS, ACCSYS deputy WP Ldr, Beam Delivery	Reviewer
Søren Pape Møller	Aarhus University, WP Ldr, Beam Delivery	Presenter
Heine Dølrath Thomsen	Aarhus University	Presenter

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 BD system 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 BD system, including for its interfaces with other systems, documented by ESS, communicated to and understood by the Work Unit team?

3. Does the design 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 by its parent Aarhus University 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 BD 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 or its parent Aarhus University, 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 BD system sufficiently understood and in accordance with activities, durations and milestone dates shown in the ACCSYS project plan?

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

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