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| Critical Design Review for the Phase Reference Line -  Charge document |
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| Critical Design Review (CDR)  of AIK 8.7  April 10, 2018 |
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| **Charge for the CDR** |
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Purpose of this CDR

The Critical Design Review (CDR) assesses if the activities related to the development of the Phase reference line elements design for the ESS linac meet all facility element requirements with acceptable risk and quality and within cost and schedule constraints.

The CDR includes the facility elements for phase reference line:

* Temperature Control Subsystem
  + Temperature Control Box design and hardware module
  + Electricity schematic drawing for installation in racks (cable connection, power connection, front panel, back panel, etc)
  + Functionality specification for ICS software/servers/network infrastructure
  + Installation and test plan
* MO to Mainline Feeding
  + Frequency combining, Amplifying, signal splitting, cabling in stub, etc
  + Phase drift compensation from MO to mainline
* Tap point
  + Prototype results
  + Production, installation and testing
* Air pressure subsystem
  + Gas pipe design, installation
  + Leak test and preliminary results
* PRL in A2T and dogleg
  + Installation plan in Dogleg and A2T(G01, accelerator tunnel)
  + Installation in A2T (D02, target building)

The CDR demonstrates that the maturity of the design is appropriate to support proceeding with manufacturing drawings and start the procuring/fabrication process.

The inputs for detailed design may include the following, where applicable and agreed by Warsaw University of Technology and ESS.

* The scope of work described in the Technical Annex AIK 8.7 Phase Reference Line.
* Product Breakdown Structure (PBS) requirements for Level 2 (L2) Accelerator, L3 and L4 disciplines including interface requirements. These requirements are managed in the DOORS database, implemented for ESS products.
* Any specifications agreed as inputs for the detailed design of the Phase Reference Line facility elements detailed above.
* Any inputs provided during previous workshops, or other technical meetings that have been agreed and accepted as applicable input to detailed design for the Phase Reference Line.

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

* Detailed design of the temperature control subsystem, MO to mainline feeding, tap point, Air pressure subsystem, PRL in A2T and dogleg.
* Results of performed tests and planned necessary tests of Phase Reference Line facility elements.
* List of special tools/equipment for assembly and installation.
* Reports from calculations, analysis, simulation and other design verification activities.

The specific information, which should be reviewed in this CDR, is listed as Deliverables. See Appendix 1.

**The CDR boundaries and limitations**

The CDR to be performed is limited in its scope and concerns only the scope related to uninstalled&uncompleted subsystems in the AIK 8.7. The scope is as defined below.

* Included in the CDR are:
  1. Temperature control loops and their implementation in EPICS
  2. Taps point;
  3. PRL installation in A2T and Dogleg;
  4. Air pressure and gas system
  5. PRL path from MO to tunnel
  6. Quality assurance and risk analysis.
* Excluded from the CDR are:
  1. Main rigid line design and installation (FEB to A2T)
  2. Temperature control concept (PID loop + heating cable solution)
  3. Directional coupler design and installation
  4. Number of tap points and their locations

**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.

The Review Committee is asked to:

1. REVIEW: Scrutinize and assess the deliverables listed in Appendix 1, presented through the material and discussions at the CDR. Note that the presentations themselves are means of communication only, and it is the design and design documentation which must be reviewed (i.e. this will kick off the production of final blue print drawings and allow for tendering processes as needed).

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

3. DECIDE: The Review Committee is to elaborate and deliver at the conclusion of this CDR, that the Phase Reference Line design and planned production meet all facility element requirements with acceptable risk and within the cost and schedule constraints, and if the maturity of this system design is sufficient to prepare manufacturing drawings and start procurement of individual components.

Suggested forms for the decision are:

* Approved, without qualifying comments or further actions;
* Approved, but with recommended actions and or clarifications;
* Not approved, but with recommended actions, for further inputs and activities, and a proposal for a follow-on review.

(If the committee rules for “Approved but with recommended actions” or “Not approved” of the CDR, it is of essence that the actions/comments requested are very precise in their formulation and that the fulfilment decision is transferred to WP8, all this due to time constraints in the schedule).

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 Warswa University of Technology and/or ESS, identifying any further design necessary and other guidance for assisting planning and future success of the activities related to its scope and deliverables.

(If the CDR is “Approved but with recommended actions”, at the CDR, there shall be a summary list of requested actions defined and who is responsible to perform needed work. In order to facilitate the actions, ESS will work with Warsaw University of Technology to accommodate any defined actions in order to meet the schedule constraints. This while awaiting the final report from the CDR review team).

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| Appendix 1  **Scope and Deliverables for Review** |
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Scope for Work Unit Phase Reference Line (PRL)

ACCSYS WBS 11.8.4 Work Unit (WU) Phase Reference Line is led by Rihua Zeng, ESS ERIC. The WU is part of ACCSYS WBS 11. Work Package (WP) 8 RF systems, led by Morten Jensen, ESS ERIC.

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

* Programming of software for temperature control system
* Detailed design
* The testing and other verification
* Installation of the remaining PRL system
* Commissioning of the system
* The needed QA process

Deliverables for CDR - Information to be reviewed

WUT is requested to deliver to the CDR secretary (Anders Sunesson) for distribution to the Review Committee and other reviewers, an agreed subset of detailed design information related to the PRL for pre-review and comments no later than five (5) working days prior to the CDR.

The phase reference line is composed of discrete parts with the responsible partner for the information to be provided at the CDR given in brackets.

* Coaxial line for dogleg/A2T (WUT)
* Temperature control (WUT)
* Tap points (WUT)
* Gas pipes(WUT)

For each system the data package shall include but not be limited to:

* System Requirement Document (ESS)
* System Design Description and related documents and data (drawings, general arrangement drawings, P&ID, FE models, etc.) (WUT)
* Updated Interface Control Documents
* Project Schedule (ESS)
* Risk register (WUT)
* CDR documents listed above shall be submitted two (2) weeks before the review.
* Agenda of the review meeting, two (2) weeks before the review.

Documents created during the CDR:

* Report on the review process and decision.

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| Appendix 2  **Review Committee and other Reviewers, Presenters and Observers** |
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The CDR Committee conducts this review with the authority of ACCSYS Project Leader, Mats Lindroos, and ESS Director General, John Womersley.

The Committee serves in an advisory capacity to:

* The Work Unit teams for ESS RF-LPS and MTA Atomki;
* The ACCSYS WP 8 Leader and deputy, and
* The ACCSYS management team.

Note that completing a Design Review does not guarantee a trouble free system; it only means the judgement of the committee is that the design is likely to succeed. Any future problems that may develop will have to be addressed by the In-Kind partner and ESS depending upon the scope in which the problem occurs.

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| Name | Organisation | Appointment for |
| Anders Sunesson | ESS, ACCSYS RF | Chairman Review Committee |
| Morten Jensen | ESS, ACCSYS RF | Review Committee Member, Secretary CDR |
| ICS rep | ESS, ICS/Chief Engineer | Review Committee Member |
| BI rep | ESS, ACCSYS BI | Review Committee Member |
| BP rep | ESS, ACCSYS Beam physics | Review Committee Member |
| Ebbe Malmstedt | ESS, Deputy WU Leader | Review Committee Member |
| Safety rep | ESS, ACCSYS Safety Lead | Review Committee Member |
| Anders Svensson | ESS Eric, Master osciallator WU lead | Review Committee Member |
| Anders Johansson | ESS/LU, LLRF WU leader | Review Committee Member |
| Rihua Zeng | ESS, ACCSYS PRL | Presenter |
| Krzysztof Czuba | Warsaw University of Technology | Presenter |
| Dominik Sikora | Warsaw University of Technology | Presenter |
| Tomas Lezsniak | Warsaw University of Technology | Presenter |
| Mateusz Żukociński | Warsaw University of Technology | Presenter |
| Wojciech Wierba | Warsaw University of Technology | Presenter |
| Radosław Papis | Warsaw University of Technology | Presenter |
| QA rep | ESS, ACCSYS QA/QC Lead | Reviewer |

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| Appendix 3  **CDR Charge Questions** |
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1. Has the project and supporting activities for the PRL progressed in accordance with the activities and milestones recorded in the ESS ACCSYS project plan?
2. Has the PRL detailed design been documented appropriately and presented in a suitable format to enable review?
3. Have the correct design options for the PRL facility elements as well as their verification methods been selected and described?
4. Have all or a sufficient coverage of requirements for the PRL facility element interfaces been identified and documented by ESS, communicated to and understood by the partner WUT?
5. Are the signal lists sufficiently well documented and comprehensive enough for detailed design with sufficient margin to accommodate expected changes?
6. Do the design choices follow ESS standards and supported hardware and software platforms?
7. Are the sub-systems and the overall system designed to be adequately flexible to accommodate future machine changes, long term usage and changes to the protection requirements?
8. Does the PRL assembly detailed design comply with the requirements for the system and its interfaces?
9. Is the PRL facility elements detailed design sufficient to prepare manufacturing drawings and start procurement of individual components process?
10. Does the partner WUT require additional input from ESS or the other partners to proceed to the PRL facility element realization process?
11. Have safety issues and technical risks been identified and eliminated or otherwise mitigated appropriate for in the detailed design?
12. What quality assurance and quality control activities have been planned and how will these be conducted and documented or reported?
13. Are there sufficient staff resources and competence assigned to the WUT scope of work to allow to progress with work in accordance with activities, durations and milestone dates shown in the ESS ACCSYS Project plan, see Appendix 4?
14. Are the strategy, policies and regulations for procurement, manufacture and assembly sufficiently defined, documented and understood by the partner WUT, including supplier source(s) and pre-procurement activities and progressed to a sufficient stage?
15. Are there any outstanding agreements to be made or other actions necessary to allow the partner WUT to achieve the project plan?

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| Appendix 4  **Detailed checklist, can be used as guidance and for clarification** |
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The four (4) main question areas for the PRL CDR are:

1. The design
   1. Is the design documented sufficiently and presented in a suitable format to enable review at this CDR?
   2. Does the design meet the requirements and specifications?
   3. Does the design meet the ESS needs? (plant integration, testing, operability, maintenance, future changes/upgrades)
   4. Are all or a sufficient coverage of requirements and specifications for the PRL assembly, including its interfaces with other systems, documented, communicated to and understood by the partner WUT?
   5. Has the design and supporting activity for the PRL facility elements progressed and reached a level of technical maturity to start the realisation process?
      1. What open technical questions exist?
      2. What is the path forward to clarify the open questions?
   6. Have a proper safety and risk analysis been performed for this stage of the project?
      1. What safety issues and technical risks have been identified?
      2. Are they documented (signal lists)?
      3. What mitigations have been implemented? Are they documented? What is the result?
      4. Future actions planed? To be eliminated or otherwise mitigated in the realisation process or identified for managing for manufacture, assembly, installation or operation?
   7. Does the partner WUT require additional input, or seek additional review, decision or approval from ESS to proceed with all work planed?
   8. Are there any outstanding agreements to be made or other actions in the work unit necessary to realize the project plan?
   9. Specific deliverables are at a minimum expected to include:

* Detailed electrical schematics;
* Procedures on manufacturing, soldering, testing, inspection, storage and delivery protection;
* Drawings of the mechanical layout;
* Simulation results and finite element analysis (FEA) reports (if required);
* Complete list of parts;
* Complete list and definition of all signal types and expected connectors;
* A detailed manufacturing, installation (in Suppliers test area) and testing programme with regular milestones to allow progress to be monitored;
* Full details of factory acceptance testing;
* A complete and detailed list of all interfaces to all ESS equipment including all additional devices, power supplies, controls, interlocks and cabling;
* Data sheets of the main components and subsystems including those from third party suppliers;
* Details on the structure of software codes;
* Detailed ordering, manufacturing and delivery schedules.

1. The manufacturing
   1. Is there a strategy and sequence for the realisation process?
   2. How is the technical vendor discussions/agreements for manufacturing documented (applicable for the selected supplier)?
   3. What mechanism is in place to ensure that the vendor have necessary experience and/or prototypes/references from similar work for evaluation by WUT? What are the conclusions made by WUT?
   4. Are the strategy, policies and regulations for procurement, manufacture and assembly sufficiently identified, defined, documented and understood by the partner WUT including supplier source(s) and pre-procurement activities and progressed to a sufficient stage?
   5. Are all needed manufacturing procedures and drawings completed? If not what is open?
   6. Are all needed procedures/inspection plans, including risk analysis for prototyping, performed and planned for mitigating actions? (e. g. bracing, machining, overall manufacturing sequence, procedures, etc.)
   7. Is the manufacturers given sufficient time to perform the work?
2. Time schedule and critical paths;
   1. Is the project planned in sufficient detail?
   2. What top three (3) risks are identified and how are they managed?
3. WUT resource plan to meet the schedule
   1. Are all resources named?
   2. Is the schedule resource loaded?
   3. Are all resources available and released by management in due time?
   4. Is there any surplus in the critical areas?
   5. Which bottlenecks do exist?