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| Preliminary Design ReviewTarget Helium Cooling System (WBS 12.2.4)PDR commitee report Target Helium Cooling System |
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| Meeting Date | Location |
| 4-5 Sep 2014 | ESS, Lund |  |
| Chairman |  |
| F. Plewinski |  |
| Committee members | **Invtees**I |
| François Plewinski (Chair)Fredrik Bergstedt (CF) Håkan Carlsson (Fluid Systems)Linda Coney (TSS)Chris Densham (RAL, External Expert)Peter Jacobsson (ES&H)Guy Laffont (CEA, External Expert) Rikard Linander (Monolith Systems) | Ulf Odén ESS Target Lead for WP 12.4 Target: Jens Harborn (PCool and PCS design engineer)Kristoffer Sjögreen (Target system)Eric pitcher (Target Division)Per Nilsson (Fluid system and CFD specialist for Target Division)Marc Kickulies (Moderator reflector plug)Mikael Olsson (Target Safety System)Daniel Lyngh (Moderator reflector system) |
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# Charge to committee

The purpose of this Preliminary Design Review is to assess whether the design has progressed far enough (is “mature” enough) to support the proposed technical and performance management baseline and is ready to proceed to the detailed/final design phase.

Specific questions that the committee should address are provided below:

1) Have system requirements been defined and are they complete and adequate enough to ensure acceptable system performance?

2) Is the proposed design expected to meet the functional and performance requirements, and are interfaces properly identified and defined?

3) Have appropriate options and alternatives been considered in selecting the design approach? Are there further value engineering opportunities that should be considered?

4) Is the proposed design sufficiently mature to proceed to final design?

5) Have major project risks and safety hazards been identified, characterized, and mitigated where appropriate?

6) Are the project plan and cost estimates reasonable?

The committee is asked to compile a set of comments and recommendations along the lines of enquiry stated above. Comments and recommendations should be separated into two categories, namely, those that need to be addressed prior to proceeding to final/detailed design, and those that should be addressed in due course during the final design process.

# Documents reviewed

The following documentation was considered for this preliminary design review.

Documents sent to the committee prior to the meeting:

* ESS-0012524: draft PCool Requirements and description
* ESS-0012527: draft PCS Requirements and description
* ESS-0011787: Supplementary System Requirements and Description Target Helium Fluid Systems
* ESS-0012362 rev. 2: Decision basis for the pressure in the Target Primary Cooling System

Documents presented to the committee during to the meeting:

* General Design and project information Ulf Odén
* Requirements and description Jens Harborn
* Introduction to the Target Helium Cooling system Jens Harborn
* System Optimization Studies Ulf Odén
* Project Risk and Mitigation Measures Ulf Odén
* Preliminary Safety Analysis Jens Harborn
* Project Plan and Cost Estimate Ulf Odén

# Committee Comments and Recommendations

## Summary

The Preliminary Design Review committee for the Target Helium cooling system have noted the significant effort provided by the team for this first review within the ESS Target Station project.

The quality of presentation, explanations provided by the team and open mind discussion were appreciated.

**The committee considers:**

* **The proposed design shall meet the overall requirements.**
* **Technology alternatives have been properly considered for these 2 systems.**
* **Major risks and safety hazards have been identified.**
* **The global time plan for these systems seems reasonable.**
* **No showstopper has been identified at this stage.**

The main recommendations, presented in the paragraphs below, are related to

* improvement the level of details, especially concerning the interfaces requirements.
* Safety classification system, based on a clear methodology applicable at ESS level,
* Increase some design margins (normal operating domain, maximum allowable helium leak during operation…) as this will certainly have a negligible effect n operating costs and safety

Most of the requirements are dealing with issues not covered by this review (e.g. safety classification) and shall be dealt with when they will be addressed in the next design phase.

## General assumption

For the following review, the committee has only considered the transition to the detailed design phase and is aware that further important issues will be addressed later in the design.

The committee is aware that this is the first preliminary review, coming early in the design phase and the first of its kind the Target Station project.

The committee has only considered the provided documentation for its recommendations and comments (see document list in paragraph 2) and is aware that a lot more information exists.

The committee notes that the system boundary is limited to the Cooling and Pressurization circuits in the global “helium facility”: it would have been beneficial to enclose at least the target helium purification system in this review. This partial view on Helium system, not including the target wheel and the target purification system then defined as interfaces, was certainly necessary to progress into the design of the PCool and PCS system.

To answer the first specific charge item, the following viewpoints have been adopted by the committee, to summarize its comments:

1. Safety
2. Performances
3. Costs
4. Availability & Reliability
5. Transversal requirements

The committee has synthetized (with corresponding colour code in the text):

* its comments,
* **its category 1 recommendations: means that the design team should address this recommendation prior to proceeding to final/detailed design,**
* its second category recommendations: means that the design team should address this recommendation in due course during the final design process).

## General assumption

**1) Have system requirements been defined and are they complete and adequate enough to ensure acceptable system performance?**

Although these 2 systems (namely PCool and PCS) seem quite simple, the committee considers their global scope and their requirements should be more detailed to cope with the usual detail level expected at this design stage.

A: Safety

* Although the off normal situations and the safety are not in the scope of this review, a methodology to categorize functions and classify components from a nuclear safety point of view is necessary, as soon as possible, in order to complete the requirement list and the system definition: this would include:
	+ Situations: classification of off-normal situations following categories depending on probability of occurrence and consequences (safety, operation),
	+ Functions: categorization accordingly to their potential impact in case they are not fulfilled,
	+ Equipment: safety and regulatory classification of the components,
	+ Requirements on classified equipment (fabrication, control, in-service inspection) shall be identified, at least to avoid significant redesign at a later stage,
	+ Initiator events: definition of the detection thresholds, definition and characterization of the protection and mitigation actions.

The committee recommends that safety requirements should be allocated to these systems, by and derived from the safety requirements on Target Station level, following a methodology common for all of ESS

* In order to converge on the safety classification (in the next few months), simplified studies to assess radiological impacts could be performed,

The committee recommends that a plan shall be provided to perform detailed impact analysis all along the detail design, to confirm the safety classification. This plan shall consider: input parameters, criteria, methodology of impact studies and resources to perform these studies.

The committee recommends that requirements on qualification should be completed.

The committee recommends that lifetime of replaceable components (safety classified) has to be demonstrated.

* One of the main difficulties for the Target Cooling System could be the qualification of a system code (Dymola for the ESS project) to support the safety demonstration if needed.
* The recommendations and comments for the safety classification are also relevant for the performance of the systems

B: Performances

* the performances requirements are identified, specified at some point, for nominal conditions, providing the interfaces issues are clarified (see committee’s comments on that in the question 2), but shall be completed anyway, by:
	+ the “Normal conditions” domain, around the nominal values already provided, should be specified: it could also allow to make the design more robust against interfaces changes (e.g. design pressure at 20 bar for the pipes and tanks)
	+ the parameters of transitions between operating modes are not specified (e.g. time for transient and transitions between modes, times for maintenance and operations etc…). This shall be aligned (or derived from):
		- Target Station requirements (top down approach),
		- interfaces requirements

The committee recommends that the level of required performances shall be detailed at the end of the “PDR phase”, to include extended normal condition domains and detailed normal transitions between operating modes.

C: Costs

Operating costs (objectives, limits…) shall be clarified:

* Design choices could have a large impact on side costs during operation and maintenance (e.g. changing filters is not only a question of filter costs…),
* A plan to reduce operation costs should be considered at this stage.

The committee recommends that operating costs objectives shall be allocated to these systems.

D: Availability & Reliability

* The only specified requirement on availability and reliability concerns the Target Station.

The committee recommends that availability and reliability objectives should be allocated to these systems, by and derived from the Target Station requirement.

The committee recommends that, from that allocation, redundancy and class of reliability at component level could be derived and reliability objectives checked.

The committee recommends that PED regulations shall also be considered for assessing availability of the system (cf. also “classification”).

E: Transversal requirements

The following requirements, not specifically related to one of the 4 categories listed above, are considered as priority by the committee.

*Impurities in the He flow*

* the acceptable ranges of impurities in the He (O2 and H2O specifically) shall be specified:
	+ this concerns the interfaces requirements with the target and the target helium purification system,
	+ this also directly concerns the PCool and PCS, as the specified helium purity could have a significant impact on leak rate specification on their conditioning phase (requirements and durations).

The committee recommends that acceptable ranges of impurities in the He (O2 and H2O values specifically) shall be specified before the end of the PDR.

*Helium leak rate*

* The objective of helium leak rate (0.7%/day) is ambitious.
* The expected rate of leak is from 3 to 5 volumes a year for small He loops up to 10 volumes a year for larger facilities (up o to 4 % a day for ESS[[1]](#footnote-1)).
* Concerning the nuclear safety aspects of this leak rate, it seems that the He leakage impact is very weak on the ESS General Safety Objectives (contribution of about 0.1% of the 50 µSv annual limit dose).

The committee recommends to take some additional margin with the value of maximal helium rate, considering: in one hand, the operating cost impact shall be minor compared to the construction costs for a challenging leak rate objective, on the other hand the limited sensitivity of such leak rate on safety impact.

Finally, the committee recommends the use of a centralized requirement management at an ESS level (such as DOORS or equivalent system) in order to identify and trace properly the requirements along the design and construction phase.

**2) Is the proposed design expected to meet the functional and performance requirements, and are interfaces properly identified and defined?**

Except for the leak rate requirement issues mentioned above, the committee considers the proposed design shall meet the overall requirements, providing:

* additional design adjustment will be done.
* the assumptions are correct (esp. regarding the “non [nuclear] safety classification” of these systems and the design pressure value).

Nevertheless some work is still to be done on the interface requirement definition. At a system level, the interfaces have been identified, but:

* No interfaces requirement type is listed in the current documentation (e.g. table 1 does not provide relevant information),
* As a consequence, detailed expected requirements (values, level of performances, flexibility, etc..) are not provided,
* the justification of some requirements is given and will have to be more comprehensive for a later design phase.

This puts a significant risk on the design options and shall be clarified before going to a more detailed phase of the design.

Any assumption made for the interface requirements could either impact the costs and schedule, both for these 2 Helium systems and their interfaces.

In addition, Building interfaces require early definition to cope with the ESS overall plan…seismic calculation etc…).

The committee recommends that an exhaustive list of the interface requirement types is established and to prioritize those that will have an immediate impact on the schedule of the ESS project.

**3) Have appropriate options and alternatives been considered in selecting the design approach? Are there further value engineering opportunities that should be considered?**

Technology alternatives have been properly considered for these 2 systems.

There are still some possibilities to improve the design and construction costs (keep working on that!). Increase of He pressure is good for cooling performance (as already said, providing that mechanical behaviour of the target is validated).

The committee recommends reconsidering sizing of all components (such heat exchangers, filtering concept, piping or pressurizing tanks in PCS), from the updated value of pressure and mass flow in the loop.

**4) Have major project risks and safety hazards been identified, characterized, and mitigated where appropriate?**

Major risks and safety hazards have been identified. Nevertheless:

The committee recommends that the interface management shall be more explicitly taken into account into the work plan and requires a close follow-up

* A clear definition of responsibilities between ESS and in-kind partners is missing. Even if a global definition exists at the ESS or Target Station level, this split shall be adapted to the specific issues related to these 2 circuits,

The committee recommends that a clear definition of responsibilities between ESS and in-kind partners shall be defined.

* It should be better to have a quantification of the risks associated to the compressor (design and procurement phases).

**5) Are the project plan and cost estimates reasonable?**

The global time plan for these systems seems reasonable. Anyway:

* intermediate milestones are missing and input dates for critical information to proceed to the detailed design and construction is missing, especially from the interfaces,
* the time plan for procurement and design of the compressor is not presented.

The committee recommends that critical milestones of the work plan, especially information coming the dates to freeze the interfaces requirement, are being issued.

Costs estimates seem inadequate for the in-kind institute (comparing to the duration of this project – 4 years- and to the total cost of the in-kind package). The expected number is around 25% of the procurements.

The committee recommends to review the costs estimates concerning the in kind contribution.

**6) Is the proposed design sufficiently mature to proceed to final design?**

No showstopper has been identified at this stage.

The committee recommends that the proposed actions related to category 1 recommendations have to be done before starting the detail design phase, in order to reduce the project risks.

# Agenda

Preliminary Design Review for the Target Helium Cooling System

September 4-5, 2014

ESS Office Building, Lund, Conference Room Linneasalen

Thursday Sep 4, 2014

10.00 Welcome and Committee Charge John Haines

10.15 General design and project information Ulf Odén

10.45 Introduction to the Target Helium Cooling System and
 interfaces Jens Harborn

11.15 System Requirements and Description Jens Harborn

12.15 Lunch

13.15 System Optimization Studies (Selection of pressure, flow rates, etc.) Ulf/Jens

13.45 Project Risks and Mitigation Measures Ulf Odén

14.15 Preliminary Hazards Analysis Jens Harborn

14.45 Project Plan and Cost Estimate Ulf Odén

15.15 Break

15.45 Committee Deliberations Review Committee

17.00 Adjourn

Friday Sep 5, 2014

9.00 Committee Deliberations Review committee

11.00 Closeout with Design Team All

11.30 Lunch

13.00 Adjourn

1. Considering the 200 days of ESS beam-on operation requests 250 days of operations for the Target He cooling systems (incl. tests and conditioning periods). [↑](#footnote-ref-1)