BDF-TSAC1
Response to charge

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The primary objective of the 1st BDF-TSAC is to make sure the members have a clear understanding of the design choices, specifications and history of the project. This includes the BDF/SHiP project scope, operational expectations and design of the various relevant subsystems, including the respective interfaces. This also includes aspects associated with radiation protection, remote handling and maintenance scenarios.

- The TSAC is impressed by the progress that the project team is able to present less than one year after the selection and approval of the BDF/SHiP.
- We found that the history, scientific goal, project scope, budget and operational expectations were presented in a clear context.
- The primary objective of the 1st BDF-TSAC to educate and introduce the committee members to the scientific basis and background as well as to the current design is more than fulfilled.

Additional objectives
Comment on the project’s current design and on its state of maturity relative to the objective of delivering a Technical Design Report in early 2026.

- It is recognised that a large amount of high quality design and analysis work has been performed
- He-cooled solution is appropriate and that the design is progressing well
- Still some fairly fundamental technical questions that are yet to be answered
- ‘Step back' and refocus on the core requirements (categorising them into essential, desired etc.)
- Provide prioritisation for the remaining months prior to the TDR
- The He-cooled design is not yet mature enough
- Testing this year will be essential in order to get the He-cooled TDR level ready
- The rest of this year must be “all-in” on the He-cooled design
- Prior to the TDR it is essential to have a defined decision milestone on the design to carry forward

Additional objectives
Evaluate the preliminary design of the target assembly, specifically for the two concepts being investigated in parallel.

- Water cooled target
  - The presented study demonstrates a high technical feasibility of the design
    - Manufacturing R&D on Ta cladding of TZM and W discs have been performed that demonstrates the good diffusion bonding of the paired materials with identified HIP conditions.
    - Structural and fatigue analyses shows a high survivability of the target for the 5-year design lifetime. For detailed comments see **Specific questions for the BDF-TSAC 1**
    - Experience with this concept in operation at other facilities is valuable, although it also reveals several disadvantages (e.g., decay heat and LOCA scenarios)
- Helium cooled target
  - The presented study demonstrates a reasonable technical feasibility of the design
    - Continued R&D is advised to address the technical challenges mentioned in other parts of this report to reach the design maturity level comparable to that of the water-cooled target. For detailed comments see **Specific questions for the BDF-TSAC 1**
    - Note that the level of experience will never be reached with this concept in time to influence the decision. This inherent risk must be systematically balanced against the benefits to the physics, safety, and reliability of the system.

Additional objectives
Evaluate the preliminary design of the target complex and associated subsystems, including integration, maintenance plans and handling aspects.

- The design of the target complex and associated subsystems (infrastructure) is quite mature for most support systems
  - Design of helium plant and associated systems are not as mature due to presently unresolved uncertainties
- It is not clear that the designs are based on well defined and vetted functional requirements.
  - Credible cost and schedule estimates?
  - Suggest documenting the requirements, cost and schedule projections with milestones for making design decisions
- FMEA efforts are in the early stages, therefore:
  - Current preliminary design of the needed infrastructure may not include critical features and capabilities
  - Important requirements are still evolving (e.g. for fault tolerance, instrumentation/diagnostics, etc).
  - Exacerbated by pursuing the two design options in parallel.
- Clearly, teams responsible for the safe and effective design and implementation of these systems have:
  - demonstrated a high-level of competency and experience in similar successful facilities
  - The needed tools and expertise
  - but need better defined and documented requirements, interface boundaries and interdependencies, and thorough FMEA results to tailor the facility design
- It is recommended that a baseline target and beamline design be formally adopted as soon as possible.
  - Focus should be on what is needed to make that decision and when the decision must be made by.
  - A formal decision making strategy should be employed to ensure an objective decision is made resulting in an appropriate and accepted level of risk.

Additional objectives
Address whether the proposal of a He-cooled full tungsten target is well justified.

- The TSAC agrees that there are obvious advantages with the helium-cooled tungsten target, e.g.
  - Optimized physics with higher particle yields with lower background
  - Cleaner operation conditions for the utility systems
  - Lesser radioactive inventory and residual heat.
- However, it comes with some drawbacks in terms of higher system complexity and it introduces new uncertainties that need to be addressed and understood.
- The committee deem the helium-cooled un-clad design to be a viable alternative, but recommends further focused engineering efforts, for bringing the technical solution to a comparable level with the water-cooled CDS design, before the ultimate selection is made.

Additional objectives
Identify possible limitations and critical items in the current design phase, among which production techniques, cooling system, thermal behaviour, prototyping activities and other technical challenges ahead.

- Any design will have its own constraints and critical considerations.
- To allow for replacement in case of unexpected trouble, it is advisable to categorize components based on their level of importance and proceed with the evaluation starting from the highest-priority items.

Additional objectives
Comment on whether the addition of a service cell would be appropriate and useful for both the safe and reliable operation of the target systems and to appropriately manage radioactive waste.

- The addition of a service cell would be appropriate and beneficial for ensuring the safe and reliable operation of the target systems. It will play a critical role in the size reduction of the target assembly and in the safe handling of waste materials
- While the service cell will still allow "hands-on" access, incorporating features and equipment (such as PIE) in the future may prove challenging. It is advised to prepare a detailed requirements document that outlines all planned activities for the service cell including what PIE will be performed on each target assembly
- This document should outline the necessary space and facility requirements for civil construction, ensuring that future features and equipment can be implemented efficiently