OAK RIDGE National Laboratory

August 11,2026| Oak Ridge, TN

MRA Preliminary Design Review Recap

Jim Janney

MRA Lead Engineer

U.S. DEPARTMENT of ENERGY

ORNL IS MANAGED BY UT-BATTELLE LLC
FOR THE US DEPARTMENT OF ENERGY

MRA Preliminary Design Review Recap

- Held March 26-27, 2024
- Review Committee: Drew Winder, Franz Gallmeier, Jacob Platfoot, Zvanko Lazic
- **Key Points**
  - The MRA design is ready to proceed to final design review with a clear path for success. The MRA design team has thoroughly explored the most important design aspects and developed methods ensure the MRA will meet all design requirements.
  - Beyond meeting requirements, the MRA design team has demonstrated several novel approaches that set a new state of the art for designing neutronics components for both optimum performance and manufacturability.
  - The team is commended for excellent work in tracking and maintaining requirements and interfaces as the overall target system design progresses.

Charge 1 – Have system requirements been defined, and are they complete and adequate to ensure acceptable system performance?

Charge 1	Have system requirements been defined, and are they complete and adequate to ensure acceptable system performance?	
Response	Yes, with some risks	
Rec.	As early as possible in final design, management should decide on number of beamlines (S.3-R03) update the project requirements.	Done. See S01020500-IS0023.
	Before vessel systems preliminary design review, Target Systems should ensure material radiation limits used for evaluation of component life have been adequately reviewed.	Target Systems has documented radiation limits in its Materials Handbook. The specific topic in question for this review was radiation damage limit for non-beam intercepting stainless steel components. This section was reviewed by the subject matter expert at SNS who concurred with the conclusions.
Comments	Consider evaluating hydrogen density in the tube moderator across each cylindrical section rather than an average throughout.	Done. See MRA Thermohydraulic Presentation.
	Consider specifying the beryllium material for crystalline grain size and impurity content.	Implementing now. Beryllium grain size and impurity requirements will be included in Beryllium Specification.
	For requirements where conservative values were chosen, consider adding notes on how the limit was chosen for future operational troubleshooting.	Done. See S03040000-DES10000.
	MRA Shipping Requirement 2335 – consider rewording to clarify length of operation separately from decay time (not operation of 1 year or less).	Done. See S03040000-SR0001.
	MRA requirements 2354, 2893, 2355 – consider rewording to include fabrication of components to the intent of the ASME BPVC.	Considered but not implemented. Fabrication of hydrogen vessels will meet requirements of SBMS Equivalent Protection Exhibit.

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

Charge 2	Is the proposed design expected to meet the functional and performance requirements, and are interfaces properly identified and defined?	
Response	Yes, with areas for improvement in final design	
Rec.	As early as possible in final design, update the project requirements to reflect the acceptable outage length for MRA replacement (S.3-R06 vs S.03.04-2344)	These requirements have been aligned with 1400 hours as the MRA outage length and Target Systems Requirement unchanged
Comments	Need to understand the impact of ORNL pressure system safety requirements, and how those will be addressed in design, installation, and operation of STS systems.	The hydrogen system is a high energy system. Due to their small size, the Hydrogen Vessels will be designed to the intent of the BPVC and fabricated under ORNL SBMS Equivalent Protection Exhibit. Pressure System Safety Review will be conducted within CMS project.
	Address discrepancies in guide entrance distances amongst STS documents.	Done. See S01020500-IS0023.
	The vessel system interface document is currently at Rev A.	This interface sheet is now updated to R01. It will see at least one more revision to add pipe support interface.
	The changing height of the MRA may update interfaces with the target wheel segments.	The MRA height did change and is now located 22.5 mm below the Target Segment Donut.
	Continue to develop and update interface documents as new interfaces are identified	Done. Will continue as required.
	Continue to work on pipe bracing – pipes are connected at the top at the flanges and at the bottom at the MRA. Perhaps check pipes (water cooling pipes) for vibration during operation. Long distance between anchor points on a pipe can result in vibrations, but bracing must work with future remote handling.	This work is planned in CMS WBS and will be starting shortly after this review.
	During final design, consider adding alignment/guiding features to the MRA to help installation and removal.	Done. See 0000064880 drawing and S03040000-IST00009.

Charge 3 - Have appropriate options and alternatives been considered in selecting the design approach?

Charge 3	Have appropriate options and alternatives been considered in selecting the design approach?	
Response	Yes	
Recommendations	None	
Comments	Consider retaining material samples from the manufactured MRA to use as a compositional reference for evaluation of activation products to inform final disposal path.	Considered and will be included in fabrication specifications

Charge 4 – Is the proposed design sufficiently mature to proceed to final design?

Charge 4	Is the proposed design sufficiently mature to proceed to final design?	
Response	Yes	
Recommendations	None	
Comments	The team has self-identified several areas for improvement in future analysis and design. The team is encouraged to document and track these areas to ensure they are addressed in the final design phase.	Done. See last slide of this presentation
	Beryllium tensile yield strength used (345 – 517 MPa) is high relative to Materion specifications for S-65 beryllium (207 MPa)	Updated to use minimum yield strength from SNS Beryllium Specifcation, which will also be requirement for STS Beryllium.
	Studying the impact of moderator misalignment on neutron performance with point-detector estimates may not be the best approach and likely overestimates the misalignment impact. Involving instrument optics simulations may give more and instrument specific insight.	Approach was not updated as the conservative result was still adequate for meeting neutron brightness KPP.

Charge 5 – Have major project risks and safety hazards been appropriately identified, characterized, and mitigated?

Charge 5	Have major project risks and safety hazards been appropriately identified, characterized, and mitigated?	
Response	Yes, but significant work remains for hydrogen components	
Recommendations	As early as possible, issue guidance document for seismic analysis.	Done. See S01030100-ESH10001
Comments	Risk due to delays during fabrication other than damage should be considered. Such as, limited vendor pool, unexpected fabrication challenges.	Noted. This is especially true now that MRA procurement float has been reduced to 16 days. Procurement related risks are being reviewed and updated now.
	Requirements for the hydrogen piping include various sources (ASME code, PHAR, Pressure system safety) that will require close interface between MRA and CMS scope that could become more challenging if the two systems are split between different engineers.	Noted. Both systems are still under the same lead engineer
	Consider adding a risk that delays to seismic requirements may cause a delay to design completion	Seismic requirements issued. See S01030100-ESH10001
	Consider adding a risk that delays to ASME BPVC equivalent protection guidance may cause a delay to design completion	Considered but not added. Hydrogen vessels will meet requirements of SBMS Equivalent Protection Exhibit to be operated in a high energy system.
	As-early as possible, document approach for equivalent protection to the ASME BPVC for design and fabrication of pressure vessels credited in the PHAR.	No MRA pressure vessel equivalent protection is currently credited in the HAR. Equivalency has not been documented beyond reference to SMBS Equivalent Protection Exhibit

Charge 6 – Does the project execution according to the acquisition plan and manufacturing plan seem reasonable and adequate?

Charge 6	Does the project execution according to the acquisition plan and manufacturing plan seem reasonable and adequate?	
Response	Yes	
Recommendations	None	
Comments	During final design, develop a more detailed alignment and measuring plan, in sufficient time to add features or build additional hardware as needed.	We have started developing a more detailed plan, but this plan will be integrated with general Target Systems alignment within the Monolith Installation WBS
	Consider tracking a list of deliverables to operation, such as measurements and other critical final documentation.	See S03040000-TDO10000. Critical measurements are listed for further development in Monolith Installation WBS
	Consider documenting and distributing best practices during the project to ensure information useful for future operation and support is not lost.	See S03040000-DES10000. We have tried to capture design decisions and rationale for future reference.
	As the design continues, reevaluate the planned split of work between vendors and ORNL staff, and ensure vendor competencies are addressed.	See S03040000-MFP10001. Acquisition Strategy has shifted slightly with STS managing EB welding directly.

Tasks for FDR Identified at PDR

Task	Status
Update reflector design based on final optimization and beamline layout	Complete
Update transfer line layout for new CMS location and to reduce streaming	Complete
Increase MRA shielding height	Complete
Dish reflector vessel lids	Not implemented. Requirement revised and confirmed in deflection budget.
Add seismic supports	Complete
Correct analysis inconsistencies	Complete
Piping analysis	Not complete. Will complete before PRR.
Venting analysis	Not complete. Will complete before PRR.
Waste characterization analysis	In process. Radionuclide inventory analysis complete.
Blowdown analysis	Not complete. Will complete before PRR.
Fatigue analysis	Complete
Seismic analysis	Complete. Included in MRA Structural and MRA Fastener Analyses. Being reviewed currently.

MRA Deliverable Status

Deliverable	Deliverable Title	Document Number	Status
Design Analysis Calculations			
	MRA Neutronics Performance, Energy Deposition, and Radiation Damage Analysis	S03040000-DAC10010	Review Comments Received
	MRA Thermohydraulic Analysis	S03040000-DAC10011	Review Comments Received
	MRA Hydrogen Vessel Structural Analysis	S03040000-DAC10012	Review Complete
	MRA Structural Analysis	S03040000-DAC10013	Review Comments Received
	MRA Fastener Analysis	S03040000-DAC10014	In Review
	MRA Hydrogen Static Heat Load Analysis	S03040000-DAC10015	Ready for Review
	MRA Loss of Cooling Analysis	S03040000-DAC10016	Ready for Review
	MRA Moderator Deflection and Tolerance Analysis	S03040000-DAC10017	Ready for Review
	MRA Seismic Pin Deflection Analysis	S03040000-DAC10018	Ready for Review
	MRA Removal Dose Rate Analysis	S03120100-TRT10015	In Review
	MRA Radionuclide Inventory	S03120100-TRT10026	Ready for Review
	Target Drive Room Beam On Dose Rate Analysis	S03120100-TRT10017	In Review
Drawings			
	Upper Reflector Vessel Drawings	0000062451	Ready for Review
	Lower Reflector Vessel Drawings	0000063718	Review Complete
	MRA Backbone/Integration Drawings	0000064880	Not Started
Technical Specification			
	MRA General Fabrication Specification	S03040000-FSP10000	Ready for Review
	MRA Welding Fabrication Specification	S03040000-FSP10001	Ready for Review
	MRA Weld Inspection Fabrication Specification	S03040000-FSP10002	Ready for Review
	MRA Testing Fabrication Specification	S03040000-FSP10003	Ready for Review
	MRA Pickling Fabrication Specification	S03040000-FSP10004	Ready for Review
	MRA Beryllium Specification	S03040000-TSP10000	Work In Progress

Thank You