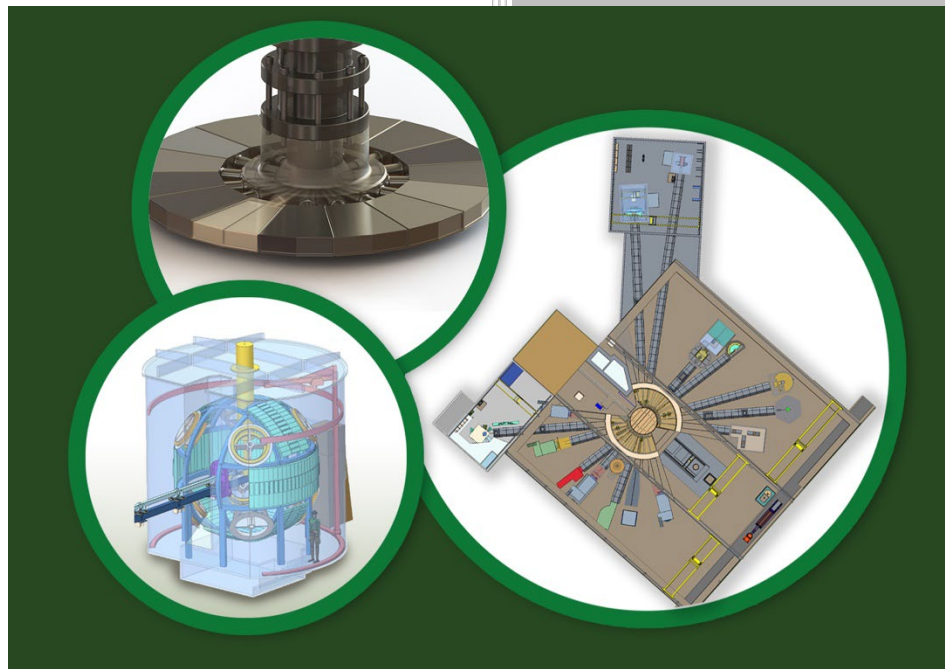


# SECOND TARGET STATION (STS) PROJECT

## System Requirements Document for Target Systems Moderator Reflector Assembly (MRA)



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**SECOND TARGET STATION (STS) PROJECT**

**SYSTEM REQUIREMENTS DOCUMENT FOR TARGET SYSTEMS MODERATOR  
REFLECTOR ASSEMBLY**

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## 1. SCOPE

This document serves to establish the requirements for the design of the Target Systems Moderator Reflector Assembly (MRA) for the Second Target Station. Subsystems within the MRA may have more detailed specific system requirements documents (SRDs). Unless explicitly stated in subsystem SRDs, the requirements of this SRD apply to all subsystems of the MRA.

## 2. METHOD

*This section left blank for update in future revision.*

### 2.1 Behavioral Analysis

#### Moderator Reflector Assembly Function

Accommodate Beam Profile received from AIC

Accommodate TVP view of Target Disk

Accommodate motion of Target Disk

Moderate Neutrons received from Target to desired energies

Maintain MRA alignment to global coordinate system

Reflect Neutrons not on instrument path back into Moderators

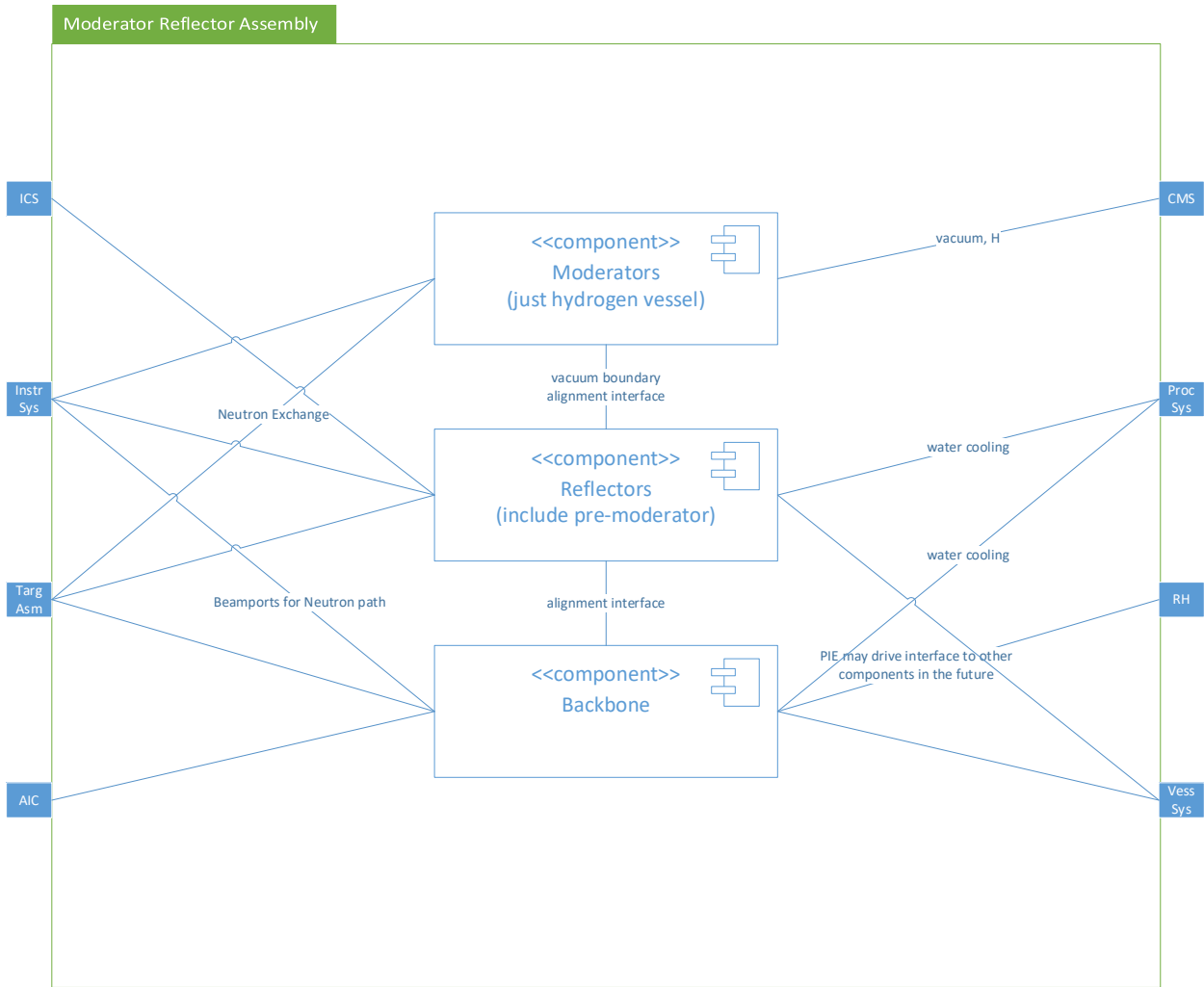
Remove heat from deposited energy

Maintain Core Vessel Environment

Allow for replacement as needed

Direct Neutrons to Instrument beamlines

## 2.2 Structural Analysis



## 3. DESIGN REQUIREMENTS

The following table is an export from the Moderator Reflector Assembly tracker on Codebeamer at the time of the Preliminary Design Review. Codebeamer is the STS project requirements tracking tool that is used to track and link requirements. The requirements with a white background are primary MRA requirements, which are decomposed from Target Systems requirements, and the requirements with a grey background are derived MRA requirements which are derived from primary MTA requirements. The Item ID is a Codebeamer ID unique to each requirement.

Summary	Description	Decomposed From	Item ID
<a href="#">MRA Proton Beam Port Size Requirement</a>	The MRA proton beam port shall be 262.8 mm wide by 80.8 mm tall or greater in order to allow for >99.9% of the nominal proton beam profile to pass through to the target.	[S.03-1028] - Accept Beam from Accelerator	<a href="#">2321</a>
<a href="#">MRA Structural Integrity Requirement</a>	The MRA shall be capable of maintaining temperature of the assembly such that structural integrity is unaffected at 700 kW beam power.	[S.03-1028] - Accept Beam from Accelerator	<a href="#">2324</a>
<a href="#">MRA Aluminum Temperature Requirement</a>	The MRA aluminum 6061-T6 structures shall have a maximum operating temperature of 100 C.	[S.03.04-2324] - MRA Structural Integrity Requirement	<a href="#">2325</a>
<a href="#">MRA Stainless Steel Temperature Requirement</a>	The MRA stainless steel structures shall have a maximum operating temperature of 200 C.	[S.03.04-2324] - MRA Structural Integrity Requirement	<a href="#">2326</a>
<a href="#">MRA Beryllium Temperature Requirement</a>	The MRA beryllium shall have a maximum operating temperature of 100 C.	[S.03.04-2324] - MRA Structural Integrity Requirement	<a href="#">2327</a>
<a href="#">MRA Water Temperature Requirement</a>	The MRA cooling water shall have a maximum temperature of 100 C.	[S.03.04-2324] - MRA Structural Integrity Requirement	<a href="#">2328</a>
<a href="#">MRA Remote Handling Requirement</a>	The MRA design shall include features to allow for remote handling and replacement	[S.03-1037] - Replacement and Disposal Path	<a href="#">2329</a>
<a href="#">MRA Ziplift Requirement</a>	The MRA shall include a Ziplift stud located over the assembly CG.	[S.03.04-2329] - MRA Remote Handling Requirement	<a href="#">2330</a>
<a href="#">MRA Pipe Cutting Requirement</a>	The MRA piping shall be designed for cutting above the upper shield block with a hydraulic shear.	[S.03.04-2329] - MRA Remote Handling Requirement	<a href="#">2331</a>
<a href="#">MRA Blowdown Requirement</a>	The MRA shall be capable of blowdown of water passages such that the subsequent water level is below the upper shield block.	[S.03.04-2329] - MRA Remote Handling Requirement	<a href="#">3588</a>
<a href="#">MRA Removal Requirement</a>	The MRA shall be capable of vertical removal from core vessel after the removal of 3 target segments.	[S.03.04-2329] - MRA Remote Handling Requirement	<a href="#">3589</a>
<a href="#">MRA Installation Requirement</a>	The MRA shall be capable of vertical installation after the removal of 3 target segments.	[S.03.04-2329] - MRA Remote Handling Requirement	<a href="#">3590</a>
<a href="#">MRA Disposal Requirement</a>	The MRA shall be capable of shipping to and disposal at a waste facility at the end of life.	[S.03-1037] - Replacement and Disposal Path	<a href="#">2332</a>
<a href="#">MRA Size Requirement</a>	The MRA shall fit within a liner designed to fit in the TN-RAM shipping cask after removal of piping above the upper shield block.	[S.03.04-2332] - MRA Disposal Requirement	<a href="#">2333</a>

<a href="#">MRA Mass Requirement</a>	The mass of the MRA shall be less than 3000 kg after removal of piping above the upper shield block and subsequent drying of water passages.	[S.03.04-2332] - MRA Disposal Requirement	<a href="#">2334</a>
<a href="#">MRA Shipping Requirement</a>	The MRA shall meet the radiological requirements for shipping in the TN-RAM cask after operation and decay time of 1 year or less.	[S.03.04-2332] - MRA Disposal Requirement	<a href="#">2335</a>
<a href="#">MRA Disposal Classification Requirement</a>	The MRA shall meet the requirements for classification as class C nuclear waste after operation and decay time of 1 year or less.	[S.03.04-2332] - MRA Disposal Requirement	<a href="#">2322</a>
<a href="#">MRA Temperature Monitoring Requirement</a>	The MRA shall include thermocouples for monitoring the temperature of the reflector vessels and backbone through the integrated control system per S01020500-IST10126.	[S.03-1042] - Accommodate timing & monitoring	<a href="#">2336</a>
<a href="#">MRA Lifetime Requirement</a>	The MRA design shall allow for a lifetime of at least 5 years of operation.	[S.03-1032] - Operational Life	<a href="#">2337</a>
<a href="#">MRA Material Lifetime Requirement</a>	The MRA materials shall allow for a lifetime of at least 5 years.	[S.03.04-2337] - MRA Lifetime Requirement	<a href="#">2338</a>
<a href="#">MRA Cyclic Loading Requirement</a>	The MRA shall be designed for a lifetime of 5 years (25000 hours of 700 kW beam power operation) or more with respect to cyclic loading.	[S.03.04-2337] - MRA Lifetime Requirement	<a href="#">2339</a>
<a href="#">MRA Availability Requirement</a>	The MRA design shall allow for greater than 95% availability for greater than 5000 hours of proton beam on target per year with accommodation for maintenance intervals in accordance with the STS operating schedule.	[S.03-1033] - Yearly Operating Hours,[S.03-1034] - Availability,[S.03-3009] - Maintenance & Lifetime Criteria	<a href="#">2344</a>
<a href="#">MRA Maintenance Requirement</a>	The MRA shall be designed to require no maintenance during its lifetime.	[S.03.04-2344] - MRA Availability Requirement	<a href="#">2345</a>
<a href="#">MRA Joining Requirement</a>	The MRA design shall use all welded construction (including friction welds and explosion bonds) on all pressure boundaries.	[S.03.04-2344] - MRA Availability Requirement	<a href="#">2346</a>
<a href="#">MRA Replacement Requirement</a>	The MRA shall be designed to be replaced in a 3 month maintenance outage.	[S.03.04-2344] - MRA Availability Requirement	<a href="#">2347</a>
<a href="#">MRA Leak Rate Requirement</a>	The MRA shall maintain leak rates less than what would cause degradation of the core vessel environment or the insulating vacuum surrounding the hydrogen boundary.	[S.03-1032] - Operational Life	<a href="#">2348</a>
<a href="#">MRA Hydrogen Transfer Line Requirement</a>	The MRA hydrogen transfer lines shall be designed and fabricated to ASME B31.12	[S.03.04-2348] - MRA Leak Rate Requirement	<a href="#">2349</a>



<a href="#">MRA Water Piping Requirement</a>	The MRA water piping shall be designed and fabricated to ASME B31.3	[S.03.04-2348] - MRA Leak Rate Requirement	<a href="#">2353</a>
<a href="#">MRA Hydrogen Vessel Requirement</a>	The MRA hydrogen vessels shall be designed to the intent of the ASME BPVC	[S.03.04-2348] - MRA Leak Rate Requirement	<a href="#">2354</a>
<a href="#">MRA Vacuum Vessel Requirement</a>	The MRA vacuum vessels shall be designed to the intent of the ASME BPVC	[S.03.04-2348] - MRA Leak Rate Requirement	<a href="#">2893</a>
<a href="#">MRA Reflector Vessel Requirement</a>	The MRA reflector vessels shall be designed to the intent of the ASME BPVC	[S.03.04-2348] - MRA Leak Rate Requirement	<a href="#">2355</a>
<a href="#">MRA Water Leak Rate Requirement</a>	All MRA water boundaries shall have a leak rate of $1 \times 10^{-6}$ mbar-l/s or less.	[S.03.04-2348] - MRA Leak Rate Requirement	<a href="#">2350</a>
<a href="#">MRA Hydrogen Leak Rate Requirement</a>	All MRA hydrogen boundaries shall have a leak rate of $1 \times 10^{-9}$ mbar-l/s or less.	[S.03.04-2348] - MRA Leak Rate Requirement	<a href="#">2351</a>
<a href="#">MRA Vacuum Leak Rate Requirement</a>	All MRA vacuum boundaries shall have a leak rate of $1 \times 10^{-9}$ mbar-l/s or less.	[S.03.04-2348] - MRA Leak Rate Requirement	<a href="#">2352</a>
<a href="#">MRA-CMS Interface Requirements</a>	Requirements derived from the MRA-CMS Interface Sheet, S01020500-IST10148	[S.03-1029] - Peak Brightness,[S.03-1035] - Safe Operation	<a href="#">2320</a>
<a href="#">MRA Hydrogen Loop Pressure Drop Requirement</a>	The MRA hydrogen loop pressure drop shall be less than 0.1 bar @ 0.5 l/s and 20 K.	[S.03.04-2320] - MRA-CMS Interface Requirements	<a href="#">2356</a>
<a href="#">MRA Hydrogen Boundary Pressure Requirement</a>	The MRA hydrogen boundary MAWP shall be 19 bara.	[S.03.04-2320] - MRA-CMS Interface Requirements	<a href="#">2357</a>
<a href="#">MRA Vacuum Boundary Pressure Requirement</a>	The MRA vacuum boundary MAWP shall be 2 bara.	[S.03.04-2320] - MRA-CMS Interface Requirements	<a href="#">2358</a>
<a href="#">MRA Vacuum Space Requirement</a>	The MRA vacuum space shall be designed for vacuum service.	[S.03.04-2320] - MRA-CMS Interface Requirements	<a href="#">2359</a>
<a href="#">MRA Vacuum Venting Requirement</a>	The MRA vacuum space shall be designed to support venting of hydrogen leaks without exceeding the MAWP.	[S.03.04-2320] - MRA-CMS Interface Requirements	<a href="#">3591</a>
<a href="#">MRA Hydrogen Venting Requirement</a>	The MRA hydrogen lines shall be designed to support venting of hydrogen after loss of transfer line vacuum without exceeding the MAWP.	[S.03.04-2320] - MRA-CMS Interface Requirements	<a href="#">3592</a>

<a href="#">MRA-Process Systems Interface Requirements</a>	Requirements derived from the MRA-Process Systems Interface Sheet, S01020500-IST10186	[S.03-1028] - Accept Beam from Accelerator	<a href="#">2360</a>
<a href="#">MRA Water Boundary Pressure Requirement</a>	The MRA water boundaries shall have a MAWP of 5 bara.	[S.03.04-2360] - MRA-Process Systems Interface Requirements	<a href="#">2361</a>
<a href="#">MRA Upper Premoderator Pressure Drop Requirement</a>	The MRA upper premoderator water loop shall have a pressure drop of less than 15 psi at 7.5 gpm and 35 C inlet temperature	[S.03.04-2360] - MRA-Process Systems Interface Requirements	<a href="#">2362</a>
<a href="#">MRA Lower Premoderator Pressure Drop Requirement</a>	The MRA lower premoderator water loop shall have a pressure drop of less than 15 psi at 7.5 gpm and 35 C inlet temperature	[S.03.04-2360] - MRA-Process Systems Interface Requirements	<a href="#">2363</a>
<a href="#">MRA Upper Reflector Pressure Drop Requirement</a>	The MRA upper reflector water loop shall have a pressure drop of less than 15 psi at 7.5 gpm and 35 C inlet temperature	[S.03.04-2360] - MRA-Process Systems Interface Requirements	<a href="#">2364</a>
<a href="#">MRA Lower Reflector Pressure Drop Requirement</a>	The MRA lower reflector water loop shall have a pressure drop of less than 15 psi at 7.5 gpm and 35 C inlet temperature	[S.03.04-2360] - MRA-Process Systems Interface Requirements	<a href="#">2365</a>
<a href="#">MRA Backbone Pressure Drop Requirement</a>	The MRA backbone water loop shall have a pressure drop of less than 15 psi at 15 gpm and 35 C inlet temperature	[S.03.04-2360] - MRA-Process Systems Interface Requirements	<a href="#">2366</a>
<a href="#">MRA-TVP Interface Requirements</a>	Requirements derived from the MRA-TVP Interface	[S.03-1041] - Measure beam profile & position	<a href="#">2371</a>
<a href="#">MRA TVP Slot Requirement</a>	The MRA shall provide a clear path through the MRA for the optical path shown in S03050230_L-M8U-8800-A001-SKEL.PRT.	[S.03.04-2371] - MRA-TVP Interface Requirements	<a href="#">2372</a>
<a href="#">MRA-Target Assembly-Core Vessel Interface Requirements</a>	Requirements derived from the MRA-Target Assembly-Core Vessel Interface Sheet, S01020500-IST10205	[S.03-1035] - Safe Operation,[S.03-1034] - Availability	<a href="#">2373</a>
<a href="#">MRA Boundary Requirement</a>	The MRA nominal boundary shall match the boundary defined in the MRA-Target Assembly-Core Vessel Interface Sheet	[S.03.04-2373] - MRA-Target Assembly-Core Vessel Requirements	<a href="#">2374</a>
<a href="#">MRA Profile Tolerance Requirement</a>	The MRA shall have an overall profile tolerance of +/- 1mm to the ideal boundary after installation.	[S.03.04-2373] - MRA-Target Assembly-Core Vessel Requirements	<a href="#">2995</a>
<a href="#">MRA Deflections Requirement</a>	The MRA outside surfaces shall not deflect more than +/- 1mm from their installed locations under any expected loading conditions.	[S.03.04-2373] - MRA-Target Assembly-Core Vessel Requirements	<a href="#">2994</a>

<a href="#">MRA-Instrument Systems Interface Sheet</a>	Requirements derived from the MRA-Instrument Systems Interface Sheet, S01020500-IS0023.	[S.03-1029] - Peak Brightness,[S.03-1030] - Number of Beamlines,[S.03-1031] - Consider Background Effects	<a href="#">2885</a>
<a href="#">MRA Neutron Beam Requirement</a>	The MRA shall deliver 18 neutron beams with the characteristics and locations described in S01020500-IS0023. The peak brightness of all neutron beams shall be greater than $2 \times 10^{14} \text{ n/cm}^2/\text{sr}/\text{\AA}/\text{s}$ at the neutron wavelength 5Å.	[S.03.04-2885] - MRA-Instrument Systems Interface Sheet	<a href="#">2887</a>
<a href="#">MRA Moderator Hydrogen Density Requirement</a>	The hydrogen in both moderators shall have a minimum average density of 72.0 kg/m <sup>3</sup> .	[S.03.04-2887] - MRA Neutron Beam Requirement	<a href="#">2888</a>
<a href="#">MRA Moderator Hydrogen Maximum Temperature Requirement</a>	The hydrogen temperature shall at no point in the moderators exceed 32 K.	[S.03.04-2887] - MRA Neutron Beam Requirement	<a href="#">2889</a>
<a href="#">MRA Moderator Alignment Requirement</a>	The MRA shall position the moderator viewed faces within +/- 1 mm of their ideal locations during installation.	[S.03.04-2887] - MRA Neutron Beam Requirement	<a href="#">2323</a>
<a href="#">MRA Moderator Operational Displacement Requirement</a>	The MRA moderators shall have a displacement of 0.3 mm or less relative to the MRA mounting points from installation to 700 kW operation.	[S.03.04-2887] - MRA Neutron Beam Requirement	<a href="#">2892</a>
<a href="#">MRA Seismic Requirement</a>	The MRA shall be capable of withstanding the loads outlined in ASCE 7 within the limits defined by the ASME BPVC, ASME B31.12, and ASME B31.3	[S.03-1035] - Safe Operation	<a href="#">2894</a>
<a href="#">MRA Shielding Requirement</a>	The MRA shielding and pipe routing design shall not impact radiation transport through the vessel systems shield stack to an extent which would require additional shielding in the target drive room roof.	[S.03-1036] - Radiation Safety	<a href="#">3593</a>