



SECOND  
TARGET  
STATION

# Vessel Systems and Target Station Shielding Path to Final Design Completion

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U.S. DEPARTMENT OF  
**ENERGY**

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# Current Status of Verification Plan Steps – Not Tested or Failed

Requirement	Item ID	Description	Preliminary Design Review	Final Design Review	Factory Acceptance Test	Installation Test	Integrated System Test
<a href="#">Core Vessel Pressure Relief</a>	<a href="#">7047</a>	The Core Vessel shall maintain an internal pressure of less than +7.35 PSIG  Note: A pressure relief system with burst disc shall be designed to ensure that +7.35 PSIG is not exceeded Note: Pressure limit determined by Proton Beam Window per Interface Sheet S01020500~IST10217		7413			
<a href="#">Vacuum Port</a>	<a href="#">7049</a>	The Core Vessel shall have a vacuum port that connects to a vacuum system  "Note: Vacuum nozzle size may be determined in collaboration with other systems to accommodate maintenance ventilation and connection to a Hydrogen~safe release stack."	7416	7416			
<a href="#">Target Temperature Limit during Facility Fire</a>	<a href="#">7054</a>	Core Vessel shielding shall keep target temperature below 800C under reasonable fire conditions		7419			
<a href="#">Impact Damage Protection</a>	<a href="#">7055</a>	The Monolith steel shielding shall protect the Target feet and Moderator Reflector Assembly from physical impact damage when the Target System is installed and in operational configuration.  Note: Monolith steel shielding does not protect Moderator Reflector Assembly or target feet that have been removed from their home positions within the monolith. Note: Monolith steel shielding provides less protection when removable shielding is not in place during maintenance activities.		7420			
<a href="#">Protect Cryogenic Transfer Lines</a>	<a href="#">7056</a>	Vessel Systems shall not permit the Core Vessel or shielding within the Core Vessel to cause the Moderator Reflector Assembly or cryogenic transfer lines to release Hydrogen under SDC2 seismic conditions	7510	7510			
<a href="#">Core Vessel Negative Pressure With Hatches Removed</a>	<a href="#">7059</a>	Core Vessel shall have an exhaust port that provides negative pressure when Core Vessel lid hatches are removed.	7513	7513			
<a href="#">Temperature Monitoring</a>	<a href="#">7065</a>	All vessel systems water cooled components should have thermocouples that monitor component temperature	7517	7517			
<a href="#">Mechanical Load Support</a>	<a href="#">7118</a>	Vessel Systems shall support the gravitational~, imbalance~, seismic and segment replacement loads imparted by the target assembly per Interface Sheet S01020500~IST10209 within the deflection limits specified in drawing S03000000~M8U~-8800~-A10001 at the physical locations specified in drawing S03020000~M8U~-8800~-A10000	7606	7606			
<a href="#">Limiting Ring Mechanical Support</a>	<a href="#">7120</a>	Vessel Systems shall not allow horizontal motion of the portion of the target shaft that contacts the limiting ring in excess of xxxx under a 40 kN seismic side load imparted on the limiting ring by the target shaft.  Note: Currently missing from Interface Sheet S01020500~IST10209~, will be added during next revision	7608	7608			
<a href="#">Target Shaft Bottom Support</a>	<a href="#">7127</a>	Vessel Systems shall allow for the full 16~,000 kg mass of the target assembly to rest on the bottom Core Vessel shield block without contacting the Moderator Reflector Assembly per Interface Sheet S01020500~IST10209	7735	7735			
<a href="#">Hydrogen Transfer Line Nozzle</a>	<a href="#">7136</a>	Vessel Systems shall provide a nozzle in the side wall of the CV for the hydrogen transfer line per interface sheet S03000000~IST10010.	7737	7737			
<a href="#">MRA Cooling Water Line Tie-Downs</a>	<a href="#">7138</a>	Vessel Systems will provide mounting features to accommodate Moderator Reflector Assembly water line tie~downs per Interface Sheet S03000000~IST10009	7739	7739			
<a href="#">Target Viewing Periscope Support</a>	<a href="#">7145</a>	Vessel Systems shall support the loads imparted by the Target Viewing Periscope assembly while maintaining the alignment tolerances specified in Interface Sheet S01020500~IST10217	7751	7751			

# Current Status of Verification Plan Steps – Not Tested or Failed

<a href="#">Target Water Line Support</a>	<a href="#">7159</a>	Vessel Systems will support target water line support assemblies on top of the Core Vessel lid per Interface Sheet S03000000~IST10004.	7760	7760			
<a href="#">Monolith Insert Interfacing Component Tolerances</a>	<a href="#">7166</a>	Vessel Systems shall maintain dimensional tolerances of monolith insert interfacing components (nozzle extensions~, Core Vessel beltline and Core Vessel internal shielding) per Interface Sheet S01020500~IST10025	7821	7821		7855	
<a href="#">Monolith Insert Support</a>	<a href="#">7168</a>	Vessel Systems shall mechanically support the monolith inserts while maintaining the tolerances described in Interface Sheet S01020500~IST10025	7823	7823			
<a href="#">Monolith Insert Installation Support</a>	<a href="#">7169</a>	Vessel Systems shall support the Monolith Inserts during the installation process without plastic deformation per Interface Sheet S01020500~IST10025	7824	7824			
<a href="#">Monolith Insert Over Pressurization Protection</a>	<a href="#">7172</a>	Vessel Systems shall ensure that the monolith inserts are not subjected to a positive pressure greater than XXXXX per Interface Sheet S01020500~IST10025  Note: This is not currently captured in the interface sheet~, but I suggested to Pete that he add it.	7827	7827			
<a href="#">Vessel Systems Temperature Monitoring</a>	<a href="#">7178</a>	Vessel Systems should include devices for monitoring the temperature of all cooled shield blocks as well as the cooled Core Vessel beltline per Interface Sheet S01020500~IST10128	7828	7828		7829	
<a href="#">Thermocouple Wiring</a>	<a href="#">7179</a>	Vessel Systems shall provide pin~-out IDs for all temperature monitoring device connections to the hermetic feedthroughs per Interface Sheet S01020500~IST10128	7830	7830			
<a href="#">Carbon Steel Temperature Limit</a>	<a href="#">7182</a>	Vessel Systems nickel plated carbon steel structures should have a maximum operating temperature of 200 C		7231			
<a href="#">MRA Support</a>	<a href="#">7405</a>	Vessel Systems shall support the loads imparted by the Moderator Reflector Assembly while maintaining the alignment tolerances specified in Interface Sheet S03000000~IST10009	7743	7743			
<a href="#">Position and gaps</a>	<a href="#">7407</a>	Vessel Systems shall ensure that all hardware adjacent to the Target and Moderator Reflector Assembly conforms to the positions and gaps outlined in Interface Sheet S01020500~IST10205	7744	7744		7745	
<a href="#">Positional deviations</a>	<a href="#">7408</a>	Vessel Systems shall ensure that all hardware adjacent to the Target and Moderator Reflector Assembly does not deviate beyond the Vessel Systems tolerance allotment per Interface Sheet S01020500~IST10205  Note: Anticipated deviations include manufacturing~, alignment~, seismic~, thermal and pressure induced.		7842			
<a href="#">Positional Deviations</a>	<a href="#">7686</a>	Vessel Systems shall ensure that all hardware adjacent to the Target Viewing Periscope does not deviate beyond the Vessel Systems tolerance allotment per Interface Sheet S01020500~IST10217  Note: Anticipated deviations include manufacturing~, alignment~, seismic~, thermal and pressure induced. Note: Currently missing from Interface Sheet S01020500~IST10217~, will be added during next revision.	7841	7841			
<a href="#">Hydrogen Transfer Line Clearance</a>	<a href="#">8048</a>	Vessel Systems shall provide 25mm of clearance between Vessel Systems hardware and the transfer line per interface sheet S03000000~IST10010.	8062	8062			
<a href="#">Hydrogen Transfer Line Support</a>	<a href="#">8049</a>	Vessel Systems shall provide features in the top of the core vessel shielding stack to accommodate hydrogen transfer line supports designed and provided by CMS per Interface Sheet S03000000~IST10010.	8063	8063			
<a href="#">Hydrogen Transfer Line Welding Access</a>	<a href="#">8050</a>	Vessel Systems shall provide appropriate welding access to the hydrogen transfer lines during MRA installation via removable hatches in the CV lid and removable shielding above the transfer lines per Interface Sheet S03000000~IST10010.	8064	8064			8133

# Current Status of Verification Plan Steps – Not Tested or Failed

Requirement	Item ID	Description	Preliminary Design Review	Final Design Review
<a href="#">Instrumentation Wire Pipe Chase</a>	<a href="#">7411</a>	Target Station Shielding shall provide a pipe chase through the bulk shielding for instrumentation wiring per Interface Sheet S01020500~IST10220	7679	7679
<a href="#">Pipe Pan Side Wall Penetrations</a>	<a href="#">7410</a>	Target Station Shielding shall provide penetrations in the pipe pan side wall for instrumentation wiring per Interface Sheet S01020500~IST10220	7678	7678
<a href="#">Target Water Line Support</a>	<a href="#">7223</a>	Target Station Shielding shall support target water line support assemblies per Interface Sheet S03000000~IST10005	7668	7668
<a href="#">Utility Pipe Clearance</a>	<a href="#">7221</a>	Target Station Shielding shall allow for utility pipes to pass through the pipe pan covers into the target drive room per Interface Sheet S03000000~IST10005	7666	7666
<a href="#">Pipe Pan Pipe Supports</a>	<a href="#">7219</a>	Target Station Shielding shall provide features within the pipe pan for mounting of pipe supports designed and provided by Process Systems per Interface Sheet S03000000~IST10005	7664	7664
<a href="#">AIC Support</a>	<a href="#">7207</a>	Target Station Shielding shall align and support the baseplate that the Proton Beam Window~, Proton Beam Window Shielding and Proton Beam Tube Assembly remote clamp are mounted to. Gravitational and seismic loads will be supported while maintaining the alignment tolerances specified in Interface Sheet S01020500~IST10217.	7653	7653
<a href="#">Transfer Line Support Features</a>	<a href="#">7204</a>	Target Station Shielding shall provide features in the pipe pan for mounting of transfer line supports per Interface Sheet S03000000~IST10011.	7652	7652
<a href="#">Pipe Pan Drain</a>	<a href="#">6980</a>	Pipe Pans shall capture water leaks in the Target Drive Room and drain to a connected leak collection system.  \\  "PHAR References:"  "CMS1~4~, CMS2~5~, LCS1~1~, LCS2~1~, LCS3~1~, LCS3~2~, LCS3~3~, LCS4~1~, VS3~1"	7649	7649
<a href="#">Impact Damage Protection</a>	<a href="#">6978</a>	The Monolith steel shielding shall protect the Target Feet and Moderator Reflector Assembly from physical impact damage when installed and in the operational configuration.  \\  Note: Target Station Shielding does not protect Moderator Reflector Assembly or Target feet that have been removed from their home positions within the monolith.  Note: Target station shielding provides less protection when removable shielding is not in place during maintenance activities.  \\  "PHAR References:"  "%%(color:rgb(226, 80, 65);)BG6~-9 (Credited)%!~, BG6~-10~, BG7~-4~, CMS2~-5"	7647	7647
<a href="#">Target Temperature Limit During Facility Fire</a>	<a href="#">6977</a>	Monolith shielding shall assist in keeping target temperature below 800C under reasonable fire conditions.  \\  "PHAR References:"  "BG1~-1~, %%(color:rgb(226, 80, 65);)BG6~-9 (Credited)%!~, BG7~-1A~, BG7~-11~, CMS7~-3~, CMS7~-5"	7646	7646

# Interface and Requirements Status

## Interface Sheets:

- All interface sheets are signed off and released as Rev0 except for VS to Bunker
- Interface sheets have been developed for all Target Systems internal interfaces

## Requirements Status:

- All VS and TSS requirements have been generated and inputted into Code Beamer
- PHAR derived requirements have been fully reviewed with the ESHQ team
- Interface derived requirements have been peer reviewed within the STS project as well as by Drew Winder at SNS
- A fully linked verification plan and associated test cases have been input into Code Beamer

# Vessel Systems Configuration and Quality Level Determination

## Second Target Station Project Configuration and Quality Level Determination

Risk Type	Level 1: Serious Consequences	Level 2: Important	Level 3: Routine
<b>Functional</b>	Significant adverse impact to achieving or maintaining key facility performance and reliability goals	Important adverse impact to a major system or component, but not blocking STS from key performance goals	Potential for negligible impact to any facility system, component, or task
1 <input checked="" type="checkbox"/>			
2 <input type="checkbox"/>			
3 <input type="checkbox"/>			
Comments:			
<b>Financial</b>	Significant unintended costs above contingency or delay of project funding for more than 1 year	Some unintended cost above contingency, or delay in funding for some major activities for a year or two	Unintended costs within available contingency, or delay in funding for non-critical activities for a short period of time
1 <input checked="" type="checkbox"/>			
2 <input type="checkbox"/>			
3 <input type="checkbox"/>			
Comments:			
<b>Schedule</b>	Significant schedule delays, especially those affecting the STS critical path	Moderate schedule delays that do not impact critical path	Minor schedule delays that do not impact other schedules
1 <input checked="" type="checkbox"/>			
2 <input type="checkbox"/>			
3 <input type="checkbox"/>			
Comments:			
<b>Sponsor / Public Concern or Confidence</b>	Significant concern about loss of confidence in the project or facility by the sponsor or the public	Minor concern about reduced confidence	Little or no concern about reduced confidence
1 <input type="checkbox"/>			
2 <input checked="" type="checkbox"/>			
3 <input type="checkbox"/>			
Comments:			
<b>Personnel Resources</b>	Significant unavailability of trained and qualified personnel to perform critical activities required for project, facility, or activity completion	Personnel are available but need additional training or qualification to perform needed supportive project or facility activities	Personnel are available and only need site or facility specific training in order to perform project or facility activities
1 <input type="checkbox"/>			
2 <input type="checkbox"/>			
3 <input checked="" type="checkbox"/>			
Comments:			
<b>Material Resources</b>	Significantly limited availability of critically required materials or equipment in order to meet the project or facility technical or operational goals	Limited availability of specialized materials or equipment needed, but alternates are available with reduced capabilities	Needed materials and equipment are available from multiple suppliers
1 <input type="checkbox"/>			
2 <input type="checkbox"/>			
3 <input checked="" type="checkbox"/>			
Comments:			
<b>Supplier Availability</b>	Significant lack of capable suppliers of critically required items or services needed for project or facility completion	Limited availability of capable suppliers of required items or services needed for project or facility completion	Multiple capable suppliers of needed items or services required for project or facility completion
1 <input type="checkbox"/>			
2 <input checked="" type="checkbox"/>			
3 <input type="checkbox"/>			
Comments:			

# TSS Configuration and Quality Level Determination

## Second Target Station Project Configuration and Quality Level Determination

Risk Type	Level 1: Serious Consequences	Level 2: Important	Level 3: Routine
<b>Functional</b>	Significant adverse impact to achieving or maintaining key facility performance and reliability goals	Important adverse impact to a major system or component, but not blocking STS from key performance goals	Potential for negligible impact to any facility system, component, or task
1 <input type="checkbox"/>			
2 <input checked="" type="checkbox"/>			
3 <input type="checkbox"/>			
Comments:			
<b>Financial</b>	Significant unintended costs above contingency or delay of project funding for more than 1 year	Some unintended cost above contingency, or delay in funding for some major activities for a year or two	Unintended costs within available contingency, or delay in funding for non-critical activities for a short period of time
1 <input type="checkbox"/>			
2 <input type="checkbox"/>			
3 <input checked="" type="checkbox"/>			
Comments:			
<b>Schedule</b>	Significant schedule delays, especially those affecting the STS critical path	Moderate schedule delays that do not impact critical path	Minor schedule delays that do not impact other schedules
1 <input type="checkbox"/>			
2 <input type="checkbox"/>			
3 <input checked="" type="checkbox"/>			
Comments:			
<b>Sponsor / Public Concern or Confidence</b>	Significant concern about loss of confidence in the project or facility by the sponsor or the public	Minor concern about reduced confidence	Little or no concern about reduced confidence
1 <input type="checkbox"/>			
2 <input type="checkbox"/>			
3 <input checked="" type="checkbox"/>			
Comments:			
<b>Personnel Resources</b>	Significant unavailability of trained and qualified personnel to perform critical activities required for project, facility, or activity completion	Personnel are available but need additional training or qualification to perform needed supportive project or facility activities	Personnel are available and only need site or facility specific training in order to perform project or facility activities
1 <input type="checkbox"/>			
2 <input type="checkbox"/>			
3 <input checked="" type="checkbox"/>			
Comments:			
<b>Material Resources</b>	Significantly limited availability of critically required materials or equipment in order to meet the project or facility technical or operational goals	Limited availability of specialized materials or equipment needed, but alternates are available with reduced capabilities	Needed materials and equipment are available from multiple suppliers
1 <input type="checkbox"/>			
2 <input type="checkbox"/>			
3 <input checked="" type="checkbox"/>			
Comments:			
<b>Supplier Availability</b>	Significant lack of capable suppliers of critically required items or services needed for project or facility completion	Limited availability of capable suppliers of required items or services needed for project or facility completion	Multiple capable suppliers of needed items or services required for project or facility completion
1 <input type="checkbox"/>			
2 <input type="checkbox"/>			
3 <input checked="" type="checkbox"/>			
Comments:			

# Relevant Risk Registry Entries

Risk ID	P6 ID	Risk Description	Status	Risk Type	WBS Level	Risk Owner	Residual	Probability	Cost Impact	Schedule Impact	Scope Impact	Risk Ranking
30	TS064140	If a critical target system component (MRA, target, core vessel, etc.) is damaged late in manufacturing, shipping, installation, then repair or replacement would be required resulting in additional costs and schedule.	Active	Threat	S.03 Target Systems	Rosenblad	3	$P \leq 5\%$	(5-20) \$M	(> 6) months or impacts critical path	Negligible impact to performance	Low - 3
102	S01/PLCD	If the facility safety basis process produces requirements out of sync with the design development process, then redesign will be required resulting in increased cost and schedule	Active	Threat	S.03 Target Systems	Rosenblad	3	$20\% \leq P < 60\%$	(0.5-5) \$M	(> 6) months or impacts critical path	Moderate impact to performance, but work-around available	High - 9
122	TS064135	If Vessel Systems beltline design is not able to be manufactured as designed, then additional cost and schedule will be required.	Active	Threat	S.03 Target Systems	Strong	3	$5\% \leq P < 20\%$	(0.5-5) \$M	(> 6) months or impacts critical path	Negligible impact to performance	Medium - 6
124	TS158435	If monolith insert designs drive non-standard nozzle extension design (ST15/16), there will be increase in cost and delay in design schedule.	Active	Threat	S.03 Target Systems	Strong	2	$60\% \leq P$	(0.5-5) \$M	(0-3) months	Negligible impact to performance	High - 8
126	TS158275	If a target systems component to be accommodated in the CV changes late in CV design, then redesign will be necessary resulting in increased cost and schedule	Active	Threat	S.03 Target Systems	Strong	2	$20\% \leq P < 60\%$	(0-0.5) \$M	(3-6) months	Negligible impact to performance	Medium - 6

- Risk 30 is impossible to mitigate, and is a risk that will be carried through manufacturing
- Risk 102 is still an active threat that could negatively impact final design and procurement
- Risk 122 has largely been mitigated through the execution of a CV manufacturing study during preliminary design
- Risk 124 has already been realized, and redesign efforts to accommodate dual channel monolith inserts on beamlines 15 and 16 have been completed at a cost to both budget and schedule
- Risk 126 is difficult to mitigate and is still an active threat. A number of changes to Target Systems technical components have required design changes within VS and TSS scope. Future changes to technical components will have a negative impact on schedule during final design and cost implications during procurement



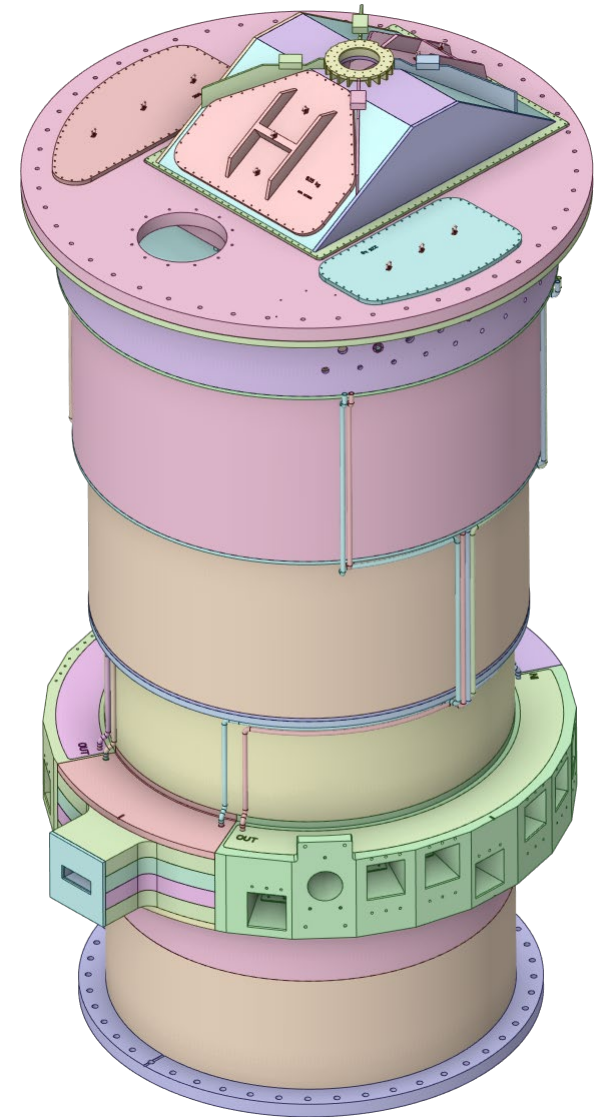
# Core Vessel Work During FDR

## Design Changes:

- Redesign east and west beltline quadrants to forged designs
  - Update thermal and mechanical analysis based on new designs
- Add alignment features to the CV skirt to align CV shielding
- Add survey and alignment fiducials
- Implement hydrogen transfer line nozzle

## Additional Analysis Required:

- Updated neutronics heating and DPA analysis
- Update thermal analysis based on new Neutronics heating data
- Update structural analysis based on new heating data
- Evaluate pressure bearing capacity of north and south beltline quadrants and revise top and bottom plenum designs if necessary
- Evaluate thermal and seismic deflections of all key interfacing surfaces



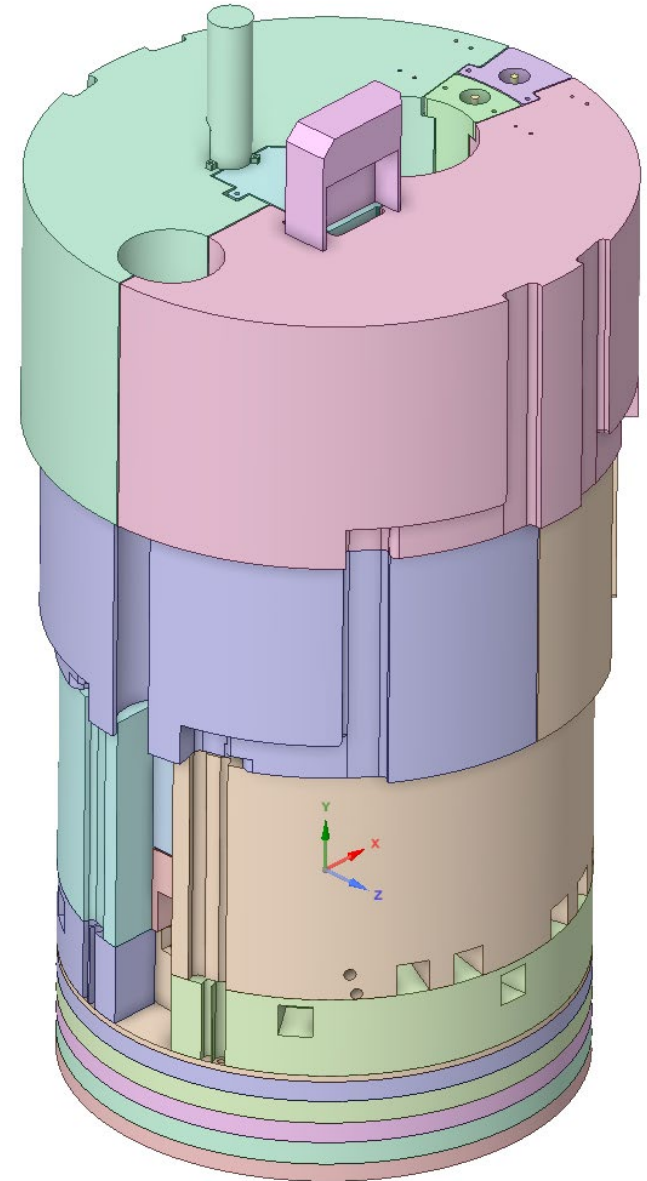
# Core Vessel Shielding Work During FDR

## Design Changes:

- Continue refining design of all three cooled shielding layers
  - Optimize design of Layer 1 to minimize thermal deflection
  - Revise layer 2 design to reduce stress and plenum deflection
  - Implement gun drilled forging design on layer 3 cooled shielding
- Fully implement seismic restraint anchor system
- Modify removable target shield block to reduce temperature
- Revise uncooled shielding as necessary to accommodate water line routing
- Implement temperature monitoring
- Add survey and alignment fiducials

## Additional Analysis Required:

- Perform steady state followed by CFD analysis of all 3 cooled shield layers
- Once designs are validated update Neutronics model with new geometry
- Obtain updated Neutronics heating and DPA data based on new designs
- Run updated thermal and structural analysis based on updated Neutronics data
  - Validate seismic restraint system via structural analysis
- Evaluate thermal and seismic deflections of all key shield surfaces



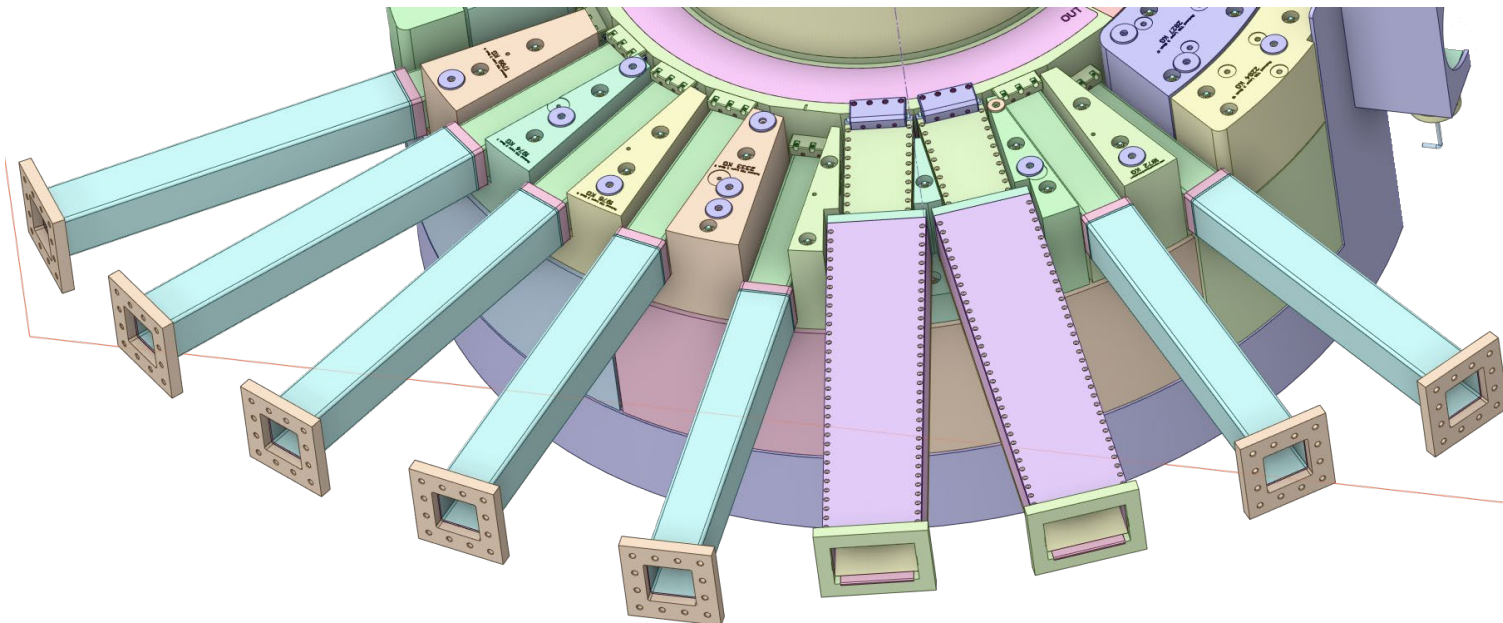
# Nozzle Extension Work During FDR

## Design Changes:

- Considering revision to the standard nozzle extension to eliminate plastic deformation results
- Add survey and alignment fiducials

## Additional Analysis Required:

- Perform structural analysis of fully featured dual channel nozzle extension to evaluate weld stresses
- Run updated standard nozzle extension structural analysis based on redesign
  - Include seismic loading in this analysis
- Perform final calculations on nozzle extension and beltline thermal deflections and the impact on monolith insert alignment



# Pressure Relief / Vent Work During FDR

## Design Changes:

- Design pressure relief system including rupture disc and piping system
  - Include piping run to vacuum system
  - Include piping run to negative air draw maintenance system
- Model piping system in Creo, incorporate into CV design

## Additional Analysis Required:

- Complete hand calculations validating CV venting design
- Complete hand calculations validating CV negative air draw



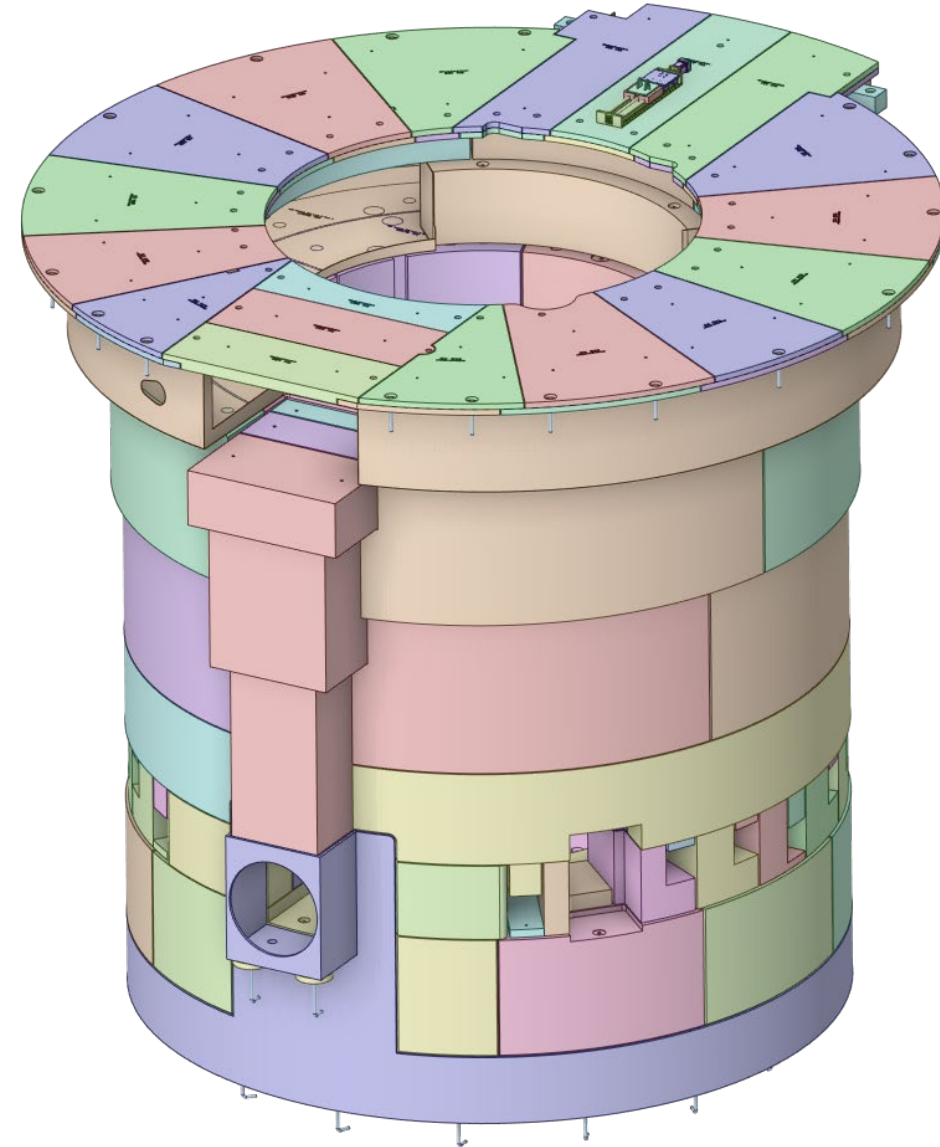
# Target Station Shielding Work During FDR

## Design Changes:

- Adjust pipe pan design to accommodate all penetrations
- Extend pipe pan through the East pipe chase and connect to drain
- Adjust pipe pan top shield plates to accommodate all utility penetrations required by Target and TVP subsystems
- Adjust the CV drain line shield clearance to match the latest Process Systems design
- Add survey and alignment fiducials

## Additional Analysis Required:

- Complete seismic calculations validating the seismic restraint system



# Thank you for your time!

