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Second Target Station Project: Moderator Reflector Assembly Seismic Block Deflection Analysis

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MODERATOR REFLECTOR ASSEMBLY SEISMIC BLOCK DEFLECTION ANALYSIS

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ABSTRACT

The Moderator Reflector Assembly seismic block is designed to prevent tipping in a seismic event while also not impacting alignment during normal operations. The hole of the seismic block must be oversized relative to the core vessel MRA seismic pin in order to prevent unwanted interaction during normal operation, as both the MRA and the core vessel structures experience relative displacements under normal operating conditions.

1. INTRODUCTION

The Moderator Reflector Assembly (MRA) is requires structural support design to restrain the MRA during a seismic event. Although the MRA would not fully tip during a seismic event due to the neighboring core vessel shielding, the nominal 10 mm of displacement to contact the shielding would impose large and potentially damaging displacements to the hydrogen transfer line. Therefore, the MRA seismic block is designed to prevent tipping of the MRA in a seismic event while also not impacting alignment during normal operations.

The alignment of the MRA is provided by 3 alignment blocks mounted to the bottom of the MRA. The MRA alignment is critical to meeting neutron performance requirements for the facility. If the seismic block were to interact with the MRA during normal operations, MRA alignment would be degraded. Therefore, the MRA seismic block hole must be precisely oversized to prevent unwanted interactions but still prevent significant displacement of the MRA during a seismic event. This simple analysis documents the combined displacements of the MRA seismic block and core vessel MRA seismic pin and sizes the MRA seismic block hole clearance.

2. DISPLACMENTS

2.1 CORE VESSEL DISPLACEMENTS

During normal operations, the core vessel MRA alignment pins and MRA seismic pin experience differential displacements driven by operational loads, most importantly thermal expansion and pressure loads. The displacements were analyzed as part of [1] and Table 2.1 summarizes the displacements of the features pertinent to MRA support.

Table 2.1 Core Vessel MRA Support Feature Displacement Under Normal Operating Conditions

	Nominal Position			Displacement			
	X (mm)	Y (mm)	Z (mm)	X (mm)	Y (mm)	Z (mm)	Total (mm)
MRA Alignment Pin 1	160.5	-405.275	0	0.077996	0.34441	-0.00029	0.35313
MRA Alignment Pin 2	-315.5	-405.275	-160.5	-0.16146	0.33554	-0.07339	0.37953
MRA Alignment Pin 3	-315.5	-405.275	160.5	-0.16236	0.33551	0.073346	0.37988
MRA Seismic Pin	-383	1240	0	-0.15501	0.74103	-0.042099	0.75824

2.2 MRA DISPLACEMENTS

The MRA also experiences relative displacement between the alignment blocks and the seismic block during normal operating conditions, mainly driven by thermal expansion. The displacements were analyzed in the MRA Structural Analysis [1], as seen in Figure 2.1. To be conservative, we will use the maximum displacement from around the seismic block hole, even though the contact surface will be towards the bottom of the hole.

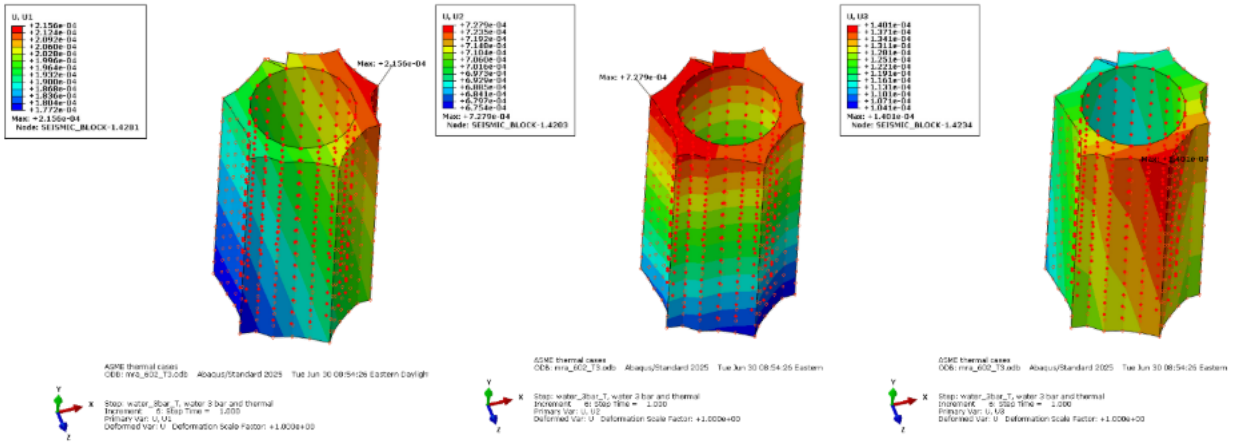

Figure 2.1 MRA Seismic Block Displacements Relative to MRA Alignment Blocks Under Normal Operating Conditions

2.3 COMBINED DISPLACEMENTS

In order to assess the combined effect of both systems displacements, a rigid MRA model will be mounted to the deformed core vessel MRA alignment pins to assess projected displacement at the seismic pin. The MRA displacements will then be linearly combined with the projected displacements. Figure 2.2 shows the projected displacement of the rigid MRA seismic block when mounted to the deformed normal operation core vessel MRA alignment pins. The MRA seismic block deflection relative to the MRA alignment blocks is then combined in Table 2.2, resulting in an XZ plane deflection of 0.37 mm. The Y direction deflection will just be reflected by ensuring sufficient engagement of the seismic pin in the seismic block.

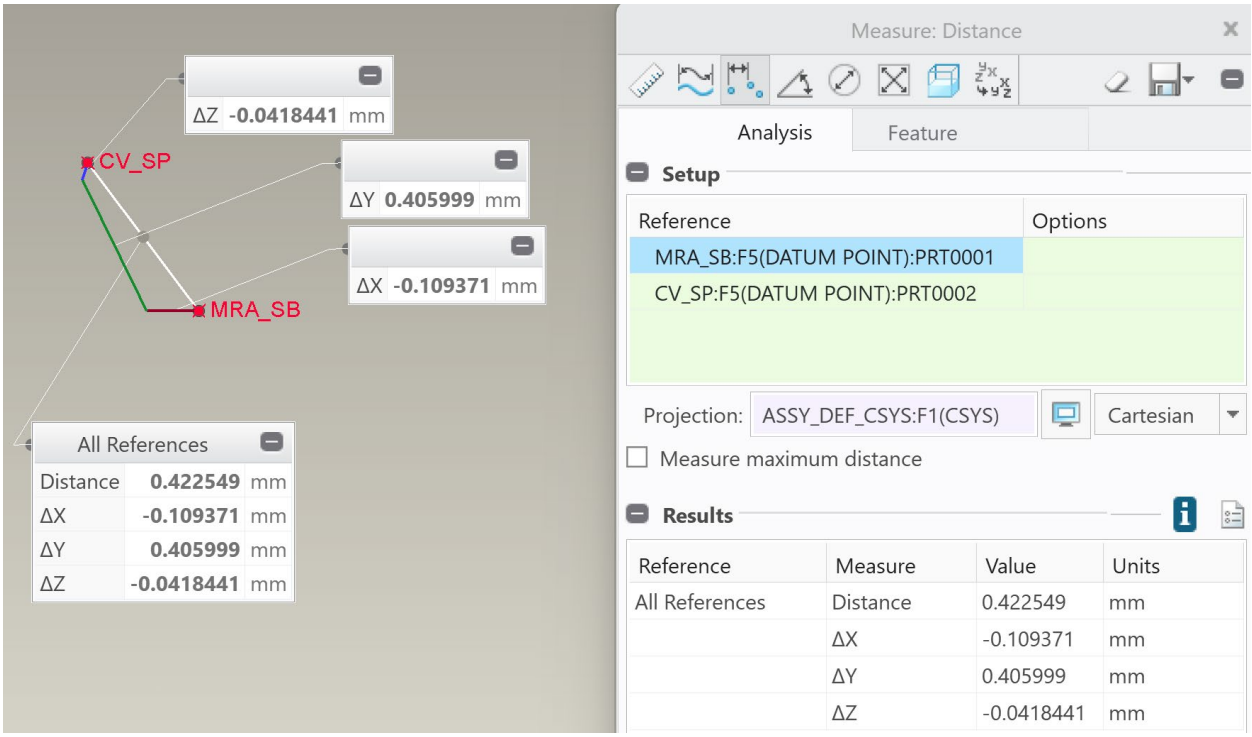

Figure 2.2 MRA Rigid Body Seismic Block Location Relative to Core Vessel MRA Seismic Pin Under Normal Operating Conditions

Table 2.2 Total MRA Seismic Block Displacement Relative to Core Vessel MRA Seismic Pin Under Normal Operating Conditions

	Displacement			
	X (mm)	Y (mm)	Z (mm)	XZ Mag (mm)
CV_SP to Rigid MRA_SB	-0.10937	0.405999	-0.04184	0.11710228
MRA_SP to Rigid MRA_SB	0.2156	0.7279	0.1401	0.25712131
Total MRA_SP to CV_SP	0.324971	0.321901	0.181944	0.37243765

3. CONCLUSIONS

The sizing of the MRA seismic block hole relative to the core vessel MRA seismic pin is critical to the intended function of the seismic support of the MRA. The relative displacement of the hole relative to the pin has been shown to be 0.37 mm under normal operating conditions. Therefore, the seismic hole should be oversized 1 mm in diameter to 22 mm compared to the 20 mm diameter pin. This oversizing provides a slight clearance during normal operating conditions. Note that during a seismic event, the core vessel MRA seismic pin will undergo additional displacement, so additional analysis will be required to establish the maximum displacement of the MRA during a seismic event.

4. REFERENCES

[1] "Structural Analysis of the Moderator Reflector Assembly," S03040000-DAC10013, 2026.
[2] "Core Vessel and Core Vessel Shielding Structural Analysis," S03060000-DAC10011.