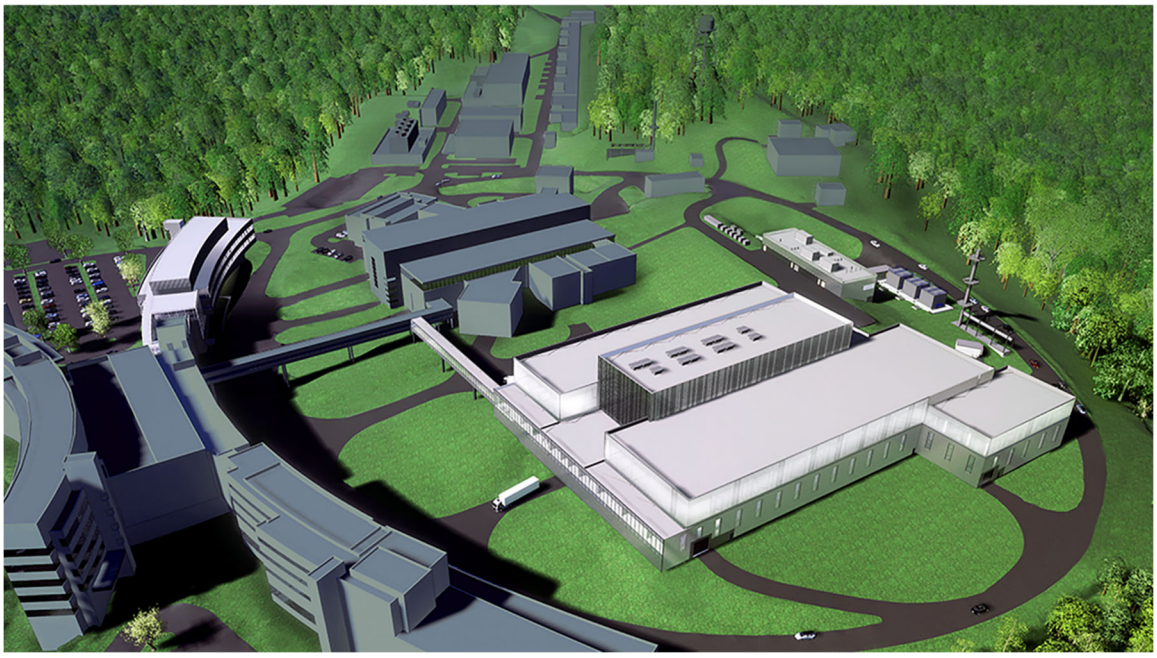
Second Target Station (STS) Target Assembly Requirements



S03020000-SR0001

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Second Target Station Project

S03020000-SR0001

SECOND TARGET STATION (STS) TARGET ASSEMBLY REQUIREMENTS

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1. STAKEHOLDER REQUIREMENTS

The requirements presented in this section represent the desires and constraints of the various stakeholders of the Target Assembly, including many of the multiple disciplines outside of the Target Assembly WBS element. The stakeholder requirements are imprecise and need further derivation to guide the engineering design of the Target Assembly meaningfully. Further derivation of the stakeholder requirements occurs in the decomposition sections to elucidate the problem to a point where an acceptable solution can be clearly identified and measured.

1.1 S.03.02-1499 Failure Indication

Components with lifetimes less than the facility should be monitored to provide an indication of needing replacement prior to failure.

Note: This is a goal, not a requirement that improves the overall reliability of the components and systems. Many components provide some early indication of impending failure prior to a loss of function. Operations desires that where possible, diagnostics and instrumentation s incorporated into the design to detect problems prior to failure. Ideally, the detection would be early enough for operations to recognize and plan maintenance at the next planned outage. Operations wants to avoid unplanned outages for failures that occur without warning.

Upstream References (1)

S.03.02-3198 Maintenance and Lifetime Criteria

1.2 S.03.02-1452 Availability Goal

The target assembly should have a high level of availability. (95% or better)

Reference Note: This objective is designed to capture the intent of the Target System's requirement Availability

Upstream References (1)

S.03-1034 Availability

1.3 S.03.02-3198 Maintenance and Lifetime Criteria

Components shall meet one of the following criteria

Reliability & Maintainability Group	Replacement Time (Beam on-off)	Minimum Lifetime*	Failure Indication
Life of Facility	N/A	40 yrs	Not anticipated
Group A (long outage, predictable failures)	1400 hours	5,000 hrs	predictable & with diagnostic warning

Group B (Long outage replacement, anticipated failures with significant consequences)	250 hrs**	2,500 hrs***	Less predictable, unreliable diagnostics
Group C (Short Outage replacement)	72 hrs	500 hrs	N/A
Group D (tuning outages)	16 hrs	192 hrs	N/A

**Note 1: Represents the technical minimum required to meet availability. Replacement at these rates would be unrealistic for most components due to costs, labor, and disposal considerations. Further margin is recommended.*

***Note 2: The replacement time for replacement without exceeding the allowed downtime is 250 hours. This criterion is much more stringent than the long outage. Therefore, the more stringent value is the requirement.*

****Note 3: The budget would be 1,250 hours, but the project desires to avoid replacement of large expensive components more frequently than once per year.*

Reference Note: This requirement is designed to satisfy IS - Target Assembly - Operations, S01020500-IST10210.

Upstream References (3)

S.03-3009	Maintenance & Lifetime Criteria
S.03-1033	Yearly Operating Hours
S.03-1034	Availability

1.4 S.03.02-1446 Minimize Contamination

Downsizing or reduction techniques (outside of the PIE cell) of activated components at ORNL shall minimize production of chips/swarf, small particulate matter, or liquid contamination.

Upstream References (1)

S.03-1036	Radiation Safety

1.5 S.03.02-1447 Operational Lifetime

The system shall be capable of use for at least 40 years.

Upstream References (1)

GRD-1013	R7 STS facility shall be designed to support a lifetime of 40 years

1.6 S.03.02-1449 Disposal Path

All items with lifetime less than the facility shall include a removal and replacement scheme and be capable of shipping to and disposal at a waste facility.

Upstream References (1)

S.03-1037	Replacement and Disposal Path

1.7 S.03.02-1454 Radiation Safety Geometry

Target Assembly geometry and materials of construction must match those referenced in the calculations used to verify requirement # 1017

NOTE: The target is partially responsible for maintaining a gap that reduces radiation streaming to the High Bay. The target has to maintain this geometry and gap; but is not fully responsible for the requirement. The overall requirement is met by careful coordination of gaps between the target, shielding in the core vessel, and shielding between the Target Drive Room and the High bay.

Upstream References (1)

S.03-1036	Radiation Safety

1.8 S.03.02-1455 Match Neutronic Model Parameters

The Target Assembly shall match the key geometry and parameters for the model documented in S030400000-DAC10010, used to verify the requirement 1029 -Peak Brightness and 1010 - Time Average Brightness.

Note: The target assembly is partly responsible for peak brightness and time averaged brightness of the facility. The target, MRA, and neutron guides develop the neutronic performance of the system. The exact details of how interaction between the target and MRA are difficult to characterize and specification adds little value to the facility. The combined neutronic analysis demonstrates the KPP for the facility and is closely coordinated between the MRA and Target Assembly. Therefore, the target requirement is to closely match the key aspects used to predict the overall system performance.

Upstream References (2)

S.03-1029	Peak Brightness
S.03-1028	Accept Beam from Accelerator

1.9 S.03.02-10947 Material radiation damage

The accumulated radiation dose (or damage) for each segment component and its constituent materials, evaluated at that component's end of life (i.e., at the planned replacement or retirement point), shall not exceed the applicable limits specified in the STS Materials Handbook (S03010300-TDO10000) or in manufacturer-published radiation tolerance data.

Note: Dose/damage limits may be expressed in different units (e.g., Gy, rad, DPA). Where DPA is used, DPA-NRT shall be applied

Upstream References (1)
S.03.02-1452 Availability Goal

2. CREDITED CONTROLS

This series of requirements satisfies the needs identified in the Hazard Analysis Report [S01030000-ESH10002]

2.1 S.03.02-1566 Hot contact

The target shall not contact Moderator components during a loss of cooling event.

Note: This event occurs without rotation

Upstream References (0)

2.2 S.03.02-1564 Max Temperature without cooling & beam off

The steady state temperature in any portion of the tungsten shall not exceed 800°C during operation or without cooling. (initiated immediately upon loss of beam)

Upstream References (0)

2.3 S.03.02-3727 Positive Engagement

The design shall prevent installation of the segment attachment bolt unless the foot is in the correct position.

Upstream References (0)

2.4 S.03.02-3006 Design Loads and Acceptance Criteria

The target assembly shall be designed so that limit states (structural integrity) are maintained under all load combinations (including seismic). Loads and limit states are defined by:

	ASME B&PVC, Section VIII, Div 2	ASCE 7-16	AISC 360	NASA**	Datasheet
Seismic Interactions & Deflections		X			

General Stress	X				
Buckling	X				
Cyclic Loading	X*				
Thread Pullout				X	
Bolt Failure			RCSC		
Slip Critical Joint			X		
COTS components					X

* The target foot fatigue life from beam pulses is estimated using best available material information to accurately estimate the fatigue life. Target foot leakage from fatigue involves water leakage into the core vessel, not a complete loss of structural connection.

**NASA Reference Publication #1228

Note: This specifically includes the segment attachment pin during a seismic event

Upstream References (1)

S.03-1478 Hydrogen Boundary interactions

2.5 S.03.02-2078 Water Tube Spacing

The target shall be capable of operating at temperatures less than 800°C in the presence of debris with dimensions less than or equal to the inner diameter of the inlet passage in the segment leg.

NOTE: If a large piece of debris makes it down the supply pipe in the segment leg, it cannot block the target and cause overheating to the safety case.

Upstream References (0)

2.6 S.03.02-1627 Isolation Jumper Position

There shall be a means to indicate the status of the segment isolation disconnects prior to operation. The status indication shall confirm the disconnect is fully engaged.

Upstream References (0)

2.7 S.03.02-1965 Segment Rotation Sensor

The target drive shall provide an interface for 3 or more speed sensors as described in S01020500-IST10104

Upstream References (0)

3. OPERATIONAL PERFORMANCE

Operational performance requirements are formulated to provide an acceptable level of performance.

3.1 S.03.02-3597 Start-up Time

The target assembly shall have torque and power to achieve 45 rpm within 10 minutes from rest.

Upstream References (0)

4. MRA INTERFACE REQUIREMENTS

Defines the requirements needed to interface with the Moderator Reflector Assembly (MRA).

4.1 S.03.02-10836 Permit MRA Vertical Removal

The target assembly shall provide features and capability to permit the MRA to be removed and installed vertically from the core vessel.

Note: the target assembly and the MRA are "nested" together and make removal of the MRA difficult. The target assembly is responsible for removing obstructions from the removal and installation path.

Upstream References (0)

5. CONVEYANCE INTERFACE REQUIREMENTS

Defines the requirements for the Target Assembly to interface with remote handling components. The Target Assembly scope does not include tooling, casks, or remote handling processes but does include aspects of Remote Handling, transportation, and disposal that cannot be changed in the service cell, PIE facility, or other means of processing. Such requirements are passed from disposal documents, shipping containers, casks, and service cell operations as interfaces to the Target Assembly.

5.1 S.03.02-10213 Disposal Preparation & Transportation

All perishable components shall be capable of transportation with a certified Type B container which has been approved by the DOE for consignment of radioactive material.

NOTE: The STS Project has selected the Energy Solutions 3-60B as the basis of design for target assembly/component waste disposal & transportation.

Upstream References (1)

S.03.02-1449	Disposal Path

5.2 S.03.02-1565 Blowdown Capability

Water-cooled components shall have the ability to remove bulk water (so as not to spill when tipped 30 degrees during lift) to individual segments while in the core vessel.

Reference Note: This requirement is designed to satisfy IS - Target Assembly - Remote Handling, Windchill # S01020500-IST10208.

Upstream References (2)

S.03.02-1446	Minimize Contamination
HAR-2895	Hazard Analysis

5.3 S.03.02-1490 Remote Handling Interface

Items with a mass >16kg and a radiation source term >100mrem/hr shall provide a remote-handling interface consisting of either:

- 1.5"-8UN threaded male stud with a length of 50.8 mm or
- 1.5"-8UN threaded female hole compatible with a 1.5"-8UN threaded male stud

This interface shall be located on a top-facing surface and shall have unobstructed access from above, including a minimum clear cylindrical tool envelope of diameter 140mm centered on the stud or hole axis, to allow tool engagement and disengagement.

Reference Note: This requirement is designed to satisfy lifting with a "Zip-stud" tool and to meet IS - Target Assembly - Remote Handling, Windchill # S01020500-IST10208.

Upstream References (0)

5.4 S.03.02-10953 Assembly Blow Down Level

The water level in the system shall be >3cm below any water boundary to disrupted for maintenance.

Note: The water level must be below the crown and valve assembly as well as the segment sealing interface before personnel can gain hands-on access.

Upstream References (0)

6. TARGET VIEWING PERISCOPE INTERFACE

Defines the requirements for the Target Assembly to interface with the Target Viewing Periscope.

6.1 S.03.02-1493 Coating Interface

The target assembly shall provide a surface interface for coating in accordance with IS - Target Assembly - Target Viewing Periscope, S01020500-IST10212.

Reference Note: This requirement is designed to satisfy IS - Target Assembly - Target Viewing Periscope, Windchill # S01020500-IST10212*.*

Upstream References (1)

S.03-1041	Measure beam profile & position

7. PROCESS SYSTEM INTERFACE

Defines the requirements on the Target Assembly for interfacing with the Process System.

7.1 S.03.02-1487 Max Pressure drop

The pressure drop through the target assembly shall not exceed 100 kPa for water circulating in Active Cooling Loop 1.

Reference Note: This requirement is designed to satisfy IS - Target Assembly - Target Process Systems, Windchill # S01020500-IST10211.

Upstream References (0)

7.2 S.03.02-1489 Interface Flanges

The target assembly shall provide two 4 inch Class 150# flanges in accordance with ASNI B16.47 at the locations indicated in *S01020500-IST10211.*

Reference Note: This requirement is designed to satisfy IS - Target Assembly - Target Process Systems, S01020500-IST10211.

Upstream References (0)

7.3 S.03.02-10958 MAWP - Target Assembly

The Target Assembly shall be designed for a Maximum Allowable Working Pressure of 758kPa, with relief devices for overpressure protection.

Upstream References (0)

8. CORE VESSEL INTERFACE

This section captures the requirements for the target assembly for the interface to the core vessel.

8.1 S.03.02-1695 Shaft Outline

The outer boundary shall meet the interface defined in S03000000-M8U-8800-A10001.

Upstream References (1)

S.03.02-1481	Interface Geometry

8.2 S.03.02-1480 Leak Rate

During vacuum operation, the total leakage into the Core Vessel from the Target Assembly shall not exceed 0.1 Torr-L/s.

Note: This captures the overall leak rate from ambient into the core vessel during vacuum operation. It is expected that the dominant source will be from a rotary seal, O-rings, and other leak sources. This does not cover "virtual leaks" from outgassing or surface contamination.

Upstream References (0)

8.3 S.03.02-1481 Interface Geometry

The target assembly shall mount in the locations indicated within S01020500-IST10209.

Upstream References (0)

8.4 S.03.02-1482 Imposed forces

Imposed forces on the core vessel interface shall not exceed those found in IS - Target Assembly - Core Vessel, S01020500-IST10209.

Upstream References (0)

8.5 S.03.02-10948 Water Leak rate

Target Assembly water boundaries and seals shall have a leak rate of 1 x 10 ^ -5 mbar-l/s or less.

Note: This captures the overall leak rate into the core vessel during vacuum operation.

Upstream References (0)

9. DFMEA REQUIREMENTS

Contains the requirements generated from assessing the impact of various systems that interface with the target assembly.

9.1 S.03.02-1546 Shaft Extraction

The shaft of the target assembly should be capable of removal without removing the core vessel lid and shielding.

Note: The tent structure of the lid and target segment access shield block may be removed to permit removal of the shaft. The intent is to remove the shaft without significant disassembly of the core vessel and contents. This provides shielding during target assembly removal and reduces overall downtime in the event of target assembly failure.

Upstream References (0)

9.2 S.03.02-1543 Spurious Stop Survival

The segments shall not undergo permanent deformation after a sudden stop, where a stop is defined as a deceleration from full speed using the peak torque of the motor.

Note: the acceleration of the stop is defined by the maximum torque that the motor can impose on the system

Upstream References (1)
S.03.02-1546 Shaft Extraction

10. CONTROL SYSTEM INTERFACE

Captures the interfaces agreed upon with the control system.

10.1 S.03.02-3599 Homing Position

The target assembly shall provide a sensor with connection to the control system at a repeatable and unique location in the target rotation.

Upstream References (0)

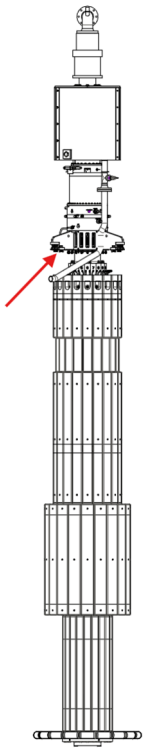
10.2 S.03.02-3598 Angular Resolution

The target assembly shall provide redundant sensors with connection to the control system with angular resolution <0.1 degree

Upstream References (0)

11. MOUNTING INTERFACE REQUIREMENTS

The following section outlines the requirements imposed on the target assembly upper mounting interface.



11.1 S.03.02-10646 Upper mounting point - Horizontal Installation tolerance

The target assembly (the axis of rotation) shall be located within +/- 1mm, of the global (master) coordinate system in the horizontal direction.

Upstream References (1)

S.03-1478	Hydrogen Boundary interactions

11.2 S.03.02-10793 Upper Mounting point - Vertical Installation tolerances

The target assembly shall be located within +/- 0.5mm, of the global (master) coordinate system in the vertical direction.

Upstream References (1)

S.03-1478	Hydrogen Boundary interactions

11.3 S.03.02-10735 Lower restraint - adjustment allowance

The lower restraint or the target assembly shall be able to withstand adjustment relative to the shield mounting points of:

Horizontal: +/- 3.5mm

Vertical: +/- 1.5mm

Upstream References (1)

S.03-1478	Hydrogen Boundary interactions

11.4 S.03.02-10699 Upper mounting point adjustment allowance

The target assembly shall permit adjustment relative to the core vessel lid of:

Horizontal: +/- 5mm

Vertical: +/-1.5mm

Upstream References (1)

S.03-1478	Hydrogen Boundary interactions

11.5 S.03.02-10698 Structural capacity during relative motion

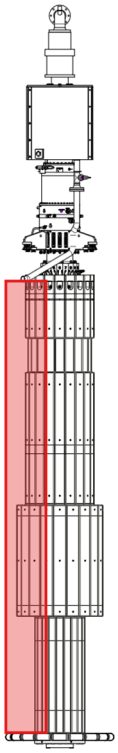
The target assembly shall be capable of maintaining structural integrity under a horizontal relative motion between base and lower extremity (snubber ring) of up to: 13mm.

Upstream References (1)

S.03-1478	Hydrogen Boundary interactions

12. MID-HEIGHT TARGET ASSEMBLY REQUIREMENS

This section outlines the requirements imposed on the target assembly above the elevation of the target foot.



12.1 S.03.02-10734 Mid-height location - Profile tolerance

The vertical surfaces of the target assembly (above the target foot) shall have a profile tolerance, when assembled, not to exceed +/-0.5mm relative to the installed axis of the shaft.

Upstream References (1)

S.03-1478	Hydrogen Boundary interactions

12.2 S.03.02-10733 Mid-Height locations - Radial deflections during normal operation

The outer profile of the target assembly (above the target) shall not deflect in the radial direction more than +/-4.5mm during normal operation and pressure testing operations

Normal operations include the worst case combinations of:

- L - Live loads (imbalance target rotation)
- P - Operational pressures (Core Vessel and component operating pressures) and pressure testing (MAWP)
- T - Operating thermal loads (beam on, cooling water)

Note 1: All deflections are measured relative to the mounting point (base) of the target assembly. (Deflection of the target assembly in isolation).

Note 2: All deflections are measured relative to the installed state of the target assembly (in the core vessel) at ambient temperature and pressures

Upstream References (1)

S.03-1478	Hydrogen Boundary interactions

12.3 S.03.02-10693 Mid-height locations - Radial deflections during seismic operation

Any portion of the target assembly shall not deflect in the radial direction more than 6.5mm during a seismic lateral force; displacement is that beyond an imposed relative displacement between mounting flange and lower extremity.

Seismic conditions include worst case combinations of:

- L - Live loads (centrifugal target rotation)
- P - Operational pressures (Core Vessel and component operating pressures)
- T - Operating thermal loads (beam on, cooling water)
- E - Seismic loads (Unfactored, per ASCE 7)

Note 1: All deflections are measured relative to the mounting point (base) of the target assembly. (Deflection of the target assembly in isolation)

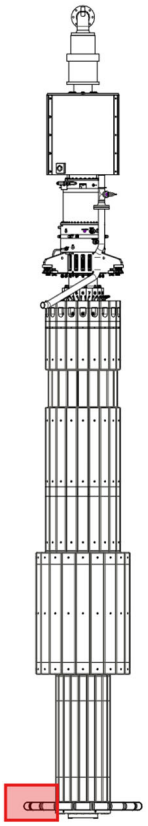
Note 2: All deflections are measured relative to the installed state of the target assembly (in the core vessel) at ambient temperature and pressures

Upstream References (1)

S.03-1478	Hydrogen Boundary interactions

13. TARGET FOOT LOCATION REQUIREMENTS

This section outlines the requirements imposed on the target assembly at the elevation of the target foot (+/- 50mm of world center)



13.1 S.03.02-10701 Foot location - Profile

The target shall have a profile within +/- 0.2mm of the nominal CAD boundary (at installation)

Upstream References (1)

S.03-1478	Hydrogen Boundary interactions

13.2 S.03.02-10732 Foot location - Radial deflections during normal operations

The outer boundary of the target assembly at the foot elevation shall deflect <0.5mm radially during the worst case combination of:

- L - Live loads (imbalance target rotation)
- P - Operational pressures (Core Vessel and component operating pressures) and pressure testing (MAWP)
- T - Operating thermal loads (beam on, cooling water)

Note 1: All deflections are measured relative to the mounting point (base) of the target assembly. (Deflection of the target assembly in isolation).

Note 2: All deflections are measured relative to the installed state of the target assembly (in the core vessel) at ambient temperature and pressures.

Upstream References (1)

S.03-1478	Hydrogen Boundary interactions

13.3 S.03.02-10702 Foot location - Vertical Deflections During Normal Operations

The outer boundary of the target assembly at the foot elevation shall not deflect in the vertical direction more than 3.25mm (down) or more than 0.25mm (up) during the worst case combination of:

- L - Live loads (imbalance target rotation)
- P - Operational pressures (Core Vessel and component operating pressures) and pressure testing (MAWP)
- T - Operating thermal loads (beam on, cooling water)

Note 1: All deflections are measured relative to the mounting point (base) of the target assembly. (Deflection of the target assembly in isolation).

Note 2: All deflections are measured relative to the installed state of the target assembly (in the core vessel) at ambient temperature and pressures.

Upstream References (1)

S.03-1478	Hydrogen Boundary interactions

13.4 S.03.02-10713 Foot location - Radial Deflections During Seismic Event

The outer boundary of the target assembly at the foot elevation shall deflect in the radial direction <0.25mm beyond any imposed displacements between mounting flange and lower extremity.

Seismic loads include worst case combinations of:

- L - Live loads (centrifugal target rotation)
- P - Operational pressures (Core Vessel and component operating pressures)
- T - Operating thermal loads (beam on, cooling water)
- E - Seismic loads (Unfactored, per ASCE 7)

NOTE 1: All deflections are measured relative to the edge of the restraint ring upon contact and remove the effects of relative motion between the restraint ring and the core vessel.

NOTE: 2 The foot motion is limited by the restraint ring; the location and gaps of the restraint limit the motion of the target shaft. The target foot is restrained at nearly the same location as the shaft and is therefore restrained from motion. The relative motion of the upper mounting flange and lower restraint

ring rely on the tolerances and deflections of the core vessel and shield blocks. The deflection herein accounts are those deflections beyond the displacements imposed by the core vessel and shielding.

Upstream References (1)
S.03-1478 Hydrogen Boundary interactions

13.5 S.03.02-10731 Foot location - Vertical Deflection during seismic event

The outer boundary of the target assembly at the foot elevation shall deflect in the vertical direction < 3.65mm (down) and <0.55mm (up) during a seismic vertical force.

Seismic conditions include the worst case combinations of:

- L - Live loads (centrifugal target rotation)
- P - Operational pressures (Core Vessel and component operating pressures)
- T - Operating thermal loads (beam on, cooling water)
- E - Seismic loads (Unfactored, per ASCE 7)

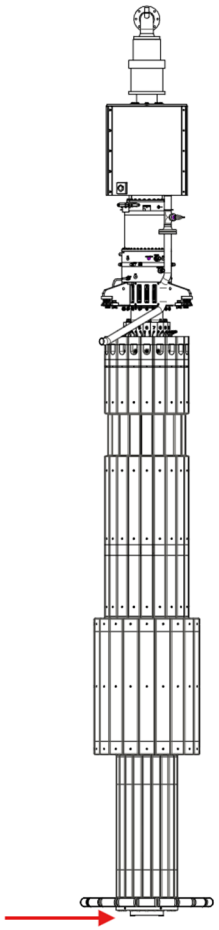
Note 1: All deflections are measured relative to the mounting point (base) of the target assembly. (Deflection of the target assembly in isolation).

Note 2: All deflections are measured relative to the installed state of the target assembly (in the core vessel) at ambient temperature and pressures.

Upstream References (1)
S.03-1478 Hydrogen Boundary interactions

14. LOWER TARGET ASSEMBLY REQUIREMENTS (SNUBBER)

This section outlines the requirements imposed on the target assembly below the target foot; areas that interact with the restraint ring.



14.1 S.03.02-10792 Snubber Nominal Gap - Horizontal

The restraint ring at the bottom of the target shall have a nominal radial gap of 6mm between rotating and static faces.

Upstream References (0)

14.2 S.03.02-10791 Snubber Nominal Gap -Vertical

The restraint ring at the bottom of the target shall have a nominal vertical gap of 8mm between rotating and static faces.

Upstream References (0)

14.3 S.03.02-10674 Profile Tolerance

The profile tolerance of the lower target extremity (snubber) shall be radially within +/-0.875mm from nominal.

Upstream References (1)

S.03-1478	Hydrogen Boundary interactions

14.4 S.03.02-10676 Radial Deflections During Normal Operation

The lower extremity (snubber) shall not deflect in the radial direction more than +/-0.5mm during the worst case combination of:

- L - Live loads (imbalance target rotation)
- P - Operational pressures (Core Vessel and component operating pressures)
- T - Operating thermal loads (beam on, cooling water)

Note 1: All deflections are measured relative to the mounting point (base) of the target assembly. (Deflection of the target assembly in isolation).

Note 2: Deflections are measured relative to the installed state of all Target Systems components at ambient temperature and pressures.

Upstream References (0)

14.5 S.03.02-10677 Vertical Deflections During Normal Operation

The lower extremity shall deflect in the vertical direction <2mm (down) and< 0.2mm (up) during the worst case combination of:

- L - Live loads (imbalance target rotation)
- P - Operational pressures (Core Vessel and component operating pressures) and pressure testing (MAWP)
- T - Operating thermal loads (beam on, cooling water)

Note 1: All deflections are measured relative to the mounting point (base) of the target assembly. (Deflection of the target assembly in isolation).

Note 2: Deflections are measured relative to the installed state of all Target Systems components at ambient temperature and pressures.

Upstream References (0)