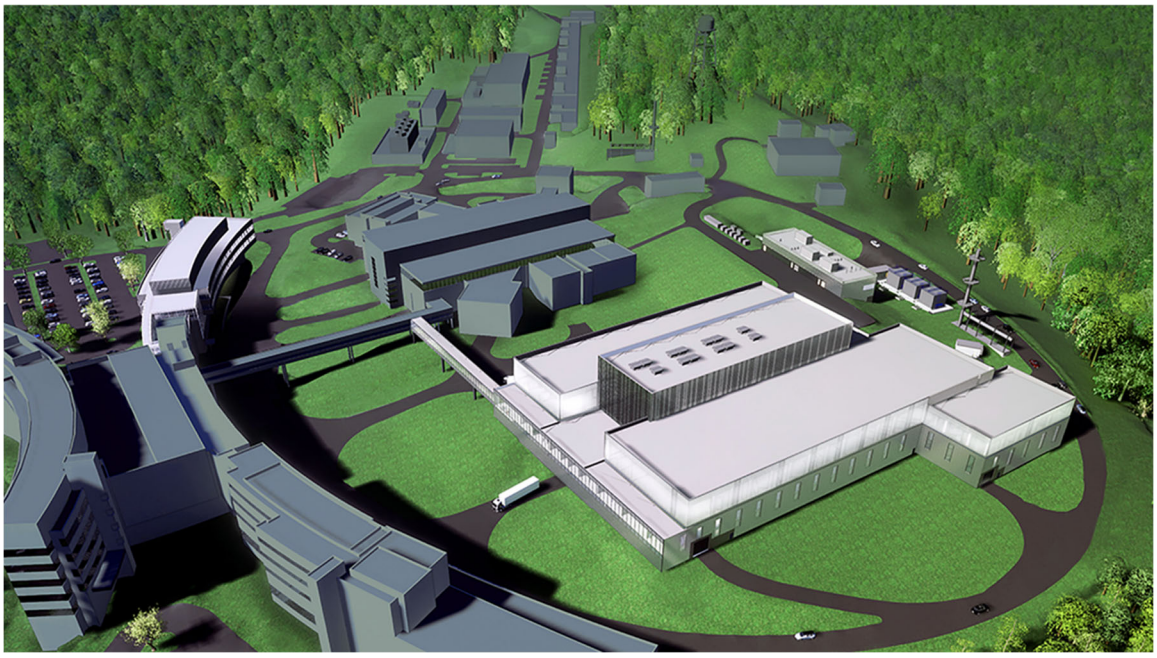
Second Target Station (STS) Target Assembly - Segment Requirements



S03020400-SRD10000

Aaron Jacques

OAK RIDGE National Laboratory

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Second Target Station Project

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SECOND TARGET STATION (STS) TARGET ASSEMBLY - SEGMENT REQUIREMENTS

Aaron Jacques

Jul 28 2026 16:56

Prepared by
OAK RIDGE NATIONAL LABORATORY
Oak Ridge, TN 37831
managed by
UT-BATTELLE LLC
for the
US DEPARTMENT OF ENERGY
under contract DE-AC05-00OR2272

1. SCOPE

The scope of the Target Segment is visually indicated below. The requirements document treats the segment as a black box. For a detailed description of the scope, please reference the Target Assembly System Design Description.

2. REQUIREMENTS DERIVED FROM CREDITED CONTROLS

The following are secondary requirements from statements credited in the Hazard Analysis.

2.1 S.03.02.03-3728 Pin Dimension

The dimension of the locating pin in the bottom of the segment shall be greater than 25mm.

Note: The locating pin of the segment shall be greater than the gap between the target shaft and the adjoining shielding. such that the segment cannot mate vertically with the shaft unless the pin is in the shaft "pocket".

Upstream References (1)

S.03.02-3727	Positive Engagement

2.2 S.03.02.03-3464 Water Tube Spacing

Water cooling tubes in the target block shall have spacing between tube centers no less than D/3 of the inlet pipe diameter.

NOTE: If a large piece of debris makes it down the supply pipe in the segment leg, it cannot block more than 3 tubes. The previous analysis document by T. McManamy "Single Target Loss of Cooling due to Flow Blockage" provides details on the acceptable nature of blocking three tubes.

Upstream References (2)

S.03.02-2078	Water Tube Spacing
HAR-2895	Hazard Analysis

2.3 S.03.02.03-3465 Hot contact

The target shall not contact Moderator components during a loss of cooling event without the beam under the following conditions:

- No flow
- Beam Off
- No rotation

Upstream References (2)

S.03.02-1566	Hot contact
HAR-2895	Hazard Analysis

2.4 S.03.02.03-3466 Max Temperature without cooling & beam off

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

Upstream References (2)

S.03.02-1564	Max Temperature without cooling & beam off
HAR-2895	Hazard Analysis

2.5 S.03.02.03-1600 Design Loads and Acceptance Criteria

The target segment (including attachment pin) 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

Upstream References (2)

S.03.02-3006	Design Loads and Acceptance Criteria
S.03.02.03-1574	Segment Lifetime

3. AVAILABILITY REQUIREMENTS

The following items are related to having a reliable machine with high availability.

3.1 S.03.02.03-3851 Seal Leak Check

The sealing surface between the segment and the drive shall have a method of leak testing.

Note: Venting and removal of the core vessel lid is permitted.

Upstream References (1)

S.03.02.02-1485	Leak Test

3.2 S.03.02.03-1501 Replaceable Gasket Interface

The sealing gasket between the segment and mount (crown) shall be capable of replacement without replacement of the segment.

Upstream References (1)

S.03.02.04-1500	Robust Interfaces

3.3 S.03.02.03-1504 Segment Replacement Time

Segment shall be capable of replacement within 240 hours

Upstream References (1)

S.03.02-3198	Maintenance and Lifetime Criteria

3.4 S.03.02.03-2301 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 (2)

S.03.02-10947	Material radiation damage
S.03.02.03-1574	Segment Lifetime

3.5 S.03.02.03-1605 Segment Spurious Stop

The segment 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.

Upstream References (1)

S.03.02-1543	Spurious Stop Survival

3.6 S.03.02.03-1574 Segment Lifetime

Segment Fatigue margin shall be equal to or greater than 1 for a 10-year operational life for all materials with the following load combinations:

Case		Beam Loads						Body Loads			Water			State	Criteria
ID	Case	Power kW	Focus[a] 10^{10}	Profile Name	Offset v/h, mm	Pulses 10^8	Trips 10^5	Grav	Rot	Accel	Temp °C	Flow gpm	Press psi	State	Criteria
A	Nominal	700	5.2	$60cm^2$	0/0	1.35	1.25	Y	Y	N	32.2	7.5	36	WOL[b]	Req 1574[c]
B	Nominal-corner	700	5.2	$60cm^2$	5.28/8.5	1.35	1.25	Y	Y	N	32.2	7.5	36	WOL[b]	Req 1574[d]
C	Nominal-low flow	700	5.2	$60cm^2$	0/0	1.35	1.25	Y	Y	N	32.2	5.24	36	WOL[b]	Req 1574[d]
D	Overfocused	714	5.5	$57cm^2$	0/0	1.35	1.25	Y	Y	N	32.2	7.5	36	WOL[b]	Req 1574[c]
E	Diffuse	700	3.57	$95cm^2$	0/0	1.35	1.25	Y	Y	N	32.2	7.5	36	WOL[b]	Req 1574[d]

[a] $10^{10} protons/pulse/mm^2$
[b] Worst of Life material conditions (irradiated elastic modulus and thermal conductivity, but not strength)
[c] Fatigue methodology (weld reduction factors, etc.) determined in accordance with ASME ASME BPVC Sec. VIII.2, Part 5; allowable stresses are determined from best-in class irradiated material limits and not ASME fatigue curves.
[d] Fatigue lifetime criteria to be evaluated; minor deviations in life are acceptable for edge, corner, and worst case conditions

Upstream References (1)

S.03.02-3198	Maintenance and Lifetime Criteria

3.7 S.03.02.03-1567 Prevent Boiling Flow

The target cooling water shall be single-phase (liquid).

Upstream References (1)

S.03.02-1493	Coating Interface

3.8 S.03.02.03-1570 Maintenance Temperatures

The surface temperature with the beam off after 10 years of operation and the following flow parameters shall not exceed 150C. -Flow Rate: 1 L/min -Inlet Flow Temperature: 33 degrees Celsius -Cooldown time before maintenance starts: 8 Hours

NOTE: The target segment must remain cool to avoid additional stress from differential thermal expansion rates within the target segment. The secondary flow rate should maintain the target below the indicated temperature.

Upstream References (2)

S.03.02.03-1574	Segment Lifetime
S.03.02-1493	Coating Interface

3.9 S.03.02.03-3848 Locating Features

The segment shall contain features that provide alignment during installation with little or no intervention by maintenance personnel.

Upstream References (1)

S.03.02.03-1504	Segment Replacement Time

3.10 S.03.02.03-10950 Segment Pin

The segment shall be capable of installation when placed within 10mm of the shaft restraint pocket. The segment shall provide 5mm of lead in to guide the segment.

Note: The pin and pocket each have lead-in features that guide the pin into the shaft pocket so long as the segment is within 10mm of the shaft pocket. The segment lead-in is 5mm, and the shaft lead-in is 5mm.

Upstream References (1)

S.03.02.03-3848	Locating Features

3.11 S.03.02.03-3850 Vertical Lift

The segment should be capable of removal from the core vessel without a coordinated jog of the lifting device.

Upstream References (1)
S.03.02.03-1504 Segment Replacement Time

4. PERFORMANCE RELATED REQUIREMENTS

The following requirements are related to, contribute to, or implement (in full or in part) the performance requirements of the Target Assembly.

4.1 S.03.02.03-1596 Target Geometry

Target Geometry shall match the geometry used in S03040000-DAC10010

Upstream References (1)
S.03.02-1455 Match Neutronic Model Parameters

4.2 S.03.02.03-1597 Target Materials

Target materials shall match the geometry used in S030400000-DAC10010

Upstream References (1)
S.03.02-1455 Match Neutronic Model Parameters

4.3 S.03.02.03-1598 Target Location

The target shall match the location used in S03040000-DAC10010.

Upstream References (1)
S.03.02-1455 Match Neutronic Model Parameters

5. INTERFACE RELATED REQUIREMENTS

The following requirements are related or implement the interface requirements from the Target Assembly.

5.1 S.03.02.03-1602 Segment Pressure Drop

The segment shall have a pressure drop of less than 62kPa at 28.4 L/min

Upstream References (1)
S.03.02-1487 Max Pressure drop

5.2 S.03.02.03-1604 Segment Ziplift

The segment shall have a threaded female hole, 1.5” -8 UNC.

Upstream References (1)

S.03.02-1490	Remote Handling Interface

5.3 S.03.02.03-10949 Water Seal Leak Rate

The interfaces for each segment to the drive system shall have a leak rate of <4 x 10 ^ -6 mbar-l/s or less.

Note: This is the leak rate into the core vessel for each segment and constitutes the total of all connections for an individual segment.

Upstream References (1)

S.03.02-10948	Water Leak rate

6. DISPOSAL PREPARATION & TRANSPORTATION REQUIREMENTS

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6.1 S.03.02.03-11214 Disposal Method

The target segment shall be capable of disposal at a waste facility at the end of life.

Upstream References (0)

6.2 S.03.02.03-10222 Transporation in 3-60B

Perishable components shall be capable of transportation within the Energy Solutions 3-60B transportation cask.

Upstream References (1)

S.03.02-10213	Disposal Preparation & Transportation

6.3 S.03.02.03-3570 Maximum dimensions

Segment shall be capable of size reduction to less than Ø685mm x 2270mm.

NOTE: This sizing is to accommodate fitting into a disposal liner that will subsequently be loaded into the 3-60B shipping container.

Upstream References (0)

6.4 S.03.02.03-1572 Segment Shear

The segment shall be capable of being severed with a shear in sections not to exceed 1905mm long.

Upstream References (2)

S.03.02.03-3570	Maximum dimensions
S.03.02-1446	Minimize Contamination

6.5 S.03.02.03- Maximum Mass

Segment mass not to exceed 1100kg.

NOTE: Two segments per disposal liner are planned per shipment.
Two segments + mass of disposal liner and lid cannot exceed 9500lb payload capacity of 3-60B.

Upstream References (0)

7. DEFLECTION & ERROR REQUIREMENTS - FOOT

The requirements in this section are generated from the need to prevent the foot (target) from contact.

- With shielding and the MRA during normal operation and a seismic event
- With the restraint ring during normal operation

The deflection of the target foot in the context of the overall target assembly is governed by the motion of the shaft. The target foot is restrained radially by the target shaft, and free to move vertically in the guide pin pocket. The requirements in this section are for the target foot *relative* to the shaft.

7.1 S.03.02.03-10750 Foot Profile

The horizontal outer boundaries of the segment foot shall be within +/-0.2mm of the locating features (bolted joint).

Note: the location of the foot boundaries is critical to maintain vertical gaps to the MRA and shielding at installation and upon subsequent segment replacements.

Upstream References (1)

S.03.02-10701	Foot location - Profile

7.2 S.03.02.03-10751 Segment Foot - Vertical Deflections - Normal Operation

The segment foot shall deflect <3.2mm (down) and <0.2mm (up) during worst case combinations 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 of the target segment. (Deflection of the target segment in isolation)

Note 2: Deflections are measured relative to the installed condition of the system in the core vessel at ambient temperature and pressure.

Upstream References (1)

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

7.3 S.03.02.03-10752 Segment foot - Vertical deflection - Seismic Event

Any portion of the target foot shall deflect <3.6mm (down) or <0.55mm (up) during a seismic event.

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 of the target segment. (Deflection of the target segment in isolation)

Note 2: Deflections are measured relative to the installed condition of the system in the core vessel at ambient temperature and pressure.

Upstream References (1)

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

7.4 S.03.02.03-10759 Segment Foot - Horizontal Deflection - Seismic Event

The foot shall deflect < 0.25mm radially outward during an operating seismic event.Seismic event includes 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 and pin of the target segment. (Deflection of the target segment in isolation)

Note 2: Deflections are measured relative to the installed condition of the system in the core vessel at ambient temperature and pressure

Upstream References (1)

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

8. DEFLECTION & ERROR REQUIREMENTS - MID HEIGHT

The requirements in this section are generated from the need to prevent the segment outer boundary from contact.

- With shielding (including MRA shielding) during normal operation and a seismic event

The deflection of the segment in the context of the overall target assembly is governed by the motion of the shaft and the local deformation of the leg. The segment is restrained radially at the top and bottom of the segment, but free to expand radially at mid-height due to centrifugal forces and free expand downward in the guide pin pocket. The requirements in this section are for the segment *relative* to the shaft and concerned with radial deflections.

8.1 S.03.02.03-10755 Profile Tolerance - Segment Mid Height

The vertical outer boundaries of the segment foot shall be within +/-0.5mm of the locating features (bolted joint and guide pin).

Note: the location of the foot boundaries is critical to maintain vertical gaps to the MRA and shielding at installation and upon subsequent segment replacements.

Upstream References (1)

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

8.2 S.03.02.03-10756 Segment Mid Height - Radial Deflections - Normal Operation

The segment shall deflect <4.5mm radially outward for 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 and pin of the target segment. (Deflection of the target segment in isolation)

Note 2: Deflections are measured relative to the installed condition of the system in the core vessel at ambient temperature and pressure

Upstream References (1)

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

8.3 S.03.02.03-10757 Segment Mid Height - Radial Deflections - Seismic Event

The segment shall deflect <6.5mm radially outward for the worst case combination 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 and pin of the target segment. (Deflection of the target segment in isolation)

Note 2: Deflections are measured relative to the installed condition of the system in the core vessel at ambient temperature and pressure

Upstream References (1)

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