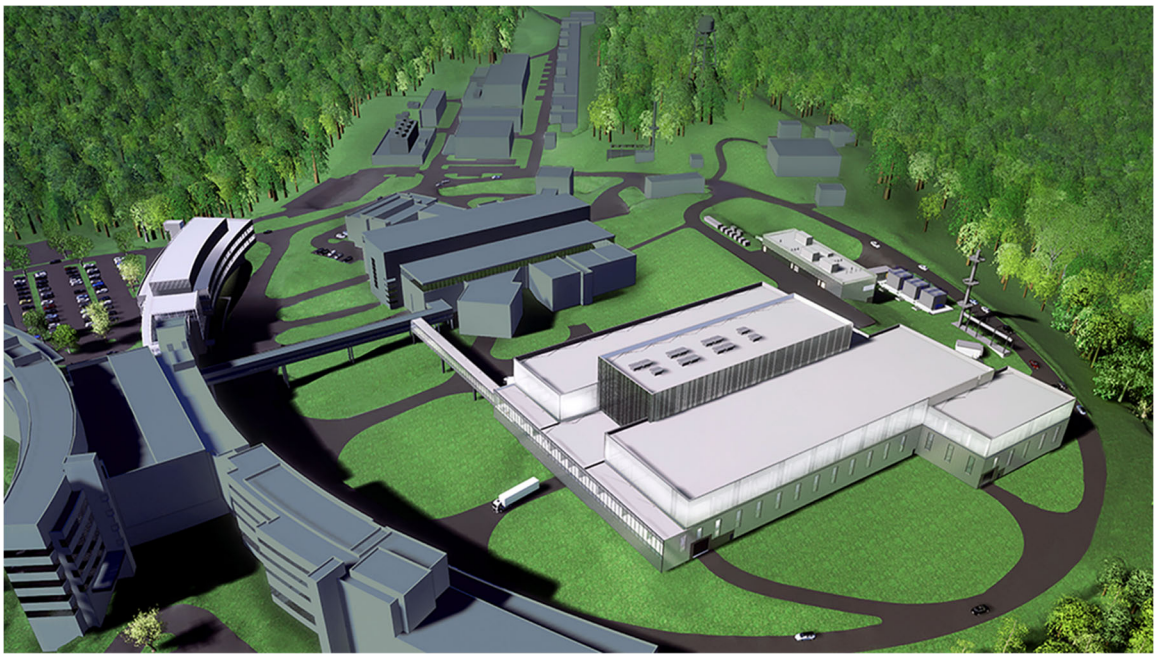
Second Target Station (STS) Target Assembly - Target Shaft Requirements



S03020300-SRD10001

Aaron Jacques

OAK RIDGE National Laboratory

ORNL IS MANAGED BY UT-BATTELLE LLC FOR THE US DEPARTMENT OF ENERGY

Second Target Station Project

S03020300-SRD10001

SECOND TARGET STATION (STS) TARGET ASSEMBLY - TARGET SHAFT REQUIREMENTS

Aaron Jacques

Jul 28 2026 16:57

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 shaft is shown below. This requirements document treats the shaft as a black box. For a detailed description of the scope, please reference the Target Assembly Design Description Document. Please note that the "crown" is functionally a part of the shaft and the target drive. The image below omits the crown, but is considered an integral part of the shaft load path.

2. INTERFACE REQUIRMENTS

The following requirements are captured to meet the overall interfaces of the target assembly. Many requirements are passed directly from the global interface requirements down to the shaft requirements.

2.1 S.03.02.04-3845 Segment Guiding

The shaft shall provide alignment features to assist in aligning the segment during installation with tapered holes, alignment guides, or similar features when the segment is within 5mm of the ideal radial and angular location.

Upstream References (1)

S.03.02.03-1504	Segment Replacement Time

2.2 S.03.02.04-10951 Pocket Clearance

The shaft pocket shall provide clearance of >0.5mm to the segment pin when fully installed; prior to rotation.

The shaft pocket shall permit free location (without binding) of the segment pin during installation, but also provide reactions to centripetal loads. The pocket clearances are taken up once the system begins rotation.

Upstream References (0)

2.3 S.03.02.04-2088 Shaft Diameter

The shaft diameter shall be less than the opening in the core vessel lid.

NOTE: This feature enables the shaft to be removed from the core vessel without removing the core vessel lid.

Upstream References (1)

S.03.02-1546	Shaft Extraction

2.4 S.03.02.04-1692 Shaft Lifting Interface

Each shaft component shall have a threaded female hole, M24x3 x >30mm deep.

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

Upstream References (1)

S.03.02-1490	Remote Handling Interface

2.5 S.03.02.04-1691 Shaft Pressure Drop

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

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

Upstream References (1)

S.03.02-1487	Max Pressure drop

3. DISPOSAL PREPARATION & TRANSPORTATION REQUIREMENTS

Note that the target shaft is a Life of Facility component and is not required to have a disposal path. The project has determined that it is a goal for the target shaft to be replaceable in the event of a water leak, deformed thread, or other issue.

3.1 S.03.02.04-10238 Maximum dimensions

Components shall have maximum dimensions when removed from the core vessel of Ø685mm x 2270mm or be capable of reduction to the indicated maximum length.

Upstream References (1)

S.03.02.04-10230	Transportation in 3-60B

3.2 S.03.02.04-10230 Transportation 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

3.3 S.03.02.04- Maximum Mass

Target shaft components (after meeting maximum dimension requirements) shall not exceed 2000kg.

Upstream References (0)

4. DEFLECTIONS, TOLERANCES, AND ERRORS

The following requirements have been decomposed from the clearance budget for the target assembly, Windchill document number 0000019003.

4.1 S.03.02.04-10742 Radial snubber clearance

The shaft and snubber shall have a nominal 6mm radial clearance between restraint and shaft.

NOTE: The shaft is to only contact the restraint in a seismic event to prevent contact with the shielding and MRA. During normal operation, there must be adequate clearance to avoid contact with the restraint. The gaps, deflections, and tolerances are captured in the target assembly clearance bedget.

Upstream References (0)

4.2 S.03.02.04-10794 Vertical snubber clearance

The shaft and snubber shall have a nominal 8mm vertical clearance between restraint and shaft

Upstream References (0)

4.3 S.03.02.04-10745 Snubber adjustment

The target assembly restraint shall have >+/-3.5mm of radial and >+/-1.5mm of vertical adjustment during installation between the shielding mounting features and the pocket for the target shaft.

Note: this can be achieved by shims, bolting, in-situ machining, or similar.

Upstream References (1)

S.03.02-10735	Lower restraint - adjustment allowance

4.4 S.03.02.04-10746 Snubber horizontal installation tolerance

The restraint ring shall placed within +/-1mm horizontally of the nominal location relative to the global coordinate system.

Upstream References (1)

S.03.02-10735	Lower restraint - adjustment allowance

4.5 S.03.02.04-10795 Snubber vertical installation tolerance

The restraint ring shall placed within +/-0.5 mm vertically of the nominal location relative to the global coordinate system.

Upstream References (1)

S.03.02-10735	Lower restraint - adjustment allowance

4.6 S.03.02.04-10747 Horizontal Shaft Deflection - Normal Operations

The shaft including structural portions of the drive) shall deflect <0.5mm in the horizontal direction 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 (2)

S.03.02-10732	Foot location - Radial deflections during normal operations
S.03.02-10676	Radial Deflections During Normal Operation

4.7 S.03.02.04-10748 Vertical Shaft Deflection - Normal Operations

The shaft including structural portions of the drive) shall deflect <2mm (down) and <0.2 (up) 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.03.02-10677	Vertical Deflections During Normal Operation

4.8 S.03.02.04-10749 Shaft runout

The shaft (all cylindrical features) shall have a geometric runout <0.875mm about the axis of rotation established by the crown bearing surfaces.

Upstream References (1)

S.03.02-10674	Profile Tolerance

5. STRUCTURAL INTEGRITY AND LIFETIMES

The shaft is a life of the facility component and must survive a variety of load conditions and specific failure modes.

5.1 S.03.02.04-10758 Structural integrity during seismic event

The shaft (and drive) must retain structural capacity during an operational seismic event with an imposed horizontal displacement of >+/-13mm between the mounting surface of the target assembly to the core vessel and the bottom of the shaft. This imposed displacement will occur event occurs simultaneously with the worst case load combinations described in ASME SEC VIII, Div 2.

NOTE: This event covers the worst case scenario of imposed deflection from the clearance budget and applied forces. Structural integrity is evaluated against ASME, AISC, codes.

Upstream References (1)

S.03.02-10698	Structural capacity during relative motion

5.2 S.03.02.04-1693 Drive Segment Connection Spurious Stop Survival

The connection between the segment and the drive 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

5.3 S.03.02.04-1694 Shaft Spurious Stop

The shaft 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

5.4 S.03.02.04-1677 Shaft Lifetime

The shaft shall have a lifetime of greater than 40 years.

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

Upstream References (1)

S.03.02-3198	Maintenance and Lifetime Criteria

S.03.02.04-1500 Robust Interfaces

Interfaces between replaceable components and lifetime of facility components shall have replaceable elements (to prevent damage to life of facility elements during replacement)

Upstream References (1)

S.03.02.04-1677	Shaft Lifetime

S.03.02.04-1687 Design Loads and Acceptance Criteria

The target shaft 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

**NASA Reference Publication #1228

Upstream References (2)

S.03.02-3006	Design Loads and Acceptance Criteria
S.03.02.04-1677	Shaft Lifetime

S.03.02.04-2029 Material Radiation Damage

The accumulated radiation dose (or damage) for each shaft 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.03.02.04-1677	Shaft Lifetime

S.03.02.04-7092 Lower Shaft Load-Bearing Integrity

The shaft shall be designed to bear its own weight, and the weight of 20 target segments on the lower most surface of the shaft.

Note: The bottom seismic nub must not collapse when the shaft and a full load of 20 segments are lowered and resting on the lower CV shielding.

Upstream References (1)
S.03.02.04-1677 Shaft Lifetime

5.5 S.03.02.04- Welded construction

The shaft shall have welded connections. No gaskets or seals shall be used within the shaft.

Note: Segment-drive connections are not part of the shaft.

Upstream References (0)