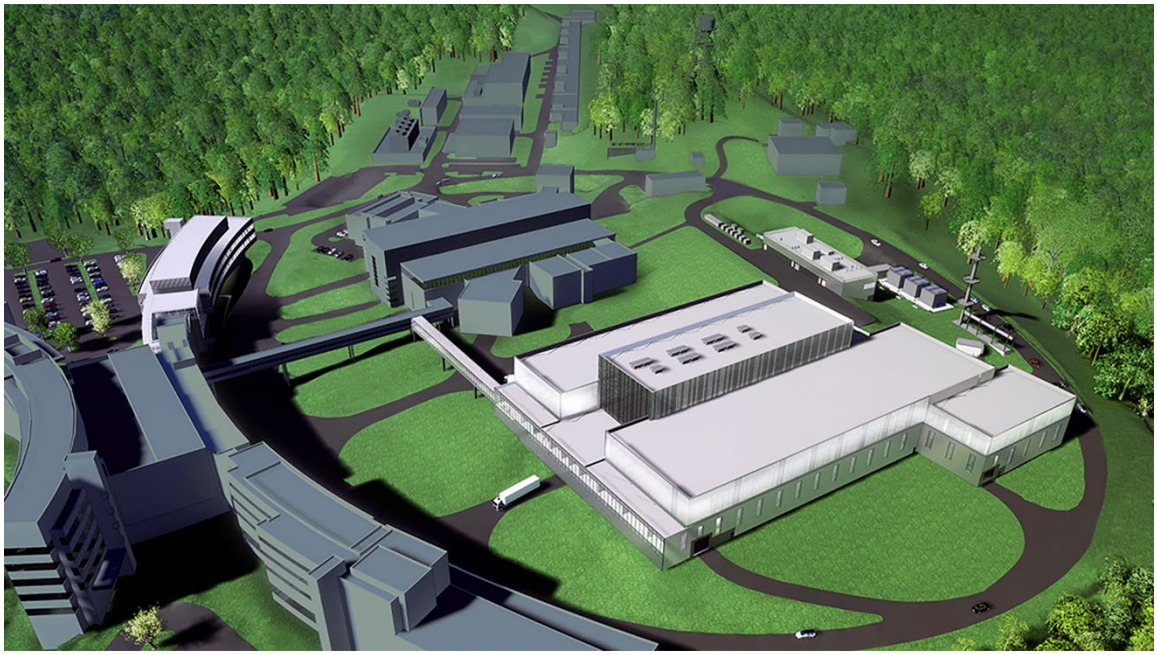
S03110000-SR0001 R01

# Second Target Station (STS): Target Vacuum Systems Requirements



Mike Strong

Apr 9, 2025

OAK RIDGE National Laboratory
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**S03110000-SRD0001 R01**

Second Target Station Project

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Mike Strong

Apr 9, 2025

Prepared by
OAK RIDGE NATIONAL LABORATORY
Oak ridge, TN 37831
managed by
UT-BATTELLE LLC
for the
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| | Signature / Date | | | | | |
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| Target Systems L2 Manager | | | Peter Rosenblad<br>Digitally signed by Peter Rosenblad<br>Date: 2025.04.11 10:10:20 -04'00' | | | |
| CAM, Acting Lead | /s/ Mike Strong | 11/30/2020 | Mike Strong<br>Digitally signed by Mike Strong<br>Date: 2025.04.09 14:03:42 -04'00' | | | |
| Vacuum Design Engineer | | | Austin Chaires<br>Digitally signed by Austin Chaires<br>Date: 2025.04.10 10:04:00 -04'00' | | | |
| NScD SME Point of Contact | | | Drew Winder<br>2025.04.09 14:48:19 -04'00' | | | |
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| Revision | Description |
|---|---|
| 00 | Initial Release |
| 01 | Complete rewrite and reformat of requirements with traceability using Codebeamer with export for approval and archiving. |
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**DEFINITIONS**

Shall, must, will, may, and should are used to define each individual requirement. The definitions of these terms are as follows:

- *Shall* – is a requirement that is binding and must be implemented
- *Must* – is an absolute, binding alternative to "shall" or "requirement"
- *Will* – is used to inform intent or declaration of purpose
    - This is not a requirement; the author must use the word 'shall' to indicate that a requirement is binding and must be implemented
- *May* – is used to indicate a desire or goal of a requirement
    - This can also be interpreted 'as nice to have' and is not binding
- *Should* – is used to indicate a desire or goal of a requirement
    - This can also be interpreted 'as nice to have' and is not binding

"Not" is used in combination with the above terms to indicate the opposite; that is, "shall not" and "must not" describe prohibitions.

**TARGET VACUUM SYSTEMS REQUIREMENTS**

## 1 General Vacuum Requirements

The following requirements are applicable to all S.03.11 Target Vacuum Systems.

1.1 Maintenance & Lifetime Criteria

All Vacuum Systems components shall meet one (or more) of the following criteria:

1. Non-replaceable components shall be designed and constructed with a negligible chance of failure beyond the life of the facility.
2. Components that are designed for the life of the facility but have a chance of failure shall be designed and constructed to permit replacement.
3. Components with expected minimum lifetime of 5000 hours shall be replaceable in 1400 hours or less.
4. Components with expected minimum lifetime of 2500 hours shall be replaceable in 250 hours or less.
5. Components with expected minimum lifetime of 500 hours shall be replaceable in 72 hours or less.
6. Components with expected minimum lifetime of 192 hours shall be replaceable in 16 hours or less.

*Note: The implications for design of the Target Vacuum Systems will include that (1) the vacuum system pump down time will be reasonable - or comparable to existing FTS performance - to allow a serviced system has been vented to return to operation in the intervals defined by this requirement, and (2) the Vacuum Systems components that have a chance of failure such as pumps, gauges and valves can themselves be replaced in the intervals defined by the requirement.*
CodeBeamer reference: S.03.11-3213

Upstream References (1)

| | |
|---|---|
| S.03-3009 | Maintenance & Lifetime Criteria |

1.2 Integrated Controls Interface

All Vacuum Systems shall allow for monitoring and control of vacuum pumps, instrumentation and appropriate valves via the Target Vacuum Control System.
CodeBeamer reference: S.03.11-6181

Upstream References (1)

| | |
|---|---|
| S.03-1042 | Accommodate timing & monitoring |

1.3 Conventional Facilities Interface - Anchorage

All Vacuum Systems where life-of-facility placement is expected shall be designed to allow anchorage to concrete floors and walls provided by Conventional Facilities.
*Note: Some vacuum systems may make use of carts or other mobile assemblies and enclosures that will not be expected to be anchored.*
CodeBeamer reference: S.03.11-6178

Upstream References (1)

| | |
|---|---|
| S.03-1043 | Interface - Conventional Facilites |

1.4 Conventional Facilities Interface - Compressed Air

Pneumatically actuated Vacuum Systems components shall be capable of functioning on facility compressed air pressure of no more than 100psig at 1.0cfm.
CodeBeamer reference: S.03.11-7550

Upstream References (1)

| | |
|---|---|
| S.03-1043 | Interface - Conventional Facilites |

1.5 Conventional Facilities Interface - Electrical Power

Electrically powered Vacuum Systems components shall be capable of functioning on either 120V or 208V power to be provided by Conventional Facilities.
*Note: The vacuum systems may have certain lower voltage needs for components such as pressure gauges and their controllers that will be considered in the Target Vacuum Control interface and not the Conventional Facilities power interface.*
CodeBeamer reference: S.03.11-7551

Upstream References (1)

| | |
|---|---|
| S.03-1043 | Interface - Conventional Facilites |

1.6 Conventional Facilities Interface - Exhaust

All Vacuum System designs shall provide for exhaust from the vacuum pumps to the Target & Instrument Building Hot Off Gas system.
*Note: The CMS Hydrogen system cold box and transfer line insulating vacuum systems may have a unique venting design that is not connected to the Hot Off Gas system. This will be determined during CMS vacuum system preliminary design, which will occur later than the Target Monolith Systems design phases.*
CodeBeamer reference: S.03.11-7552

Upstream References (2)

| | |
|---|---|
| S.03-1043 | Interface - Conventional Facilites |
| S.03-1035 | Safe Operation |

1.7 STS Vacuum System Design and Fab Procedure

All vacuum systems shall be designed in accordance with S01020000-PC0007 STS Project Design and Fabrication of Pressure and Vacuum Systems.
CodeBeamer reference: S.03.11-6209

Upstream References (1)

| | |
|---|---|
| S.03-1035 | Safe Operation |

**2 Safety Requirements**

The following requirements are derived by hazard analysis conducted in collaboration with the Environment, Safety, Health & Quality (ESHQ) group. None of these requirements are related to credited controls, but all are reasonable preventive or mitigative features to be considered in design of the vacuum systems to address conceivable hazard events.

2.1 Redundant Vacuum Pumping

For vacuum systems expected to function without interruption during operations, the systems should have redundant vacuum pumps.
*Note: Within the scope of Target Vacuum Systems, this is applicable to the AIC Inflatable Seals Vacuum Systems and Core Vessel Vacuum System where continuous pumping must occur to maintain operational conditions, but not to the CMS Hydrogen Vacuum System where vacuum pumping is not active after cryogenic cool down nor to the Component Drying Vacuum System which functions independently of target operations.*
CodeBeamer reference: S.03.11-7506

Upstream References (1)

| | |
|---|---|
| S.03-1035 | Safe Operation |

2.2 Welded Connections

Where practical for life-of-facility vacuum components, the vacuum systems should use welded connections.
*Note: This will not be expected at connections with COTS vacuum components that typically employ flanged connections nor at connections with removable components that are not expected to last for the life of the facility or are designed to be replaceable, but it will be considered in the design of custom-fabricated and permanently-installed tubing sections and also at the interface to certain serviced systems such as the Core Vessel, which will be described in the appropriate interface documentation between those systems and the Target Vacuum Systems.*
CodeBeamer reference: S.03.11-7502

Upstream References (1)

| | |
|---|---|
| S.03-1035 | Safe Operation |

2.3 Minimize Use of Combustible Materials

Where practical for life-of-facility vacuum components, the vacuum systems should be fabricated from noncombustible materials.
*Note: This will not be expected for COTS vacuum components, but will be considered on custom-design tubing sections.*
CodeBeamer reference: S.03.11-7507

Upstream References (1)

| | |
|---|---|
| S.03-1035 | Safe Operation |

## 3 AIC Inflatable Seal Vacuum System Requirements

The following requirements are applicable to the S.03.11.02 AIC Inflatable Seals Vacuum Systems used on the Proton Beam Window (PBW) and the PBW Shielding, which includes maintaining a vacuum in the interstitial spaces of the seal assembly during operations as well as pumping out the seal to retract the seal assembly before component removal. There are anticipated to be two independent but functionally-identical inflatable seal vacuum systems servicing the PBW and PBW Shielding, and the requirements listed in this section apply to both.

3.1 Inflatable Seal Interstitial Volume Pressure

Each Inflatable Seal Vacuum System shall be capable of maintaining ≤1 Torr during operations.
*Note: Pressure will not be measured at the interstitial space where vacuum is required when the Inflatable Seal is installed so will be measured at some distance from the Inflatable Seal, but the pressure gradient that may exist between the Inflatable Seal and the point of pressure measurement is not expected to be significant since operation at rough vacuum will maintain viscous flow in the vacuum system.*
CodeBeamer reference: S.03.11-6175

Upstream References (1)

| | |
|---|---|
| S.03-1040 | Isolated Environments |

3.2 Inflatable Seal Pumpout Vacuum

Each Inflatable Seal Vacuum System shall be capable of achieving ≤20 Torr via connection to the Helium line provided by Process Systems to retract the Inflatable Seal assembly in preparation for removal.
*Note: This vacuum is intended only to collapse the Inflatable Seal in preparation for removal of the PBW or PBW Shielding assemblies and will not be maintained during operations.*
CodeBeamer reference: S.03.11-6174

Upstream References (1)

| | |
|---|---|
| S.03-1037 | Replacement and Disposal Path |

## 4 Core Vessel Vacuum System Requirements

The following requirements are applicable to the S.03.11.03 Core Vessel (CV) Vacuum System, which maintains either a rough vacuum continuously during operations or pumps atmosphere out of the CV after service events and prior to Helium backfill depending on the mode selected in operations.

### 4.1 Core Vessel Vacuum System Pressure

The Core Vessel Vacuum System shall be capable of maintaining of pressure of ≤1 Torr either during operations or during preparation for Helium fill.
*Note: The Core Vessel will be capable of maintaining an environment of either rough vacuum or subatmospheric-pressure Helium backfill. Operations will determine whether the vacuum will be maintained continuously during operation or only for pumpdown prior to Helium backfill.*
CodeBeamer reference: S.03.11-6176

Upstream References (1)

| | |
|---|---|
| S.03-1035 | Safe Operation |

### 4.2 Core Vessel Vacuum and Helium Modes (Process Systems Interface)

The Core Vessel Vacuum System shall include features that allow operation with either vacuum or a Helium fill in the Core Vessel.
CodeBeamer reference: S.03.11-7731

Upstream References (1)

| | |
|---|---|
| S.03-1035 | Safe Operation |

### 4.3 Core Vessel Environment Monitoring

The Core Vessel Vacuum System shall allow for monitoring of the composition of the Core Vessel environment drawn through the vacuum system.
CodeBeamer reference: S.03.11-7618

Upstream References (1)

| | |
|---|---|
| S.03-1033 | Yearly Operating Hours |
| S.03-1042 | Accommodate timing & monitoring |

## 5 CMS Hydrogen Vacuum System Requirements

The following requirements are applicable to the S.03.11.04 CMS Hydrogen Vacuum System, which provides an insulating vacuum in the Hydrogen transfer lines and coldbox prior to cool down for operations.

*This section will be completed during Preliminary Design of the S.03.11.04 CMS Hydrogen Vacuum System.*

## 6 Component Drying Vacuum System Requirements

The following requirements are applicable to the S.03.11.05 Component Drying Vacuum System, which maintains vacuum in Remote Handling pits where active, spent components are stored prior to disposal.

*This section will be completed during Preliminary Design of the S.03.11.05 Component Drying Vacuum System.*