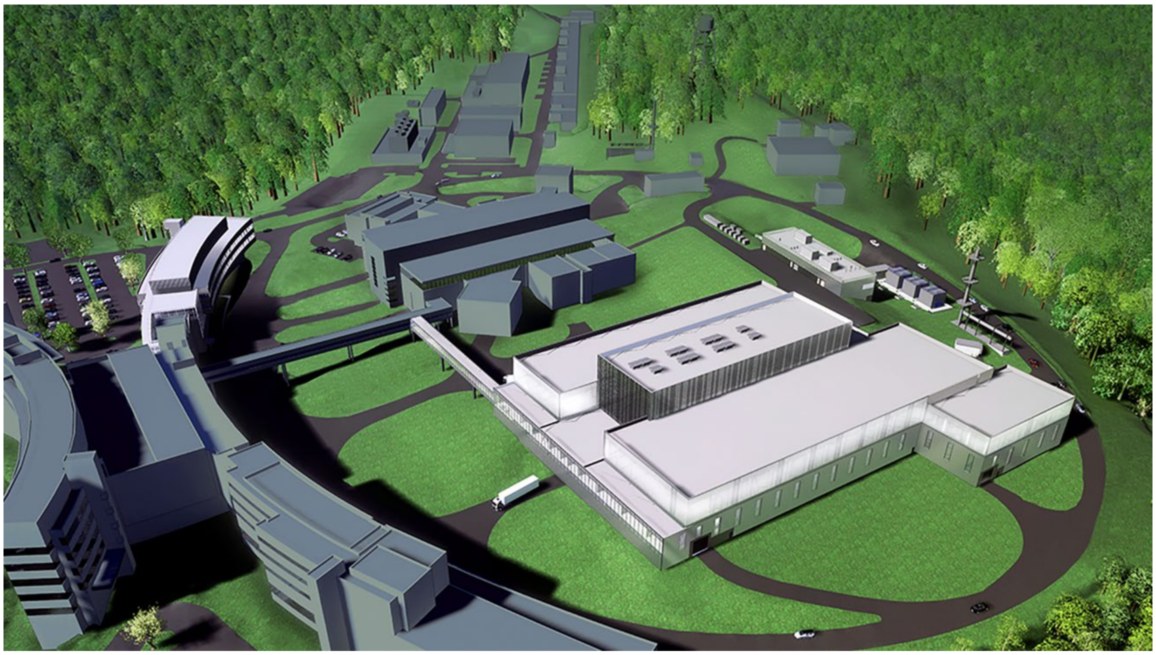
Second Target Station Project: Interface Sheet - Vessel Systems (S.03.06) to Vacuum Systems (S.03.11)



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March 2025

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Second Target Station Project

INTERFACE SHEET – VESSEL SYSTEMS (S.03.06) TO VACUUM SYSTEMS (S.03.11)

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March 2025

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CONTENTS

1. PURPOSE

This document defines the interface between Target System's Vessel Systems (VS) and Vacuum Systems. Requirements derived from this document will be included in the System Design Requirements for VS and Vacuum Systems.

2. SCOPE

The scope of this document is the complete definition for the interface between VS and Vacuum Systems.

2.1 INTERFACING PARTS OR COMPONENTS

No.	Components (Vessel Systems)		Components (VS)	
	Name	Functional reference Number	Name	Functional reference Number
1	Vacuum Systems	TBD	Vessel Systems	S03060000-M8U-8800-A10000.asm
2				
3				
4				

3. ACRONYMS AND DEFENITIONS

ICD	Interface Control Document
IS	Interface Sheet
SSC	Structure, System or Component
STS	Second Target Station
WBS	Work Breakdown Structure
PS	Process Systems
VS	Vessel Systems
CV	Core Vessel

4. DOCUMENTS APPLICABLE TO THE INTERFACING SSCS

Ref	Document Titles	Document Control System Location

5. INTERFACE DEFENITION

5.1 TECHNICAL DESCRIPTION OF THE INTERFACE

VS consists of the Core Vessel (CV), Core Vessel internal shielding, and Nozzle Extensions. Vacuum Systems consists of vacuum pumps, vacuum tubing, valves and pressure-monitoring instrumentation. The VS components that interface with Vacuum Systems include the Core Vessel and Nozzle Extensions. The subsequent sections define the interfaces of relevant VS systems with Vacuum Systems.

5.2 INTERFACE DATA

5.2.1 Vessel Systems Internal Environment Operating Modes

The CV is being designed to operate either in vacuum mode or helium mode to create an inert environment. Vacuum mode must evacuate the CV to a sufficiently low pressure to allow for efficient neutron generation and transport to occur. This will be accomplished by continuously pumping on the CV with a vacuum system to maintain the desired CV vacuum level. Helium mode fills the CV with high purity helium gas, which also allows for efficient neutron generation and transport due to the long mean free path of helium gas. Helium mode operation requires a vacuum system to evacuate the CV prior to backfill with Helium to create a system pressure slightly below atmospheric pressure. Both CV operating modes will only require a rough vacuum within the CV:

- Vacuum Mode Operating Pressure: ≤1 torr
- Helium Mode Operating Pressure: ≤700 torr

Pressure in the installed system will be measured in the vacuum tubing at some distance from the vessel, and analysis of vacuum performance will calculate pressure at the vacuum pump inlet. Since the system will not be expected to achieve pressure below a rough vacuum, however, the gas flow in the system will maintain a viscous or laminar flow regime so any pressure gradient between the vessel and the location of pressure measurement or calculation is not considered to be significant enough to factor into performance of the system.

5.2.2 Vacuum Pumping Performance

In addition to the operating modes, regular maintenance activities within Target Systems will require breaking the vacuum seal on the CV. To support maintenance activities such as target segment changeout, it is important that the CV can be evacuated to the operating vacuum level in a timely manner. The following performance metric for pump down of the system is expected:

- Pump down time to operating pressure (vacuum mode), or prior to backfill (helium mode): <1 hour

5.2.3 Vessel Systems Relevant Characteristics

The following physical characteristics of the Vessel Systems hardware will be used as inputs for Vacuum performance analysis:

- Approximate free volume contained within the Core Vessel assembly: 5.035m^3
- Approximate free volume contained within the Vacuum System tubing: <0.3m^3

The table below lists the surface areas of all substantial components contained within the CV for estimation of off-gassing behavior that may be expected for performance analysis.

Table 1: Surface Areas and materials of all VS internal components

Item	Surface Area	Quantity	SA Subtotal	Material
Core Vessel (including lid)	tbd	1	tbd	316SS
Standard Nozzle Extensions	tbd	15	tbd	304SS
QIKR Nozzle Extension	tbd	1	tbd	304SS
Dual Channel Nozzle Extension	tbd	2	tbd	304SS
Standard Monolith Insert	tbd	15	tbd	304SS
QIKR Monolith Insert	tbd	1	tbd	304SS
Dual Channel Monolith Insert	tbd	2	tbd	304SS
Core Vessel Drain Line	tbd	1	tbd	304SS
Target Assembly	tbd	1	tbd	304SS
Moderator Reflector Assembly	tbd	1	tbd	304SS
Target Viewing Periscope	tbd	1	tbd	Al, 304SS
Shield Block #12085	tbd	1	tbd	Ni Plated Steel
Shield Block #10286	tbd	1	tbd	Ni Plated Steel
Shield Block #10287	tbd	1	tbd	Ni Plated Steel
Shield Block #10288	tbd	1	tbd	Ni Plated Steel
Shield Block #10289	tbd	1	tbd	Ni Plated Steel
Shield Block #10290	tbd	1	tbd	Ni Plated Steel
Shield Block #10291	tbd	1	tbd	Ni Plated Steel
Shield Block #10292	tbd	1	tbd	Ni Plated Steel
Shield Block #10293	tbd	1	tbd	316SS
Shield Block #10294	tbd	1	tbd	316SS
Shield Block #10295	tbd	1	tbd	316SS
Shield Block #10296	tbd	1	tbd	316SS
Shield Block #10297	tbd	1	tbd	316SS
Shield Block #23A	tbd	1	tbd	Ni Plated Steel
Shield Block #23B	tbd	1	tbd	Ni Plated Steel
Shield Block Water Piping	tbd	1 Lot	tbd	304SS
Total VS Internal Surface Area	tbd	N/A	tbd	N/A

5.2.4 Estimated Vacuum Leaks

The table below catalogs all removable seals and corresponding estimated leak rates for analysis of vacuum performance. The primary construction of the CV and nozzle extensions is welding, and for the purpose of analysis may be assumed to provide a perfect vacuum seal relative to the removable seals at the rough vacuum levels that the CV is operated at since actual weld leak rates will be orders of magnitude below the removable seal leak rates.

Table 2: Removable seal leak rates in the CV assembly

Sealing Item	**Seal Type**	**Seal Qty**	**Leak rate per seal (Torr*L/sec)**	**Leak Subtotal**
CV Primary Lid	Metal	1	tbd	tbd
CV Tent Lid	Metal	1	tbd	tbd
CV Tent Target Hatch	Elastomer	1	tbd	tbd
CV Tent MRA Hatch	Elastomer	1	tbd	tbd
CV North Utility Hatch	Elastomer	1	tbd	tbd
CV South Utility Hatch	Elastomer	1	tbd	tbd
Target Bellows Flange	Elastomer	1	tbd	tbd
Target Rotating	Elastomer	1	0.1	0.1
TVP Bellows Flange	Elastomer	1	tbd	tbd
Standard Nozzle Extension	Metal	15	tbd	tbd
QIKR Nozzle Extension	Metal	1	tbd	tbd
Dual Channel Nozzle Extension	Metal	2	tbd	tbd
Proton Beam Window	Inflatable	1	$1x10^{-4}$	$1x10^{-4}$
Proton Beam Window Shielding	Inflatable	1	$1x10^{-4}$	$1x10^{-4}$
Spare Utility Nozzles	Gasket	16	tbd	tbd
Cryogenic Transfer Line	tbd	1	tbd	tbd
Vacuum Line	Elastomer	6	tbd	tbd
Total Estimated Leak rate	N/A	N/A	N/A	tbd

5.2.5 Off-normal operations

It has historically proven difficult to avoid water leaks within the core vessels of other spallation sources around the world. Because of this, the ability to keep the target system operating with a water leak is critical to maintaining acceptable beam availability. The vacuum system for the CV should be designed and sized to maintain operability with a leak rate of up to **TBD** in vacuum mode, and a leak rate of **TBD** in helium mode.