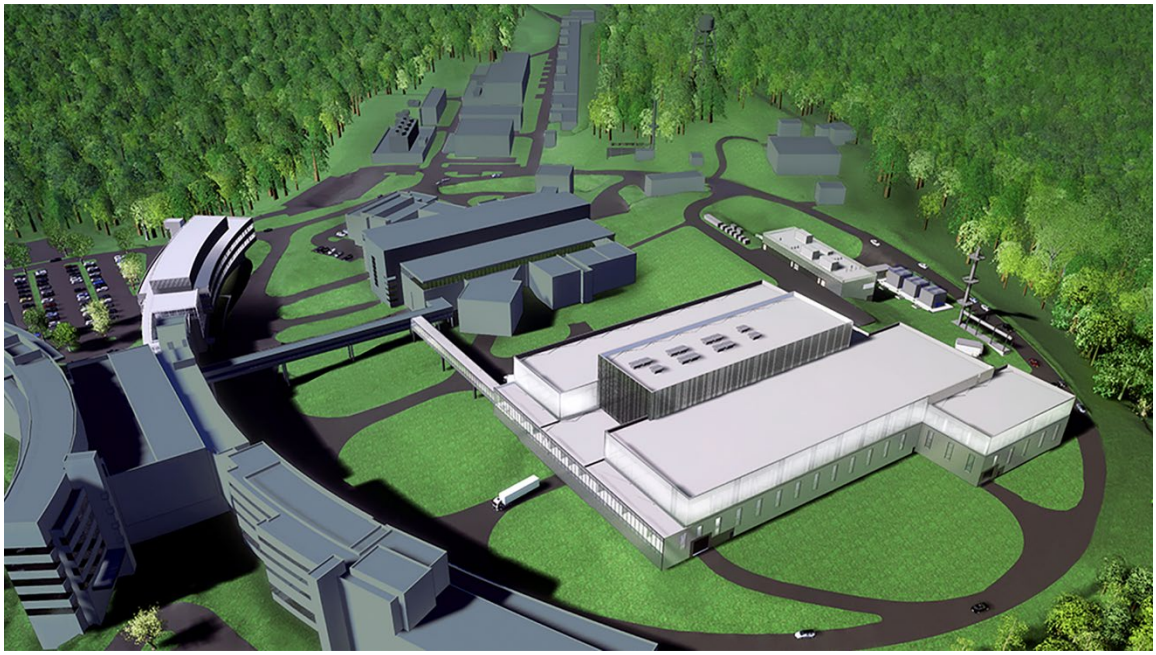
Second Target Station Project: Interface Sheet - Vessel Systems (S.03.06) to Process Systems (S.03.09)



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March 2025

OAK RIDGE National Laboratory

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Second Target Station Project

INTERFACE SHEET – VESSEL SYSTEMS (S.03.06) TO PROCESS SYSTEMS (S.03.09)

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March 2025

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CONTENTS

1. PURPOSE

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

2. SCOPE

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

1. INTERFACING PARTS OR COMPONENTS

No.	Components (PS)		Components (VS)	
	Name	Functional reference Number	Name	Functional reference Number
1	Process Systems	S03090000-M8U-8800-A10000.asm	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
[1]	Target Process Systems P&IDs	

5. INTERFACE DEFENITION

5.1 TECHNICAL DESCRIPTION OF THE INTERFACE

VS consists of the Core Vessel, Core Vessel internal shielding, and Nozzle Extensions. Process Systems consists of Activated cooling loops, Low Level Liquid Waste system, Leak Collection systems, and Helium/Nitrogen Gas Distribution Systems. The VS components that interface with PS include the Core Vessel and the Core Vessel water cooled shielding. The subsequent sections define the interfaces of relevant VS systems with PS.

5.2 INTERFACE DATA

5.2.1 Cooling Water Interface

Process Systems will provide cooling water (supply and return) to the cooled CV shield blocks listed below:

Table 1: Supply and return water line details for all Vessel Systems water cooled components

Item	Supply Line Spec	Supply Qty	Return Line Spec	Return Qty
Shield Block #297	1'' SCH40	2	1.5'' SCH40	1
Shield Block #296	1'' SCH40	3	1.5'' SCH40	1
Shield Block #295	1'' SCH40	3	1.5'' SCH40	1
Shield Block #294	1'' SCH40	2	1.5'' SCH40	1
Shield Block #293	1'' SCH40	2	1.5'' SCH40	1
Core Vessel Beltline North Quadrant	1'' SCH40	1	1'' SCH40	1
Core Vessel Beltline South Quadrant	1'' SCH40	1	1'' SCH40	1
Core Vessel Beltline East Quadrant	1'' SCH40	1	1'' SCH40	1
Core Vessel Beltline West Quadrant	1'' SCH40	1	1'' SCH40	1

For the internal shield blocks, VS will provide the cooled shield blocks and associated water piping that resides inside of the core vessel. Each block water pipe will be welded to a utility nozzle in the top portion of the core vessel. Process Systems will provide supply and return water piping to the ambient side utility connection residing in the pipe pan.

For the CV beltline quadrants, Vessel Systems will provide the Core Vessel and beltline water piping up to the pipe pan elevation. Process Systems will provide supply and return water and water piping to the open ends of the core vessel water pipes. A detailed breakdown of design responsibilities is described below.

The Vessel Systems team is responsible for:

- Reviewing the P&IDs and communicating changes to design
- Providing the following design table inputs for each water cooled component:
    - Total heat load: Derived from energy deposition data provided to VS by Neutronics
    - Energy deposited in the water: Derived from energy deposition data provided to VS by Neutronics
    - Component water volume
    - Component pressure drop
    - Required water flow rate

- Maximum design pressure for the component
- Materials of construction in contact with water

The Process Systems team is responsible for:

- Generating the associated P&IDs
- Providing the required water cooling flows at the proper temperature and pressure to cool the components
- Pressure relief in water system to protect the components from overpressure

Table 1 below shows the current design basis table for all Vessel Systems cooled components.

Table 2: The portion of the PS cooling water design basis table containing VS components

STS Process Systems Design Basis 2.8 MW Beam/700 KW to STS										
	Technical Component Design Values						Primary Cooling Loop			
Target Systems Energy Deposition	STS Design Baseline Heat Load, Watts	Energy Deposited In Water Watts	Component Water Volume, cm^3	Component Pressure Drop, PSI	Component MAWP, PSIA	Component Material of Construction	Design Basis Flow GPM	Design Basis ΔT °F	Primary T Inlet °F	Pipe Size, Inches
CV Beltline North Segment	101	1	46,869	0.4	75.0	316L SS	8.0	0.1	90	1
CV Beltline South Segment	184	2	50,401	0.4	75.0	316L SS	8.0	0.2	90	1
CV Beltline East Segment	389	4	43,423	0.4	75.0	316L SS	8.0	0.4	90	1
CV Beltline West Segment	2,999	30	67,778	0.4	75.0	316L SS	8.0	3.2	90	1
CV Shield Block #297 (2 supply, 1 return)	9,213	110	295,432	0.4	75.0	316L SS	16.0	4.9	90	1
CV Shield Block #296 (3 supply, 1 return)	26,410	277	110,464	0.4	75.0	316L SS	24.0	9.5	90	1
CV Shield Block #295 (3 supply, 1 return)	26,865	281	110,464	0.4	75.0	316L SS	24.0	9.6	90	1
CV Shield Block #294 (2 supply, 1 return)	12,702	54	169,043	0.4	75.0	316L SS	16.0	6.8	90	1
CV Shield Block #293 (2 supply, 1 return)	12,702	54	169,043	0.4	75.0	316L SS	16.0	6.8	90	1

5.2.2 Helium Gas Interface

One of the primary functions of the Core Vessel is to provide a suitable environment for neutron spallation to occur while minimizing loss in neutron collection efficiency. In order to accomplish this, the CV will operate in one of two modes; 1) rough vacuum or 2) sub-atmospheric helium. In order to operate in partial pressure helium mode, helium gas will be provided to the CV by Process Systems. Two 1'' SCH40 pipe nozzles will be provided at the CV wall for helium connections. A helium feed line will terminate just inside the CV wall. A helium return line will connect to the inside helium nozzle and route down to the target elevation within the CV. A detailed breakdown of design responsibilities is described below:

The Vessel Systems team is responsible for:

- Reviewing the P&IDs and communicating changes to design
- Providing the following design table inputs:
  - Normal helium flow
  - Helium pressure
  - Service type (intermittent or continuous)
  - Duty factor

The Process Systems team is responsible for:

- Generating the associated P&IDs
- Providing the required helium gas flow at the proper pressure

Table 3: The portion of the PS Helium design basis table containing VS components

Helium User	Normal Flow SCFM	Max Flow SCFM	Pressure PSIG	Service Type I/C	Duty Factor	Purpose
Core vessel feed	0.15	2	0.1	C	1	Helium mode of operation
Core vessel back fill	10		0.1	I		Break vacuum in system

5.2.3 Utility Line Physical Interfaces

Vessel Systems and Process Systems share a number of utility line physical interfaces. The core vessel contains 44 utility nozzles that are used to pass cooling water, helium gas and electrical connections from the ambient side to the vacuum side of the core vessel. These utility nozzles serve all of the water cooled CV shield blocks as well as the Moderator Reflector Assembly. Vessel Systems is responsible for connecting all internal components to their corresponding utility nozzles inside the CV. Process Systems is responsible for connecting to the ambient side of all utilized utility nozzles. In addition to utility nozzle connections, Process Systems will also connect to the 4 supply and 4 return lines from the CV beltline that run up the outside walls of the CV and penetrate vertically into the pipe pan. The ambient side of all water and gas line connections will be field welded by Process Systems. The penetration type listed in table 4 provides additional information about each nozzle incorporated into the CV design. The Figures and table below describe the interface details.

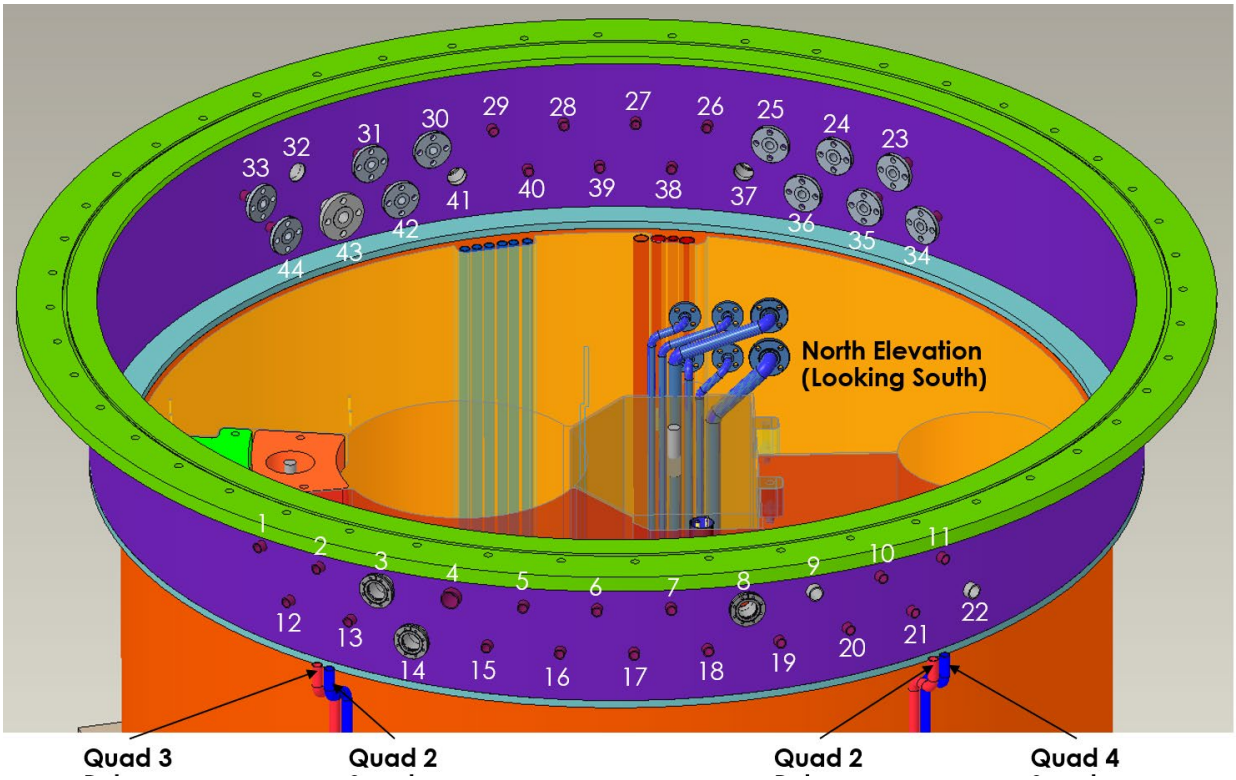

Figure 1: North Elevation CAD Screen Capture and numbering of utility nozzles

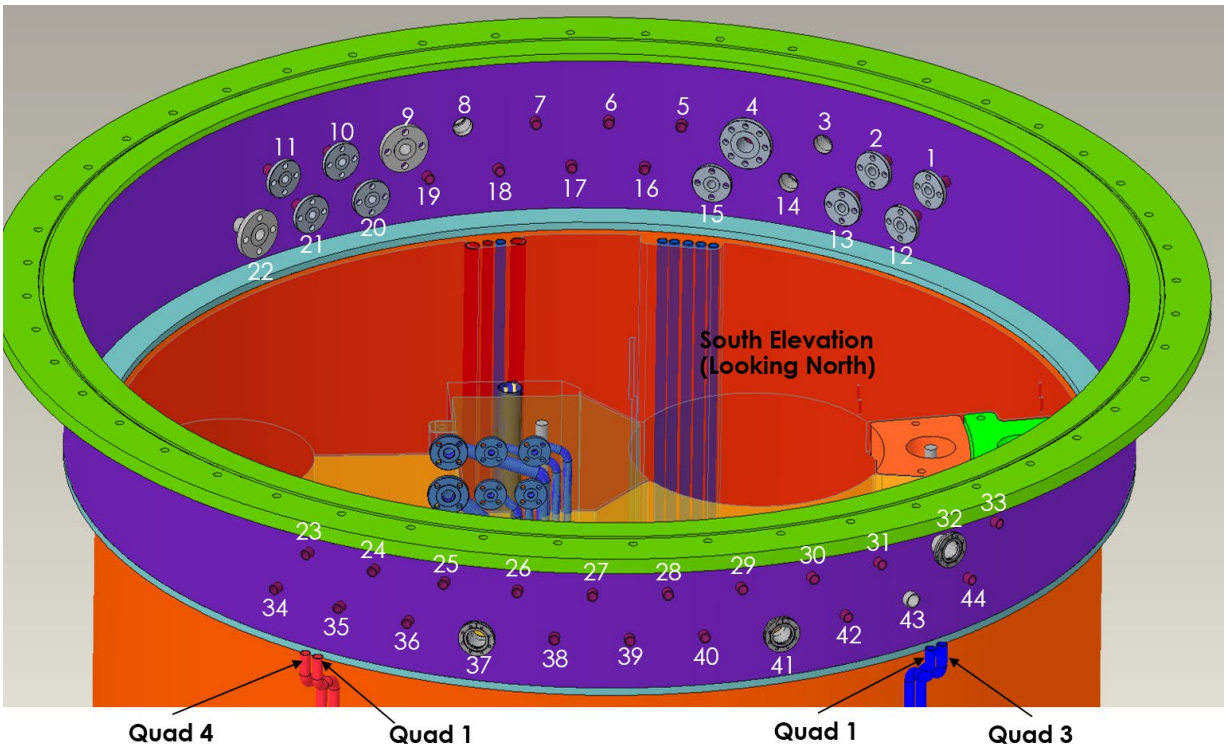

Figure 2: South Elevation CAD Screen Capture and numbering of utility nozzles

Table 4: Utility nozzle identification table

Process Nozzle Number	Utility Type	Penetration Type	Supply/Return	Connected Component	Ambient Side Interface (x,y,z)	Vacuum Side Interface (x,y,z)
1	TBD	2.5" Tube, DN63 CF Flange	TBD	Spare	(1161.69, 4268,-1202.45)	(1066.08, 4268, -1103.96)
2	TBD	1.63" Tube, DN35 CF Flange	TBD	Spare	(982.542, 4268, -1352.35)	(902.067, 4268, -1241.59)
3	TBD	2" Pipe, Open	TBD	Spare	(801.18, 4268, -1506.8)	N/A
4	TBD	1.5" Pipe, Open	TBD	Spare	(572.131, 4268, -1571.92)	(522.179, 4268, -1434.68)
5	TBD	1" Pipe, Open	TBD	Spare	(347.545, 4268, -1635.07)	(331.952, 4268, -1561.71)
6	TBD	1" Pipe, Open	TBD	Spare	(116.605, 4268, -1667.53)	(111.373, 4268, -1592.71)
7	Water Cooling	1.5" Pipe, Welded	Return	CV Shield Block 294-Outlet	(-116.605, 4268, -1667.53)	(-111.373, 4268, -1592.71)
8	Water Cooling	1.5" Pipe, Welded	Return	CV Shield Block 296-Outlet	(-354.813, 4268, -1669.26)	
9	Helium Gas	1" Pipe, Welded	Supply	Helium Supply	(-571.721, 4268, -1570.79)	(-522.722, 4268, -1436.17)
10	TBD	1.63" Tube, DN35 CF Flange	TBD	Spare	(-784.769, 4268, -1475.94)	(-720.492, 4268, -1355.05)
11	TBD	2.5" Tube, DN63 CF Flange	TBD	Spare	(-982.542, 4268, -1352.35)	(-902.067, 4268, -1241.59)
12	TBD	1" Pipe, Open	TBD	Spare	(1074.48, 4114.8, -1280.52)	(986.478, 4114.8, -1175.64)
13	Water Cooling	1" Pipe, Welded	Supply	CV Shield Block 296 - Inlet #3	(885.813, 4114.8, -1417.6)	(813.26, 4114.8, -1301.49)
14	Water Cooling	1" Pipe, Welded	Supply	CV Shield Block 296 - Inlet #2	(694.119, 4114.8, -1559.2)	N/A
15	Water Cooling	1" Pipe, Welded	Supply	CV Shield Block 296 - Inlet #1	(460.755, 4114.8, -1606.85)	(423.017, 4114.8, -1475.24)
16	Water Cooling	1" Pipe, Welded	Supply	CV Shield Block 294 - Inlet #1	(232.642, 4114.8, -1655.33)	(222.204, 4114.8, -1581.06)
17	Water Cooling	1" Pipe, Welded	Supply	CV Shield Block 294 - Inlet #2	(0, 4114.8, -1671.6)	(0, 4114.8, -1596.6)
18	Water Cooling	1" Pipe, Welded	Supply	CV Shield Block 297 - Inlet #1	(-232.642, 4114.8, -1655.33)	(-222.204, 4114.8, -1581.06)
19	Helium Gas	1" Pipe, Welded	Return	Helium Return	(-460.755, 4114.8, -1606.85)	(-440.083, 4114.8, -1534.75)
20	TBD	1" Pipe, Open	TBD	Spare	(-679.901, 4114.8, -1527.08)	(-624.214, 4114.8, -1402.01)
21	TBD	1.5" Pipe, Open	TBD	Spare	(-885.813, 4114.8, -1417.6)	(-813.26, 4114.8, -1301.49)
22	TBD	2" Pipe, Open	TBD	Spare	(-1074.48, 4114.8, -1280.52)	(-982.396, 4114.8, -1170.77)
Process Nozzle Number	**Utility Type**	**Penetration Type**	**Supply/Return**	**Connected Component**	**Ambient Side Interface (x,y,z)**	**Vacuum Side Interface (x,y,z)**
23	TBD	2.5" Tube, DN63 CF Flange	TBD	Spare	(-982.542, 4268, 1352.35)	(-902.067, 4268, 1241.59)
24	TBD	1.63" Tube, DN35 CF Flange	TBD	Spare	(-784.769, 4268, 1475.94)	(-720.492, 4268, 1355.05)
25	Water Cooling	2" Pipe, Welded	Return	MRA Combined Return	(-571.721, 4268, 1570.79)	(-524.894, 4268, 1442.13)
26	Water Cooling	1.5" Pipe, Welded	Return	CV Shield Block 295 Outlet	(-347.545, 4268, 1635.07)	(-331.952, 4268, 1561.71)
27	Water Cooling	1.5" Pipe, Welded	Return	CV Shield Block 297 Outlet	(-116.605, 4268, 1667.53)	(-111.373, 4268, 1592.71)
28	Water Cooling	1.5" Pipe, Welded	Return	CV Shield Block 293 Outlet	(116.605, 4268, 1667.53)	(111.373, 4268, 1592.71)
29	TBD	1.5" Pipe, Open	TBD	Spare	(347.545, 4268, 1635.07)	(331.952, 4268, 1561.71)
30	TBD	2" Pipe, Open	TBD	Spare	(571.721, 4268, 1570.79)	(524.894, 4268, 1442.13)
31	Electrical	1.63" Tube, Open	N/A	MRA Thermocouples	(784.769, 4268, 1475.94)	(720.492, 4268, 1355.05)
32	Electrical	1.63" Tube, Open	N/A	CV Thermocouples	(1004.15, 4268, 1382.09)	N/A
33	Electrical	1.63" Tube, Open	N/A	CV Thermocouples	(1161.19, 4268, 1202.45)	(1066.08, 4268, 1103.96)
34	Water Cooling	1.5" Pipe, Welded	Supply	MRA Backbone Supply	(-1074.48, 4114.8, 1280.52)	(-986.478, 4114.8, 1175.64)
35	Water Cooling	1" Pipe, Welded	Supply	MRA Upper Premod. Supply	(-885.813, 4114.8, 1417.6)	(-813.26, 4114.8, 1301.49)
36	Water Cooling	1" Pipe, Welded	Supply	MRA Lower Premod. Supply	(-679.901, 4114.8, 1527.08)	(-624.214, 4114.8, 1402.01)
37	Water Cooling	1" Pipe, Welded	Supply	MRA Upper Reflector Supply	(-470.887, 4114.8, 1642.18)	
38	Water Cooling	1" Pipe, Welded	Supply	MRA Lower Reflector Supply	(-232.642, 4114.8, 1655.33)	(-222.204, 4114.8, 1581.06)
39	Water Cooling	1" Pipe, Welded	Supply	CV Shield Block 293 - Inlet #2	0, 4114.8, 1671.6	(0, 4114.8, 1596.6)
40	Water Cooling	1" Pipe, Welded	Supply	CV Shield Block 293 - Inlet #1	(232.642, 4114.8, 1655.33)	(222.204, 4114.8, 1581.06)
41	Water Cooling	1" Pipe, Welded	Supply	CV Shield Block 297 - Inlet #2	(470.817, 4114.8, 1641.93)	N/A
42	Water Cooling	1" Pipe, Welded	Supply	CV Shield Block 295 - Inlet #1	(679.901, 4114.8, 1527.08)	(624.214, 4114.8, 1402.01)
43	Water Cooling	1" Pipe, Welded	Supply	CV Shield Block 295 - Inlet #2	(885.813, 4114.8, 1417.6)	(809.895, 4114.8, 1296.1)
44	Water Cooling	1" Pipe, Welded	Supply	CV Shield Block 295 - Inlet #3	(1074.48, 4114.8, 1280.52)	(986.478, 4114.8, 1175.64)

5.2.4 Drain Line Interface

The CV contains a drain port near the bottom of the vessel. Vessel Systems will provide a 3'' SCH40 pipe stub that exits the side of the core vessel. Process Systems or CF will field weld the drain line to this pipe stub. The final location of the pipe stub interface is currently (1400, -998.79, 0) relative to the monolith global center.

5.2.5 Target Supply and Return Water Pipe Supports

The Target supply and return water lines run above the floor near the ceiling of the target drive room. These water lines will need to be structurally supported. The design and procurement of the pipe supports is in Process Systems scope. These supports have not yet been designed and may require anchoring to the Core Vessel lid. Once a design of the pipe supports has been developed, any required anchor features will be added to VS and described in this section.