In-Vessel Structures - Vacuum Vessel ICD

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National Spherical Torus eXperiment Upgrade

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Interface Control Document

IN-VESSEL STRUCTURES–
VACUUM VESSEL STRUCTURES

NSTX-U-ICD-IVS-VVS-0

Revision 0
June 18, 2019

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Change Record

Revision	Date	Description of Change
0	June 18, 2019	Initial Release

References

[1] GENERAL REQUIREMENTS DOCUMENT, NSTX-U-RQMT-GRD-001-01

[2] SYSTEM REQUIREMENTS DOCUMENT, VACUUM VESSEL AND INTERNAL HARDWARE, NSTX-U-RQMT-SRD-004-01

1. Purpose

This document describes the various interfaces between the following subsystems: In-Vessel Structures and the Vacuum Vessel Structures. The interface locations and boundaries that connect the Vacuum Vessel Structures to the Vacuum Vessel Structures are identified based on different interface types.

2. Scope

The In-Vessel Structures consists of consist of the Passive Plates, Outboard Divertors, and Neutral Beam Armor. The Vacuum Vessel Structures consists Vacuum Vessel and Umbrella Structures. While this is the responsibility of the VVIH RE and ICD is required to due to the complexity of the systems and the COGs required to implement the various components. The scope of this document addresses any defined interfaces between these identified system elements.

3. Responsibilities

The interfaces are managed between the following organizations:

- Vacuum Vessel & Internal Hardware
- Systems Engineering and Integration

4. Interfaces

Interface requirements in the following sections are identified with a requirement number, ICD followed by a number [ICD-IVS-VVS-X] where X is a sequential count beginning with 001, IVS represents In-Vessel Structures and VVS represents Vacuum Vessel Structures. There is also a unique identifier for all interfaces in the format [#####-#####-X]. The identifier is a concatenation of two level 5 WBS values and the interface type. This is followed by an interface description and a list of references. References provide evidence pertaining to interfaces include but are not limited to drawings, calculations, or specifications. Reference also include an reference to a paragraph that identifies the set of interface definitions.

4.1. Interface Types

The top-level interface types are defined in Table 1. Within each heading there are sub-headings to address any special sub-elements that need consideration. For example, the Mechanical has four sub-

elements that need to be addressed: Structural, Spatial, Location, and Wall/Floor Penetration. For those interface types with sub-interfaces there are corresponding sub-sections.

Table 1. Interface Types

Heading	Abbreviation	Name
4.2	Me	Mechanical
4.3	Ep	Electrical Power
4.4	Si	Signal
4.5	Di	Diagnostics
4.6	Gf	Gas/Fluid
4.7	Va	Vacuum
4.8	Sw	Software
4.9	Th	Thermal
4.10	Pe	Plasma/Eddy/Halo Current

Table 2 provides the N2 Diagram identifying all the interfaces for NSTX-U while Table 3.

Table 2. N2 Diagram Interface types

Plasma Facing Components	Me,Th, Pe		Me,Th, Va,Pe						Me	Me	Me, Pe		Me			
	In Vessel Structure	Me,Di, Pe			Th			Me,Th, Pe	Me		Me, Di, Pe			Di		
		Vacuum Vessel Structure			Me,Va	Me	Me	Me, Th, Pe	Me	Me,Va	Me,Di, Va		Si	Di,Si		
		Va	Centerstack Structure			Va	Me, Gf	Me	Me	Me				Di		
		Me	Me, Th, Ep	Magnets			Gf	Me			Di		Si	Di		
Si		Me, Va			Heating Systems		Gf	Th		Me		Gf, Si	Si	Si	Si	
					Si, Va, Me, Sw	Vacuum Pumping System		Si	Si	Gf, Si	Si		Si,Va	Si	Si	
				Gf,Si			Coolant System	Gf				Gf,Sw	Si, Sw	Si		
	Th, Gf	Ep,Di, Th, Va	Ep, Gf, Th, Pe		Si		Si	Bakeout System						Me	Si	
			Gf,Va	Gf,Va	Ep	Gf,Si			Gas Delivery System	Me	Va		Si,Sw	Si	Si	
		Gf	Si			Si,Gf,Va			Gf	Wall Conditioning System			Si,Sw	Si	Si	
		Me,Va	Me,Va	Me	Me	Gf,Si	Gf			Va, Ep	Diagnostics		Si,Sw	Si	Si	Si
				Ep	Ep	Ep	Ep	Ep	Ep	Ep	Ep	Power Systems	Si	Ep, Si	Ep, Si, Di, Gf	Ep
					Si					Me, Si	Si		Centralized Instrumentation and Control	Si, Me		
										Sw		Si	Si,Sw	Integrated Machine Operations		
								Ep							Operations & Safety Systems	
Me		Me	Me	Me	Me	Me		Me	Me	Me	Me	Me	Me	Me	Me, Ep	D-Site Locations (Test Cell

Table 3. Callout

In-Vessel Structure	**Me, Di, Pe**
	Vacuum Vessel Structure

The remainder of this document addresses each of the interfaces. Note the template includes a paragraph heading for each interface and a table for each interface type. In the event there is no interface, the table will remain blank with a blank row.

The following paragraphs in Section 4 address each of the interfaces and Section 5 that addresses any off-project interfaces. Off-project interfaces are those external interfaces that interact with the NSTX-U system.

4.2. Mechanical Interfaces

This paragraph addresses any type of mechanical interfaces to include a structural, spatial, location dependent interfaces or areas where penetrations in a wall or floor are required. These are identified independently as the interface parameters will likely be different.

4.2.1. Structural Interfaces

This identifies any interfaces between the system elements that require a structural interface. This could be based on various forces placed on the system and by the system.

Identifier	Interface	References
1.1.1.2.3-1.1.2.1.1-S	The **Neutral Beam Armor** is mounted to the **Vacuum Vessel** wall at Bay G, with the vessel reacting all loads on the armor.	See Paragraph 4.2.1.1 Drawing DB1377
1.1.1.2.2-1.1.2.1.1-S	The **Outboard Divertor** structures are mounted via clevesis to the **Vacuum Vessel**.	See Paragraph 4.2.1.1 Drawing DB1043
1.1.1.2.1-1.1.2.1.1-S	Brackets welded to **Vacuum Vessel** wall are used to support **Passive Plates**	See Paragraph 4.2.1.3, Drawing DB1051
1.3.3.1.3-1.1.2.1.1-S	The **vacuum vessel** provide structural support for the **In-Vessel Helium Lines**.	See Paragraph 4.2.1.4, Drawing DC11041

4.2.1.1. Neutral Beam Armor – Vacuum Vessel

Interface Notes:

- **T**he Neutral Beam Armor is not part of the Recovery project but is included for completeness**.**

ICD-IVS-VVS-001: The NB Armor mount is welded to the Vessel. Drawing DB1377 Sheet 2 Section A-A defines the location of the welds.

4.2.1.2. Outboard Divertor – Vacuum Vessel

Interface Notes:

- **T**he Outboard Divertor to vessel mount already exists is not part of the Recovery project but is included for completeness**.**
- The Outboard Divertor is mounted to rails. The rails are shown in Figure 1.

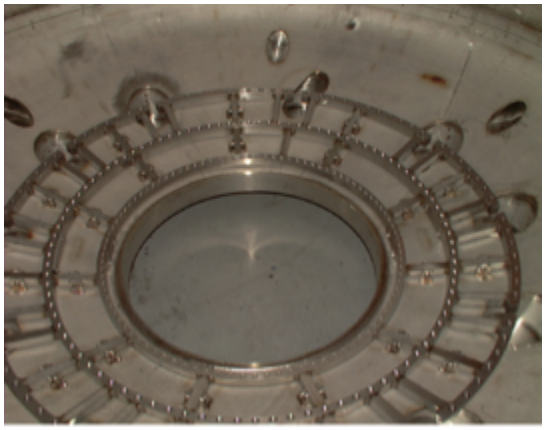

Figure 1. OBD Rail system

ICD-IVS-VVS-002: The OBD rail system system is mounted to the vessel with field provided standoff support. These supports are welded to the vessel wall. These supports are bolted to the rail system.

4.2.1.3. Passive Plates – Vacuum Vessel

Interface Notes:

- The Passive Plates mounts are already mounted to the vessel and not part of recovery scope but is included for completeness.
- The Passive plates mount to the brackets attached to the wall as shown in Figure 2.
- Existing drawing Section Y-Y DB1051 is being replaced by DB1495.

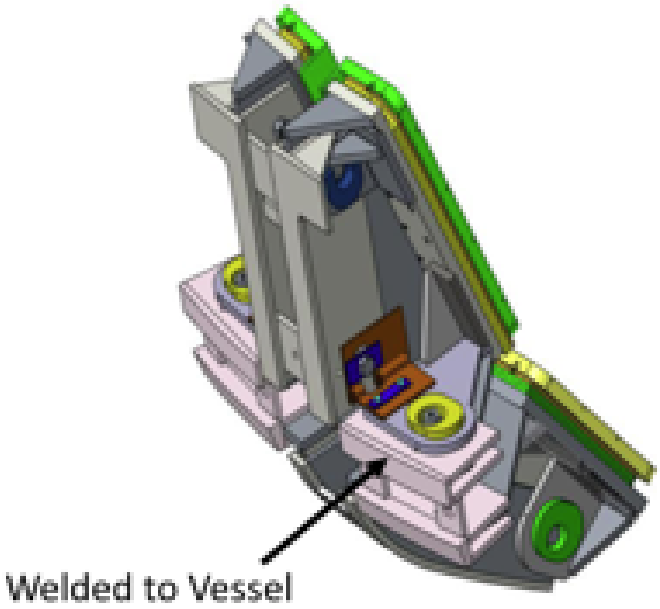

Figure 2. Passive Plate support structure connected to vessel mounting bracket

ICD-IVS-VVS-003: The primary and secondary support bracket assembly is welded in four locations to the vessel wall and is shown in DB1495. Figure 2 shows a model of the primary and secondary passive plates welded to the wall.

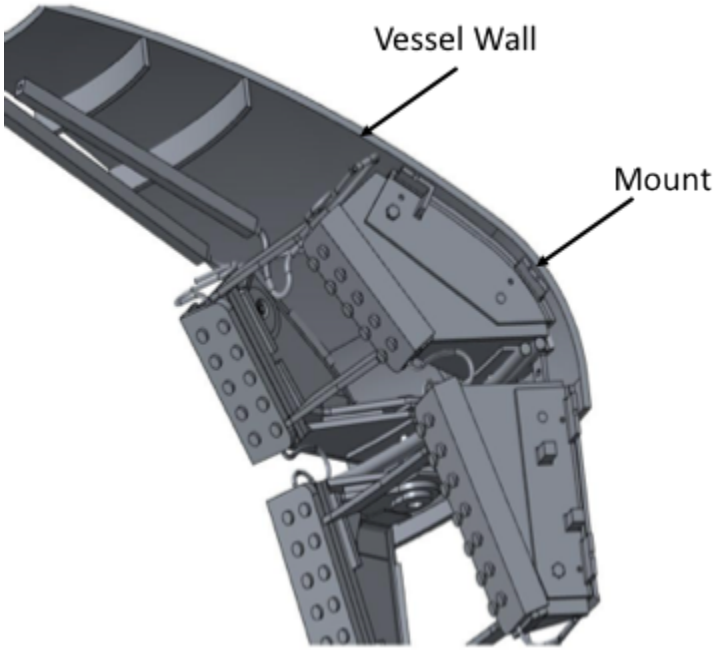

Figure 3. Passive Plate Mount on Vessel Wall

4.2.1.4. Helium Tubes - Vessel Wall

Interface Notes:

- Helium tube support structures are provided

ICD-IVS-VVS-004: The Helium Tube support bracket are placed on long helium tube run as shown as Figure 4**.** These support structures will be welded to the vessel wall.

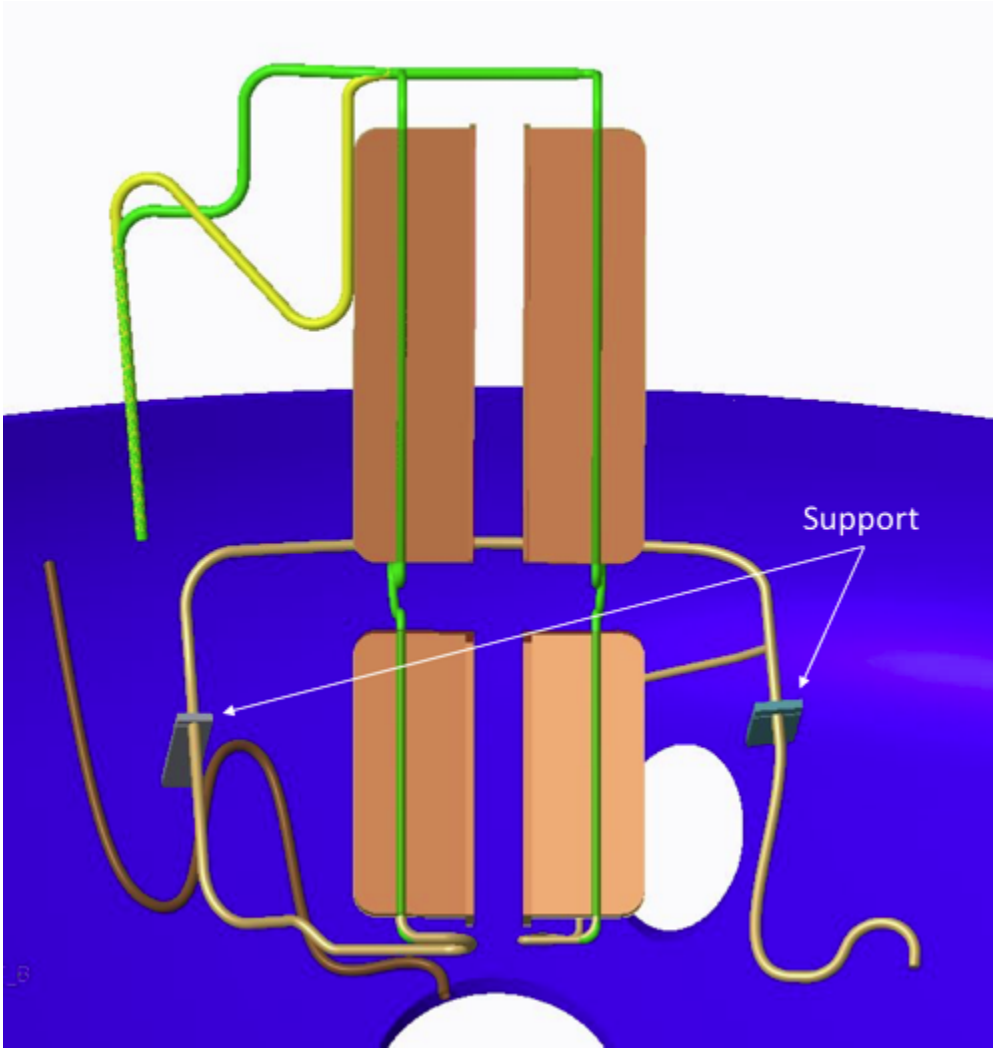

Figure 4. Helium Tube Support Structure

4.2.2. Spatial Interface

This identifies any interfaces between the system elements pertaining to spatial restrictions or constraints.

Identifier	Interface	References
N/A		

4.2.3. Location Interfaces

This identifies any interfaces between the system elements that have any particular dependencies on element location or location constraints.

Identifier	Interface	References
N/A		

4.2.4. Wall/Floor Penetration Interfaces

This identifies any interfaces between the system elements any penetrations or modifications to the wall or floor of the D-Site building.

Identifier	Interface	References
N/A		

4.3. Electrical Power Interfaces

This identifies any interfaces between the system elements requiring AC, DC, rectification or power conditioning.

Identifier	Interface	References
N/A		

4.4. Signal Interfaces

This identifies any interfaces between the system elements and signals that are used to either send or receive control information or data. It explicitly includes the type of physical interface such as Ethernet or Fiber Optic or any specific protocols.

Identifier	Interface	References
N/A		

4.5. Diagnostic Interfaces

This identifies any interfaces between the system elements with any instrumentation or diagnostic equipment to collect performance data.

Identifier	Interface	References
1.1.1.2.2-1.1.2.2.D	**Vacuum Vessel Thermocouples** measure temperature are attached to the surface **Outboard Divertor** mechanical structures	See Paragraph 4.5.1, 9D1095
1.1.1.2.1-1.1.2.2.D	**Vacuum Vessel Thermocouples** measure temperature at the surface of the **Passive Plates**	See Paragraph 4.5.2, 9D1095, 9D1471

4.5.1. Vacuum Vessel Thermocouples – Outboard Divertor

Interface Notes:

- **T**he Outboard Divertor is not part of the Recovery project but is included for completeness**.**

ICD-IVS-VVS-005: The thermocouples are attached to the vessel using feedthru Ceramaseal 19 Pin Thermocouple Type Flanges as defined in Drawing 9D-1095 Sheets 160 (Upper) and & 155 (Lower).

4.5.2. Vacuum Vessel Thermocouples – Passive Plates

Interface Notes:

- The existing thermocouples are currently being used and not part of the recovery Passive plate scope, but the interface is included for completeness.

ICD-IVS-VVS-006: The thermocouples are attached to the vessel using feedthru Ceramaseal 19 Pin Thermocouple Type Flanges as defined in Drawing 9D-1095 Sheets 160 (Upper) & 155 (Lower). Drawing 9D1471 identifies the location of the thermocouples.

4.6. Gas/Fluid Interfaces

This paragraph has two different types of interfaces: Gas and Fluid.

4.6.1. Gas Interfaces

This identifies any interfaces between the system elements that use any type of gas (e.g., He).

Identifier	Interface	References
N/A		

4.6.2. Fluid Interfaces

This identifies any interfaces between the system elements that use any type of gas (e.g., ionized water).

Identifier	Interface	References
N/A		

4.7. Vacuum Interfaces

This identifies any interfaces between the system elements that pertain to the Vacuum.

Identifier	Interface	References
N/A		

4.8. Software Interfaces

This identifies any interfaces between the system elements that use software that may exchange interfaces with other software components. This includes application programming interfaces (APIs) or any other exchange of information between different software applications.

Identifier	Interface	References
N/A		

4.9. Thermal Interfaces

This identifies any interfaces between the system elements that pertain to Thermal characteristics.

Identifier	Interface	References
N/A		

4.10. Plasma Interfaces

This paragraph has two different types of interfaces: Plasma and Eddy/Halo Current.

4.10.1. Plasma Interfaces

This identifies any interfaces between the system elements with the Plasma.

Identifier	Interface	References

N/A		

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4.10.2. Eddy/Halo Current Interfaces

This identifies any interfaces between the system elements with the Eddy/Halo Currents.

Identifier	Interface	References
1.1.1.2.2-1.1.2.1.1.E	Halo currents that flow between the Vacuum Vessel into or out of the Outboard Divertor at points where outboard divertors attach to the vessel	4.10.2.1

4.10.2.1. Outboard Divertor and Vacuum Vessel

ICD-IVS-VVS-007: There are HALO currents that comes through the tiles and into the OBD to the Vessel structure. A Calculation is being developed to determine the effect of the Halo loads on the Clevis joints attaching the OBD rail system to the vessel.

5. Off-Project Interfaces

The off-project interfaces are components that are not specifically part of the NSTX-U system. They may include external systems and interfaces where the program has little control on part of the interface. They are provided for completeness.

There are no external interfaces.