Center Stack Structure - Vacuum Vessel ICD

Interface Document: NSTXU_1-1-3-3_IC_104

REVISION 0

July 1, 2019

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National Spherical Torus eXperiment Upgrade

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Interface Control Document

CENTER STACK STRUCTURE: VACUUM VESSEL SYSTEM

NSTX-U-ICD-CSS-VVS-0

Revision 0
June 27, 2019

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Change Record

Revision	Date	Description of Change
0	June 27, 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: Center Stack Structure and the Vacuum Vessel Structure. The interface locations and boundaries that connect the Center Stack Structure to the Vacuum Vessel Structure are identified based on different interface types.

2. Scope

The Center Stack Structures include the Center Stack Casing, Pedestal, PF-1a Support Structures, PF-1b Support Structures, and PF-1c Support Structures. The Vacuum Vessel Structures consist of the Vacuum Vessel and the Umbrella Structures. While this is technically within the responsibility of the VVIH's RE, an ICD is required due to the complexity of the combined system. Part of the Center Stack Structure, consists of the Machine Core Structure, was placed under the responsibility of a single COG. The Machine Core Structures provide the support structures for the Magnets, Pedestal and OH outer skirt. The scope of this document addresses any defined interfaces between these identified system elements.

3. Responsibilities

The interfaces are managed between the following organizations:

- VVIH RE
- Center Stack COG
- Systems Engineering and Integration

4. Interfaces

Interface requirements in the following sections are identified with a requirement number, ICD, followed by a number [ICD-CSS-VVS-X], where "X" is a sequential count beginning with 001, CSS represents Center Stack Structure, and VVS represents Vacuum Vessel Structure. 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. References also include a 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 provides the specific details of the interface.

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, Th	Me, Gf	Me	Me					Di		
		Me	Me, Th, Ep	Magnets			Gf	Me			Di		SI	Di		
Si		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							Si, Me	
			Gf,Va		Ep	Gf,Si			Gas Delivery System	Me	Va		Si,Sw	Si	Si	
		Gf				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.

Vacuum Vessel Structure	Me
Va	Center Stack 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 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 that include a structural, spatial, location dependent interfaces or areas where penetrations into a wall or floor are required. These are identified independently as interface parameters will likely be different.

4.2.1. Structural Interfaces

This identifies any interfaces between 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
1.1.2.1-1.1.3.3.8-S	**The PF-1c Structure** connects the Center Stack Assembly to the **Vacuum Vessel Mounting Flange(Nozzle)**	See Paragraph 4.2.1.1

4.2.1.1. PF1c Structure - Vacuum Vessel Mounting Flange

Interface Notes:

- In between the thirty-six (36) mounting holes of ICD-CSS-VVS-001, are an additional thirty-six (36) holes that are used to hold the PF1c assembly together. These seventy-two total holes evenly distribute the compressive load into the G-10 of the ceramic break.
- Relevant drawings will be provided at the Machine Core Structure FDR.

ICD-CSS-VVS-001: As shown in Figure 1, PF1c Flange Mounting, below, the ceramic break mounting flange (reentrant flange) for the upper PF1c assembly rests on top of the Vacuum Vessel upper mounting flange (Nozzle). The lower PF1c assembly, mates against the bottom of the Vacuum Vessel's lower mounting flange (Nozzle). Each PF1c assembly is bolted against the corresponding VV mounting flange through a G10 (green) with thirty-six (36) threaded tensioning rods threading into the custom made Nut, Isolator.

ICD-CSS-VVS-002: The torque will be provided in the installation procedures.

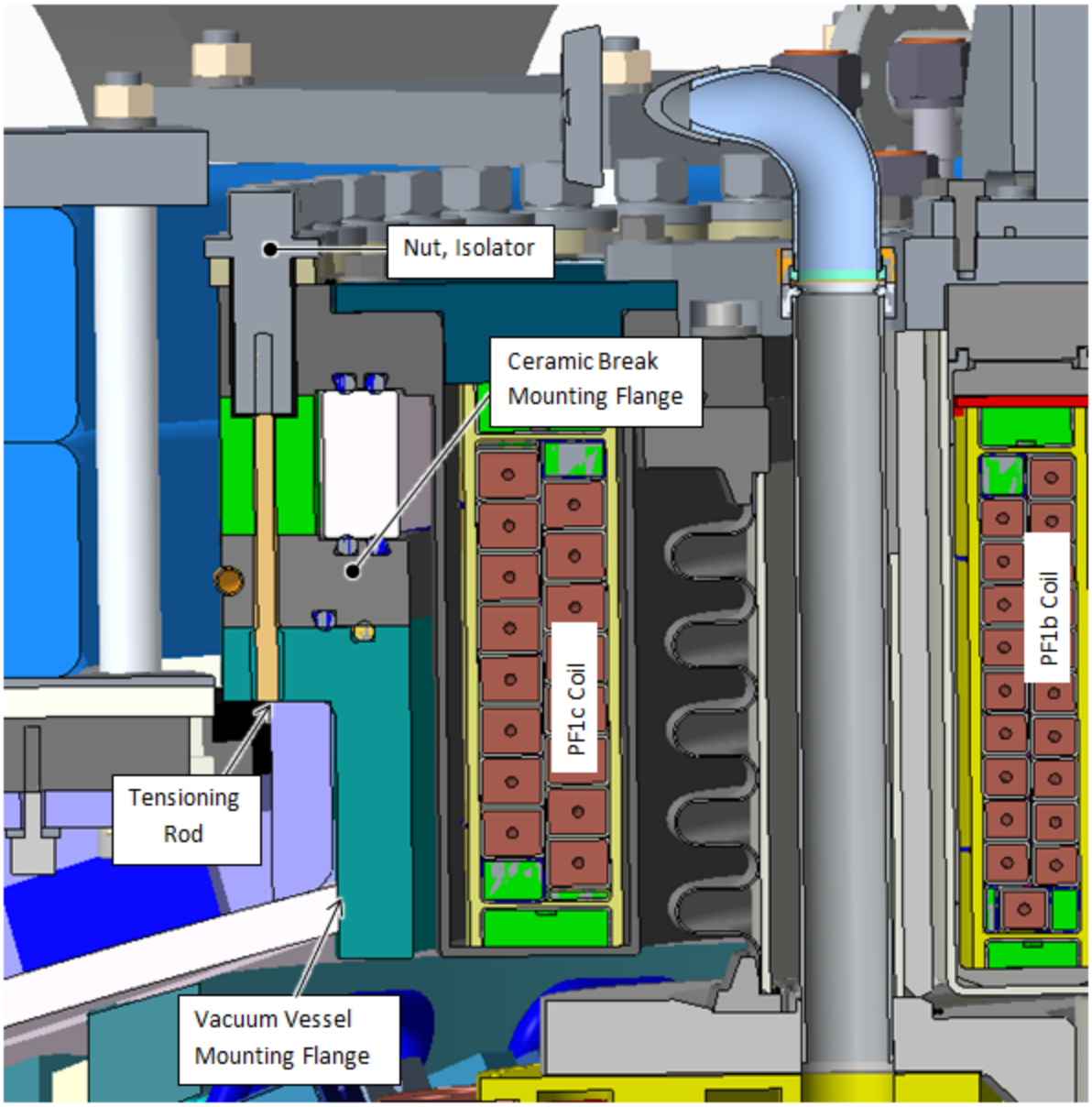

Figure 1: PF1c Flange Mounting

Because the lower section does not have a ceramic break, the Vacuum Vessel Mounting Flange (aka Nozzle) mates to the PF1c support (can). This arrangement requires a different threaded tensioning rod. Additionally, two nuts are included in the lower section to provide for an anti-rotation mechanism (See Figure 2: PF1c Lower Section below). NOTE: The final configuration for this bolting arrangement is still to be determined and may replace two nuts with a single nut.

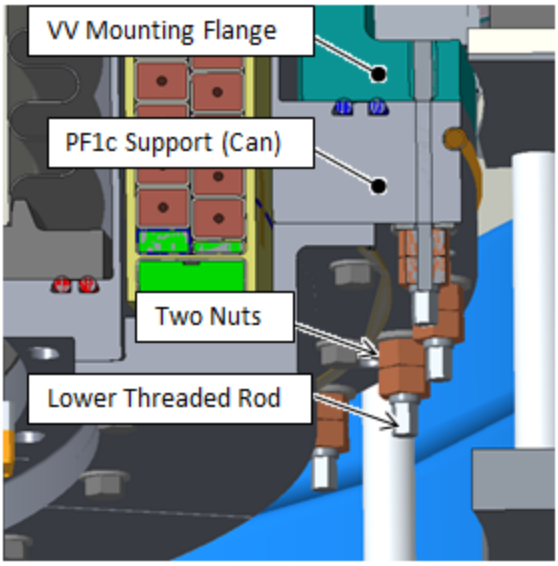

Figure 2: Lower Section, PF1c to Vacuum Vessel

4.2.2. Spatial Interface

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

Identifier	Interface	References
1.1.2.1-1.1.3.3.8-Sp	**The PF-1c Structure needs to be aligned with the Vacuum Vessel Mounting Flange (Nozzle) bolt holes**	See Paragraph 4.2.2.1

4.2.2.1. PF1c Structure - Vacuum Vessel Mounting Flange

Interface Notes:

- The tolerances provided in the following interfaces are subject to change. The final values will be presented at the Machine Core Structures FDR.

ICD-CSS-VVS-003: The surface of the ceramic break mounting flange that mates against the vacuum vessel mounting flange will have a flatness tolerance no greater than .007 inches.

ICD-CSS-VVS-004: All of the threaded rod mounting holes are positioned within .01 inches of their theoretically correct positions

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 and 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
N/A		

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 fluid (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
1.1.3.3.8-1.1.2.1.1-V	Interface has double O-ring seal w/ pumped interspace where the **break assembly** meets the **main vessel**.	See Paragraph 4.7.1

4.7.1. Center Stack Break Assembly - Vacuum Vessel

ICD-CSS-VVS-005: There is a Double O-ring seal between the PF1c assemblies and the Vacuum Vessel Mounting Flange. In this Double O-ring seal, one of the O-ring grooves is in the Vacuum Vessel Mounting Flange (Nozzle). The other groove is in the Ceramic Break Mounting Flange.

ICD-CSS-VVS-006: The space between the O-rings is vacuum pumped. This vacuum pumped 'interspace' is not emphasized in Figure 3: Double O-Ring Seals, below, but is similar to the other Double O-ring seals that are described in the Center Stack Structure -Vacuum Pump System ICD. The interspace between these Double O-ring seals is radially larger than the other Double O-ring seal interspaces.

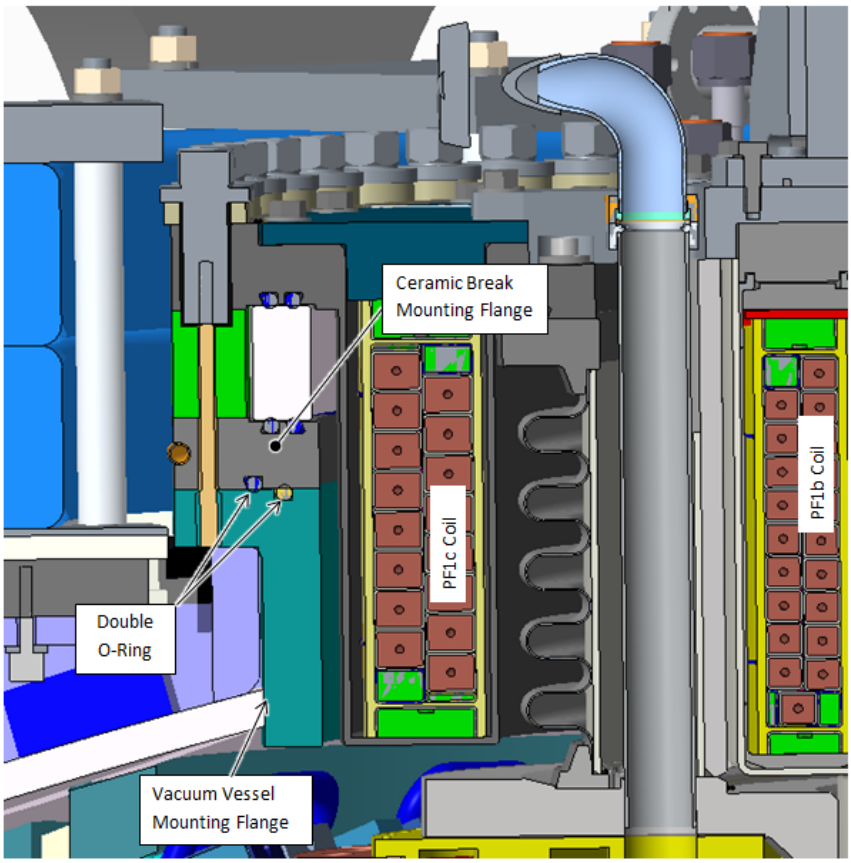

Figure 3: Double O-Ring Seals

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 Eddie/Halo Current.

4.10.1. Plasma Interfaces

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

Identifier	Interface	References
N/A		

4.10.2. Eddy/Halo Current Interfaces

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

Identifier	Interface	References
N/A		

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.