

# Vacuum Vessel - Vacuum Pumping ICD

Interface Document: NSTXU\_1-1-2\_IC\_100

REVISION 0

June 24, 2019

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# **National Spherical Torus eXperiment Upgrade**

## National Spherical Torus Experiment Upgrade

### **Interface Control Document**

### **VACUUM VESSEL STRUCTURE : VACUUM PUMPING SYSTEM**

NSTX-U-ICD-VVS-VPS-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

[3] SYSTEM REQUIREMENTS DOCUMENT, AUXILIARY SYSTEMS, NSTX-U-RQMT-SRD-005-01

# 1. Purpose

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

## 2. Scope

The Vacuum Vessel Structure consists of Vacuum Vessel, Umbrella Structure and Lids, Ports, and Coil supports. The Vacuum Pumping System consists of vacuum pumps, valves, TIV & Shutter Actuation System and Interspace Vacuum Pumping System. These interfaces focus on the IVPS and the Vacuum Vessel and Umbrella Structure. 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
- Vacuum Pumping
- Systems Engineering and Integration

## 4. Interfaces

Interface requirements in the following sections are identified with a requirement number, ICD followed by a number [ICD-VVS-VPS-X] where X is a sequential count beginning with 001, VVS represents Vacuum Vessel Structure and VPS represents Vacuum Pumping System. 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 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,D,Pe			Th			Me,Th,Pe	Me		Me,D,Pe			DI			
		Vacuum Vessel Structure			Me,Va	Me	Me	Me,Th,Pe	Me	Me,Va	Me,D,Pe		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									GF,Sw	SI,Sw	SI		
							Coolant System	GF									
	Th,GF	Ep,D,Th,Va	Ep,GF,Th,Pe		SI			SI							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	Diagnosics			SI,Sw	SI	SI	SI
				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 Protection			
								Ep							Operations & Safety Systems		
Me		Me	Me	Me	Me	Me		Me	Me	Me	Me	Me	Me	Me	Me,Ep		SI Site Locations (Task Cell)

Table 3. Callout

Vacuum Vessel Structure	Me, Va
	Vacuum Pumping System

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.

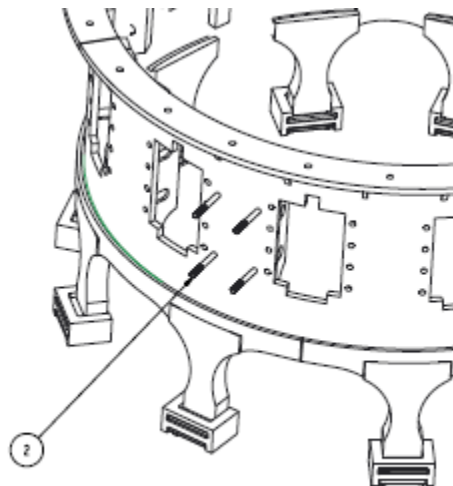
Identifier	Interface	References
1.1.2.1.2- 1.3.1.7-S	<b>IVPS manifolds</b> mounted to the surface of the <b>umbrella structure</b>	See Paragraph 4.2.1.1 Drawing DB14596, DB1497

#### 4.2.1.1. IVPS Manifold - Umbrella Structure

**Interface Notes:**

- These are field fit and provides some adjustability in the field

**ICD-VVS-VPS-001:** The interface is located on Bay A on the upper umbrella section as shown in Figure 1.



**Figure 1. Location of Upper Manifold**



**ICD-VVS-VPS-002:** The interface is located on Bay D of the Lower Umbrella Structure

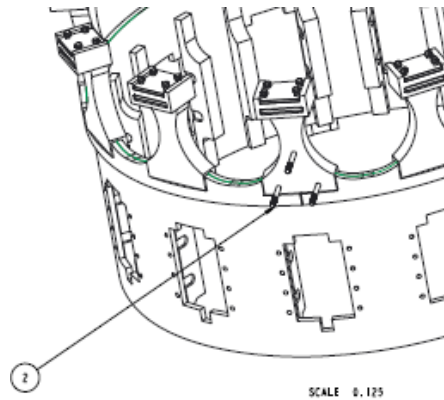


Figure 2. Lower Valve Manifold

**ICD-VVS-VPS-003:** Four  $\frac{3}{4}$ " threaded rods will be welded onto the upper and lower umbrella for each G10 plate mounting and these plates will be bolted in place in the field.

#### 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

N/A		
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## 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

1.1.2.1.1- 1.3.1.7-V	Provision for <b>IVPS</b> access to interspace via access holes and fittings at vacuum ports on <b>Vessel flanges</b> .	See Paragraph 4.7.1
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#### 4.7.1. IVPS – Vessel Flange

**ICD-VVS-VPS-004:** The Dual O-Ring Design is shown In Figure 1. It connects the Vessel flange shown below the dual O-ring Marker to the PF-1C Outer flange where the half dovetail grooves are located. The Vacuum port is located on the PF-1C outer flange.

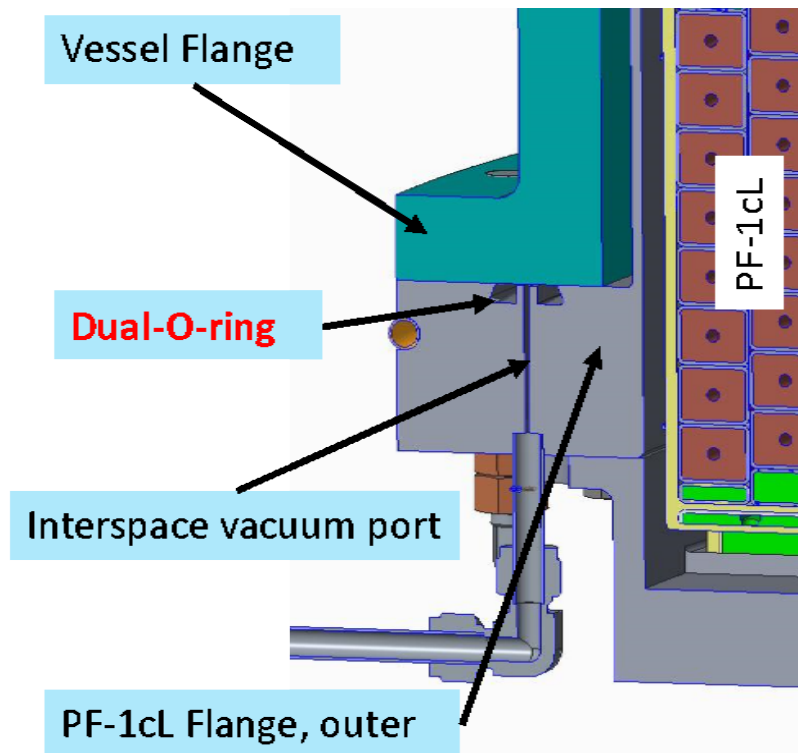
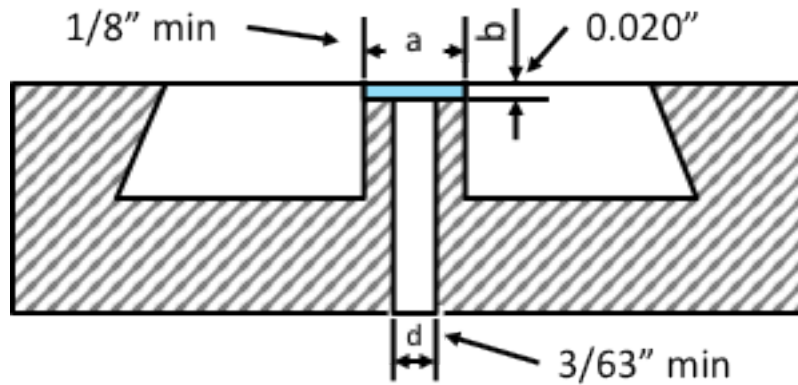


Figure 1. Center Stack Flange Vacuum Interface

**ICD-VVS-VPS-005:** There are no allowable gap between the metal to metal flanges. The maximum tolerance of 0.013" on each flange is to maintain the required compression ratio of between 8 and 22%.

**ICD-VVS-VPS-006:** The flange seal type is a double O-ring and has the minimum dimensions identified in Figure 2. For a given height, 0.02", a min width 1/8" is required for transitional flow status.



**Figure 2. Double O-ring Design**

## 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		

### 4.10.2. Eddy/Halo Current Interfaces

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