PRINCETON PLASMA PHYSICS LABORATORY

ENG-064 - ICD - INTERFACE CONTROL DOCUMENT

Vacuum Vessel Structures - Diagnostics Interface Control Document

NSTXU_1-1-2_ICD_101

Work Planning #:
Effective Date: **03/02/2020**
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National Spherical Torus eXperiment Upgrade

National Spherical Torus Experiment Upgrade

Interface Control Document

VACUUM VESSEL STRUCTURE : DIAGNOSTICS

NSTX-U-ICD-VVS-DIA-0

Revision 0
February 19, 2020

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Change Record

Revision	Date	Description of Change
0	February 19, 2020	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, Diagnostics, NSTX-U-RQMT-SRD-011-01

1. Purpose

This document describes the various interfaces between the following subsystems: Vacuum Vessel Structure and the Diagnostics. The interface locations and boundaries that connect the Vacuum Vessel Structure to the Diagnostics 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 Diagnostics consists Thermocouples, Mirnov sensors, Rogowski coils, Langmuir probes Neutron measurements, Magnetics Multi-pulse Thompson Scattering (MPTS), Plasma TV, CHERS, spectroscopy, FIDA, BES, MSE, High-K Scattering, and microwave diagnostics, among other instrumentation and diagnostics. 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 Structure
- Diagnostics
- 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-DIA-X] where X is a sequential count beginning with 001, VVS represents Vacuum Vessel Structure and DIA represents Diagnostics. 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 includes 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

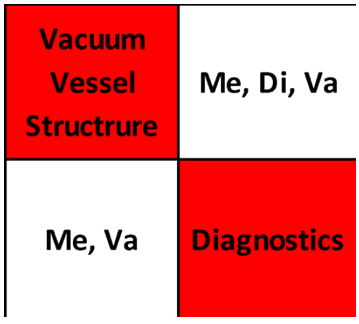
Heading	Abbreviation	Name
4.2	Me	Mechanical
4.3	Ep	Electrical Power
4.4	Si	Signal
4.5	Di	Diagnostics
4.6	Gf	Gas/Fluid
4.7	Va	Vacuum
4.8	Sw	Software
4.9	Th	Thermal
4.10	Pe	Plasma/Eddy/Halo Current

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 Structures	Me,Di, Pe			Th			Me,Th, Pe	Me		Me, Pe			Di		
		Vacuum Vessel Structure			Me,Va	Me, Va	Me	Me, Th, Pe	Me	Me,Va	Me,Di, Va		Si	Di, Me		
		Va	Centerstack Structures			Va, Th	Me, Gf	Me	Me					Di		
		Me	Me, Th, Ep	Magnets				Me			Di		SI	Di	Me	
Si		Me, Va			Heating Systems		Gf	Th		Me		Si	Si	Si	Si, Me, Di	
					Si, Va, Me, Sw, Gf	Vacuum Pumping System		Si	Si	Si	Si		Si,Va	Si	Si	
				Gf,Si			Coolant System	Gf				Gf,Sw	Si, Sw	Si	Si	
	Th, Gf	Ep,Di, Th, Va	Ep, Gf, Th, Pe		Si		Si	Bakeout System							Si, Me	
			Gf,Va			Me, Gf,Si			Gas Delivery System	Gf	Va		Si,Sw	Si	Si, Me	
		Gf				Si,Gf,Va			Me	Wall Conditioning System			Si,Sw		Me	
		Me,Va	Me,Va	Me	Me	Gf,Si	Gf			Va, Ep	Diagnostics		Si,Sw	Si	Si, Me	Si
				Ep	Ep	Ep	Ep	Ep	Ep	Ep	Ep	Power Systems	Ep,Si	Ep, Si	Si, Me,Di, Ep	Ep
					Si					Me, Si	Si		Centralized Instrumentation and Control	Si, Me		
												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



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
1.1.2.1.1-1.4.1.2.6-S	**High Frequency MHD diagnostic** Sensors are mounted to the **vessel wall**	See Paragraph 4.2.1
1.1.2.1.1-1.4.1.2.7-S	**TAE Antennas** are mounted to the **vessel wall**, which supports them.	See Paragraph 4.2.2 Drawing 9D11266
1.1.2.1.1-1.4.1-S	Some **diagnostics** such as sample coupons and Faraday cups are mounted to **inner vessel wall**. Viewing dumps are also mounted to the wall. Accelerators are mounted to the vessel inner wall.	See Paragraph 4.2.3
1.4.1.2.1-1.1.2.1.1-S	**Rogowski** coils mounted on outer surface of **vacuum vessel** via insulated supports	See Paragraph 4.2.4, 9D1600
1.4.1.9.1-1.1.2.1.1-S	**SSNPAs** bolt to **vessel**, supporting the diagnostic	See Paragraph 4.2.5 Drawings 9D11249 -9D11252
1.4.1.9.2-1.1.2.1.1-S	**iFLIP** is mounted to the inside **vessel** wall	See Paragraph 4.2.6, Drawing 9D1148

1.4.1.9.3-1.1.2.1.1-S	**sFLIP** mounted to the inside **vessel** wall	See Paragraph 4.2.7 Drawing 9D1480, 9D11483
1.1.2.1.1-1.4.1.23-S	**Blackening** required where optics views intersect the **vessel**	See Paragraph 4.2.8, Drawings 9D11242, 9D11264, 9D11266

4.2.1.1. Vessel Wall - HF MHD Sensors

Interface Notes:

- This interface is an existing component and not considered part of recovery scope but is included for completeness.

ICD-VVS-DIA-001: The interface will be defined in a subsequent version of this ICD.

4.2.1.2. Vessel Wall – TAE Antennas

Interface Notes:

- This interface is an existing component and not considered part of recovery scope but is included for completeness.

ICD-VVS-DIA-002: The interface is identified in Drawing 9D11266.

4.2.1.3. **Inner Vessel Wall – Sample Coupons/Faraday Cups**

Interface Notes:

- This interface is an existing component and not considered part of the recovery scope.

ICD-VVS-DIA-003: The interface will be defined in a subsequent version of this ICD.

4.2.1.4. Vessel – Rogowski Coils

Interface Notes:

- This interface is an existing component and not considered part of recovery scope but is included for completeness.

ICD-VVS-DIA-004: The Rogowski coil runs along the exterior of the vessel and uses a support bracket that is mounted on the Upper PF5 structure at Bay KL as defined in Drawing 9D1600.

4.2.1.5. Inner Vessel Wall – SSNPAs

Interface Notes:

- This interface is an existing component and not considered part of recovery scope but is included for completeness.

ICD-VVS-DIA-005: Drawings 9D11249 through 9D11252 identify the locations of the SSNPAs at the Bay I Tangent, Bay L Active Radial, BayB Passive Radial, and Bay L Active Radial SSNPA.

4.2.1.6. Inner Vessel Wall – iFLIP

Interface Notes:

- This interface is an existing component and not considered part of recovery scope but is included for completeness.

ICD-VVS-DIA-006: The IFLIP probe Overview is provided in the Drawing 9D1148. The iFLIP Box installation is installed in a channel located on the mid-plane near Bay G.

4.2.1.7. Inner Vessel Wall – sFLIP

Interface Notes:

- This interface is an existing component and not considered part of recovery scope but is included for completeness.

ICD-VVS-DIA-007: The sFLIP probe Overview is provided in the Drawings 9D1480, 9D11483. The sFLIP Box installation is installed in a channel located on the mid-plane near Bay I.

4.2.1.8. Inner Vessel Wall – Blackening

ICD-VVS-DIA-008: The blackening material will be mounted to the vessel walls as shown in Drawings 9D11242, 9D11264, 9D11266. The Blackening is placed around Bay I, J, and L as shown in Figure 1.

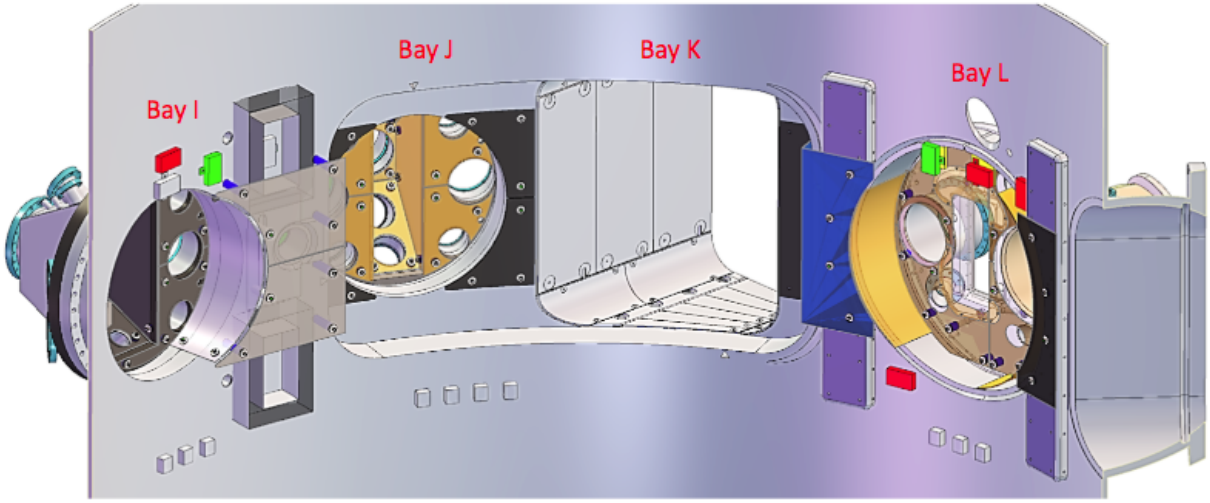


Figure 1. Vessel Wall Blackening

4.2.2. Spatial Interface

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

Identifier	Interface	References
1.1.2.1.1-1.4.1.7-Sp	Special **vessel** penetrations designed to provide appropriate views for the **BES diagnostic.**	See Paragraph 4.2.2.1, Drawing 9D1819
1.1.2.1.1-1.4.1.6-Sp	Special **vessel** penetrations designed to provide appropriate views for the **T-FIDA** diagnostic.	See Paragraph 4.2.2.2, Drawing 9D11018
1.4.1.5.2-1.1.2.1.2-Sp	**Poloidal CHERS** optics assemblies reside within the arches of the **umbrella structure**	See Paragraph 4.2.2.3

4.2.2.1. Vessel Penetrations – BES Diagnostic

Interface Notes:

- This interface is an existing component and not considered part of recovery scope but is included for completeness.

ICD-VVS-DIA-009: The BES penetration is located near Bay B as identified in Drawing 9D1819.

4.2.2.2. Vessel Penetrations – T-FIDA

Interface Notes:

- This interface is an existing component and not considered part of recovery scope but is included for completeness.

ICD-VVS-DIA-009: The Toroidal FIDA penetrations are located near Bays F & L as identified in Drawing 9D11018.

4.2.2.3. P-CHERS – Umbrella Structure

Interface Notes:

- This interface is an existing component and not considered part of the recovery scope.

ICD-VVS-DIA-010: The interface will be defined in a subsequent version of this ICD.

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
1.1.2.1.1-1.4.1.2.2-D	**Poloidal Flux Loops** mounted on the inner and outer surfaces of **vacuum vessel;** leads mounted to vessel surface.	See Paragraph 4.5.1, Drawing 9D1095, DC1238

4.5.1. Flux Loops – Vacuum Vessel

Interface Notes:

- This interface is an existing component and not considered part of recovery scope but is included for completeness.
-

ICD-VVS-DIA-011: The flux loop locations are identified in Drawing DC1238. The External Flux Loop CWS are identified in Drawings 9D 1095 Sheet 235 (Lower) and 240 (Upper).

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
1.1.2.1.1-1.4.1.22-V	Numerous **diagnostic port covers** are mounted to vacuum flanges on the **vessel**. These port covers often support multiple diagnostics, and so cannot be attributed to any single diagnostic system.	See Paragraph 4.7.1
1.4.1.3-1.1.2.1.1-V	Laser beam entrance and exit flight tubes (with windows) on vacuum vessel ports; blackening of inner vessel wall required within field of view of the collection optics, in order to reduce stray light	
1.4.1.9.1-1.1.2.1.1-V	SSNPAs bolt to vessel, making vacuum seal	
1.4.1.9.3-1.1.2.1.1-V	sFLIP vacuum boundary is a window mounted on a vessel flange	Drawing C-9D1480
1.4.1.9.4-1.1.2.1.1-V	fusion products detector interfaces to the vessel via a TIV (future)	
1.4.1.5.1-1.1.2.1.1-V	CHERS background view is via window mounted directly to vessel	

4.7.1. Port Covers – Vacuum Vessel

Interface Notes:

- **XX**

ICD-VVS-DIA-001: The Flange name and location

ICD-VVS-DIA-001: The Flange seal type

4.7.2. Port Covers – Vacuum Vessel

Interface Notes:

- **XX**

ICD-VVS-DIA-001: The Flange name and location

ICD-VVS-DIA-001: The Flange seal type

4.7.3. Port Covers – Vacuum Vessel

Interface Notes:

- **XX**

ICD-VVS-DIA-001: The Flange name and location

ICD-VVS-DIA-001: The Flange seal type

4.7.4. Port Covers – sFLIP

Interface Notes:

- This interface uses existing drawings and is not part of recovery
- Drawing states target location may vary

ICD-VVS-DIA-001: The Flange is a Port Wire Feed through per Drawing C-9D1480. and may be located on Port J.

4.7.5. Port Covers – Vacuum Vessel

Interface Notes:

- **XX**

ICD-VVS-DIA-001: The Flange name and location

ICD-VVS-DIA-001: The Flange seal type

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.