



ENG-064 - ICD - INTERFACE CONTROL DOCUMENT

Vacuum Vessel Structure - Gas Delivery System Interface Control Document

NSTXU_1-1-2_ICD_100

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National Spherical Torus eXperiment Upgrade

National Spherical Torus Experiment Upgrade

Interface Control Document

VACUUM VESSEL STRUCTURES : GAS DELIVERY SYSTEM

NSTX-U-VVS-GDS-ICD-0

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Change Record

Revision	Date	Description of Change
0	November 15, 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 Structures and the Gas Delivery System. The interface locations and boundaries that connect the Vacuum Vessel Structures to the Gas Delivery 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 Gas Delivery and Injection System consists of three Low Field Side Injectors, High Field Side Injectors, Lower Divertor Hi Flow injections system, Massive Gas Injectors, Private Flux Region Fueling and Supersonic Gas Injector (future). 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
- Gas Delivery System
- 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-GDS-X] where X is a sequential count beginning with 001, VVS represents Vacuum Vessel Structures and GDS represents Gas Delivery System. There is also a unique identifier for all interfaces in the format [#####-#####-X]. The identifier is a concatenation of two level 5 SBS 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 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	
					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	
		Gf				Si,Gf,Va		Me	Wall Conditioning System				Si,Sw		Si	
		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	Me,Ep,Si,Di,Gf	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

Vacuum Vessel Structure	Me
	Gas Delivery 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- 1.3.4.3.2-S	Lower MGI valve is supported by the lower umbrella	See Paragraph 4.2.1.1, Drawing EA3511
1.1.2.3.2- 1.3.4.2.1-S	Some main chamber fueling systems are supported from the outer PF supports	See Paragraph 4.2.1.2, Drawing EA3008

4.2.1.1. MGI - Umbrella

ICD-VVS-GDS-001: The umbrella has 4 - 3/8-16 UNC-2A x 1 1/2" LG THREADED WELD STUDs mounted in the lower umbrella near Bay F as identified in the weld stud view of drawing EA3511. The valve connects to the Organ Pipe on Bay F. Figure 1 provides a picture of the MGI connector.

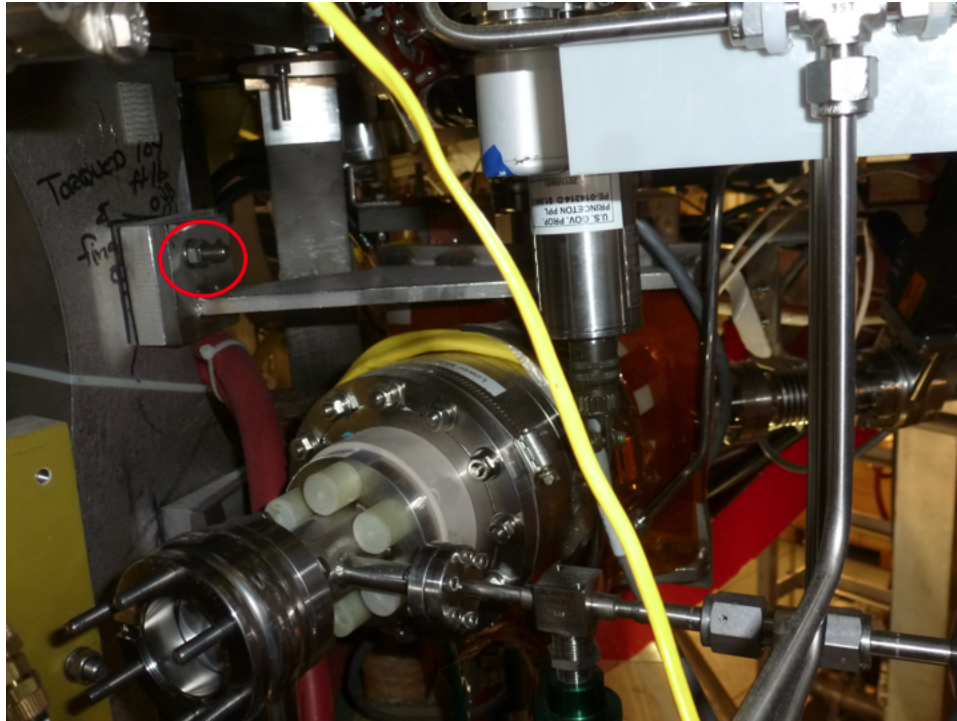


Figure 1. MGI bolted to Umbrella

4.2.1.2. Chamber Fueling System – PF Supports

ICD-VVS-GDS-002: The Lower Gas injection system is mounted using $\frac{1}{2}$ " G11 board to the PF-3 supports using 4 holes that are field fit to match the support rods between Bays D&E per Note 3 of Drawing EA3008.

ICD-VVS-GDS-003: The Lower Gas injection system is mounted using $\frac{1}{2}$ " G11 board to the PF-5 supports at approximately Bay H as shown in Figure 2. During a walkdown in the field of the existing Gas injectors, there was a an injector mounted on the lower PF-4 support as shown in Figure 3.

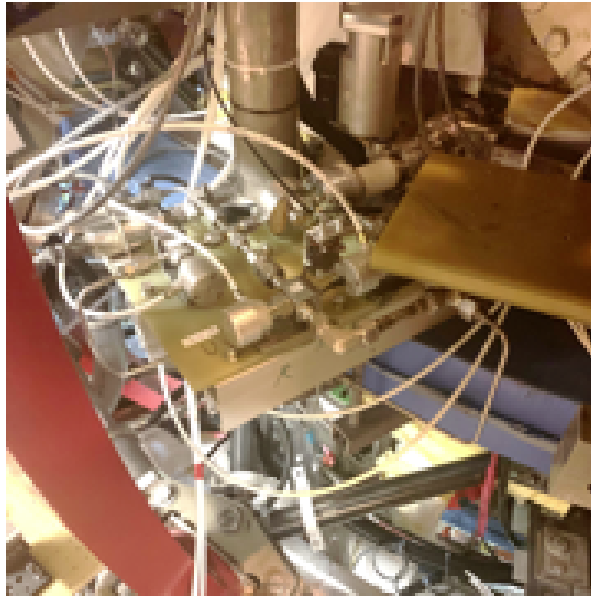


Figure 2. Gas Injection System on PF-5 Support

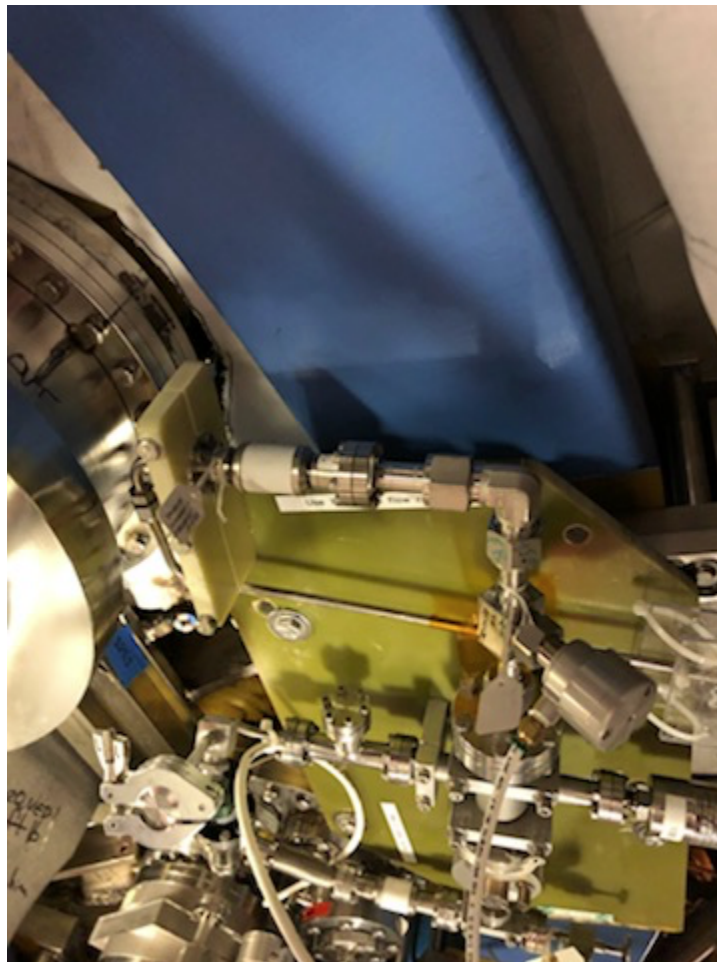


Figure 3. Mount on Lower PF-4 support

4.2.2. Spatial Interface

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

Identifier	Interface	References
1.1.2.1.2- 1.3.4.3.1-Sp	Gas lines for high-field side injectors enter the umbrella through the arches of the umbrella structure	See Paragraph 4.2.2.1
1.1.2.1.2- 1.3.4.3.2-Sp	Gas lines and electrical signals for massive gas injectors (MGI) enter the umbrella through the arches of the umbrella structure	See Paragraph 4.2.2.2, Drawing EA3517
1.1.2.1.2- 1.3.4.3.2-Sp	Vacuum piping for the lower massive gas injector enter the umbrella through the arches of the umbrella structure	See Paragraph 4.2.2.3, Drawing EA3517
1.1.2.1.2- 1.3.4.2.5-Sp	Gas lines for the private flux region injectors enter the umbrella through the arches of the umbrella structure	See Paragraph 4.2.2.4 Drawing EA3517, E-EA3543
1.1.2.1.1- 1.3.4.2.1-Sp	The injectors for the gas injection systems are typically mounted on flange welded directly to the vessel.	See Paragraph 4.2.2.5 Drawings EA3512, EA3513, DB1485

4.2.2.1. High Field Side Injectors - Umbrella

Interface Notes:

- High Field Side Injectors is not part of the recovery scope but is included for completeness.

ICD-VVS-GDS-004: The High Field Side Injector run through the Umbrella to get to the center stack structure. The Ex-vessel components are connected next to the Umbrella as shown In Figure 5. There are a total of four injectors aligned with Bays C, E, I, and K.

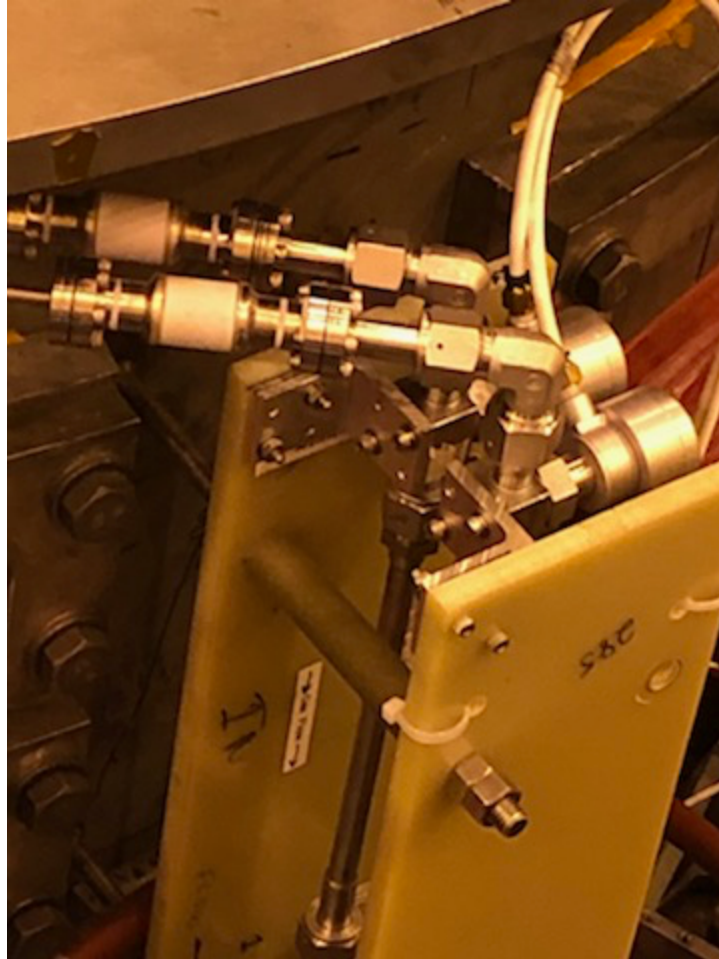


Figure 5. Injector mounted to umbrella

4.2.2.2. MGI - Umbrella

Interface Notes:

- MGI is not part of the recovery scope but is included for completeness.

ICD-VVS-GDS-005: The MGI signals and gas lines run through the umbrella is around Bay F (lower) and between Bay K&L Upper as indicated in Drawing EA3517.

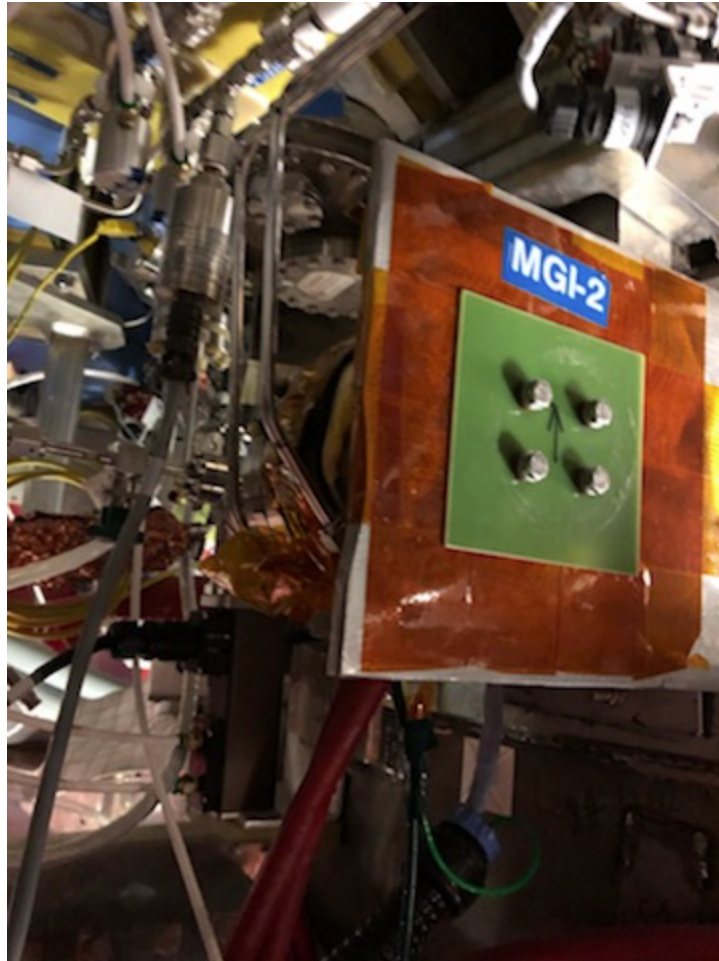


Figure 6. MGI Mounted to Umbrella

4.2.2.3. MGI - Umbrella

ICD-VVS-GDS-006: The Bay I Midplane MGI is mounted to the vacuum vessel with a mount using 3/8-16UNC-2B HEX NUTs as shown in Drawing EA3512. Upper MGI Assmbly is shown in Drawing EA3513.

4.2.2.4. Private Flux Injectors - Umbrella

ICD-VVS-GDS-007: The injector is mounted at 285 ° (Bay J) upper organ pipe and 15 ° (Bay A) lower organ pipe.

ICD-VVS-GDS-008: The injector is mounted to the vessel using a G-10 board.

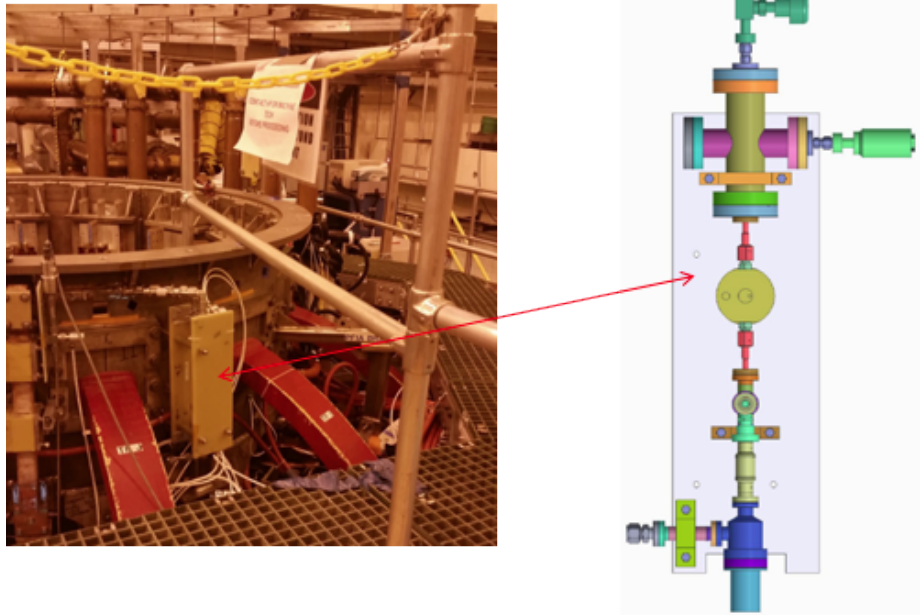


Figure 2. PFR Injector Manifold

4.2.2.5. Gas Injection - Vessel

ICD-VVS-GDS-009: There are three ports 2 3/4 CF ports that are welded to the vessel as shown in Drawing DB1485. The location is shown view B-B.

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		

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
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 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.