Interface Control Document CENTER STACK STRUCTURE : GAS DELIVERY

Interface Document: NSTXU_1-1-3-3-6_IC_100

REVISION 0

October 17, 2019

PREPARED BY:	**Kathleen Lukazik**	10/11/2019 12:41:35 PM
	Kathleen Lukazik,	
REVIEWED BY:	**Robert A. Ellis**	10/11/2019 2:05:41 PM
	Robert A. Ellis,	
REVIEWED BY:	**George D. Loesser**	10/11/2019 2:51:56 PM
	George D. Loesser,	
REVIEWED BY:	**Peter Dugan**	10/17/2019 11:10:55 AM
	Peter Dugan,	
REVIEWED BY:	**Dang Cai**	10/17/2019 5:00:10 PM
	Dang Cai,	
APPROVED BY:	**Yuhu Zhai**	10/17/2019 5:17:22 PM
	Yuhu Zhai,	

PRINCETON PLASMA PHYSICS LABORATORY
P.O. BOX 451
PRINCETON, N.J. 08543

National Spherical Torus eXperiment Upgrade

National Spherical Torus Experiment Upgrade

Interface Control Document

CENTER STACK STRUCTURE: GAS DELIVERY SYSTEM

NSTX-U-ICD-CSS-GDS-0

Revision 0
May 22, 2018

_____
Prepared By: P. Dugan, Systems Engineering

_____
Reviewed By: D. Loesser, VVIH RE

_____
Reviewed: D. Cai, Gas Delivery RE

_____
Reviewed By: Y. Zhai, NSTX-U Project Engineer

Change Record

Revision	Date	Description of Change
0	May 22,2019	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.

[4] NSTX-U Gas Delivery and Injection System Parameters, NSTX-U-RQMT-RD-014-01

1. Purpose

This document describes the various interfaces between the following subsystems: Center Stack Structure and the Gas Delivery System. The interface locations and boundaries that connect the Center Stack Structure to the Gas Delivery System are identified based on different interface types.

2. Scope

The Center Stack Structure consists of the Center Stack Casing, Pedestal, PF-1a Support Structures, PF-1b Support Structures, and PF-1c Support Structures. The Gas Delivery System consists of Outboard Divertor injections system, Massive Gas Injectors, High Field Side Injectors, and Private Flux Region Fueling. 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 Systems
- 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-GDS-X] where “X” is a sequential count beginning with 001, CSS represents Center Stack Structure, 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 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,Di, Pe			Th			Me,Th, Pe	Me		Me, Di, Pe			Di		
		Vacuum Vessel Structure	Me		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.

Centerstack Structure	Me
Gf, Va	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
1.1.3.3.11-1.3.4.3.2-S	The **MGI** valve sits on the **PF-1a support** or equivalent, providing mechanical support where it is connected to an organ pipe.	See Paragraph 4.2.1.1

4.2.1.1. Massive Gas Injection - PF-1a Coil

Interface Notes:

- The Massive Gas Injector is not a part of the recovery scope, but is included for completeness.

ICD-CSS-GDS-001: The MGI Valve is bolted on the corners of the interface to the common flange as shown in Figure 1. The four bolts are located at the bottom of the valve mount and are bolted to the common flange.

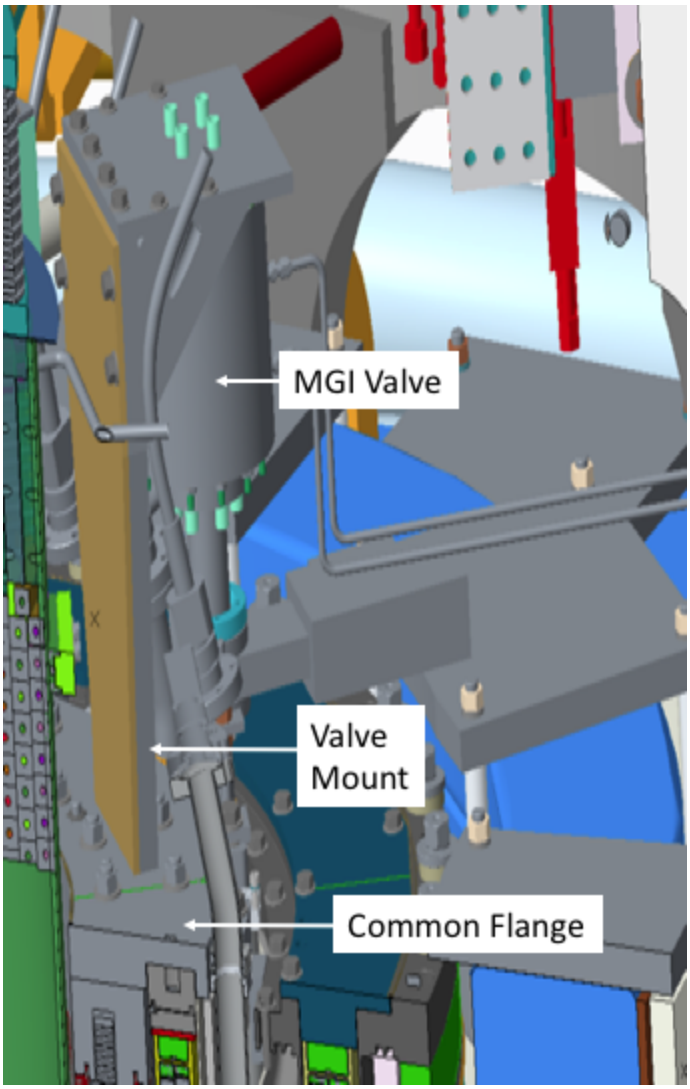

Figure 1. MGI Valve mounted on the Common Flange

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		

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
1.3.4.3.1-1.1.3.3.6.Gf	**High field side injector gas** enters the in-vessel tubing at the end of the organ pipe flange on the **Center Stack Casing**.	See Paragraph 4.6.1.1, Ref 4, Drawing EA3517
1.3.4.3.2-1.1.3.3.6.Gf	**Massive gas injector** gas enters at the end of the organ pipe flange on the **Center Stack Casing**.	See Paragraph 4.6.1.2, Ref 4, Drawing EA3517
1.3.4.2.5-1.1.3.3.6.Gf	**Private flux region fueling** gas enters at the end of the organ pipe flange on the **Center Stack Casing**.	See Paragraph 4.6.1.3, Ref 4, Drawing EA3517

Interface Notes:

- Drawing 9D11556, as shown in Figure 2, provides the locations for the gas feeds. The gas injection tubes that run to the Center Stack First Wall are identified by the dashed lines originating from Bays I, D, and C.

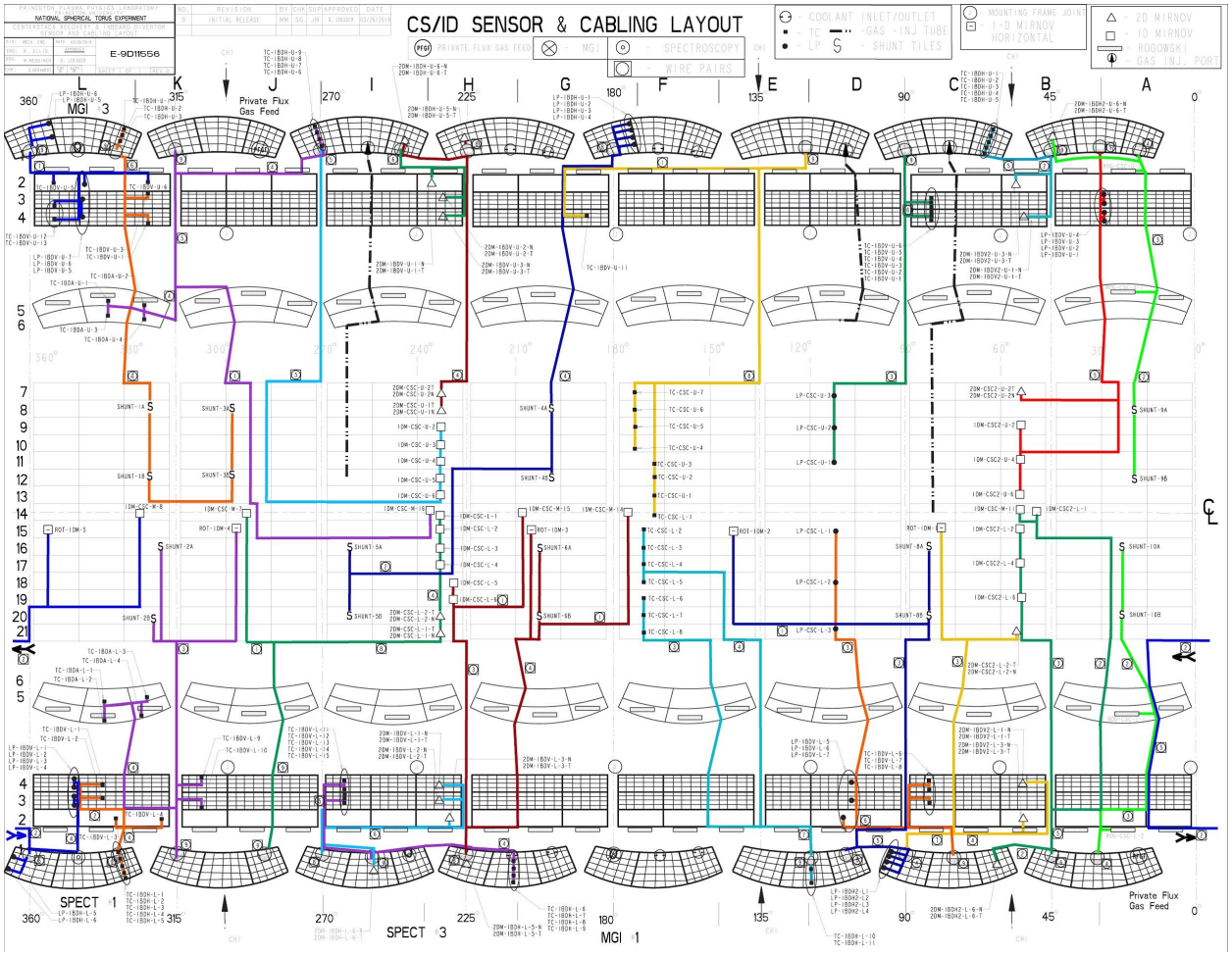

Figure 2. Center Stack Sensor Cabling and Gas Flow Diagarm

4.6.1.1. High Side Field Injector to Organ Pipes

Interface Notes:

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

ICD-CSS-GDS-002: There are three high field side injectors identified in Ref 4 and shown in Figure 2. They are located: Bay C through the 75 degree organ pipe, Bay I through the 255 degree organ pipe, and Bay E through the 105 degree organ pipe as shown by the dashed lines of Figure 2.

ICD-CSS-GDS-001: The maximum pressure rate is 2500 torr.

4.6.1.2. Massive Gas Injection to Organ Pipes

Interface Notes:

- The Massive Gas Injector is not a part of the recovery scope, but is included for completeness.
- There are three MGIs identified in the requirements document yet Figure 2 shows two the other is on the midplane of the vessel.

ICD-CSS-GDS-003: The MGI gas injectors are shown on Drawing 2 and consist of two Injectors: MGI1 Upper 345 degree Organ Pipe and MGI2: Lower 180 degree Organ Pipe.

ICD-CSS-GDS-004: The pressure rate is between 1000 - 5000 torr.

ICD-CSS-GDS-005: The flow rate is between 50 - 125 Tl/s.

4.6.1.3. Private Flux Region to Organ Pipes

ICD-CSS-GDS-006: The location of the Private Flux Region Injectors are identified in Figure 2. They are located in the Upper 285 degree organ pipe and the Lower 15 degree organ pipe. The type of gas is typically Deuterium, but can be adjusted based on the research requirements.

ICD-CSS-GDS-007: The pressure rate is between 50 - 5000 torr.

ICD-CSS-GDS-008: The flow rate is between 10 - 250 Tl/s.

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
1.3.4.3.1-1.1.3.3.6.Va	**High field side injector** gas has a vacuum interface to the casing at the end of the organ pipe flange on the **Center Stack Casing**.	See Paragraph 4.7.1, Drawing EA3517
1.3.4.3.2-1.1.3.3.6.Va	**Massive gas injector** has a vacuum interface at the flange on the end of the organ pipe flange on the **Center Stack Casing**.	See Paragraph 4.7.2, Drawing EA3517
1.3.4.2.5-1.1.3.3.6.Va	**Private flux region fueling** system has vacuum interface at the organ pipe flange on the **Center Stack Casing**.	See Paragraph 4.7.3, Drawing EA3517

4.7.1. High Side Field Injector to Center Stack Casing

Interface Notes:

- The High Side Field Injector is not a part of the recovery scope, but is included for completeness.
- Note the drawing shows a connection at 285 degrees. but neither is shown in Figure 2 nor Ref 4.

ICD-CSS-GDS-009: The vacuum is maintained by a valve as shown in Drawing EA3517 labeled Center Stack fueling.

4.7.2. MGI to Center Stack Casing

Interface Notes:

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

ICD-CSS-GDS-010: The vacuum is maintained by a valve as shown in Drawing EA3517.

4.7.3. Private Flux Fueling to Center Stack Casing

ICD-CSS-GDS-011: The vacuum is maintained by a Torus Interface Valve (TIV) that is installed on the injector manifold, as shown by the red ellipse in Figure 3.

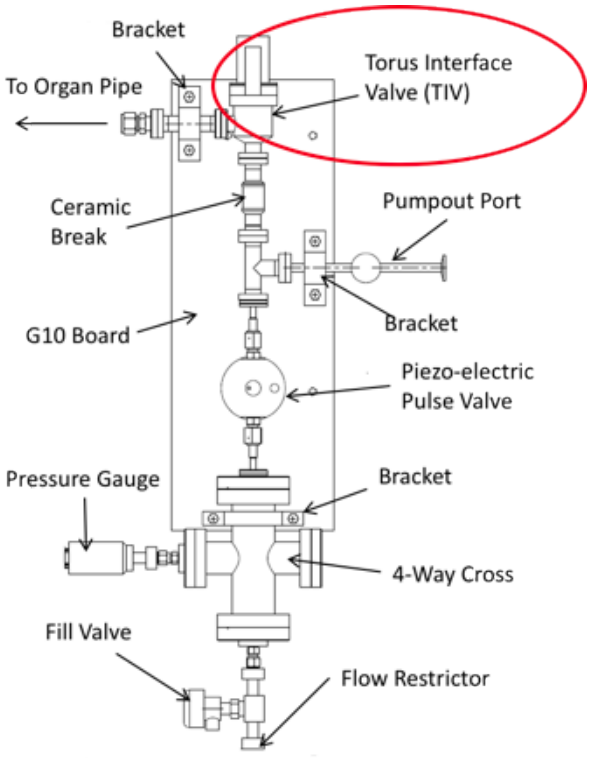

Figure 3. Private Flux Injector Manifold

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.