

# Wall Conditioning System - Gas Delivery System Interface Control

**Interface Document: NSTXU\_1-3-4\_IC\_100**

**REVISION 0**

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**PREPARED BY:**      **Peter Dugan**      9/11/2019 8:43:58 AM

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Peter Dugan,

**REVIEWED BY:**      **Yuhu Zhai**      9/11/2019 10:27:15 AM

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Yuhu Zhai,

**REVIEWED BY:**      **Dang Cai**      9/11/2019 11:16:16 AM

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Dang Cai,

**REVIEWED BY:**      **Peter Dugan**      9/11/2019 2:46:05 PM

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Peter Dugan,

**REVIEWED BY:**      **William R. Blanchard**      9/12/2019 9:36:11 AM

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William R. Blanchard,

**APPROVED BY:**      **Robert A. Ellis**      9/12/2019 10:57:26 AM

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Robert A. Ellis,

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**

### **WALL CONDITIONING SYSTEM : GAS DELIVERY SYSTEM**

NSTX-U-WCS-GDS-ICD

**Revision 0  
September 5, 2019**

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Prepared By: P. Dugan, Systems Engineering

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Reviewed By: D. Cai, Wall Conditioning RE

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Reviewed: W. Blanchard, Gas Delivery System COG

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Reviewed By: Y. Zhai, Project Engineer

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Approved By: R. Ellis, Chief Engineer

## Change Record

Revision	Date	Description of Change
0	September 5, 2019	Initial Release

# References

[1] GENERAL REQUIREMENTS DOCUMENT, NSTX-U-RQMT-GRD-001-01

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

# 1. Purpose

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

# 2. Scope

The Wall Conditioning System consists of Glow Discharge Cleaning (GDC), the Trimethylboron (TMB) System, and the Li Evaporator (LITER). 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:

- Wall Conditioning System
- 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-WCS-GDS-X] where X is a sequential count beginning with 001, WCS represents Wall Conditioning System 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,Si		
		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	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						Me	SI,Me	
			Gf,Va			Gf,SI		Gas Delivery System	Me	Va		SI,Sw		Me		
		Gf				SI,Gf,Va		Gf	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	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

Gas Delivery System	Gf
Me	Wall Conditioning 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
N/A		

### 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
1.3.4.1- 1.3.5.1.1-L	GDC and filament power supplies reside in the Gas Storage and Delivery cage in the gallery	See Paragraph 4.2.3.1, Drawing EA4500

#### 4.2.3.1. GDC & Filament Power Supplies – Gas Storage and Delivery Systems

**ICD-WCS-GDS-001:** The power supplies for the GDC and Filament Voltage Power Supplies are located in CTC-EE-449 in the GDC rack as defined in Drawing EA4500 Sheet 3. They are currently in two different caged locations; however, they do share a common PLC.

#### 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		
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#### Interface Notes:

- The PLC signals use the Vacuum Pumping PLC to control both the Wall Conditioning and Gas Delivery systems. These interfaces are addressed on the Vacuum Pumping to Gas Delivery and Wall Conditioning ICDs.

## 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
1.3.5.2- 1.3.4.2.1-G	dTMB system shares an injector location with a main chamber valve	See Paragraph 4.6.1.1
1.3.5.2- 1.3.4.3.1-G	dTMB system shares an injector location with a high-field side injector	See Paragraph 4.6.1.2

1.3.5.2- 1.3.4.2.3-G	Lower dTMB feed is shared with a divertor gas injector	See Paragraph 4.6.1.3
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#### 4.6.1.1. TMB – Main Chamber Valve

**Interface Notes:**

- Drawing could not be identified for this configuration a visual inspection in the Test Cell and discussions with the Responsible Engineer verified the design.

**ICD-WCS-GDS-002:** There is a shared port for the TMB and the main chamber valve. There is a common TIV and a “T” connection to share the location of the port. In addition to the TIV, both TMB and the main chamber valve have interlocks preventing operation of both simultaneously.

#### 4.6.1.2. TMB – High Field Side Injector

**Interface Notes:**

- Drawing could not be identified for this configuration a visual inspection in the Test Cell and discussions with the Responsible Engineer verified the design.

**ICD-WCS-GDS-003:** There is a shared port for the TMB and high field side injector on the Center Stack Organ Pipe. There is a common TIV and a “T” connection to share the location of the port. In addition to the TIV, both TMB and the high field side injectors have interlocks preventing operation of both simultaneously.

#### 4.6.1.3. TMB – Divertor Gas Injector

**Interface Notes:**

- Drawing could not be identified for this configuration a visual inspection in the Test Cell and discussions with the Responsible Engineer verified the design.

**ICD-WCS-GDS-004:** There is a shared port for the TMB and the Divertor Gas Injector. There is a common TIV and a “T” connection to share the location of the port. In addition to the TIV, both TMB and the Divertor have interlocks preventing operation of both simultaneously. Figure 1 provides a picture of the “T” connection (red ellipse) interconnecting the TMB and Gas injectors.

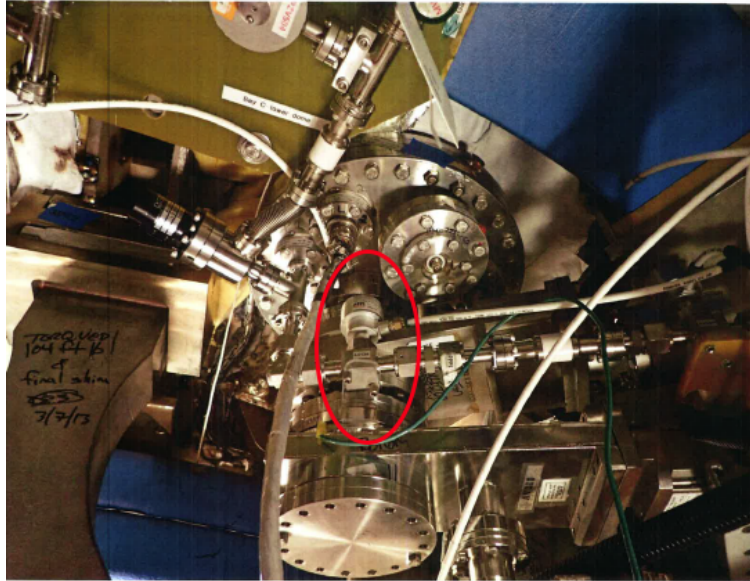


Figure 1. "T" connection connection TMB and Gas Lines

#### 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 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		
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## 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.

- The dTMB system exhausts through the D-Site Stack
- Boronization system valves controlled by compressed air via D- Site Instrument Air.