# Vacuum Pumping System - Wall Conditioning System Interface Contr

## Interface Document: NSTXU_1-3-1_IC_100

## REVISION 0

## September 12, 2019

| | | |
|---|---|---|
| **PREPARED BY:** | **Peter Dugan** | 9/11/2019 8:45:13 AM |
| | Peter Dugan, | |
| **REVIEWED BY:** | **Yuhu Zhai** | 9/11/2019 10:28:32 AM |
| | Yuhu Zhai, | |
| **REVIEWED BY:** | **Dang Cai** | 9/11/2019 11:19:35 AM |
| | Dang Cai, | |
| **REVIEWED BY:** | **Peter Dugan** | 9/11/2019 2:45:40 PM |
| | Peter Dugan, | |
| **REVIEWED BY:** | **William R. Blanchard** | 9/12/2019 9:36:48 AM |
| | William R. Blanchard, | |
| **APPROVED BY:** | **Robert A. Ellis** | 9/12/2019 10:58:05 AM |
| | 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

# VACUUM PUMPING SYSTEM: WALL CONDITIONING SYSTEM

NSTX-U-ICD-VPS-WCS-0

**Revision 0**
**September 5, 2019**

_____
Prepared By: P. Dugan, Systems Engineering

_____
Reviewed By: D. Cai, RE

_____
Reviewed By: B. Blanchard, VPS COG

_____
Reviewed By: Y. Zhai, Project Engineer

_____
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

[3] SYSTEM DESIGN DESCRIPTION, Vacuum and Fueling, NSTX-U-SDD-V&F-R0

# 1 Purpose

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

# 2 Scope

The Vacuum Pumping System consist of Valves, Vacuum Pumps and Roughing Pumps, Vacuum Gauges and Residual Gas Analyzers, and TIV, Shutter Actuation System, and Interspace Pumping System. The Wall Conditioning System consists of Glow Discharge Cleaning, the Trimethylboron (TMB) System, and the Li Evaporator (LITER). 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 Pumping System
- Wall Conditioning 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-VPS-WCS-X] where “X” is a sequential count beginning with 001, VPS represents Vacuum Pumping System, and WCS represents Wall Conditioning 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 and 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 | 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 | | | Me, Gf,Si | | | Gas Delivery System | Gf | Va | | Si,Sw | | Me | |
| | | 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 Pumping System | Si |
| Si, Gf, Va | Wall Conditoning 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 |
|---|---|---|
| N/A | | |

### 4.2.4 Wall/Floor Penetration Interfaces

This identifies any interfaces between the system elements and 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 |
|---|---|---|
| 1.3.1.5-1.3.5.3-Si | Probe Drive Control of the LITER position. | See Paragraph 4.4.1, Drawing AE6002, AE6006 |
| 1.3.1.3-1.3.5.4-Si | Prevent Shutter/TIV movement when shroud is inserted. | See Paragraph 4.4.2, Drawing EA5500 |

### 4.5.1 Probe Drive Control - LITER

**ICD-VPS-WCS-001:** The interface between the Vacuum systems and LITER controls is included in drawing AE6002 Sheet 14. The LITER rack layout is identified in drawing AE6006 Sheet 1.

### 4.5.2 Shutter Actuation – Granule injector

**ICD-VPS-WCS-002:** The Shutter Action systems and the Lithium Pellet Injector is identified in drawing EA5500 Sheet 35.

## 4.6 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 | | |

## 4.7 Gas/Fluid Interfaces

This paragraph has two different types of interfaces: Gas and Fluid.

### 4.7.1 Gas Interfaces

This identifies any interfaces between the system elements that use any type of gas (e.g., He).

| Identifier | Interface | References |
|---|---|---|
| 1.3.1.3-<br>1.3.5.3-G | **TIV and shutter actuation** system controls TIV on the LITER assembly, including preventing TIV closure when **LITER** inserted. | See Reference 4.6.1.1, Drawing ED1024, Ref 3 |

| | | |
|---|---|---|
| 1.3.5.4-1.3.1.3-G | **Shutter actuation** of the shutter on the **Granule injector (LGI)** here air line connects to valve or shutter mechanism. | See Reference 4.6.1.2, Ref 3, Drawing 9D11040 |

**Interface Notes:**

- There is gas going from the WCS to the VPS (such as the helium gas for the dTMB process) which the vacuum system has to pumpout.

#### 4.7.1.1 Shutter Activation - LITER

**ICD-VPS-WCS-003:** The LITER Shutter is defined in Drawing ED1024 and Shutter operation is described in Paragraph 11.1.3.1 of Ref 3. LITER control systems connect to NSTX-U TVPS PLC to obtain information such as shutter and TIV status. The LITER state needs to be either in the Home/Retracted or Parked to operate with the TIV and Shutter.

#### 4.7.1.2 Shutter Activation – Granule Injector

**ICD-VPS-WCS-004:** The granule injector cube is connected to NSTX-U at the midplane of Bay J through an 8" toroidal interface valve (TIV). From the controls standpoint, the system sends out a pair of dry contact relay signals to the TVPS system to relay the status of the gate valve protection Baffle/Shutter so that the TIV is not accidentally closed on an extended baffle. The Gas Injector state needs to be Home/Retracted on order for the Shutters to be in the proper state.

### 4.7.2 Fluid Interfaces

This identifies any interfaces between the system elements that use any type of fluid (e.g., ionized water).

| Identifier | Interface | References |
|---|---|---|
| 1.3.1.6-1.3.5.2-F | The water cooling system supplies cooling water to TMB pump, MP08 Pump Group (PG-08). | See Paragraph 4.6.2.1, Drawing EA1518 |

#### 4.7.2.1 Cooling Water System - TMB

**Interface Notes:**

- This is a new design and will be implemented in the near future due to the addition of a Chiller (C01)

**ICD-VPS-WCS-005:** The type of fluid is chilled water is sent to the TMB vacuum pump and is identified as PG-08 as shown in drawing EA1518.

**ICD-VPS-WCS-006:** The connection consists of a ½" line.

## 4.8 Vacuum Interfaces

This identifies any interfaces between the system elements that pertain to the Vacuum.

| Identifier | Interface | References |
|---|---|---|
| 1.3.5.2-1.3.1.1-V | **TMB** and the **Vacuum System** PLC at the 6" TVPS Foreline. | See Paragraph 4.7.1, Ref 3 |

### 4.8.1 TMB and Vacuum PLC

**ICD-VPS-WCS-007:**The torus vacuum pumping system (TVPS) consists of two 2650 L/s TMPs. During dTMB operations the TVPS system is reconfigured. Valves AV-18, AV-19, and AV- 20 are closed isolating TMP-2 and the backing pump (PG-02) from the dTMB system. TMP-1 foreline valve AV-14 is closed, crossover valve AV-25 is opened, and PG-08 isolation valve is opened routing all TMP-1 exhaust gas though the TMB skid backing pump PG-08.

## 4.9 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 | | |

## 4.10 Thermal Interfaces

This identifies any interfaces between the system elements that pertain to Thermal characteristics.

| Identifier | Interface | References |
|---|---|---|
| N/A | | |

## 4.11 Plasma Interfaces

This paragraph has two different types of interfaces: Plasma and Eddie/Halo Current.

### 4.11.1 Plasma Interfaces

This identifies any interfaces between the system elements with the Plasma.

| Identifier | Interface | References |
|---|---|---|
| N/A | | |

### 4.11.2 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.