



# ENG-064 - ICD - INTERFACE CONTROL DOCUMENT

## Vacuum Pumping System - Operations and System Safety Interface Control Document

*NSTXU\_1-3-1\_ICD\_101*

Work Planning #:  
Effective Date: **03/09/2020**  
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# **National Spherical Torus eXperiment Upgrade**

## National Spherical Torus Experiment Upgrade

### **Interface Control Document**

### **VACUUM PUMPING SYSTEM: OPERATIONS & SAFETY SYSTEMS**

NSTX-U-VPS-OSS-ICD-0

**Revision 0**  
**January 18, 2020**

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### Change Record

| Revision | Date             | Description of Change |
|----------|------------------|-----------------------|
| 0        | January 18, 2020 | Initial Release       |
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## 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 REQUIREMENTS DOCUMENT, Operations and Safety Systems, NSTX-U-RQMT-SRD-012-00.
- [4] REQUIREMENTS DOCUMENT, Centralized Control System, NSTX-U-RQMT-RD-025-00.

# 1. Purpose

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

# 2. Scope

The Vacuum Pumping System consists of vacuum pumps, valves, TIV & Shutter Actuation System, and Interspace Vacuum Pumping System. The OSS consists of the Personnel Safety System - Safety Instrumented System, Trapped Key System, Configuration Managed Safeguards, Centralized Control System, Vessel and Diagnostic Ground Systems, Radiation Monitoring System, and Test Cell Oxygen Deficiency Monitor. 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
- Operations & Safety 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-VPS-OSS-X] where “X” is a sequential count beginning with 001, VPS represents Vacuum Pumping System, and OSS represents Operations & Safety Systems. 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. References 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<br>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                           |
|                          |                      |                         |                        |         | 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                         |
|                       | Operations & System Safety |

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 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                          |
|--------------------------|---------------------------------------------------------------------------------------|-------------------------------------|
| 1.7.3.2.2-<br>1.3.1.4-Si | Information is passed between the <b>Ground Fault Monitor and Vacuum System PLCs.</b> | See Paragraph 4.4.1, Drawing EA1500 |

|                          |                                                                                                                               |                                                     |
|--------------------------|-------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------|
| 1.3.1.4-<br>1.7.3.2.2-Si | Control/status signals at connector on the Vacuum PLC.                                                                        | See Paragraph 4.4.1, Drawing EA3500                 |
| 1.3.1.4-<br>1.7.3.8-Si   | CCS provides equivalent to previously existing "No-Facility ESTOP" and "LOOP SET" equivalent signals to the vacuum system PLC | See Paragraph 4.4.2, Drawing EA1500, EA3500, EA4500 |

#### 4.4.1. Ground Fault Monitor – Vacuum Pumping PLCs

**Interface Notes:**

- The first two defined interfaces in the table are similar. As a result, they are both addressed in this section.

**ICD-VPS-OSS-001:** Permissives and status information is exchanged with the Ground Fault monitor the TVPS as identified in the Network Diagram Drawing EA1500 Sheet 105.

**ICD-VPS-OSS-002:** The GFM and TVPS PLCs exchange the permissive and signals using six fiber optic cables.

#### 4.4.2. Vacuum Pumping System PLC - CCS

**Interface Notes:**

- The TVPS PLC controls the Gas Delivery System and Wall Conditions System as indicated in Drawing EA1500 Sheet 105.
- The Glow Discharge System Drawing identified in Drawing EA4500 Sheet 11 has the same cabling identified in Drawing EA3500 Sheet 60 and is included for completeness.
- Drawing EA3500 Sheet 60 is labeled as MGI as the same signals are sent to the MGI and TVPS via a "T" connection.

**ICD-VPS-OSS-003:** The CCS provides NO-ESTOP and Loop Set signals used by the TVPS PLC as identified in Drawing EA3500 Sheet 60.

**ICD-VPS-OSS-004:** The signals are 120 VAC.

## 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.