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PRINCETON PLASMA PHYSICS LABORATORY

ENG-064 - ICD - INTERFACE CONTROL DOCUMENT

Test Cell - Bakeout Systems Interface Control Documents

NSTXU_1-8-1-1_ICD_101

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National Spherical Torus eXperiment Upgrade

National Spherical Torus Experiment Upgrade

Interface Control Document

TEST CELL :
BAKEOUT SYSTEM

NSTX-U-ICD-TCS-BOS-0

Revision 0
December 14, 2019

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Change Record

Revision	Date	Description of Change
0		Initial Release

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References

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

[2] SYSTEM REQUIREMENTS DOCUMENT, Test Cell, NSTX-U-RQMT-SRD-010-02

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

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1. Purpose

This document describes the various interfaces between the following subsystems: Test Cell and the Bakeout System. The interface locations and boundaries that connect the Test Cell to the Bakeout System are identified based on different interface types.

2. Scope

The Test Cell consists of the platforms, cable trays, racks, penetrations, floor, and crane.
The Bakeout System consists of the Helium Heating and Cooling System, Helium Skid, Ex-Vessel Helium Manifolds, In-Vessel Helium Lines, Bakeout Bus Bar, and Helium Feedthroughs. The scope of this document addresses any defined interfaces between these identified system elements.

3. Responsibilities

The interfaces are managed between the following organizations:

- Test Cell
- Bakeout 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-TCS-BOS-X] where X is a sequential count beginning with 001, TCS represents Test Cell and BOS represents Bakeout 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.

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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

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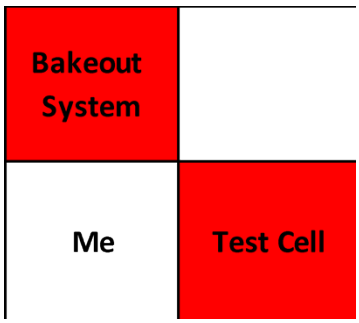
Plasma Facing Components	Me,Th, Pe		Me,Th, Va,Pe						Me	Me	Me, Pe		Me			
	In-Vessel Structures	Me,Di, Pe			Th			Me,Th, Pe	Me		Me, Pe			Di		
		Vacuum Vessel Structure			Me,Va	Me, Va	Me	Me, Th, Pe	Me	Me,Va	Me,Di, Va		Si	Di, Me		
		Va	Centerstack Structures			Va, Th	Me, Gf	Me	Me					Di		
		Me	Me, Th, Ep	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



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.

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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
1.8.1.1.2-1.3.3.2.1-S	Trays support DC bakeout cabling	See Paragraph 4.2.1.1, Drawing EB1092
1.8.1.1-1.3.3.2-S	DC supplies supported by the platform	See Paragraph 4.2.1.2, Drawing EB1092
1.8.1.1-1.3.3.3.1-S	Skid on NTC floor, piping supported by walls and platform	See Paragraph 4.2.1.3
1.8.1.1.1-1.3.3.3.2-S	MTWS manifold pipes are supported from the test cell platforms	See Paragraph 4.2.1.4
1.8.1.1.1-1.3.3.1.2-S	Ex-vessel Helium manifold pipes are supported from the test cell platforms	See Paragraph 4.2.1.5
1.8.1.1.2-1.3.3.4-S	Trays support cables for bakeout PLC and control cabling	See Paragraph 4.2.1.6

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4.2.1.1. Trays- Bakeout

ICD-TCS-BOS-001: The 119’ platform supports two DC power supplies and provides individual cable trays for each conductor leading to the Bakeout Bus Bar. Drawing EB1092 provides the locations of the cable trays leading the the Bakeout Bus Bar.

4.2.1.2. DC Supplies - Platform

ICD-TCS-BOS-002: The 119’ platform supports two DC power supplies. The location of the power supplies is shown in Drawing EB1092.

4.2.1.3. Piping - Walls

ICD-TCS-BOS-003: The pipes are hung via unistrut. The unistrut is mounted to the platform using a threaded rod as shown in Figure 1.

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Figure 1. Pipe hanger supported from platform

ICD-TCS-BOS-004: The walls have channels to provide mounting hardware e.g., unistrut. Figure 2 shows the pipe mounting hardware that is attached to the wall via a piece of unistrut. Similarly, a pipe hanger is attached to another piece of unistrut to support the water pipe.

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Figure 2. Pipes supported by the wall

4.2.1.4. MTWS Manifold - Platform

Interface Notes:

- The manifold is connected to the vacuum vessel, however, the pipes leading up to the MTWS manifold are supported from the platform.

ICD-TCS-BOS-005: The water lines leading up to the manifolds are attached to the platform. The pipes are hung using standard pipe hangers that are connected to unistrut.

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Figure 3. Water Lines feedling manifolds supported from platform

4.2.1.5. Helium Manifold - Platform

Interface Notes:

- The In-vessel and ex-vessel helium manifold is dircetly connected to the vacuum vessel. However, the pipes leading up to the manifolds are supported from the platform.

ICD-TCS-BOS-006: The pipe hangers for the helium lines are supported by the 119’ platform as shown in Figure 4.

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Figure 4. Helium lines feeding the manifold supported from platform

4.2.1.6. Trays - Bakeout PLC cables

ICD-TCS-BOS-007: The cable trays contain low-power signal cables that run from the PLC as shown in Figure 5. Conduits are used to get from the PLC enclosure to the cable tray as shown in the center of Figure 5.

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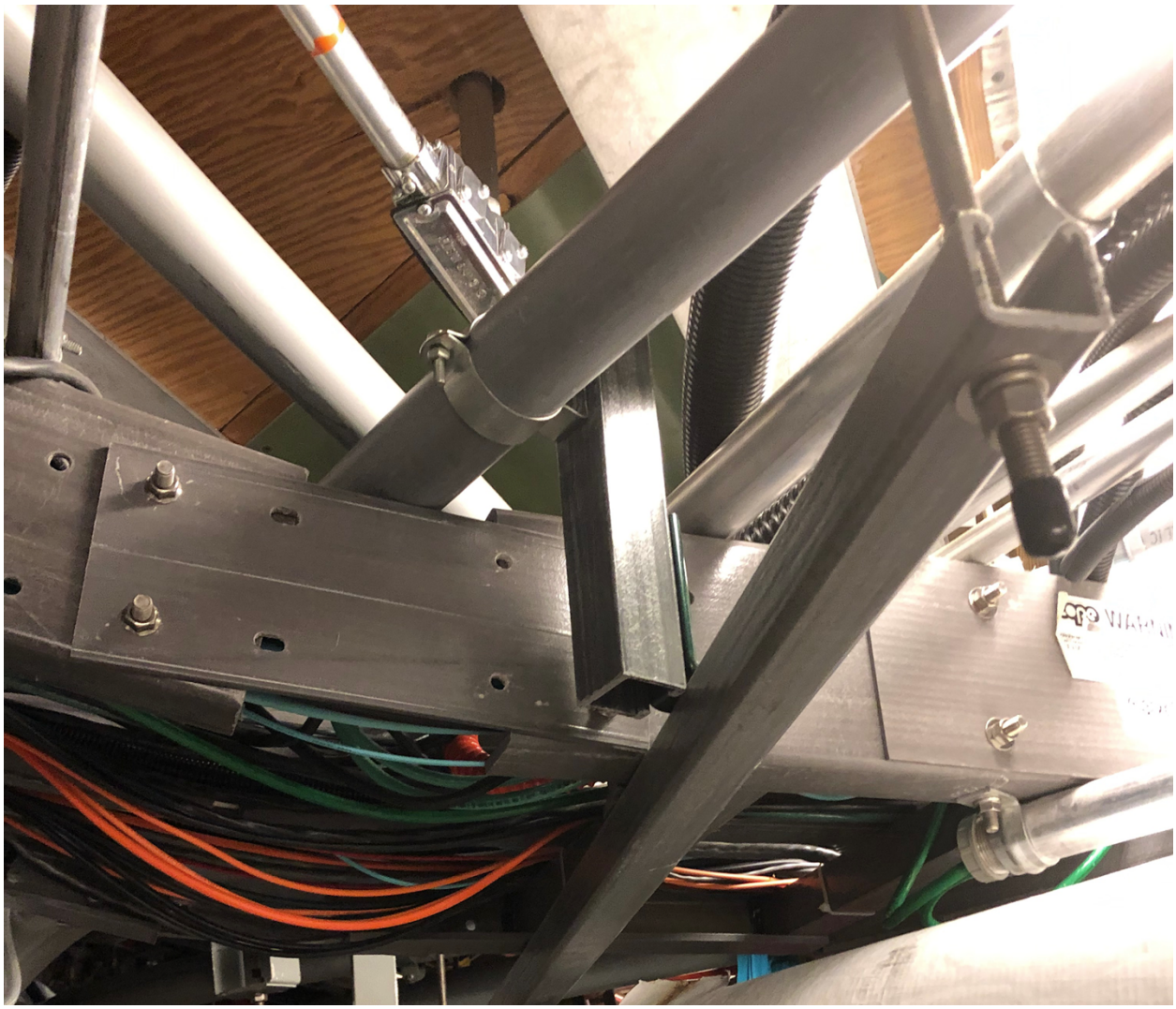

Figure 5. Cable trays contain PLC wiring

ICD-TCS-BOS-008: The cable trays are supported from the platform. Figure 6 shows the threaded rod that is attached to the beam and connects to unistrut on which the cable tray rests.

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Figure 6. Cable Tray supported from platform

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.

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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
1.8.1.1.5-1.3.3.1-W	Helium piping passes through penetrations in the NTC wall	See Paragraph 4.2.4.1, FA1030, FA1064
1.8.1.1.5-1.3.3.1.1-W	Helium pipes from the pump room enter the NTC floor.	See Paragraph 4.2.4.2, Drawing EB1045, FA1030

4.2.4.1. Helium Pipes - NTC Walls

ICD-TCS-BOS-009: The penetration is a 12” diameter liquid helium supply pipe on the east wall through penetration #1632 in accordance with Drawings FA1030 Sheet 2. FA1064 shows the drawing for the actual penetration details.

4.2.4.2. Helium Pipes - NTC Floor

ICD-TCS-BOS-010: The penetration is a 2’ x 3’ rectangle through penetration #515 in accordance with Drawings EB1045 Sheet 2 and FA1030 Sheet 1.

ICD-TCS-BOS-011: The penetration is sealed per HILTI C-AJ8056.

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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.

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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

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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		

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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.

There are no external interfaces.