

Test Cell - Integrated Machine Operations Interface Control Docu

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National Spherical Torus eXperiment Upgrade

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Interface Control Document

TEST CELL : INTEGRATED MACHINE OPERATIONS

NSTX-U-TCS-IMO-ICD

**Revision 0
October 25, 2019**

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Change Record

Revision	Date	Description of Change
0	October 25, 2019	Initial Release

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, RTC&P, NSTX-U-RQMT-SRD-008
- [4] NSTX-U Machine Instrumentation, NSTX-U-RQMT-RD-008-03.

1. Purpose

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

2. Scope

The Test Cell consists of the platforms, cable trays, racks, penetrations, floor, and crane. The Center Stack Structures include the Center Stack Casing, Pedestal, PF-1a Support Structures, PF-1b Support Structures, and PF-1c Support Structures. The Integrated Machine Operations consists of the Machine Instrumentation and Real-Time Control and Protection Systems such as the Digital Coil Protection System, and the Shorted Turn Protection System. 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
- Integrated Machine Operations
- 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-IMO-X] where X is a sequential count beginning with 001, TCS represents Test Cell and IMO represents Integrated Machine Operations. 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	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	
		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

Integrated Machine Operations	
Me	Test Cell

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
1.8.1.1.4- 1.7.3.4.5-S	The Laser is attached to the test cell wall	See Paragraph 4.2.1.1
1.8.1.1.4- 1.7.3.4.5-S	The Target Is attached to the Test Cell wall	See Paragraph 4.2.1.2
1.8.1.1.1- 1.7.3.4.5-S	The Camera Needs to be mounted to the platform to provide a view of target	See Paragraph 4.2.1.3

4.2.1.1. Test Cell - Laser

Interface Notes:

- This system has not yet had its FDR, but is included for completeness.

ICD-TCS-IMO-001: Laser Mount will be attached to the Test Call Wall and calibrated to ensure the laser strikes the mirror. Drawings for the Mounts are TBD.

4.2.1.2. Test Cell - Target

Interface Notes:

- This system has not yet had its FDR, but is included for completeness.

ICD-TCS-IMO-002: The Target will be attached to the Test Cell Wall and calibrated to ensure the laser strikes the target in teh appropaite . Drawings for the Mounts are TBD.

4.2.2. Spatial Interface

This identifies any interfaces between the system elements pertaining to spatial restrictions or constraints.

Identifier	Interface	References
1.8.1.1- 1.7.3.4.5-Sp	Line of Sight is needed across the test cell between the Laser, Mirror, and Target	See Paragraph 4.2.2.1

4.2.2.1. Test Cell - Laser

Interface Notes:

- This system has not yet had its FDR.

ICD-TCS-IMO-003: There needs to be line of sight (red line) from the North Test Cell Wall to the Mirror on the Umbrella to allow operations of the instrumentation as shown in Figure 1.

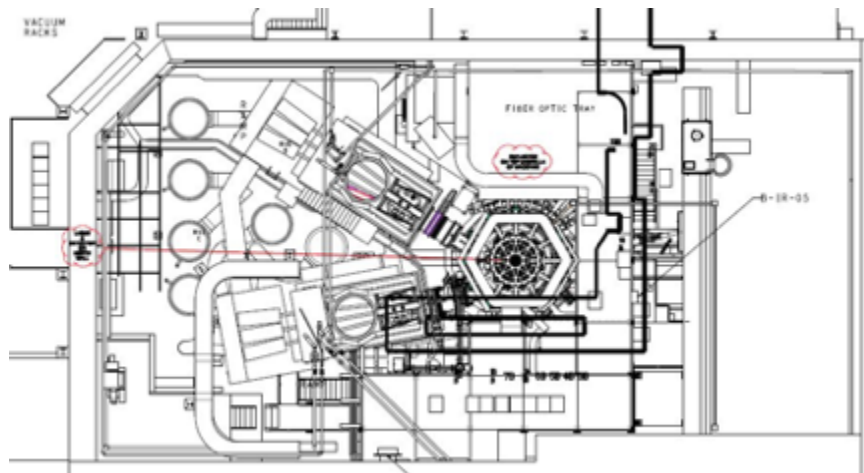


Figure 1. Line of Sight Laser Shot Across Testbed.

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
1.8.1.1.5- 1.7.3.4.1-W	Fiber optics Strain, Temp, and Disp leave NTC via penetrations	See Paragraph 4.2.4.1, Drawing FA1030, 9D11537
1.8.1.1.5- 1.7.3.6.8-W	Ip Calculator fibers go through penetrations	See Paragraph 4.2.4.2, Drawing FA1030, AE4005
1.8.1.1.5- 1.7.3.6.1-W	FPDP Data Stream fibers go through penetrations	See Paragraph 4.2.4.3, Drawing FA1030

4.2.4.1. Strain - Penetration

ICD-TCS-IMO-004: All penetrations are captured in Drawing 9D11537 Sheet 1 identifies Penetration 6298 leaving the DARM and Penetration 6297.

ICD-TCS-IMO-005: Drawing FA1030 Sheet 2 identifies the penetration as a 6" diameter penetration and is labeled as Fiber optics for BES-2 Diagnostics.

4.2.4.2. Ip Calculator - Penetration

Interface Notes:

- This system is already installed in the field and required a walkdown to establish the path of the interface.

ICD-TCS-IMO-006: The IP Calculator penetrations leaving the junction area is Penetration 6026. Following the cable trays from Penetration 6026 there are several penetrations in close proximity to the cable tray so penetration 6335, 6291, 6272, 6273, 6245, 6297, or 6246 are used entering the Test Cell from the Gallery. Based on Drawing FA1030 Sheet 2 identifies Penetration 6335 as Fiber Optics for Computing is most likely the penetration being used the others are Fiber Optics for Specific diagnostics. Figure 2 provides a picture of the penetrations.



Figure 2 Fiber Penetrations near Gallery Wall

ICD-TCS-IMO-006: The wiring that pass from the Junction Area to the Test Cell are identified in AE4005 Sheet 24.

4.2.4.3. FPDP Data Stream - Penetration

Interface Notes:

- This system is already installed in the field and required a walkdown to establish the path of the interface.

ICD-TCS-IMO-006: The IP Calculator penetrations leaving the junction area is Penetration 6026. Following the cable trays from Penetration 6026 there are several penetrations in close proximity to the cable tray so penetration 6335, 6291, 6272, 6273, 6245 or 6246 are used entering the Test Cell from the Gallery. Based on Drawing FA1030 Sheet 2 identifies Penetration 6335 as Fiber Optics for Computing is most likely the penetration being used the others are Fiber Optics for Specific diagnostics.

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
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 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.