

Power Systems - Operations & System Safety

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PREPARED BY: **Peter Dugan** 6/25/2019 8:27:55 AM

Peter Dugan,

REVIEWED BY: **Timothy N. Stevenson** 6/25/2019 11:54:11 AM

Timothy N. Stevenson,

REVIEWED BY: **John Dellas** 6/25/2019 3:24:15 PM

John Dellas,

REVIEWED BY: **Peter Dugan** 6/26/2019 6:39:31 AM

Peter Dugan,

APPROVED BY: **Stefan Gerhardt** 7/1/2019 12:19:34 PM

Stefan Gerhardt,

PRINCETON PLASMA PHYSICS LABORATORY
P.O. BOX 451
PRINCETON, N.J. 08543



National Spherical Torus Experiment Upgrade

Interface Control Document

**POWER SYSTEMS:
OPERATIONS & SAFETY SYSTEMS**

NSTX-U-PWR-OSS-ICD-0

**Revision 0
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Prepared By: P. Dugan, Systems Engineering

Reviewed By: J. Dellas, Power RE

Reviewed: T. Stevenson, Operations RE

Reviewed By: Y. Zhai, NSTX-U Project Engineer

Change Record

Revision	Date	Description of Change
0	June 20, 2019	Initial Release

References

- [1] GENERAL REQUIREMENTS DOCUMENT, NSTX-U-RQMT-GRD-001-01.
- [2] SYSTEM REQUIREMENTS DOCUMENT, POWER SYSTEMS NSTX-U-RQMT-SRD-006-01.
- [3] SYSTEM REQUIREMENTS DOCUMENT, Operations and Safety Systems, NSTX-U-RQMT-SRD-012-01.

1. Purpose

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

2. Scope

The Power Systems consist of the AC Power, AC/DC Conversions, DC Rectifiers, and control and protection. 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:

- Power Systems
- 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-PWR-OSS-X] where “X” is a sequential count beginning with 001, PWR represents Power Systems, 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 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 Structure	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 Structure			Va,Th	Me,Gf	Me	Me	Me				DI		
		Me	Me,Th,Ep	Magnets				Me			DI		SI	DI	Me	
SI		Me,Va			Heating Systems		Gf	Th		Me		Gf,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,Va	Ep	Gf,SI		Gas Delivery System	Me	Va			SI,Sw	SI	Me	
		Gf				SI,Gf,Va		Gf	Watt Conditioning System				SI,Sw	SI	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		
									Sw		SI	SI,Sw	Integrated Machine Operations	Me		
								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

Power Systems	Me, Ep, SI, DI, Gf
	Operations & Safety Systems

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 structural, spatial, and 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
1.7.3.10.1- 1.5.4-S	The TKS prevents the SLD from pressurizing when access is allowed in the NTC.	See Paragraph 4.2.1

Interface Notes:

- The interface has been defined and is currently being developed and will be completed by the FDR.

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
1.5.1.2- 1.7.3.7-P	Electrical power for radiation area monitors.	See Paragraph 4.3.1
1.5.1.2- 1.7.3.1.1-P	Electrical power for the PSS-SIS from D-Site Auxiliary Power	
1.7.3.2.2- 1.5.1.2-P	AC power is provided to the ground fault detector	

4.3.1. Electrical Power to Radiation Monitors

ICD-PWR-OSS-001: The location of the power connection in the NBTC Observatory Gallery to a standard 110 Wall power out connected to box U/LP-457 as shown in Figure 1.



Figure 1. Power Panel

ICD-PWR-OSS-002: The voltage is 120 V and current is a 20 A.

ICD-PWR-OSS-003: The location of the main control panel power connection in the east wall to a standard 110 Wall power out connected to box LP-474 as shown in Figure 2.



Figure 2. Control panel power panel

4.3.2. D-Site Auxiliary Power - PSS-SIS

Interface Notes:

- The interface has been defined and is currently being developed and will be completed by the FDR.

4.3.3. Ground Fault Detector - AC Power

Interface Notes:

- The interface has been defined and is currently being developed and will be completed by the FDR.

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
1.5.1.1.4- 1.7.3.1.1-Si	13.8 SV1 & SV2 breakers to FCPC thyristor rectifiers (SV1-SB01 through SV1-SB09, SV2-SB01 to SV2-SB09, SV1-SB12, SB2-SV12) are opened upon a PSS-SIS Emergency Stop	See Paragraph 4.4.1
1.5.1.1.4- 1.7.3.1.1-Si	Variable frequency 13.8 kV breakers to NB power supplies (ESV2-SB-10, ESV2-SB-11) are opened upon a PSS-SIS Emergency Stop	See Paragraph 4.4.2
1.5.1.1.1- 1.7.3.1.1-Si	Fixed frequency 13.8 kV breaker to NB high voltage power supplies (ESF1-SB10) are opened upon a PSS-SIS Emergency Stop	See Paragraph 4.4.3
1.5.1.1.1- 1.7.3.1.1-Si	Fixed Frequency 13.8 kV breaker (ESF2-SB05) for NBI 480 VAC pulsed power (arc and filament supplies) are opened upon a PSS-SIS Emergency Stop	See Paragraph 4.4.4

4.4.1. SV1 & SV2 Breakers - PSS-SIS Emergency Stop

Interface Notes:

- The interface has been defined and is currently being developed and will be completed by the FDR.

4.4.2. ESV2-SB-10, ESV2-SB-11 Breakers - PSS-SIS Emergency Stop

Interface Notes:

- The interface has been defined and is currently being developed and will be completed by the FDR.

4.4.3. 13.8 kV Breakers - PSS-SIS Emergency Stop

Interface Notes:

- The interface has been defined and is currently being developed and will be completed by the FDR.

4.4.4. ESF2-SB05 Breakers - PSS-SIS Emergency Stop

Interface Notes:

- The interface has been defined and is currently being developed and will be completed by the FDR.

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
1.5.1.1.4- 1.7.3.1.1-D	Position indicators on SV1 and SV2 breakers used to assess status of breakers by PSS-SIS	See Paragraph 4.5.1
1.5.3.1.2- 1.7.3.1.1-D	PSS-SIS detects the position of the TF disconnect switches via mechanical sensor	See Paragraph 4.5.2
1.5.3.1.3- 1.7.3.1.1-D	PSS-SIS detects the position of the TF ground switches via mechanical sensor	See Paragraph 4.5.3
1.5.3.2.3- 1.7.3.1.1-D	PSS-SIS detects the position of the OH ground switches via mechanical sensor	See Paragraph 4.5.4
1.5.3.3.3- 1.7.3.1.1-D	PSS-SIS detects the position of the PF ground switches via mechanical sensor	See Paragraph 4.5.5
1.5.3.1.8- 1.7.3.1.1-D	PSS-SIS detects position of TF bus links in PCTS via a "light curtain" device.	See Paragraph 4.5.6

4.5.1. SV1 and SV2 breakers - PSS-SIS

Interface Notes:

- The interface has been defined and is currently being developed and will be completed by the FDR.

4.5.2. TF disconnect switches - PSS-SIS

Interface Notes:

- The interface has been defined and is currently being developed and will be completed by the FDR.

4.5.3. TF ground switches - PSS-SIS

Interface Notes:

- The interface has been defined and is currently being developed and will be completed by the FDR.

4.5.4. OH ground switches - PSS-SIS

Interface Notes:

- The interface has been defined and is currently being developed and will be completed by the FDR.

4.5.5. PF ground switches- PSS-SIS

Interface Notes:

- The interface has been defined and is currently being developed and will be completed by the FDR.

4.5.6. TF bus links- PSS-SIS

Interface Notes:

- The interface has been defined and is currently being developed and will be completed by the FDR.

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
1.5.3.1.3- 1.7.3.1.1-G	PSS allows the TF ground switches to close during a PSS Emergency Stop	See Paragraph 4.6.1.1
1.5.3.2.3- 1.7.3.1.1-G	PSS allows the OH ground switches to close during a PSS Emergency Stop	See Paragraph 4.6.1.2
1.5.3.3.3- 1.7.3.1.1-G	PSS allows the PF ground switches to close during a PSS Emergency Stop	See Paragraph 4.6.1.3

4.6.1.1. TF ground switches - PSS-SIS

Interface Notes:

- The interface has been defined and is currently being developed and will be completed by the FDR.

4.6.1.2. OH ground switches - PSS-SIS

Interface Notes:

- The interface has been defined and is currently being developed and will be completed by the FDR.

4.6.1.3. PF ground switches - PSS-SIS

Interface Notes:

- The interface has been defined and is currently being developed and will be completed by the FDR.

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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4.11. Other Interfaces

This paragraph provides other interface types

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.

0.1.1.11 Electrical power for the **PSS-SIS** from **C-Site Power**.