Diagnostics - Center Stack Structure ICD

Interface Document: NSTXU_1-1-3-3_IC_100

REVISION 0

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National Spherical Torus eXperiment Upgrade

National Spherical Torus Experiment Upgrade

Interface Control Document

DIAGNOSTICS:
CENTER STACK STRUCTURE

NSTX-U-ICD-DIA-CSS-0

Revision 0
June 18, 2019

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Change Record

Revision	Date	Description of Change
0	June 18, ,2019	Initial Release

References

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

[2] SYSTEM REQUIREMENTS DOCUMENT, Diagnostics, NSTX-U-RQMT-SRD-011-01.

[3] SYSTEM REQUIREMENTS DOCUMENT, VACUUM VESSEL AND INTERNAL HARDWARE, NSTX-U-RQMT-SRD-004-01.

[4] Polar Region: Design, Preliminary Design Review, 8/2/2018

[5] REQUIREMENTS DOCUMENT, CS AIR-SIDE DIAGNOSTICS, NSTX-U-RQMT-RD-005-01

1. Purpose

This document describes the various interfaces between the following subsystems: Diagnostics and the Center Stack Structure. The interface locations and boundaries that connect the Diagnostics to the Center Stack Structure are identified based on different interface types.

2. Scope

The Diagnostics consist of Thermocouples, Mirnov sensors, Rogowski coils, and Langmuir probes. The Center Stack Structures include the Center Stack Casing, Pedestal, PF-1a Support Structures, PF-1b Support Structures, and PF-1c Support Structures. The scope of this document addresses any defined interfaces between these identified system elements.

3. Responsibilities

The interfaces are managed between the following organizations:

- Diagnostics
- VVIH
- Systems Engineering and Integration

4. Interfaces

Interface requirements in the following sections are identified with a requirement number, ICD, followed by a number [ICD-DIA-CSS-X] where “X” is a sequential count beginning with 001, DIA represents Diagnostics, and CSS represents Center Stack Structure. 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, Di, 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	Wall 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	Si	Ep, Si	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.

Center Stack Structure	
Me, Va	Diagnostics

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
1.4.1.2.8-1.1.3.3.6-S	Halo current **Rogowski** coils are wrapped around the **casing,** under the tiles.	See Paragraph 4.2.1.1

4.2.1.1. Halo Current Rogowski Coils to Casing

Interface Notes:

- There are two interface locations: one at the angled section, and the other in the gaps between the Horizontal tile and the Center Stack Casing as shown by the red circles in Figure 1.

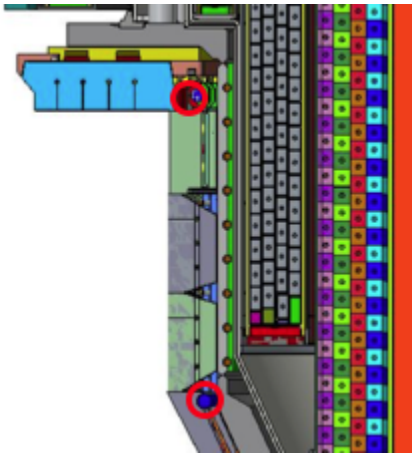

Figure 1. Location of the Halo Rogowski Coils

ICD-DIA-CSS-001: The Halo Rogowski interface is located between the Center Stack casing and the angled section and is secured under the angled section tile as shown in Figure 2. The coil is represented by the ‘flat pale’ yellow cylinder. whose axis comes out of the plane of the paper.

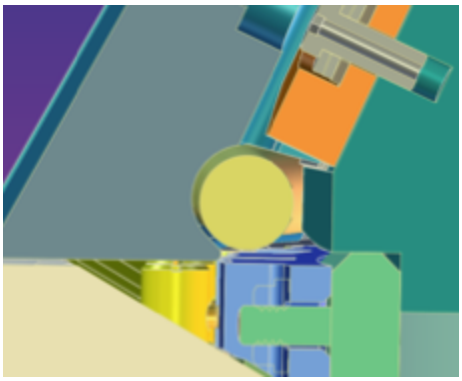

Figure 2. Angled Section Rogowski Coil.

ICD-DIA-CSS-002: The angled section Halo Rogowski coil is not mounted; rather, it fits snugly in a cut out in the angle section tile as shown in Figure 2. The coil is constrained by the angled tiles (grey), vertical tile grid (blue), angle tile mount (orange), and angled section of the Center Stack Casing (teal).

ICD-DIA-CSS-003: The IBDH Halo Rogowski interface is located between the Center Stack casing and the IBD-H. The coil is secured with 72 clamps and studs in the gap between the IBDH and the Low Heat Flux Vertical Tile as shown in Figure 3. The stud locations are identified in drawing DC-11204. The coil is represented as the blue cylinder.

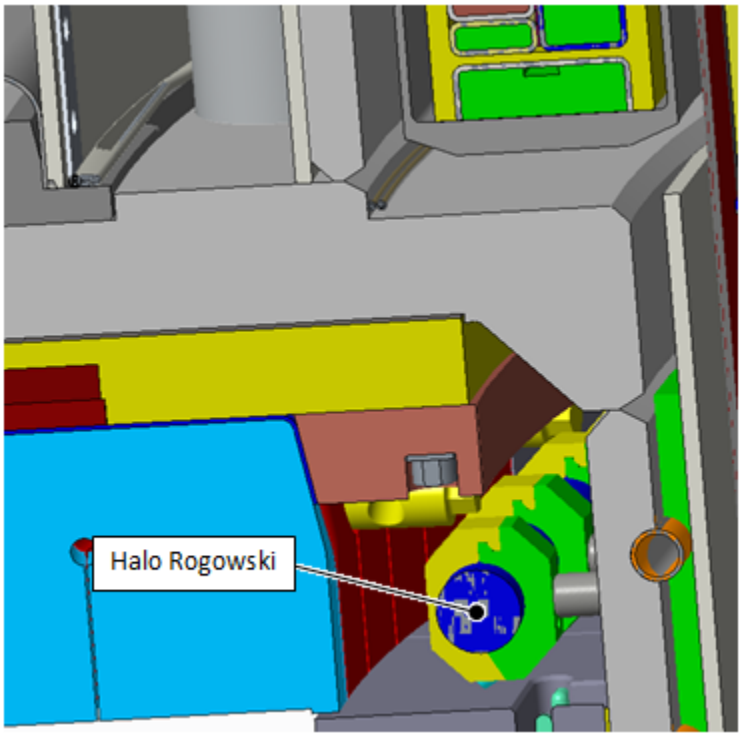

Figure 3. IBDH Rogowski Coil.

4.2.2. Spatial Interface

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

Identifier	Interface	References
1.4.1.2-1.1.3.3-Sp	Allowance for egress of **Rogowski** and other diagnostics wires from **CS assembly.**	See Paragraph 4.2.2.1 Drawing 9D11556
1.4.1.2-1.1.3.3-Sp	Allowance for **flux loops** and thermocouples on inner-PF surfaces at the **CS Assembly** at the surface of the wires.	See Paragraph 4.2.2.2,, Ref 5
1.4.1.2.1-1.1.3.3.11-Sp	**Ip Rogowski coils** must pass through holes in the **PF-1a support structure** to exit the CS assembly.	See Paragraph 4.2.2.3, Ref 5, Drawing DC11138, DC11182

4.2.2.1. Halo Current Rogowski to Center Stack

ICD-DIA-CSS-004: The Rogowski coils are shown as grey rectangles as shown in Figure 4. The Halo Rogowskis follow the green line to exit at the following Organ Pipes: Upper Bay A (15 degrees) and Lower between Bays A & B (30 degrees).

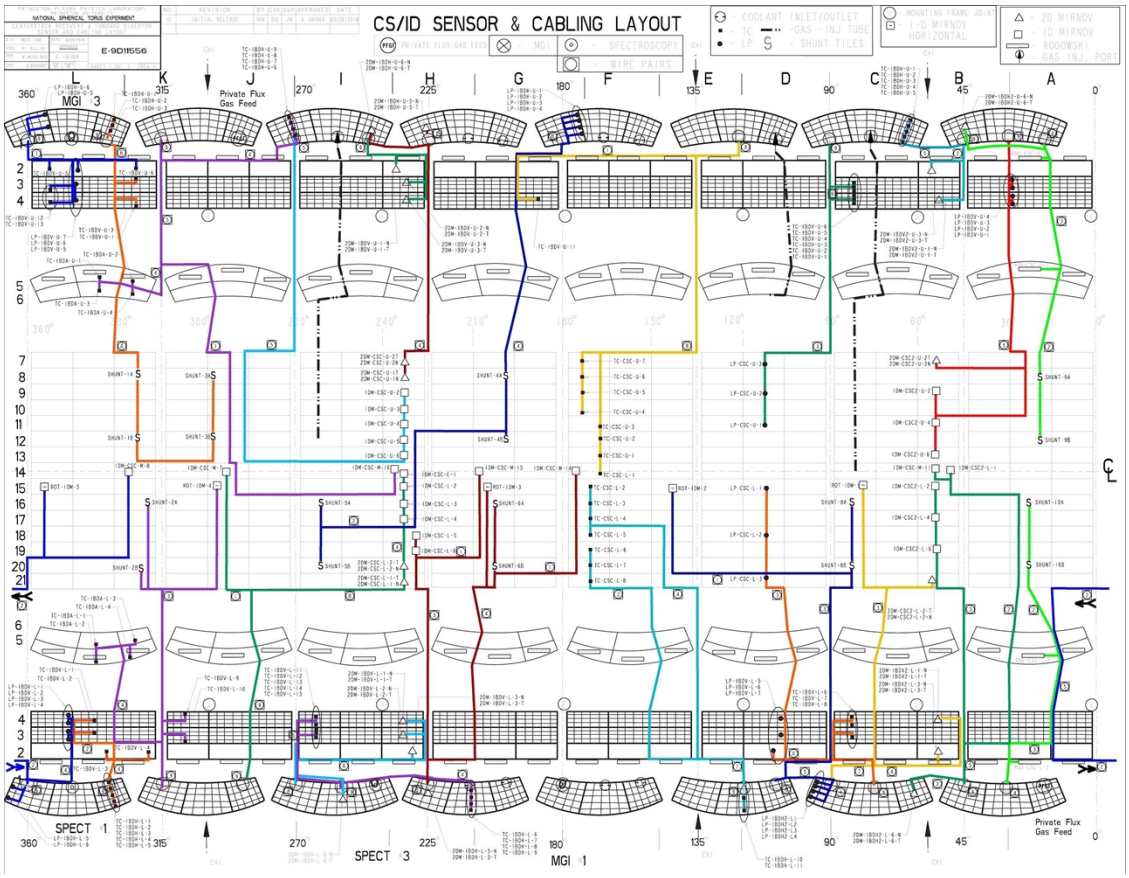

Figure 4: Cabling Layout

4.2.2.2. Flux loops to Center Stack Assembly

ICD-DIA-CSS-006: The flux loops are wrapped around the bellows on the air side as shown in Figure 5.

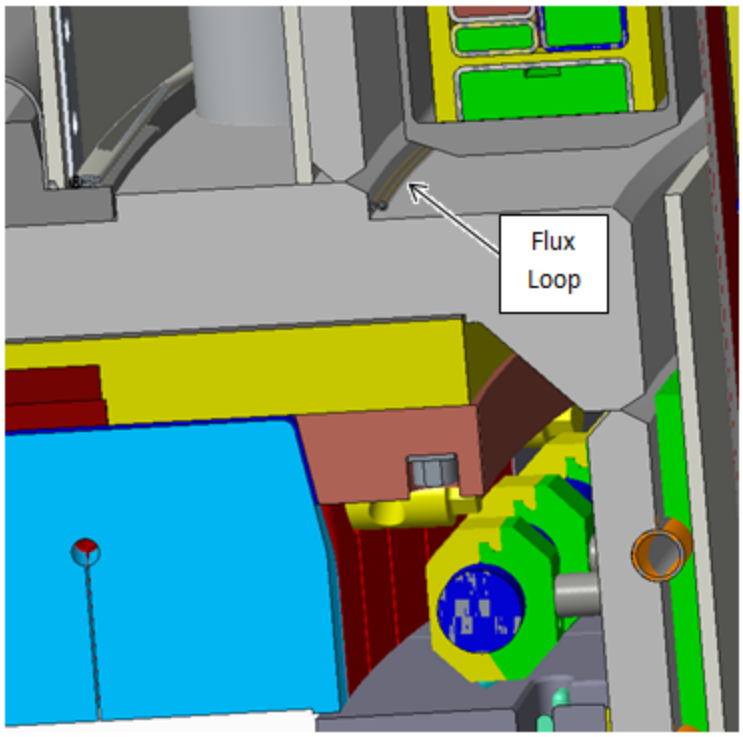

Figure 5: Flux Loop on IBDH

ICD-DIA-CSS-007: The flux loops are installed on the casing, and the coil support structures as shown in Figure 6..

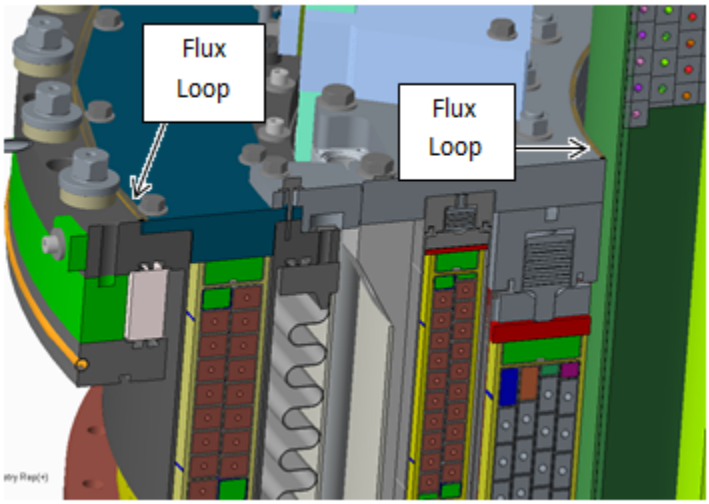

Figure 6: Flux Loops on PF1a&b Common Flange and PF1c Cap Flange

4.2.2.3. Plasma Current Rogowski to PF-1A Support

Interface note:

- Plasma rogowski coils are a continuous loop around the entire vessel, from the center stack to the vessel.

ICD-DIA-CSS-007: Three Plasma Current Rogowski coils run vertically up along the TF/OH. At the angled section, the Plasma Current Rogowski coils angle outward. At the vertical section, the Plasma Current Rogowski coils then run vertically, between the OD of the PF1a coils, and the ID of the center stack casing. Figure 4 shows a cross-section of the center stack casing, with the routing of one rogowski coil highlighted with black/white arrows. The clearance between the OD of the PF-1A and the vertical section including at the interface as shown in Figure 4, is in accordance with Ref 4. This particular clearance is true for the spaces between the slings that hold the PF1a coils. The slings do not run continuously around the coils. Rather, they have a segmented design, with gaps between the segments, where the plasma rogowski coils can run. The Plasma Current Rogowski coils then runs vertically between the OD of the PF1a coils, and the ID of the PF1b coils, and goes out the top of the Polar Region.

ICD-DIA-CSS-008: These coils may be placed at angular locations conducive to machine assembly, and alignment, and consistent with route availability along the outer NSTX-U vacuum vessel [Ref 5]. The sensor locations were chosen to maximize clearance between the Center Stack Casing and Inner TF/OH bundle. In addition, openings are provided in the common flange between PF1a and PF-1b to allow egress of the Plasma Current Rogowski coil.

ICD-DIA-CSS-009: Bends in the Current Plasma Rogowski coil shall be minimized [Ref. 5]. Note the bends in the Rogowski in Figure 4 below.

ICD-DIA-CSS-010: The current Rogowski coils have cut outs in the common flange to allow passage of the Plasma Current Rogowski Coils. Drawing 11138 is the drawing for the common flange while drawing DC11182 represents the coil assembly.

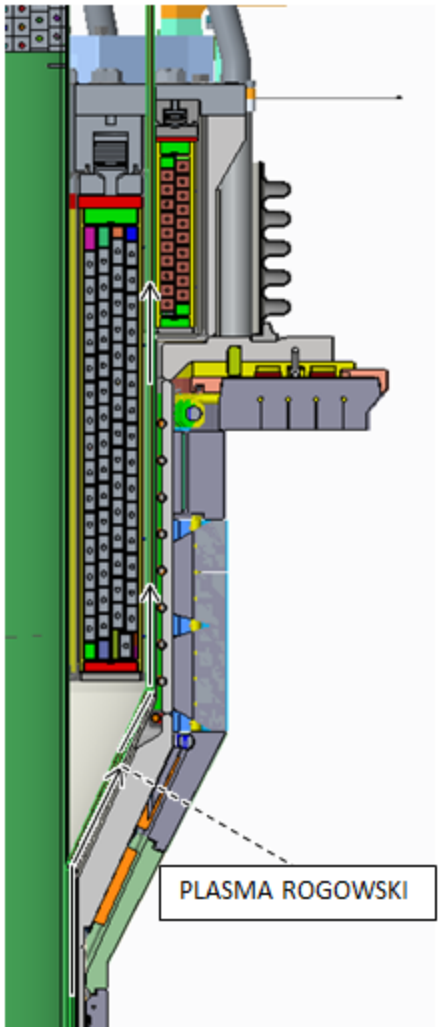

Figure 4. Plasma Rogowski Routing.

4.2.3. Location Interfaces

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
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
1.4.1.2.2-1.1.3.3.6-V	**Mirnov** Sensors leads leave vacuum via feedthroughs on the organ pipes on the **casing flanges.**	See Paragraph 4.7.1 Drawing 9D1095, 9D11556
1.4.1.17-1.1.3.3.6-V	**Langmuir Probe** Sensors leads leave vacuum via the organ pipes on the **casing flanges.**	See Paragraph 4.7.2 Drawing 9D1095, 9D11556
1.4.1.2.8-1.1.3.3.6-V	**Rogowski Halo** Sensors leads leave vacuum via the organ pipes on the **casing flanges.**	See Paragraph 4.7.3 Drawing 9D1095, 9D11556

Interface Notes:

- Drawing B-9D1095 has over 200 sheets identified. The sheets are listed for each interface.

4.7.1. Mirnov – Casing Flanges

ICD-PFC-CSS-008: The organ pipe port and sensors are documented and identified in drawing 9D1095, Sheets 50, 60,81,85,100,101,105,115,125 as well as Drawing 9D11556 (Figure 2).

ICD-DIA-CSS-010: The feedthrough connector is a 19 pin Ceramaseal Flange.

4.7.2. Langmuir Probe – Casing Flanges

ICD-DIA-CSS-009: The organ pipe port and sensors are documented and identified in drawing B-9D1095, Sheets 60,70,82,95 as well as Drawing 9D11556 (Figure 2).

ICD-DIA-CSS-001: The feedthrough connector is a 19 pin Ceramaseal Flange.

4.7.3. Halo Current Rogowski – Casing Flanges

ICD-DIA-CSS-010: The organ pipe port and sensors are documented and identified in drawing B-9D1095, Sheets 82,100, 106, 110, 115,205, 220, as well as Drawing 9D11556 (Figure 2).

ICD-DIA-CSS-011: The feedthrough connector is a 19 pin Ceramaseal Flange.

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 over part of the interface. They are provided for completeness.

There are no external interfaces.