Interface Control Document MAGNETS : DIAGNOSTICS

Interface Document: NSTXU_1-1-3_IC_102

REVISION 0

November 6, 2019

PREPARED BY:	**Kathleen Lukazik**	10/11/2019 11:35:40 AM
	Kathleen Lukazik,	
REVIEWED BY:	**Brentley C. Stratton**	10/11/2019 11:39:44 AM
	Brentley C. Stratton,	
REVIEWED BY:	**Robert A. Ellis**	10/11/2019 2:03:57 PM
	Robert A. Ellis,	
REVIEWED BY:	**Peter Dugan**	10/17/2019 11:07:30 AM
	Peter Dugan,	
REVIEWED BY:	**Steve Raftopoulos**	11/5/2019 12:14:43 PM
	Steve Raftopoulos,	
APPROVED BY:	**Yuhu Zhai**	11/6/2019 2:12:25 PM
	Yuhu Zhai,	

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

National Spherical Torus eXperiment Upgrade

National Spherical Torus Experiment Upgrade

Interface Control Document

MAGNETS:
DIAGNOSTICS

NSTX-U-ICD-MAG-DIA-0

Revision 0
May 15, 2019

Change Record

Revision	Date	Description of Change
0	May 15, 2019	Initial Release

References

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

[2] SYSTEM REQUIREMENTS DOCUMENT, MAGNET SYSTEMS, NSTX-U-RQMT-SRD-002-02.

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

[4] CS Air-Side Diagnostics, NSTX-U-RQMT-RD-005-01

[5] Inner-PF Coil Interfaces to Coil Support Designs and Cooling Systems

1. Purpose

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

2. Scope

The Magnets address the TF Coils, OH Solenoid, Resistive Wall Mode, Outer PF coils, PF-1a coils, PF-1b Coils, and PF-1c Coils. The Diagnostics system consists of Thermocouples, Mirnov sensors, Halo and Plasma Current Rogowski coils, Langmuir probes, Neutron measurements, Magnetics Multi-pulse Thompson Scattering (MPTS), Plasma TV, CHERS, spectroscopy, FIDA, BES, MSE, High-K Scattering, and microwave diagnostics, among other instrumentation and diagnostics. The scope of this document addresses any defined interfaces between these identified system elements.

3. Responsibilities

The interfaces are managed between the following organizations:

- Magnets
- Diagnostics
- Systems Engineering and Integration

4. Interfaces

Interface requirements in the following sections are identified with a requirement number, ICD, followed by a number [ICD-MAG-DIA-X] where “X” is a sequential count beginning with 001, MAG represents Magnets, and DIA represents Diagnostics. 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. 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		
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	Si	
		Gf	Si			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	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		
								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.

Magnets	**Di**
Me	**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
1.4.1.2.4-1.1.3.2-S	A **Rogowski coil** is mounted to the **outer TF leg**, for use in the diamagnetic flux measurement.	See Paragraph 4.2.1.1, DC1947
1.4.1.2.1-1.1.3.3.2-S	**Plasma Current Rogowski** coils mounted on the **OH solenoid under the microtherm insulation**	See Paragraph 4.2.2.2, Ref 4

4.2.1.1. Rogowski Coil – Outer TF

Interface Notes:

- Drawing 9D1095 Sheet 16 provides the CWD for the Rogowski Coil

ICD-MAG-DIA-001: The TF Rogowski coil is mounted to the TF-Outer Leg as shown In Figure 1. The interface uses G-10 base clamps to secure to the TF leg. There are eight 316 SS cap screws that secure the assembly. The Rogowski coil assembly is identified by the red cylinder, and Green and Yellow components

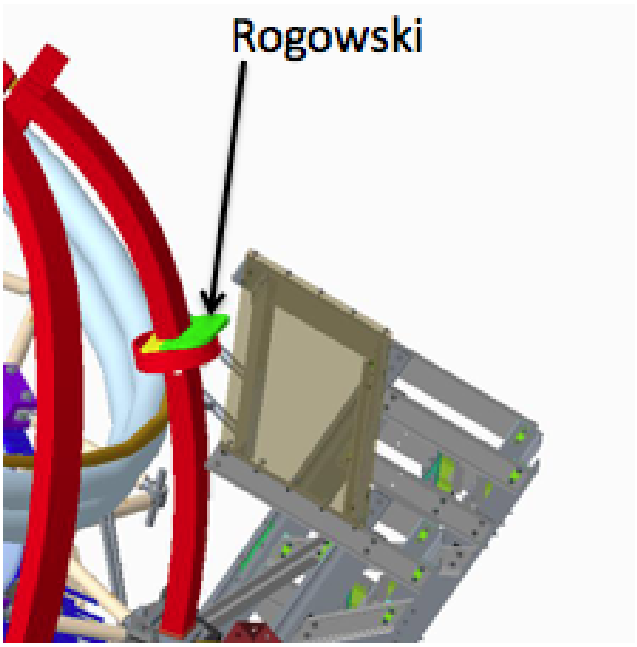

Figure 1. TF Rogowski Mounted on TF Leg

4.2.1.2. Plasma Current Rogowski Coils – OH solenoid

ICD-MAG-DIA-002: Figure 2 shows that the Rogowski Coil is held against the OH coil by the Microtherm blanket, until the Rogowski Coil enters the angled section. The micro-therm insulation is, in-turn, held in place by tightly wrapping Kapton tape around the insulation. Figure 2 shows the Plasma Current Rogowski coil (brown) mounted between the OH Coil (green) and the Microtherm (white) until the Rogowski coil enters the angled section of the Center Stack Casing. Note that there are 3 Plasma current Rogowski coils as defined in Ref 4.

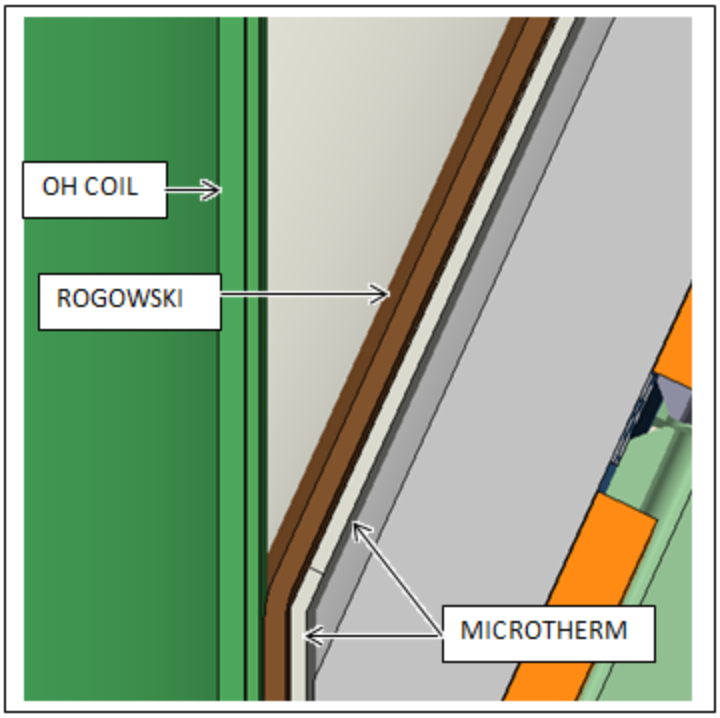

Figure 2. Plasma Current Rogowski

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
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
1.1.3.3.2-1.4.1.2.2-D	**Poloidal Flux Loops** mounted on the **Ohmic Heating Solenoid**	See Paragraph 4.5.1, Drawing 9D1095, Ref 4
1.1.3.3.3-1.4.1.2.2-D	**Poloidal Flux Loops** mounted on **Inner Poloidal Field 1a Coils**	See Paragraph 4.5.2,Drawing 9D1095, Ref 4
1.1.3.3.4-1.4.1.2.2-D	**Poloidal Flux Loops** mounted on Inner **Poloidal Field 1b Coils**	See Paragraph 4.5.3, Drawing 9D1095, Ref 4
1.1.3.3.5-1.4.1.2.2-D	**Poloidal Flux Loops** mounted on Inner **Poloidal Field 1c Coils**	See Paragraph 4.5.4, Ref 4

Interface Notes:

- Ref 4 provides the locations for all the Airside diagnostics specifically Flux Loops.

4.5.1. Poloidal Flux Loops – OH Solenoid

ICD-MAG-DIA-003: The Flux Loops (0.037") are wrapped horizontally around the OH coil. The OH consists of nine Flux Loops: one along the midplane, four upper coils and four lower coils

ICD-MAG-DIA-004: The Flux Loops are identified in the CWD, Drawing, 9D1095 Sheets 25, 30.

4.5.2. Poloidal Flux Loops – PF-1a

ICD-MAG-DIA-005: The Flux Loops (0.046" thick) are wrapped horizontally around the PF1a coil and fit between the coils and the slings that holds the coil in place. Figure 2 shows the location of the four flux loops in the OD in yellow.

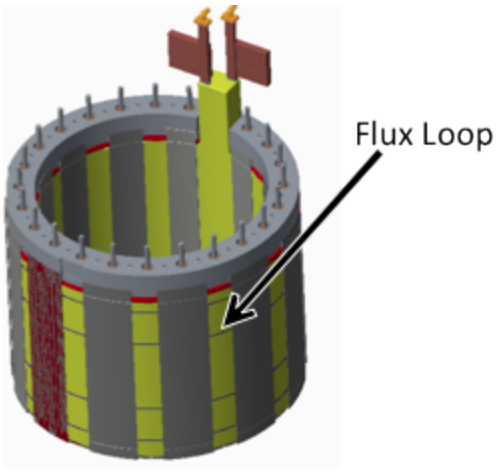

Figure 2. PF-1a Flux loop Diagnostics

ICD-MAG-DIA-006: The Flux Loops are identified in the CWD, Drawing, 9D1095 Sheets 10, 25.30.

4.5.3. Poloidal Flux Loops – PF-1b

ICD-MAG-DIA-007: The Flux Loops (0.046” thick) are wrapped horizontally around the PF-1b coil, and fit between the coils , and the slings that holds the coil in place. Figure 3 shows the location of the two flux loops in the OD in yellow.

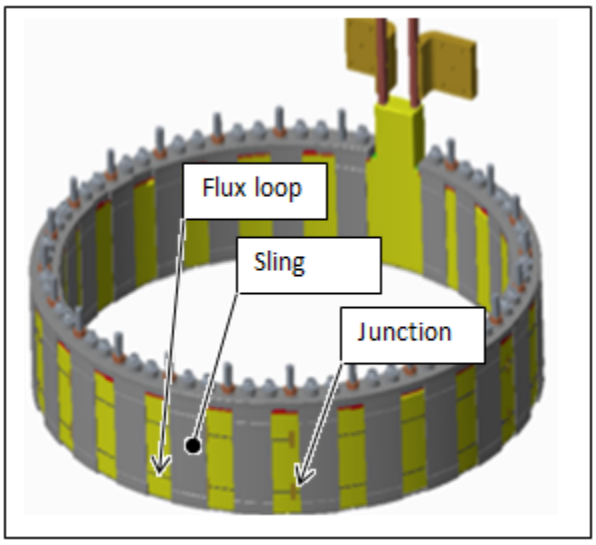

Figure 3.PF-1b Flux loop Diagnostics

ICD-MAG-DIA-008: The Flux Loops are identified in the CWD 9D1095 Sheets 10, 46

4.5.4. Poloidal Flux Loops – PF-1c

ICD-MAG-DIA-009: The two Flux Loops (0.046" thick) are wrapped horizontally around the PF-1c coil, and fit between the coils, and the slings that holds the coil in place. Electrical junctions can be made between the slings,

ICD-MAG-DIA-010: The Flux Loops are not identified in the CWD. Drawing 9D1095 requires updating.

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

There are no external interfaces.