Interface Control Document MAGNETS : COOLANT SYSTEMS

Interface Document: NSTXU_1-1-3_IC_103

REVISION 0

October 30, 2019

PREPARED BY:	**Kathleen Lukazik**	10/11/2019 11:35:36 AM
	Kathleen Lukazik,	
REVIEWED BY:	**Robert A. Ellis**	10/11/2019 2:02:34 PM
	Robert A. Ellis,	
REVIEWED BY:	**Steve Raftopoulos**	10/11/2019 3:45:57 PM
	Steve Raftopoulos,	
REVIEWED BY:	**Peter Dugan**	10/17/2019 11:05:58 AM
	Peter Dugan,	
REVIEWED BY:	**Joseph Petrella**	10/30/2019 9:41:20 AM
	Joseph Petrella,	
APPROVED BY:	**Yuhu Zhai**	10/30/2019 10:44:04 AM
	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:
COOLANT SYSTEMS

NSTX-U-ICD-MAG-CLS-0

Revision 0
May 14, 2019

_____
Prepared By: P. Dugan, Systems Engineering

_____
Reviewed By: S. Raftopoulus, Magnets RE

_____
Reviewed: J. Petrella, Coolant RE

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

Change Record

Revision	Date	Description of Change
0	May 14, 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, March 8, 2018.

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

[4] Design Point Spreadsheet, NSTX_CS_Upgrade_Open_Revision_03_20_18

1. Purpose

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

2. Scope

The Magnets consists of Inner and Outer PF and TF coils, OH Solenoid, and Bus Bars. The Coolant Systems consists of High and Low-Pressure NTC Coolant Water Distribution, Field Coil and Bus Bar Water Coolant System, De-ionization process, and OH-Water Pre-Heater 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:

- Magnets
- Coolant 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-MAG-CLS-X] where "X" is a sequential count beginning with 001, MAG represents Magnets, and CLS represents Coolant 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. 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

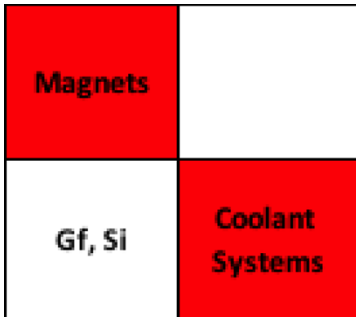
Heading	Abbreviation	Name
4.2	Me	Mechanical
4.3	Ep	Electrical Power
4.4	Si	Signal
4.5	Di	Diagnostics
4.6	Gf	Gas/Fluid
4.7	Va	Vacuum
4.8	Sw	Software
4.9	Th	Thermal
4.10	Pe	Plasma/Eddy/ Halo Current

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 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.



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
N/A		

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
1.3.2.4-1.1.3.4-Si	Sense-switches on the **coil bus** run ground switches are fed to the **water systems PLC**, where they can be used to determine the FCPC permissive status.	See Paragraph 4.4.1, Drawing 5Ga505

4.4.1. Coil Systems- Water Systems - PLC

ICD-MAG-CLS-001: The CWD for the water cooling systems to the bus is contained in Drawing GA6505 Sheets 37. The sheet provides the FCPC Finale as well as the PLC Permissives. Flow Switches monitored by the water system PLC to determine FCPC permissive status

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

1.3.2.1.1-1.1.3.4-F	Provides **cooling water** to various **bus bars.**	See Paragraph 4.6.2.1, Ref [4] Drawing 5GA522
1.3.2.1.1-1.1.3.3.1-F	Provides **cooling water** for **TF inner legs**, after water has passed through outer legs.	See Paragraph 4.6.2.2, Ref [4], Drawing 5Ga522
1.3.2.1.1-1.1.3.2-F	Provides **cooling water** for **TF outer legs**, before water is passed to inner legs.	See Paragraph 4.6.2.3, Ref [4], Drawing 5Ga522
1.3.2.1.1-1.1.3.1-F	Provides **cooling water** to the Outer **PF coils.**	See Paragraph 4.6.2.4, Ref [4], Drawing 5Ga522
1.3.2.1.2-1.1.3.3.3-F	**High-Pressure NTC Cooling Water Distribution** hose connections at **PF-1a** coil leads; cold water cools outer layers first	See Paragraph 4.6.2.5, Ref [4], Drawing 5Ga522
1.3.2.1.2-1.1.3.3.4-F	**High-Pressure NTC Cooling Water Distribution** hose connections at **PF-1b** coil leads; cold water cools outer layers first	See Paragraph 4.6.2.5, Ref [4], Drawing 5Ga522
1.3.2.1.2-1.1.3.3.5-F	**High-Pressure NTC Cooling Water Distribution** hose connections at **PF-1c** coil leads; cold water cools outer layers first	See Paragraph 4.6.2.5, Ref [4], Drawing 5Ga522
1.3.2.1.3-1.1.3.3.2-F	**OH Water Pre-Heater System** Hose connections at **Ohmic Heating Solenoid** coil leads; flows controlled so that the cooling wave on the coil propagates up all layers at the same rate	See Paragraph 4.6.2.5, Ref [4], Drawing 5Ga522

4.6.2.1. Cooling Water - Bus Bars

ICD-MAG-CLS-002: The type of fluid is Deionized water using a connection of 1/2" PARKER HOSE: MULTIPURPOSE OIL RESISTANT AIR & WATER HOSE, NONCONDUCTIVE, SERIES 7094, COLOR - RED as shown on Drawing 5GA522 Sheets 4, 5. Sheet 5 shows the Copper Bus Flow

ICD-MAG-CLS-003: The maximum working pressure is defined in Ref 4. The actual working pressure will be validated in the field.

ICD-MAG-CLS-004: The mass flow rate consists of Bus Bar feeds with values defined in Ref 4. The mass flow rate will be validated in the field.

4.6.2.2. Cooling Water - Inner TF legs

ICD-MAG-CLS-005: The type of fluid is Water, using a connection of 1/2" PARKER HOSE: MULTIPURPOSE OIL RESISTANT AIR & WATER HOSE, NONCONDUCTIVE, SERIES 7094, COLOR - RED as shown on Drawing 5GA522, Sheets 7&12

ICD-MAG-CLS-006: The maximum working pressure is defined in Ref 4. The actual working pressure will be validated in the field.

ICD-MAG-CLS-007: The mass flow rate consists of Inner TF feeds with values defined in Ref 4. The mass flow rate will be validated in the field.

4.6.2.3. Cooling Water - Outer TF legs

ICD-MAG-CLS-008: The type of fluid is Water, using a connection of 1/2" PARKER HOSE: MULTIPURPOSE OIL RESISTANT AIR & WATER HOSE, NONCONDUCTIVE, SERIES 7094, COLOR - RED as shown on Drawing 5GA522 Sheets 7

ICD-MAG-CLS-009: The maximum working pressure is defined in Ref 4. The actual working pressure will be validated in the field.

ICD-MAG-CLS-010: The mass flow rate consists of Outer TF feeds with values defined in Ref 4. The mass flow rate will be validated in the field.

4.6.2.4. Cooling Water to Outer PF legs

ICD-MAG-CLS-011: The type of fluid is Water, using a connection of 1/2" PARKER HOSE: MULTIPURPOSE OIL RESISTANT AIR & WATER HOSE, NONCONDUCTIVE, SERIES 7094, COLOR - RED as shown on Drawing 5GA522 Outer PF Sheets 16-19 Inner-PF Sheets: 13-15

ICD-MAG-CLS-012: The maximum working pressure is defined in Ref 4. The actual working pressure will be validated in the field.

ICD-MAG-CLS-013: The mass flow rate consists of PF-2 to PF-5 feeds with values defined in Ref 4. The mass flow rate will be validated in the field.

4.6.2.5. Cooling Water to Inner PF legs

ICD-MAG-CLS-014: The type of fluid is Water, using a connection of 1/2" PARKER HOSE: MULTIPURPOSE OIL RESISTANT AIR & WATER HOSE, NONCONDUCTIVE, SERIES 7094, COLOR - RED as shown on Drawing 5GA522 Sheets: 13-15.

ICD-MAG-CLS-015: The maximum working pressure is defined in Ref 4. The actual working pressure will be validated in the field.

ICD-MAG-CLS-016: The mass flow rate consists of PF-1a, PF-1b, and PF1c feeds with values defined in Ref 4. The mass flow rate will be validated in the field.

4.6.2.6. Cooling Water to OH Pre-Heater

ICD-MAG-CLS-017: The type of fluid is Water, using a connection of 1/2" PARKER HOSE: MULTIPURPOSE OIL RESISTANT AIR & WATER HOSE, NONCONDUCTIVE, SERIES 7094, COLOR - RED as shown on Drawing 5GA522 Sheets: 13-15.

ICD-MAG-CLS-018: The maximum working pressure values are defined in Ref 4. The actual working pressure will be validated in the field.

ICD-MAG-CLS-019: The mass flow rate consists of four feeds(OH-1 to OH-4) and values are defined in Ref 4. The mass flow rate will be validated in the field.

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 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		

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.