



ENG-064 - ICD - INTERFACE CONTROL DOCUMENT

Gas Delivery System - Integrated Machine Operations Interface Control Document

NSTXU_1-3-4_ICD_100

Work Planning #:
Effective Date: **12/05/2019**
Prepared By: **Peter Dugan**

Reviewed By	Dang Cai, Responsible Engineer	12/03/2019 11:33:34 AM
Reviewed By	Frank Hoffmann, Responsible Engineer	11/22/2019 10:38:52 AM
Reviewed By	Yuhu Zhai, Project Engineer	11/22/2019 08:48:57 AM
Approved By	Robert A. Ellis, Chief Engineer	12/05/2019 08:25:08 AM



National Spherical Torus eXperiment Upgrade

National Spherical Torus Experiment Upgrade

Interface Control Document

GAS DELIVERY SYSTEM : INTEGRATED MACHINE OPERATIONS

NSTX-U-GDS-IMO-ICD

**Revision 0
November 12, 2019**

Reviewed By: P. Dugan, Systems Engineering

Reviewed By: D. Cai, RE

Reviewed: F. Hoffmann, RTC&P RE

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

Reviewed By: R. Ellis, Chief Engineer





Change Record

Revision	Date	Description of Change
0	November 12, 2019	Initial Release



References

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

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

[3] SYSTEM REQUIREMENTS DOCUMENT, Real-time Control and Protection, NSTX-U-RQMT-SRD-008-00

1. Purpose

This document describes the various interfaces between the following subsystems: Gas Delivery System and the Integrated Machine Operations. The interface locations and boundaries that connect the Gas Delivery System to the Centralized Instrumentation & Control are identified based on different interface types.

2. Scope

The Gas Delivery and Injection System consists of three Low Field Side Injectors, High Field Side Injectors, Lower Divertor Hi Flow injections system, Massive Gas Injectors, Private Flux Region Fueling and Supersonic Gas Injector (future). The Integrated Machine Operations consists of the Front Panel Data Port (FPDP), and Physics Control Systems, Digital Coil Protection System, Shorted Turn Protection, and the Ip Calculator. The scope of this document addresses any defined interfaces between these identified system elements.

3. Responsibilities

The interfaces are managed between the following organizations:

- Gas Delivery System
- Real Time Control & Protection
- Systems Engineering and Integration

4. Interfaces

Interface requirements in the following sections are identified with a requirement number, ICD followed by a number [ICD-GDS-IMO-X] where X is a sequential count beginning with 001, GDS represents Gas Delivery System 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,Me		
		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	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

Gas Delivery System	Si
	Integrated Machine Operations

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
1.3.4.5- 1.7.3.6.1-Si	All gas injection system control information is delivered by digital output modules from the real-time data stream; gas system signals is often archived by the stream	See Paragraph 4.4.1, AE1002

Interface Notes:

- The Private Flux Region has a +150V signal from the valve driver interface within the Gas Delivery system (SBS 1.3.4.5). This is included for completeness in completing the interface.
- The MGI has three trigger signals via fiber optics from the valve driver interface within the Gas Delivery system (SBS 1.3.4.3.2) This is included for completeness in completing the interface.

4.4.1. Real Time Control System – Valve driver

ICD-GDS-IMO-001: The valve driver interface sends out to the SAD using the FPDP data stream to the SAD as shown in the interconnection in the center of Figure 1. Figure 1 is a snapshot of the block diagram as shown in Figure

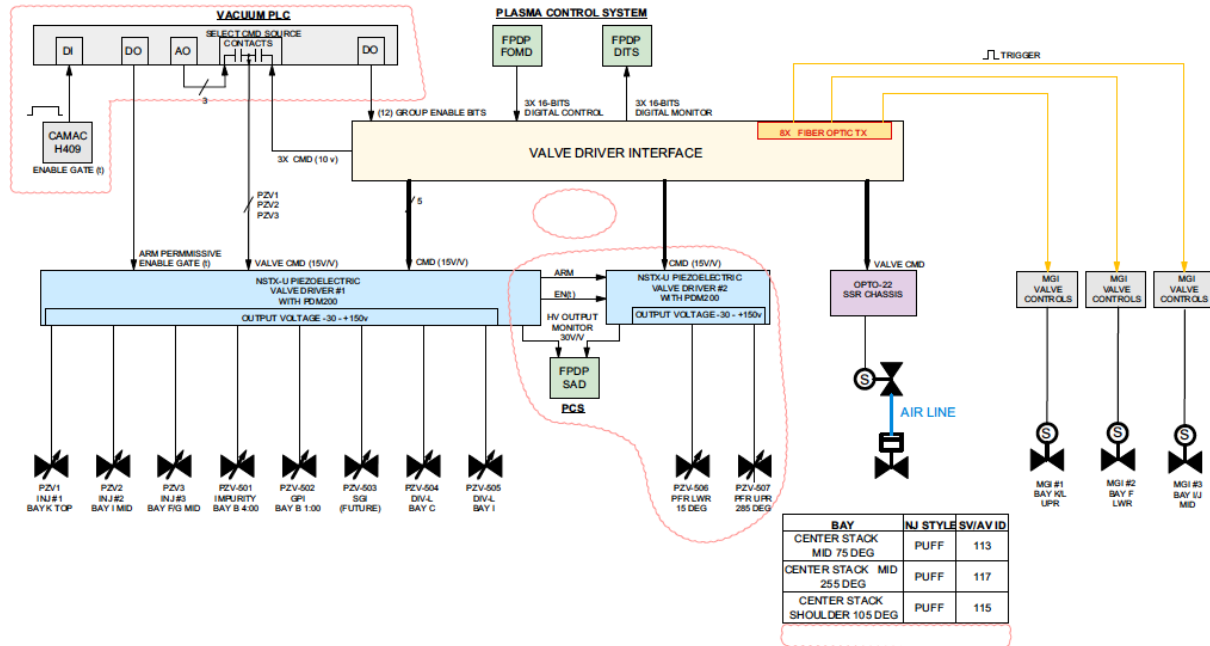


Figure 1. Gas Injection Block Diagram

ICD-GDS-IMO-002: The valve driver interface also receives signals and sends signals to the plasma Control System via the FPDP data stream. The output is sent to the DITS from the Valve Driver Interface as shown in the center top of Figure 1.

4.4.2. 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		

4.5. Gas/Fluid Interfaces

This paragraph has two different types of interfaces: Gas and Fluid.

4.5.1. Gas Interfaces

This identifies any interfaces between the system elements that use any type of gas (e.g., He).

Identifier	Interface	References
N/A		

4.5.2. 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		

4.6. Vacuum Interfaces

This identifies any interfaces between the system elements that pertain to the Vacuum.

Identifier	Interface	References
N/A		

4.7. 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		

Interface Notes:

- The Private Flux Region data is stored via the Plasma Control System and is addressed in the Integrated Machine Operations - Centralized Instrumentation and Control ICD.

4.8. Thermal Interfaces

This identifies any interfaces between the system elements that pertain to Thermal characteristics.

Identifier	Interface	References
N/A		

4.9. Plasma Interfaces

This paragraph has two different types of interfaces: Plasma and Eddy/Halo Current.

4.9.1. Plasma Interfaces

This identifies any interfaces between the system elements with the Plasma.

Identifier	Interface	References
N/A		

4.9.2. 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.