

<b>PPPL</b>	<b>PRINCETON PLASMA PHYSICS LABORATORY</b>	<b>PROCEDURE</b>	<b>No. ENG-064 Rev 0 page 1 of 5</b>
<b>Subject:</b>  <b>Interface Control</b>	<b>Effective Date:</b>  8/1/18	<b>Initiated by:</b>  <b>Head, Engineering Department</b>	
	<b>Supersedes:</b>  NEW	<b>Approved:</b>  <b>Director</b>	

**Management System (Primary):** 03.00 ENGINEERING (ENG)  
**Management System Owner:** Engineering Department Head  
**Management Process:** 03.06 Technical Project Management  
**Process Owner:** Engineering Department Head  
**Sub-Process:** 03.06.12 Scope Management, Planning, Definition, Verification, and Scope Change Control  
**Sub-Process Owner:** Engineering Department Head  
**Subject Matter Expert:** Engineering Department Head; Chief Engineer; Fabrication Group Head

### **Applicability**

This procedure applies to all systems of sufficient complexity, whether internal or due to the relation with other systems, or subsystems, that benefit from developing well defined interface documents.

### **Introduction**

This procedure describes the development and use of interface lists and interface control documents.

An interface is a boundary between system elements or subsystems that define the flow of physical or virtual interface quantities across the boundary (e.g. voltage, current, power, heat, force, pressure, flow, data, etc.). Interface Control is the process of developing a formal technical agreement between two or more elements that document the functional, performance, and physical characteristics required to exist at the boundary. Boundaries are tied to both system decomposition and the responsible engineer or organization responsible for implementing the elements or subsystems. This establishes clear lines of effort and communications between the responsible organizations. An initial definition of a system's or subsystem's interfaces should be identified in its SRD per ENG-050.

Interface control coordinates the interfaces to ensure that systems and subsystems can be assembled and function together. As a design evolves, increasingly detailed interface data is developed and documented in Interface Control Documents (ICDs).

An N2 Diagram is used to identify each interface in a high-level view. The N2 diagram is a tool to identify all the system interfaces to be managed in one table. It identifies the interfaces that exist between subsystems or system elements that have been defined as part of functional

decomposition and requirements generation. The axes of the N2 diagram are defined by the Responsible Engineers, based on the decomposition of the system. Interfaces between elements flow in a clockwise direction. The output of the element on the row provides as input into the element in the column. The interface types are listed in the squared in the appropriate square. Figure 1 provides a simple notional system decomposition consisting of a Vessel Structure, Magnets, Heating System, Diagnostics, and a Power Generation system. Note: Several arrows are included to show the interface flow. An empty box indicates that there is no interface to be managed. In the other boxes, the types of interfaces are identified and are to be included in an Interface Control Document (ICD).

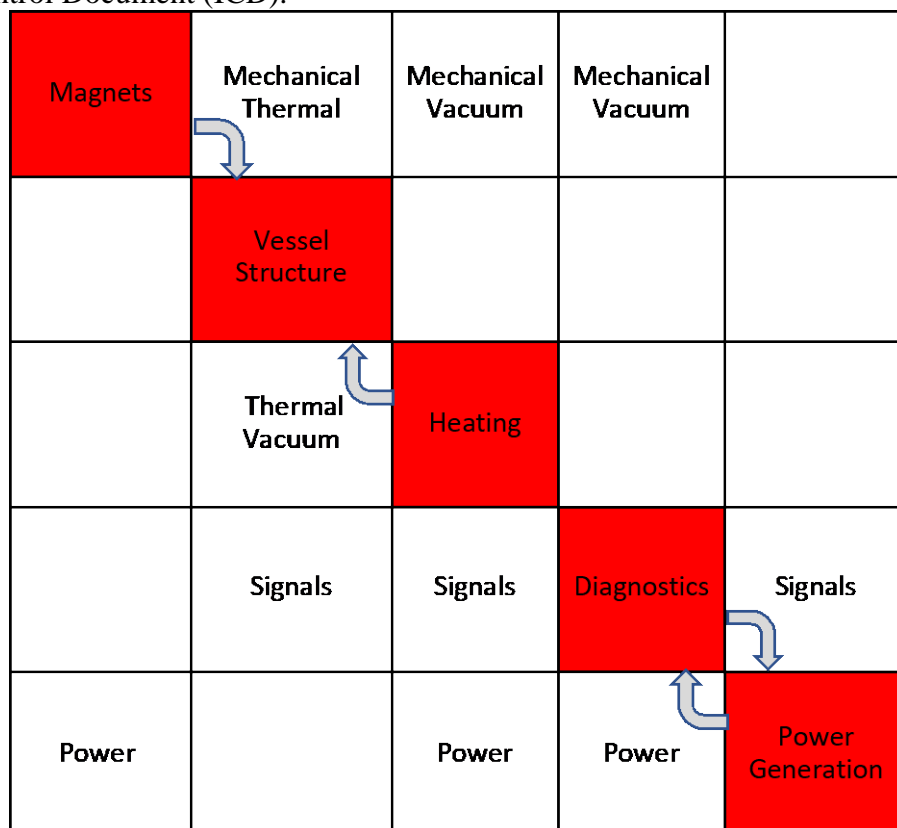


Figure 1. Sample N2 Diagram

There are different types of interfaces including, but not limited to, Mechanical, Electrical Power, Signal, Software, Gas/Fluid, Plasmas, Thermal, Diagnostic, or Vacuum. There may be other sub-categories to these interface definitions. The interfaces required may vary based on the system design and requirements. For example, under mechanical there may be structural or spatial critical interfaces. The N2 Diagram includes the top-level interfaces. This diagram allows an initial depiction of the interface types that occur throughout the system.

For each pair of interfaces identified in an N2 diagram, there is a corresponding ICD. The ICD is the mechanism by which all interfaces are managed. The main purpose of the ICD is to establish formal communications between the organizations required to manage the interfaces. ICDs

document and control the interfaces between system elements and organizations. The ICD includes at a minimum:

- A unique identifier for each interface
- Organizational entities responsible for compliance on each side of the interface
- An interface description with reference documents that provide detail and design basis to verify compliance, e.g. calculations, sketches, drawings, specifications.

Initially, references could be sketches and simple calculations that affect the interface but as the design matures, these could be drawings and calculations that are placed under configuration management. The calculation or drawings referenced are those that affect the interface.

The interface control documents provide input to the system design, integration, and verification processes. Interface control defines the integration constraints that ensure that the pieces that comprise the system can be assembled and will function properly.

## **REFERENCES**

ENG-030	Technical Procedures
ENG-033	Design Verification
ENG-036	Control of Temporary Modifications
ENG-050	Job Requirements Documentation & Control

## **Procedure**

This procedure describes the process for developing the N2 Diagram, Interface Control Documents and Interface Lists for engineering work.

Responsible Engineers	1. Develop interface list to other Systems, Subsystems, or Elements
Chief Engineer	2. Consults with all Responsible Engineers and develops the initial N2 Diagram.
Chief Engineer and Responsible Engineers	3. Sign off the N2 Diagram.
Chief Engineer	4. Extracts Interface Lists, noting if any is part of a Credited Control.
Responsible Engineer	5. Signs the Interface List to acknowledge it.
Interfacing Responsible Engineers	6. Develop Interface Control Document, and sign it.

- |                         |   |
|-------------------------|---|
| Chief Engineer          | 7. Reviews and signs Interface Control Document.  |
| Design Review<br>Chair  | 8. Uses Interface List to check Design Review Board representation.   |
| Design Review<br>Board  | 9. Uses Interface Control Document to confirm integration of design being reviewed.   |
| Responsible<br>Engineer | 10. Uses Interface List to develop Technical Procedure review list.   |
| All                     | 11. Can revise N2 Diagram, Interface Control Documents and Interface Lists as the design maturity increases, their record will be set at the Final Design Review. |

### **TRAINING**

- |                                 |   |
|---------------------------------|---|
| Head, Engineering<br>Department | 1. Ensures the appropriate training methods and means (below) are provided and obtains concurrence of the Management System Owner and the Management Process Owner. |
|---------------------------------|---|

**Target Audience:** Responsible Engineers, Cognizant Individuals, Chief Engineer

Instructor: Head, Engineering Department

Training Method:

- X Briefings (major re-issue, new positions)
- X Required Reading (major re-issue and minor revisions)
- X Email distribution (minor revisions)

- |                                 |  |
|---------------------------------|--|
| Head, Engineering<br>Department | 2. Notifies the Human Resources Training Office of the training so that they will be aware of the training requirements and be able to provide assistance and guidance in the course development, implementation, tracking, and maintenance if needed. |
|---------------------------------|--|

### **Records Requirements specific to this procedure**

Records Custodians must assure records are maintained as follows:

Record Title	Record Custodian	Location	Retention Time
N2 Diagram	Chief Engineer	Ops Center	See record Schedule for specific Project Type <i>Reference Admin 17, Cartographic, Aerial Photography, Architectural &amp; Engineering Records (30.c)</i>
Interface	Responsible	Ops Center	See record Schedule for specific Project

Control Document	Engineers (2)		Type <i>Reference Admin 17, Cartographic, Aerial Photography, Architectural &amp; Engineering Records (30.c)</i>
Interface list	Responsible Engineer	Ops Center	See record Schedule for specific Project Type <i>Reference Admin 17, Cartographic, Aerial Photography, Architectural &amp; Engineering Records (30.c)</i>

### ATTACHMENTS:

1. N2 diagram – worked example
2. Interface list – worked example
3. Interface Control Documents – worked example

**N2 diagram - Worked Example**

**Attachment 1**

System Name:				Chief Engineer:		
				Date:		
Subsystem	<Interface Type>					
	Subsystem					
		Subsystem				
			Subsystem			
				Subsystem		
					Subsystem	
						Subsystem
Subsystem X RE: _____						
Subsystem X RE: _____						
Subsystem X RE: _____						
...						



<b>PPPL</b>	PRINCETON PLASMA PHYSICS LABORATORY	<b>PROCEDURE</b>	No. ENG-064 Rev 0 page 1 of 6
Interface Control Document - worked example			Attachment 3

## Interface Control Document

<Subsystem 1> –  
<Subsystem 2>

Revision <#>  
<Date>

---

Prepared By: <Subsystem 1> RE

---

Prepared By: <Subsystem 2> RE

---

Reviewed By: Systems Engineer

---

Reviewed By: Chief Engineer

### Change Record

Revision	Date	Description of Change



<b>PPPL</b>	<b>PRINCETON PLASMA PHYSICS LABORATORY</b>	<b>PROCEDURE</b>	<b>No. ENG-064 Rev 0 page 2 of 6</b>
<b>Interface Control Document - worked example</b>			<b>Attachment 3</b>


**References**

[1] &lt;Reference 1&gt;

**1. Purpose****2. Scope****3. Responsibilities**

The interfaces are managed between the following organizations:

<Subsystem 1>

<Subsystem 2>

**4. Interfaces****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 1 provides the N2 Diagram identifying all the interfaces for <System>. There is a specific callout highlighted in blue specifically identifying these interfaces between the Vacuum Vessel Structure.

Table 1. N<sup>2</sup> Diagram Interface types  
<Insert N2 diagram with callout>

## 4.2 Mechanical Interfaces

This paragraph addresses any type of mechanical interfaces to include structural, spatial, location dependent interfaces or areas where penetrations in a wall or floor are required. These are identified independently as the interface parameters will likely be different.

### 4.2.1 Structural Interfaces

This identifies any interfaces between the system elements that require a structural interface. This could be based on various forces placed on the system and by the system.

Number	Interface Description	References
ICD- <ID01>- <ID-02>- <#>	<description of the interface to include element and interface boundaries	<Provide extracts or references of interface requirements from calculations/drawings>

### 4.2.2 Spatial Interface

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

Number	Identifier	Interface	References

### 4.2.3 Location Interfaces

This identifies any interfaces between the system elements that have any particular dependencies on element location or location constraints.

Number	Identifier	Interface	References

### 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.

Number	Identifier	Interface	References

## 4.3 Electrical Power Interfaces

This identifies any interfaces between the system elements requiring AC, DC, rectification or power conditioning.

Number	Identifier	Interface	References

#### 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.

Number	Identifier	Interface	References

#### 4.5 Diagnostic Interfaces

This identifies any interfaces between the system elements with any instrumentation or diagnostic equipment to collect performance data.

Number	Identifier	Interface	References

#### 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).

Number	Identifier	Interface	References

##### 4.6.2 Fluid Interfaces

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

Number	Identifier	Interface	References

#### 4.7 Vacuum Interfaces

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

Number	Identifier	Interface	References

#### 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.

Number	Identifier	Interface	References

#### 4.9 Thermal Interfaces

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

Number	Identifier	Interface	References

#### 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.

Number	Identifier	Interface	References

##### 4.10.2 Eddy/Halo Current Interfaces

This identifies any interfaces between the system elements with the Eddy/Halo Currents.

Number	Identifier	Interface	References

#### 5. Off-Project Interfaces

The off-project interfaces are components that are not specifically part of the system. They may include external systems and interfaces where the program has little control on part of the interface. They are provided for completeness.