S01020500-IST10128

SECOND TARGET STATION (STS) PROJECT

Interface Sheet for Vessel Systems and Vessel Systems I&C

Chris Anton
Dana Humphreys

October 2024

OAK RIDGE NATIONAL LABORATORY
MANAGED BY UT-BATTELLE FOR THE US DEPARTMENT OF ENERGY

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1. PURPOSE

This document defines the interface between Vessel Systems (S.03.06) and Vessel Systems I&C (S.06.03.06). The interface described in this document will provide inputs to the design of Vessel Systems and Vessel Systems I&C. Requirements derived from this document are included in the Vessel Systems Requirements Document and the Target Controls Requirement Document.

2. SCOPE

The scope of this document is the complete interface definition for the interface between Vessel Systems and Vessel Systems I&C as identified in the parent Interface Control Document for Integrated Control Systems and Target Systems S01020500-IC0009.

No.	Components (Vessel Systems)		Components (Vessel Systems I&C)	
	Name	Functional reference Number	Name	Functional reference Number
1	Vessel Systems Temperature Instrumentation		Vessel Systems Process Instrumentation control hardware and software	
2	Vessel Systems Instrumentation Cable inside core vessel		Vessel Systems Instrumentation Cable outside core vessel	

3. ACRONYMS AND DEFINITIONS

I&C Instrumentation and Controls for Integrated Control Systems
ICD Interface Control Document
IS Interface Sheet
P&IDs Piping and Instrumentation Diagrams
PCD Process Control Description
PLC Programmable Logic Controller
SSC Structure, System or Component
WBS Work Breakdown Structure

4. REFERENCES

4.1 DOCUMENTS APPLICABLE TO THE INTERFACING SSCS

Ref	Document Titles	Document Control System Location
[1]	Interface Control Document for Integrated Control Systems and Target Systems	S01020500-IC0009
[2]	Integrated Control Systems Requirement Document	S06000000-SR000002
[3]	Target Controls Requirement Document	S06030000-SR0001
[4]	Vessel Systems Requirement Document	S03060000-SR0001

5. INTERFACE DEFINITION

5.1 TECHNICAL DESCRIPTION OF THE INTERFACE

The Vessel Systems includes the core vessel and adjoining components (WBS S.03.06). Internal water-cooling channels (Activated Cooling Loop 2 by WBS S.06.09.02) ensure the vessel assembly is uniformly cooled to limit temperature variations and eliminate thermal shifts that could reduce the component alignment. Temperature instrumentation will be located on the vessel structure to monitor the vessel temperature.
The interface points between Vessel Systems and Vessel Systems I&C are therefore defined as described below:

5.1.1 Interface No. 1: Vessel System Temperature Instrumentation --- Vessel Systems Process Instrumentation control hardware and software

Vessel Systems

- Responsible for design, procurement, and installation of Vessel Systems temperature instrumentation

Vessel Systems I&C

- Responsible for providing monitoring and control of temperature instrumentation
- Responsible for the design, procurement, and installation of the PLC cabinet assembly
- Responsible for design and implementation of EPICS operator screens for Vessel Systems process instrumentation

5.1.2 Interface No. 2: Vessel Systems Instrumentation Cable inside core vessel --- Vessel Systems Instrumentation Cable outside core vessel

Vessel Systems

- Responsible for the design, procurement, and installation of core vessel vacuum feedthroughs for temperature instrumentation cable (Vessel Systems I&C will assist in selection)
- Responsible for design, procurement, and installation of instrumentation wiring for temperature instrumentation in the core vessel to and including a connector at the Vacuum/Ambient boundary outside the core vessel (connectors provided by Vessel Systems I&C)

Vessel Systems I&C

- Responsible for the design, procurement, and installation of instrumentation cable from the connector to the PLC cabinet.

Anything outside the noted criteria of this document requires review by Vessel Systems and Vessel Systems I&C.

5.1.3 Design Responsibility

5.1.3.1 Piping and Instrumentation Diagrams (P&IDs)

Target Process Systems (S.03.09) is responsible for designing and drafting the P&IDs for the Vessel Systems (S.03.06). Vessel Systems I&C (S.06.03.06) will provide input for the instrumentation and controls portion of the P&IDs.

5.1.3.2 Process Control Description (PCD)

Target Process Systems will provide a PCD, with input from Target Vessel Systems, describing the proper functionality and control for Vessel Systems.

Target Process Systems will also provide an Setpoint and Alarm List, with input from Vessel Systems, showing process control setpoints and alarm limits for Vessel Systems instrumentation.

5.1.3.3 Software

The PCD and Setpoint and Alarm List, described in Section 5.1.1.2, will serve as design input to the Vessel Systems I&C software which will provide monitoring and control of the Vessel Systems. This includes PLC logic for process instrumentation, EPICS configuration, operator interface screens, process data monitoring, and alarm handling.

5.1.3.4 Field Instrumentation and Final Control Element Selection

Vessel Systems will provide process conditions for the instrumentation to Vessel Systems I&C, who will provide technical expertise on the instrument selection and/or development. Vessel Systems will be responsible for the final selection and purchase of the instrumentation, calibration certificates, and manufacturer drawings. Vessel Systems and Vessel Systems I&C will work to together to ensure all devices are compatible with the STS standard PLCs. Vessel Systems I&C will prepare Instrument Datasheets to document the instrumentation selected.

Type K thermocouples will be used to monitor component temperatures within the Core Vessel. We plan to utilize the same type of thermocouple utilized on the SNS IRP. Kapton insulated thermocouple wire will be used to transfer the signal from the sensor to the connector at the top of the core vessel. Crimp-push type pins will be installed at the vacuum connector end of the thermocouple wire (Kurt J. Lesker FTATC026A/ FTATC026C or equivalent). The vacuum connector will be a 20 pin MIL-SPEC thermocouple vacuum feedthrough (Kurt J. Lesker TFTVKA0003 or equivalent). We anticipate utilizing one connector for all of the MRA thermocouples, and two additional connectors for the core vessel and core vessel shielding thermocouples.

5.1.3.5 Installation Diagrams

The current Core Vessel design contains 42 utility nozzle ports located at the top of the core vessel. The ambient side of these nozzles reside in the pipe pan. Four utility nozzles have been designated for thermocouple vacuum feedthroughs. All of the MRA thermocouple connections will pass through port 14. The Core Vessel and Core Vessel Shielding thermocouples will pass through port #37 and port #41.

Figure 1 below shows the physical locations of the utility ports, and Table 1 below provides X,Y,Z coordinates for each port with respect to global center.

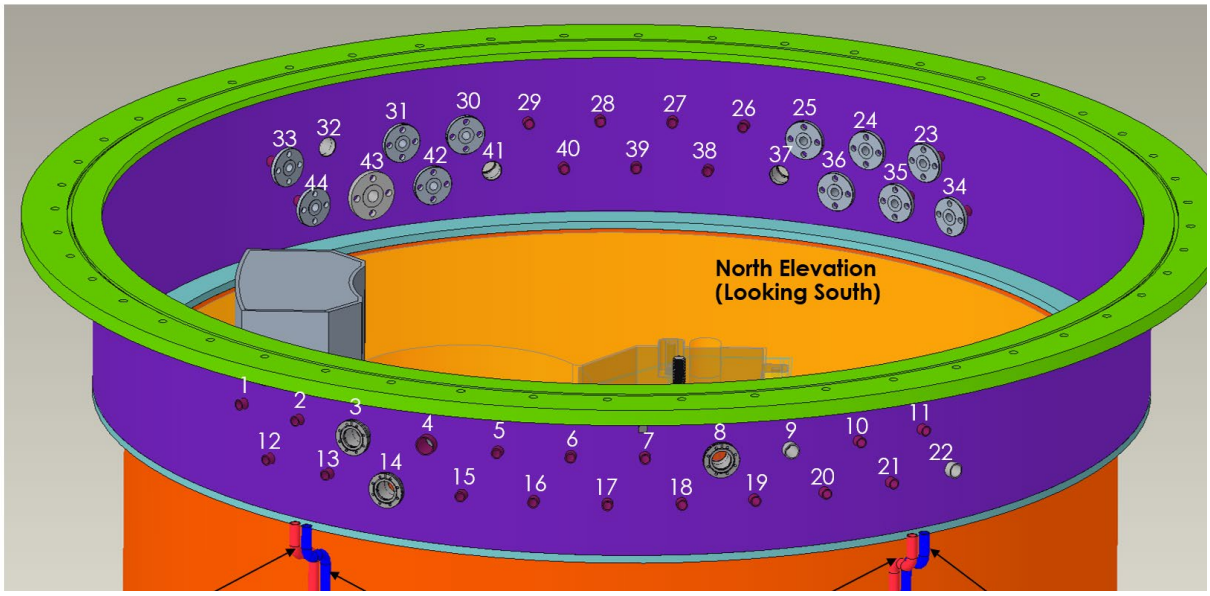

Figure 1: Core Vessel utility nozzle identification numbers

Process Nozzle Number	Utility Type	Penetration Type	Supply/Return	Connected Component	Ambient Side Interface (x,y,z)	Vacuum Side Interface (x,y,z)
1	TBD	1" Pipe, Flange	TBD	Spare	(1161.69, 4268,-1202.45)	(1066.08, 4268, -1103.96)
2	TBD	1" Pipe, Flange	TBD	Spare	(982.542, 4268, -1352.35)	(902.067, 4268, -1241.59)
3	TBD	2.5" Tube, DN63 CF Flange	TBD	Spare	(801.18, 4268, -1506.8)	N/A
4	Water Cooling	2" Pipe, Flange	Return	MRA Midle Backbone Return	(572.131, 4268, -1571.92)	(522.179, 4268, -1434.68)
5	Water Cooling	1" Pipe, Welded	Return	Shield Block #6	(347.545, 4268, -1635.07)	(331.952, 4268, -1561.71)
6	Water Cooling	1" Pipe, Welded	Return	Shield Block #2	(116.605, 4268, -1667.53)	(111.373, 4268, -1592.71)
7	Water Cooling	1" Pipe, Welded	Return	Shield Block #3	(-116.605, 4268, -1667.53)	(-111.373, 4268, -1592.71)
8	Electrical	1.63" Tube, DN35 CF Flange	N/A	Thermocouples	(-354.813, 4268, -1669.26)	N/A
9	Water Cooling	1.5" Pipe, Flange	Return	MRA Upper Backbone Return	(-571.721, 4268, -1570.79)	(-522.722, 4268, -1436.17)
10	Water Cooling	1" Pipe, Flange	Supply	MRA Upper Reflector Supply	(-784.769, 4268, -1475.94)	(-720.492, 4268, -1355.05)
11	TBD	1" Pipe, Flange	TBD	Spare	(-982.542, 4268, -1352.35)	(-902.067, 4268, -1241.59)
12	Water Cooling	1" Pipe, Flange	Supply	Shield Block #21	(1074.48, 4114.8, -1280.52)	(986.478, 4114.8, -1175.64)
13	Water Cooling	1" Pipe, Flange	Supply	Shield Block #22	(885.813, 4114.8, -1417.6)	(813.26, 4114.8, -1301.49)
14	Electrical	1.63" Tube, DN35 CF Flange	N/A	Thermocouples	(694.119, 4114.8, -1559.2)	N/A
15	Water Cooling	1" Pipe, Flange	Supply	MRA Upper Moderator Supply	(460.755, 4114.8, -1606.85)	(423.017, 4114.8, -1475.24)
16	Water Cooling	1" Pipe, Welded	Supply	Shield Block #6	(232.642, 4114.8, -1655.33)	(222.204, 4114.8, -1581.06)
17	Water Cooling	1" Pipe, Welded	Supply	Shield Block #4	(0, 4114.8, -1671.6)	(0, 4114.8, -1596.6)
18	Water Cooling	1" Pipe, Welded	Supply	Shield Block #1	(-232.642, 4114.8, -1655.33)	(-222.204, 4114.8, -1581.06)
19	Water Cooling	1" Pipe, Welded	Supply	Shield Block #5	(-460.755, 4114.8, -1606.85)	(-440.083, 4114.8, -1534.75)
20	Water Cooling	1" Pipe, Flange	Supply	MRA Lower Reflector Supply	(-679.901, 4114.8, -1527.08)	(-624.214, 4114.8, -1402.01)
21	Water Cooling	1" Pipe, Flange	Supply	MRA Lower Moderator Supply	(-885.813, 4114.8, -1417.6)	(-813.26, 4114.8, -1301.49)
22	Water Cooling	1.5" Pipe, Flange	Supply	MRA Middle Backbone Supply	(-1074.48, 4114.8, -1280.52)	(-982.396, 4114.8, -1170.77)
Process Nozzle Number	**Utility Type**	**Penetration Type**	**Supply/Return**	**Connected Component**	**Ambient Side Interface (x,y,z)**	**Vacuum Side Interface (x,y,z)**
23	TBD	1" Pipe, Flange	TBD	Spare	(-982.542, 4268, 1352.35)	(-902.067, 4268, 1241.59)
24	TBD	1" Pipe, Flange	TBD	Spare	(-784.769, 4268, 1475.94)	(-720.492, 4268, 1355.05)
25	TBD	1" Pipe, Flange	TBD	Spare	(-571.721, 4268, 1570.79)	(-524.894, 4268, 1442.13)
26	Water Cooling	1" Pipe, Welded	Return	Shield Block #5	(-347.545, 4268, 1635.07)	(-331.952, 4268, 1561.71)
27	Water Cooling	1" Pipe, Welded	Return	Shield Block #1	(-116.605, 4268, 1667.53)	(-111.373, 4268, 1592.71)
28	Water Cooling	1" Pipe, Welded	Return	Shield Block #4	(116.605, 4268, 1667.53)	(111.373, 4268, 1592.71)
29	Water Cooling	1" Pipe, Welded	Return	Shield Block #7	(347.545, 4268, 1635.07)	(331.952, 4268, 1561.71)
30	Water Cooling	1" Pipe, Flange	Return	Shield Block #22	(571.721, 4268, 1570.79)	(524.894, 4268, 1442.13)
31	Water Cooling	1" Pipe, Flange	Return	Shield Block #21	(784.769, 4268, 1475.94)	(720.492, 4268, 1355.05)
32	TBD	2.5" Tube, CF Flange	TBD	Spare	(1004.15, 4268, 1382.09)	N/A
33	TBD	1" Pipe, Flange	TBD	Spare	(1161.19, 4268, 1202.45)	(1066.08, 4268, 1103.96)
34	TBD	1" Pipe, Flange	TBD	Spare	(-1074.48, 4114.8, 1280.52)	(-986.478, 4114.8, 1175.64)
35	TBD	1" Pipe, Flange	TBD	Spare	(-885.813, 4114.8, 1417.6)	(-813.26, 4114.8, 1301.49)
36	TBD	1" Pipe, Flange	TBD	Spare	(-679.901, 4114.8, 1527.08)	(-624.214, 4114.8, 1402.01)
37	Electrical	1.63" Tube, DN35 CF Flange	N/A	Thermocouples	(-470.887, 4114.8, 1642.18)	N/A
38	Water Cooling	1" Pipe, Welded	Supply	Shield Block #3	(-232.642, 4114.8, 1655.33)	(-222.204, 4114.8, 1581.06)
39	Water Cooling	1" Pipe, Welded	Supply	Shield Block #2	0, 4114.8, 1671.6	(0, 4114.8, 1596.6)
40	Water Cooling	1" Pipe, Welded	Supply	Shield Block #7	(232.642, 4114.8, 1655.33)	(222.204, 4114.8, 1581.06)
41	Electrical	1.63" Tube, DN35 CF Flange	N/A	Thermocouples	(470.817, 4114.8, 1641.93)	N/A
42	TBD	1" Pipe, Flange	TBD	Spare	(679.901, 4114.8, 1527.08)	(624.214, 4114.8, 1402.01)
43	TBD	1.5" Pipe, Flange	TBD	Spare	(885.813, 4114.8, 1417.6)	(809.895, 4114.8, 1296.1)
44	TBD	1" Pipe, Flange	TBD	Spare	(1074.48, 4114.8, 1280.52)	(986.478, 4114.8, 1175.64)

Table 1: Core Vessel utility nozzle identification table.

5.1.3.6 Wiring of Field Instrumentation and Final Control Elements

Vessel Systems I&C is responsible for providing documentation for instrumentation cable terminations at the instrumentation and at the PLC enclosures. Vessel Systems I&C will also provide fabrication drawings and wiring drawings for the related PLC cabinet assembly.

5.1.4 Procurement

Vessel Systems is responsible for procurement of instrumentation, vacuum feedthroughs and associated connectors as described in section 5.1.3.4. All field instrumentation shall be purchased with calibration certificates and manufacturer drawings. Vessel Systems will also procure cable from the instrumentation to the vacuum feedthroughs as described in section 5.1.3.4.

Vessel Systems I&C is responsible for the procurement of control system hardware, including PLC cabinet assemblies, intermediate junction boxes, and cable/conduit between the PLC cabinet and field instrumentation. They will also procure any software packages required for control and monitoring of the Vessel Systems.

The financial responsibility for the components is summarized in the following table:

WBS S.03.06 Vessel Systems	WBS S.06.03.06 Vessel Systems I&C
Vessel Systems instrumentation	Cabling/conduit from cable connector to PLC
Cabling between Vessel Systems instrumentation and vacuum feedthrough	PLC system
Vacuum feedthrough and cable connectors	Control software & associated computing
	Patch panels and/or junction boxes (if needed)

5.1.5 System Installation

Vessel Systems will be responsible for installing all field instrumentation and wiring from the field instrumentation in the core vessel to the vacuum feedthrough cable connector. Vessel Systems will also be responsible for installation of the thermocouple vacuum feedthroughs.

Vessel Systems I&C will be responsible for installing PLC cabinet assemblies, intermediate junction boxes, and cable/conduit between the PLC cabinet and cable connectors. They will also be responsible for configuration of field instrumentation, as required.

5.1.6 System Testing

Prior to Vessel Systems Integration Testing, Vessel Systems I&C will provide ICS checkout procedures/testing which include the following:

- Verifying wiring is installed correctly
- Verifying the instrumentation is performing as required as each instrumented component is installed within the core vessel.
- Testing control algorithms to the extent possible without endangering equipment
- Verification of signal from field instrumentation to EPICS

Vessel Systems will provide overall System Integrated Testing which includes sequence of operation, start-up, and commissioning procedures. Vessel Systems I&C will support this testing.

5.1.7 Summary of Design Responsibility

Table 1 below summarizes design documentation responsibility of Vessel Systems and Vessel Systems I&C:

Summary of Design Responsibility	
Vessel Systems (S.03.06)	Vessel Systems I&C (S.06.03.06)
S.03.09 - P&ID (S.03.06 and S.06.03.06 will provide input)	Software (PLC, EPICS, operator interface screens, etc.)
S.03.09 – PCD (S.03.06 will provide input)	Instrument datasheets (S.03.06 will provide process conditions)
S.03.02 – field instrumentation procurement and procurement documentation (S.06.03.06 will provide input selection)	Wiring diagrams for instrumentation
S.03.02 - Installation diagrams	Fabrication drawings for PLC cabinet assembly
S.03.02 - Installation of field instrumentation	Installation of PLC cabinet assemblies, intermediate junction boxes, and cable/conduit between the PLC cabinet and the cable connectors
S.03.02 - Installation of Vacuum Feedthroughs	Configuration of field instrumentation, as needed
S.03.02 - System integration testing (S.06.03.06 will support)	ICS checkout testing

5.2 INTERFACE DATA

The block diagrams shown in Figure 1, illustrates the interfaces between Vessel Systems and Vessel Systems I&C. Moderator Reflector Assembly and Accelerator Interface Components are not in the scope of this document.

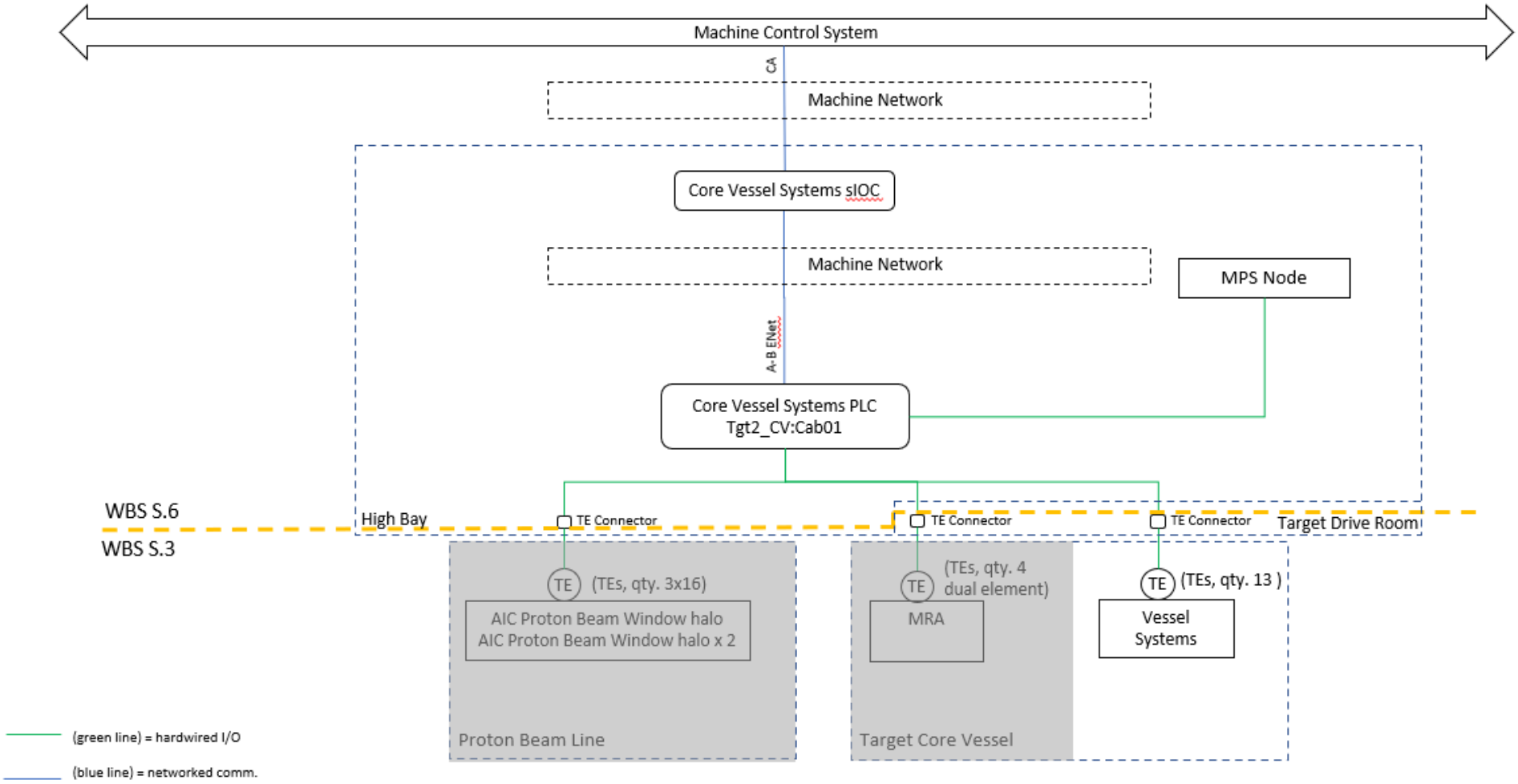

Figure 1: Vessel Systems I&C

(Moderator Reflector Assembly and Accelerator Interface Components are not in the scope of this document)