S01020500-IST10104

SECOND TARGET STATION (STS) PROJECT
Interface Sheet for ICS TPS & Target Assembly

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September 2023

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

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Revision	Description
00	Initial Release

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FIGURES

TABLES

1. PURPOSE

This document defines the interface between ICS TPS and the Target Assembly. The target rotation system rotates the target at an angular velocity adequate to ensure a single pulse into each segment. The technical interface described in this document will define the details of sensor speed selection and instrumentation to monitor the target rotation. The main requirements derived from this document are included in the System Design Requirements for Integrated Control Systems [2] and Target Assembly Systems Requirements [3].

2. SCOPE

The scope of this document is the interface definition between the ICS TPS and the target rotation system as identified in the parent Interface Control Document S01020500-IC0009 between Integrated Control Systems (ICS) WBS S.06 and Target Systems WBS S.03.

2.1 INTERFACING PARTS OR COMPONENTS

No.	**Components (Target Systems)**		**Components (ICS - TPS)**	
	Name	Functional reference Number	Name	Functional reference Number
1	Target Assembly	N/A	Target Protection System	N/A
2				
3				

3. ACRONYMS AND DEFINITIONS

2oo3	Two-out-of-three interlock logic
CEC	Credited Engineering Control
COTS	Commercial-Off-the-Shelf
DC	Direct Current
EPICS	Experimental Physics and Industrial Control System
ICD	Interface Control Document
IOC	Input/Output Controller
IS	Interface Sheet
PHAR	Preliminary Hazzard Analysis Report
PLC	Programmable Logic Controller
SIL	Safety Integrity Level
SSC	Structure, System, or Component
STS	Second Target Station
TPS	Target Protection System
WBS	Work Breakdown Structure

4. REFERENCES

4.1 DOCUMENTS APPLICABLE TO THE INTERFACING SSCS

Ref	Document Titles	Document Control System Location
[1]	ICD for Accelerator Systems and Target Systems S01020500-IC0009	EDRM
[2]	STS Integrated Control Systems Requirements, S06000000-SR0002	EDRM
[3]	System Requirements Document for Target Systems Target Assembly, S03020000-SR0001	EDRM
[4]	Preliminary Hazard Analysis Report S01030000-ES0002	EDRM

5. INTERFACE DEFINITION

5.1 TECHNICAL DESCRIPTION OF THE INTERFACE

The rotation of the STS target will be monitored by the Target Protection System (TPS) to mitigate events that are identified in the Preliminary Hazard Analysis Report (PHAR) TS3-2, and TS3-3. TPS will ensure that the rotation is within the angular velocity defined in the hazard analysis and will shut-off beam operations otherwise. The angular velocity on the target disc is generated from the drive module at the top of the target assembly. A 5m long axle connects the drive with the target segments. See Figure 1.

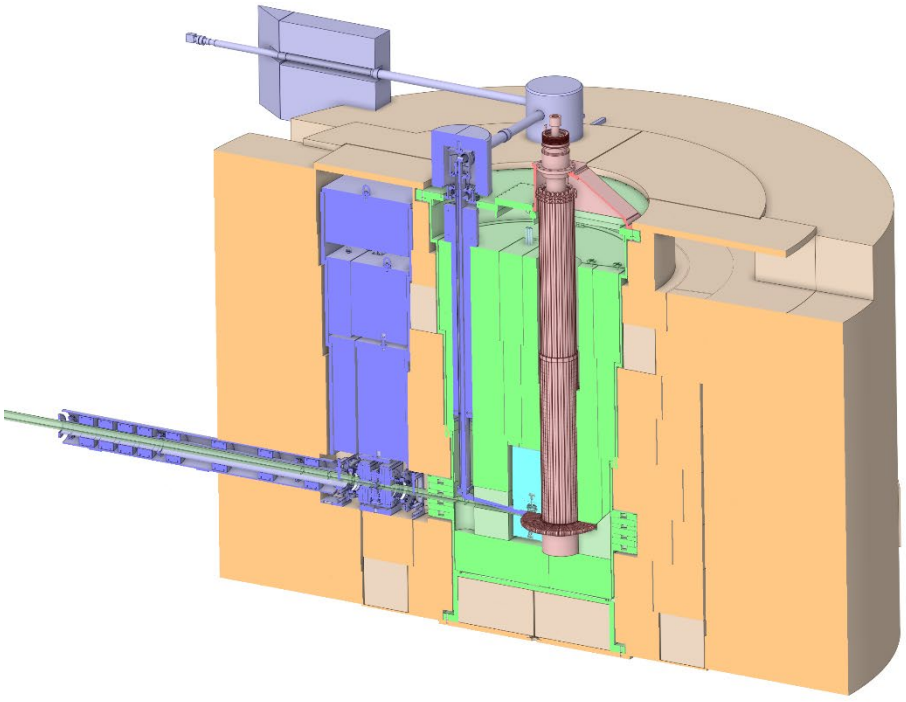

Figure 1: Rotating Target Representational Layout

5.2 ICS WBS (S.06.06) RESPONSIBILITIES

The TPS will monitor the target rotation using independent triple module redundancy sensors (2oo3). The ICS WBS (S.06.06) will be responsible for the following:

- Qualification of sensors for radiation and operating environment
- Specification and communication of mechanical, electrical, radiation, maintenance and other applicable requirements to WBS S.03.02 for sensor selection
- Specification and communication of Preventative Maintenance and calibration requirements to operations
- Evaluation of the speed sensor selection before final approval is made
- The speed sensor electrical information will be captured under the S.06.06 drawings and build of materials.
- Installation of the speed sensors during factory acceptance testing, installation, commissioning, and maintenance
- Evaluate the mechanical and mounting interface of the speed sensors
- Instrumentation of speed sensors
- Design, build, and installation of the electrical cabinet
- Specification, purchasing, and installation of galvanized conduits or cable trays from the sensor location to the TPS electrical cabinet
- Specification, Purchasing, and installation of cable for instrumentation – (Main power, Analog, and Discrete signals)
- Logic, programming, and scale of signals to allow speed detection
- Integration testing and commissioning of the CEC sensors
- Specify and provide identification for sensor, conduit, cable tray, and wiring

In addition to the items mentioned above, the ICS WBS (S.06.06) will implement techniques and procedures to allow qualified personnel to perform calibration and maintenance on the CEC system. The safety design will be such that it provides easy access for Preventive Maintenance (PM), testing, and calibration, with minimal disruption to the overall safety system.

5.3 TARGET ASSEMBLY WBS (S.03.02) RESPONSIBILITIES

The Target Assembly WBS (S.03.02) will select and provide a mounting interface for the speed sensors based on best practices and access for Preventive Maintenance (PM)

The Target System WBS (S.03.02) will be responsible for the following:

- Selection of the speed sensors
- Provide mounting interfaces for the speed sensors on the target assembly
- Provide adjustment features to accommodate the proper function of the sensors (thermal expansion, installation tolerances, etc.)
- Designate the detection media on the fabrication drawing as “TPS”
- Location of the sensors & detection media that will determine the overall speed of the system (TS3-2)
- Location of the sensor & detection media that will determine the presence (or lack of) individual segment (TS 3-3)
- Designate the sensor mounting interface as “TPS” on the fabrication drawings

It will be desirable that the speed sensors are Commercial-Off-the-Shelf (COTS) that meet the desired Safety Integrity Level (SIL) where possible. The selection of speed sensors depends on the mounting location of the target assembly, the radiation levels, and the instrumentation. The location and radiation levels of the sensors that will be mounted are unknown at this point in the project. The location must be evaluated by ICS WBS (S.06.06).

5.4 TECHNICAL REQUIREMENTS FOR THE SPEED SENSOR

The CEC speed sensors will monitor the angular velocity of the target disc. Due to the estimated high radiation levels of the target segments during and after beam operation, a radiation-resilient sensor is preferred. Using a Class 1E safety-rated sensor is preferred but not required.

5.4.1 Preferred Sensor Standards

1) IEEE 323
2) IEEE 344
3) IEC 61508
4) Class 1E per IEEE 323

5.4.2 Sensor Reliability Requirements

1) Sensor shall be capable of operating reliably for more than one year without replacement

5.4.3 Sensor Electrical Requirements

1) Signal Level: 50 mV, 75 mV, 100 mV, 150 mV, 250 mV, or 500 mV
    a. Signal shape: Sine wave <50KHz (>4μs)
2) OR Signal Level: 11 – 24 VDC
    a. Signal shape: square wave <50KHz (>4μs)
3) Input Voltage: 16 – 24VDC
4) Cable: twisted pair, overall and individual shielded, 18AWG, radiation resilient insulation

5.4.4 Sensor Mounting Requirements

The interface of the speed sensor should consider the following:

1) There shall be 3 or more sensor interfaces located at different measurement locations on the target drive
2) Thermal expansion – the expansion could affect the detection of the target segment media as the sensor could move such that it no longer detects the target
3) Sensing gap – the gap between the sensor head and the target segment media must be such that it accommodates the variations between each target segment
4) Vibration – the target rotation and other systems will introduce vibration that could cause the sensor to get loose such that it no longer provides a reliable signal
5) Replacement – the mechanical actions of replacing the sensor should be robust
6) Damage – the sensor should be protected such that it does not get damaged during target maintenance activities
7) The sensor should be capable of removal within TBD hours of turning beam off.
8) Attachment – target assembly should provide a hole for sensor mounting (details TBD) to ensure it meets the vacuum requirements

9) Provide a yellow circle >2” in diameter around the sensor mounting interface, clearly visible (without obstruction) from within the Target drive room.

5.5 CEC INSTRUMENTATION DETAILS

5.5.1 TPS Signal Implementation Strategies

TPS is a standalone system that ensures high reliability to protect personnel and the environment from hazards associated with the target assembly. As a result, the TPS will minimize common failures and ensure that all low-voltage signals will have galvanic isolation between each power supply. In addition, TPS will not allow other control systems to monitor the electrical signals of the CEC speed sensors. However, the TPS will make the angular velocity data available to the Experimental Physics and Industrial Control System (EPICS) through a mailbox PLC and a dedicated IOC. Other control systems can then use the EPICS data as needed.

5.5.2 TPS CEC Speed Signal Names

The TPS and target assembly documentation will use the Table 1 numbering system to label and identify the CEC speed sensors in drawings, software, and procedures.

Table 1: Speed Sensor Identification Names

Sensor Index	EPICS Signal Name
CEC Speed Sensor 1	Tgt2_TPS:SZT_HB25001A
CEC Speed Sensor 2	Tgt2_TPS:SZT_HB25001B
CEC Speed Sensor 3	Tgt2_TPS:SZT_HB25001C

The breakdown of the numbering system is as follows:
Tgt2 = Second Target Station
TPS = Target Protection System
SZT = Safety Instrument Function of a speed sensor (ISA 5.1 standard)
HB = Located in the High Bay
25001 = Index and Target Assembly
A or B or C = It implies three instances of the speed sensors (2oo3 voting)