INTERFACE CONTROL DOCUMENT TITLE AND APPROVAL PAGE

ICD Number: ICD-125-0001 Vacuum Vessel Themocouples	**Primary Author**: P. Goranson
Impacted WBS Elements: WBS 171, WBS 4, and WBS 5	**Type of Interface:** Mechanical/Envelope/Functional Interface

Description of Interface:

The Vacuum Vessel subassembly (VVSA) utilizes thermocouples to monitor the temperature of the VV body and port extensions during bakeout and operation. This ICD defines the requirements for installation, placement, and routing the thermocouples as well as interfacing to other WBS elements:

- Cryostat (WBS 171) – feed throughs interfaces;
- Power Systems (WBS 4) – 110 v ac for the power conditioning panels; and
- Central I&C Systems (WBS 5) – provides capabilities to receive and interpret the temperature data provided by the VV thermocouples

Record of Revisions

Revision Number	Description	Date
0	Initial Issue	April27, 2005.

Approvals

WBS Manager: (WBS 12) ? Paul Goranson Signature Not Verified Digitally signed by Paul Goranson DN: cn=Paul Goranson, c=US Date: 2005.04.28 14:25:16 -04'00'	**WBS Manager: (WBS 171)**
WBS Manager: (WBS 4)	**WBS Manager: (WBS 5)**
Project Engineer: (Stellarator Core)	**Project Engineer: (Electrical Systems)**
Project Engineer: (Auxiliary Systems)	**Systems Engineering Support Manager:**

ICD DETAIL SHEET

(Use Continuation Sheets as Necessary to Include the Following Applicable Information)

Scope of Interface:

Thermocouples shall be provided to monitor the VV temperature during standby and bakeout operation. Thermocouples are to be provided by WBS 12 only for the inner port extensions during initial phase operation. Thermocouples for outer port extensions will be provided outside the MIE project during upgrade operation. Provisions must be provided by WBS 171 and WBS 12 for future hookup of the additional thermocouples, i.e. connectors at the cryostat and expansion capability at the signal conditioner interface.

WBS 12 will be responsible for overall design of the system including choice and location of components, mounting provisions, lead routing, signal conditioning, and electrical isolation.
WBS 12 will be responsible for coordination of the thermocouple design with the other interfacing disciplines (WBS 171 and WBS 5).
WBS 4 will be responsible for providing power to the signal conditioning panels.

Equipment and Responsibility List:

Vacuum Vessel Systems (WBS 125): Goranson
Cryostat (WBS 171) Gettlefinger
Power Systems (WBS 4) – Ramakrishnan
I&C Systems (WBS 5) - Oliaro

Related ICDs:

Notes and Abbreviations:

Other Pertinent Information:

Criteria

- Thermocouples will be operated in a range from room temperature to 375 C
  - Thermocouple leads mounted on or near the VV body must be rated for operation from room temperature to 375 C, but should not be damaged by fault conditions during which the vessel temperature may drop well below room temperature.
  - Thermocouple leads mounted at the extremity of the inner port extensions must be rated for operation from room temperature to 150 C.

- The thermocouple junctions will be grounded to the VV, but the signal conditioning system must provide a method for isolating the VV from ground to allow checking for ground faults.

- The leads will be insulated from all structure including the VV and Cryostat.

- The signal conditioners will be of the isolated type to prevent ground loop currents. Additionally, the instrument cabinet will be isolated from ground by insulation and isolation transformers.

- All thermocouples must be redundant with provisions to switch over to a backup if the primary unit should fail. Redundant thermocouple wires will be routed out to the signal conditioning unit.

- During initial operation all inner port extensions, except 4, 12, and the spacer port, will terminate within the cryostat. Provisions must be made for addition of thermocouples during later upgrade operation when the outer port extensions, which extend through the cryostat, will be added.

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Criteria (continued)

- The inner port extensions will be complete units with thermocouples, heater tapes and insulation wrap, at the time they are welded into the VV through the Modular Coil shells. Thermocouples will be installed on Port 12, the Spacer Port, and the NB port, and the VV body before assembly into the Modular coils. Care must be taken during welding to prevent damage to the thermocouples and heaters.

Hierarchy

The Magnetic Loop diagnostics (Loops) will be mounted on the Vacuum Vessel first, followed by the Coolant Tubes, and then the Thermocouples. The routing paths of the Coolant Tubes have precedence over Loops in that they are fixed, however, the bracket mount locations are flexible and will be located to be compatible with (avoid) the Loops. The Thermocouples will utilize space left over after the installation of the other systems.

Layouts will be done to assure compatibility of all the systems.

Thermocouple Type

Omega XCIB-K-4-3-X
- Inconel Overbraided
- Type K
- Bolted connection
- Grounded junction
- Ceramic connector
- X length in feet

SignalConditioners

Isolated type
89 required per field period (267 total), expandable to 120 per field period.
Model type TBD

Placement and Number

The thermocouple mounts and routing must be compatible with the coolant tubes, coolant tube mount brackets, and the loop diagnostics. The following list does not include the redundant backup units.

- VV body
  9 units per field period:
  - 2 near near spacer weld joint, one inboard and one outboard
  - 1 at the top vertex of the bean section
  - 1 at the lower vertex of the bean section
  - 1 on the inboard wall midplane at $\pm$30 degrees

  1 additional per field period at the inboard midplane at 0 degrees

- Round (conflat) flanges (22 ports per period)
  - 2 on every port extension, 1 at the flange, 1 near the vessel wall

- NB Port (2 total per field period)
  1 at the 3 oclock position and 1 at the 9 oclock position

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Placement and Number (continued)

- Port 12 (16 total per field period)
  2 near the vessel wall and 2 at the flange on each port

- Port 4 (16 per field period)
  2 near the vessel wall and 2 at the flange, each side

- Spacer Port (2 total per field period)
  2 on each port extension

The total number of active thermocouples to be installed, as part of the MIE project, per field period is 89. The total number of redundant thermocouples per field period is also 89. The approximate positions of the thermocouples on one field period is shown in Figure 1.

Lead Routing

- The leads from port extension mounted thermocouples, excluding Port 12, Port 4, and the NB Port, will route out the individual ports, terminating in plugs near the port flanges. Final connection to the plugs will be done after installation of the cryostat. (Figure 2)

- Foam-filled conduit containing hookup leads will interface the flange plugs and penetrate the cryostat. Multiple cannon connectors and leads will be provided so that each conduit may hookup **TBD** ports. An extra two sets will be provided on each for hookup of future outer port extension thermocouples.

- The leads from all VV body mounted thermocouples, the vertical ports(Port 12), Port 4, and the NB ports will be routed outside the cryostat along Port 12. This totals 19 on one side of Port 12 and 18 on the other, a total of 37? per field period,distributed between the top and bottom ports. A 2 ¾ inch conflat flange will be provided on each side of each vertical port (4 total per field period) at the cryostat flange interface. A typical MDC feedthrough has provisions for 10 pairs of type K thermocouples, giving 40 positions per field period.

Mounting

- The thermocouples will be attached to clips spot welded to the VV components. Each clip will include a mounting hole for a 6-32UNC screw.

- The thermocouple leads will be attached by Inconel 600 clips spot welded to the VV components.

ICD DETAIL SHEET

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Documentation

An installation drawing will locate the thermocouples, route the leads, and detail typical installation. The thermocouples will be given unique identifiers and a lead length required for each unit.

Field Period Thermocouple Location, Quantity, and Routing

Region	Attachment Location	Number	Interface	Total (Field Period)
PORTS				
NB	Port extension, at 3:00 and at 9:00	2 at flg	PORT 12A	2
PORT 12A	Port extension	2 at VV, 2 at flg Each side	PORT 12A	8
PORT 12B	Port extension	2 atVV, 2 at flg Each side	PORT 12B	8
PORT 4A	Port extension, at 12:00 and 6:00 position	2 at VV, 2 at flg Each side	PORT 12A	8
PORT 4B	Port extension	2 at VV, 2 at flg Each side	PORT 12B	8
2A	Inner Extension	1 at VV, 1 at flg	Out port	2
2B	Inner Extension	1 at VV, 1 at flg	Out port	2
5A	Inner Extension	1 at VV, 1 at flg	Out port	2
5B	Inner Extension	1 at VV, 1 at flg	Out port	2
6A	Inner Extension	1 at VV, 1 at flg	Out port	2
6B	Inner Extension	1 at VV, 1 at flg	Out port	2
7A	Inner Extension	1 at VV, 1at flg	Out port	2
7B	Inner Extension	1 at VV, 1 at flg	Out port	2
8A	Inner Extension	1 at VV, 1 at flg	Out port	2
8B	Inner Extension	1 at VV, 1 at flg	Out port	2
9A	Inner Extension	1 at VV, 1 at flg	Out port	2
9B	Inner Extension	1 at VV, 1 at flg	Out port	2
10A	Inner Extension	1 at VV, 1 at flg	Out port	2
10B	Inner Extension	1 at VV, 1 at flg	Out port	2
11A	Inner Extension	1 at VV, 1 at flg	Out port	2
11B	Inner Extension	1 at VV, 1 at flg	Out port	2
15A	Inner Extension	1 at VV, 1 at flg	Out port	2
15B	Inner Extension	1 at VV, 1 at flg	Out port	2
DOME A ports	Inner extension	1 at dome, 1 at flg, both ports	Out ports	4
DOME B ports	Inner extension	1 at dome, 1 at flg, both ports	Out port	4
SPACER PORT	Port extension	1 at VV, 1 at flg	Out port	2
BODY Toroidal Location				
Next to +60 degree Spacer welds	3:00 position 9:00 position	1 1	Port 12A Poty 12B	2 2
0 degrees	12:00 position 6:00 position 9:00 position	1 inbd of Port 12A 1 inbd of Port 12B midline	Port 12A Port 12B Port 12A	1 1 1
±30 degrees	9:00 position	1	Port 12A	2
			Total	**89**

Interface Block Diagrams:

VACUUM VESSEL TEMPERATURE CONTROL plg 4/08/05