SNS 100000000-IC0001-R01

SNS Interface Control Document

1.6 Target Systems

and

1.7 Neutron Scattering Instruments

Date: February 2001

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SNS # 100000000-IC001-R01

SNS Interface Control Document

Interfacing WBS elements

1.6 Target Systems

and

1.7 Neutron Scattering Instruments

WBS 1.6 STL and date **Tony Gabriel 10/08/00**

WBS 1.7 STL and date **R. Kent Crawford 10/10/00**

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1.0 General Interface Description

1.1 WBS 1.6 Target Station

The target station includes the mercury target, moderators, beam channels to the face of the biological shield and beam shutters capable of blocking each of these beam channels (see Figure 1.1-1). Eighteen beam passages facing 4 moderators are to be provided: 12 single and 6 multi-channel. Beam ports at the target vessel and shutter must accommodate beam-defining inserts: apertures, guides, collimators, and the associated shielding immediately surrounding the beam.

1.2 WBS 1.7 Instruments

Instruments (WBS 1.7) shall provide neutron scattering experiment components including neutron optical components, beam guides, neutron beam line and local shielding, neutron choppers, neutron detectors and all related data acquisition and control systems (see Figure 1.2-1). Also, each instrument will provide a certain range of sample environment equipment, including such equipment as is specialized for that particular instrument, or which is so commonly used that each instrument requires its own.

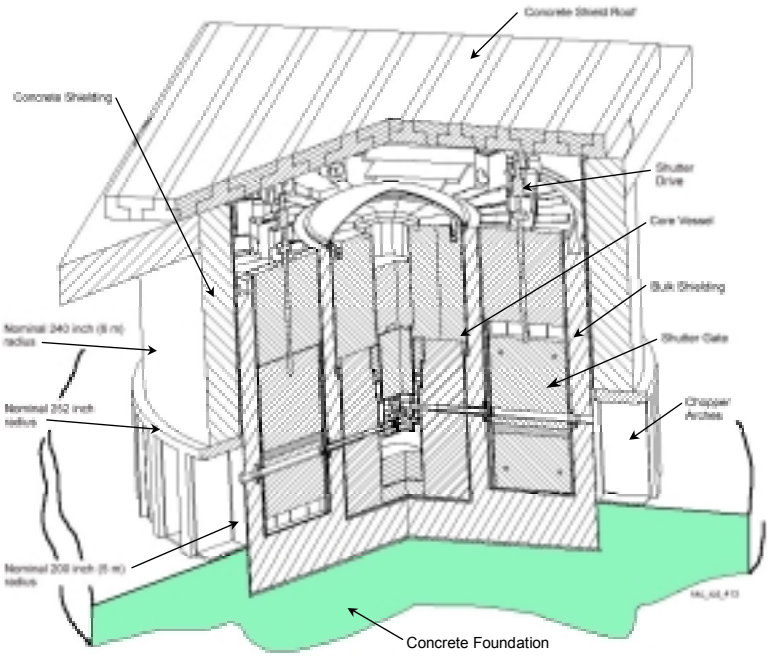

Figure 1.1-1 Target Station Configuration

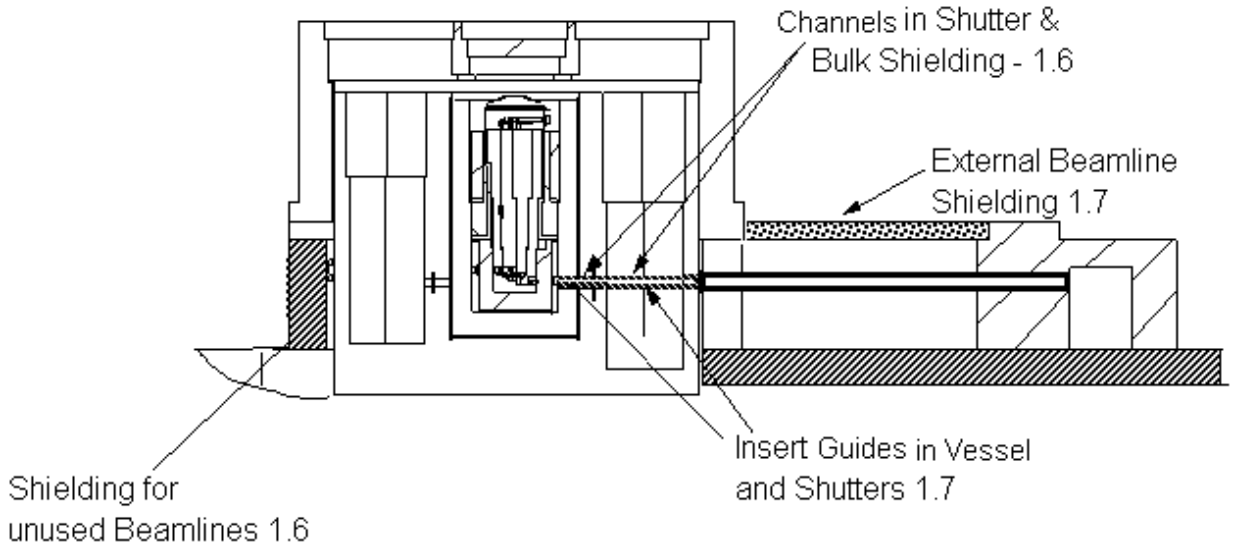

Figure 1.2-1 Typical Instrument Configuration

2.0 Interfaces

Interfaces are defined by Target Station WBS elements

2.1 Interfaces with Target Assembly (WBS 1.6.1)

There are no interfaces with the target or target process equipment.

2.2 Interfaces with the Moderator Systems (WBS 1.6.2)

WBS 1.6 shall provide the initial four moderators in the target station, two above the target and two below. Parameters for each of the moderators are provided in Table 2.2-1.

The moderators shall be positioned to illuminate groups of beam channels in three shutters as shown in Tables 2.2-1, 2.2-2 and Figure 2.2-1. The elevation parameter is the precise elevation of the beam line as defined by the insert configuration. The core vessel inserts, however, are located 7.31 inch above and below the target centerline. The physical constraints of the target facility and the width of the shutters determine the angular position of the beam lines. The location of the multi-channel shutters is given in Table 2.2-3.

Table 2.2-1 - General Moderator Parameters

Moderator Location	Configuration
Top upstream	Supercritical H_2, decoupled, poisoned, 20K
Top downstream	Supercritical H_2, coupled, pre-moderated, 20K
Bottom upstream	Ambient H_2O, decoupled, poisoned, 300 K
Bottom downstream	Supercritical H_2, coupled, pre-moderated, 20K
Dimensions of viewed faces	
Height	120 mm
Width	100 mm
Elevation of top moderator centers above proton beam line	Upstream = 7.0473 inch (179 mm) Downstream = 7.6323 inch (194 mm)
Elevation of bottom moderator centers below proton beam line	Upstream = 6.6 inch (168 mm) Downstream = 7.6323 inch (194 mm)
Elevation of core vessel insert centers above and below proton beam line	7.31 inch (186 mm)

Table 2.2-2 - Moderator assignment to neutron beam shutters

Moderator	Neutron beam shutters
Top upstream (decoupled H_2)	1,2,3,10,11,12
Top downstream (coupled H_2)	4,5,6
Bottom upstream (ambient)	7,8,9,16,17,18
Bottom downstream (coupled H_2)	13,14,15

Table 2.2-3 - Shutter Types

Multi-channel shutters	1,4,8,11,14,16
Single-channel shutters	2,3,5,6,7,9,10,12,12,15,17,18

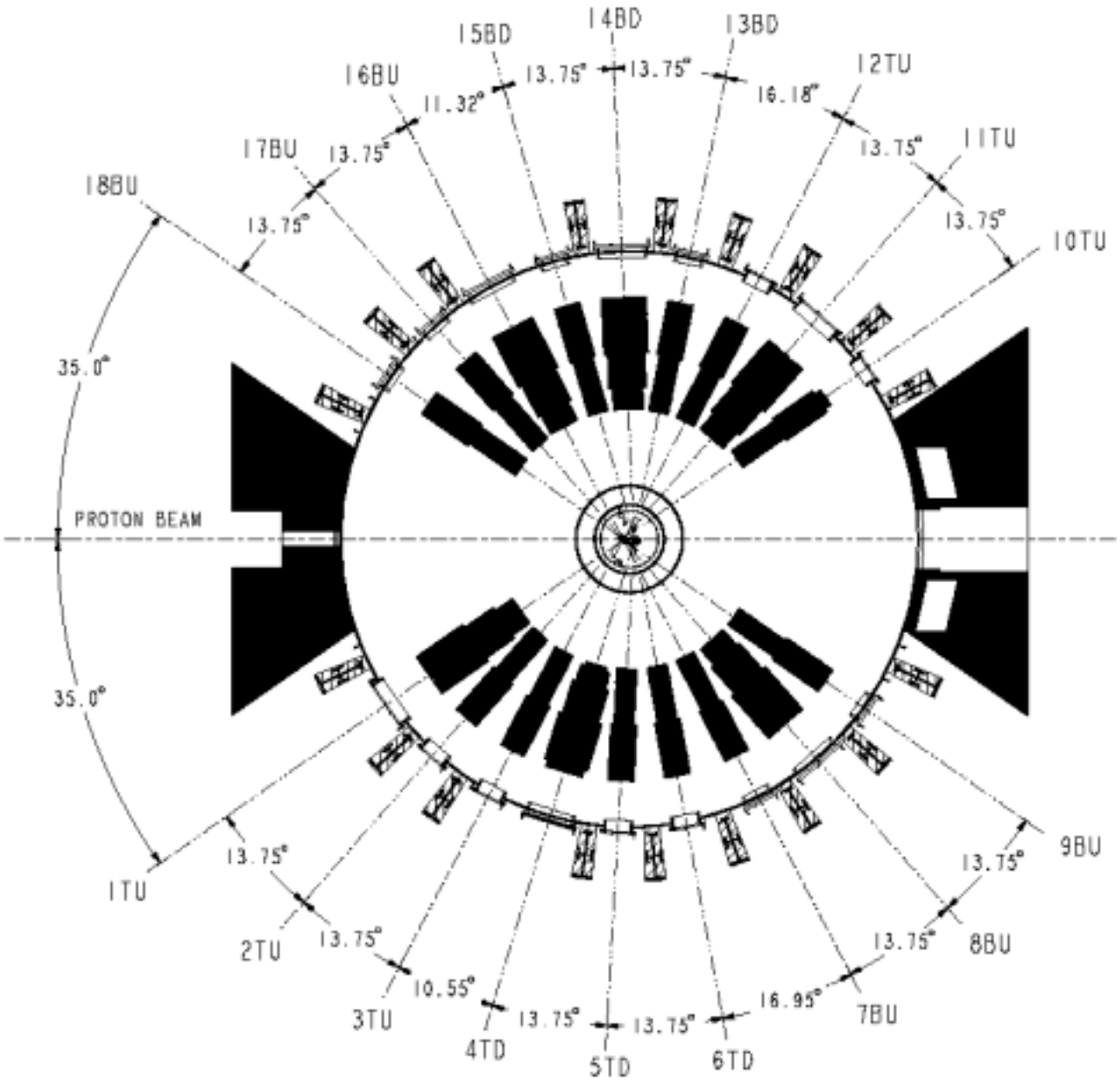

Fig. 2.2-1. Neutron flight tube arrangement.

The position of the upper moderator faces is shown in Figure 2.2-2 and the position of the lower moderator faces in Figure 2.2-3. An elevation view of the moderators is shown in Figure 2.2-4.

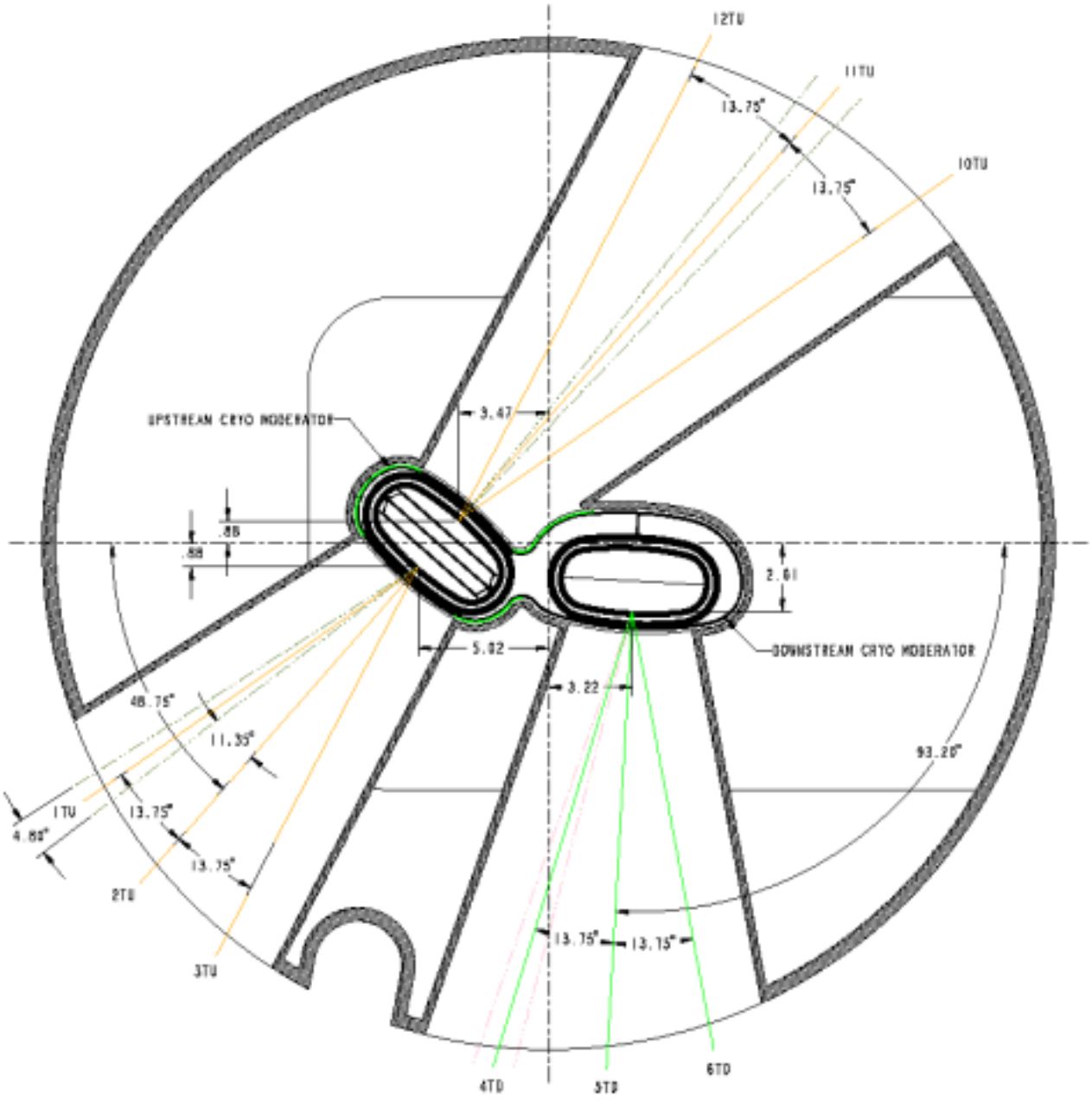

Fig. 2.2-2. Top Moderator Focal Points (plan view)

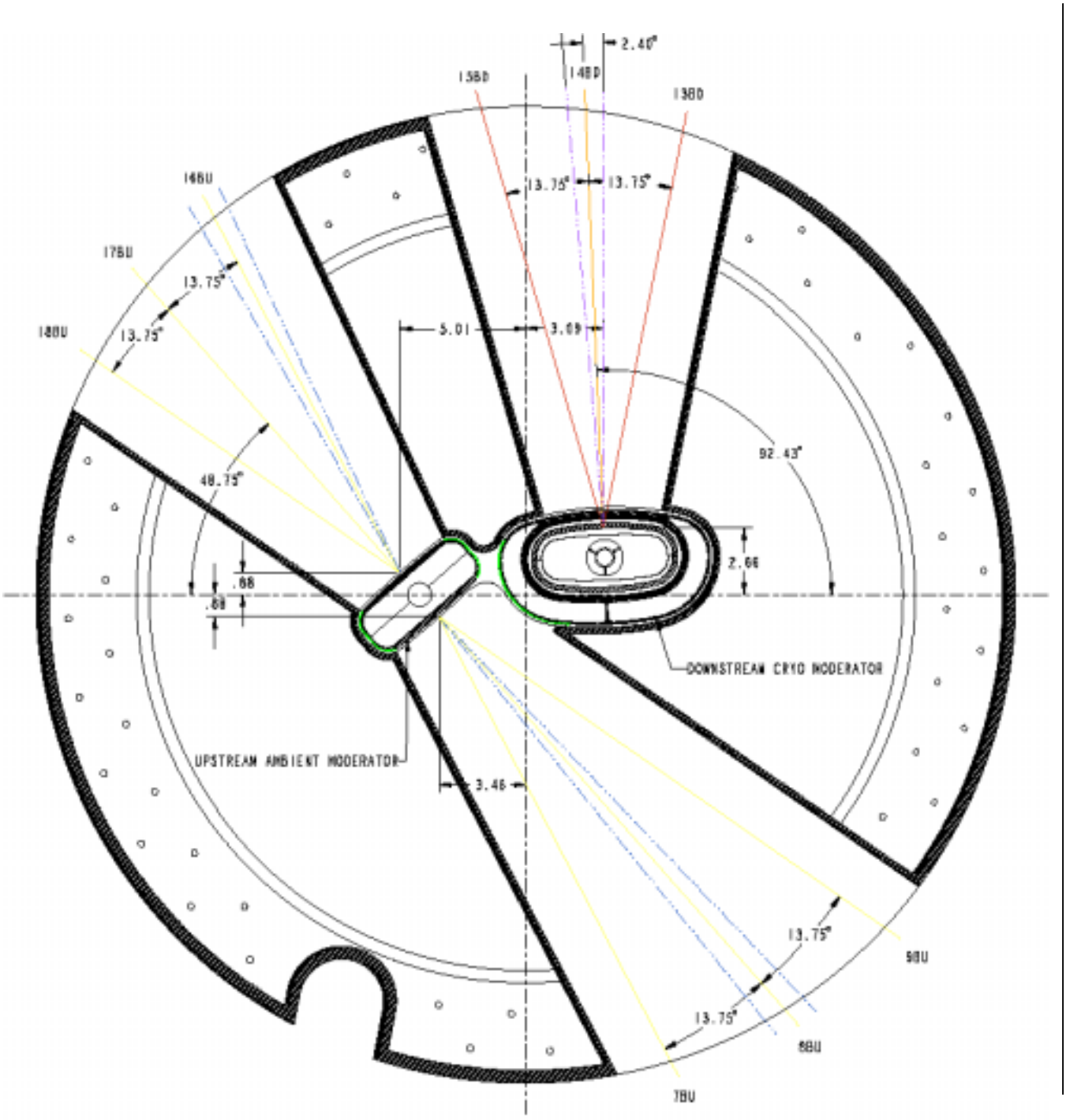

Fig. 2.2-3. Bottom Moderator focal Points (plan view)

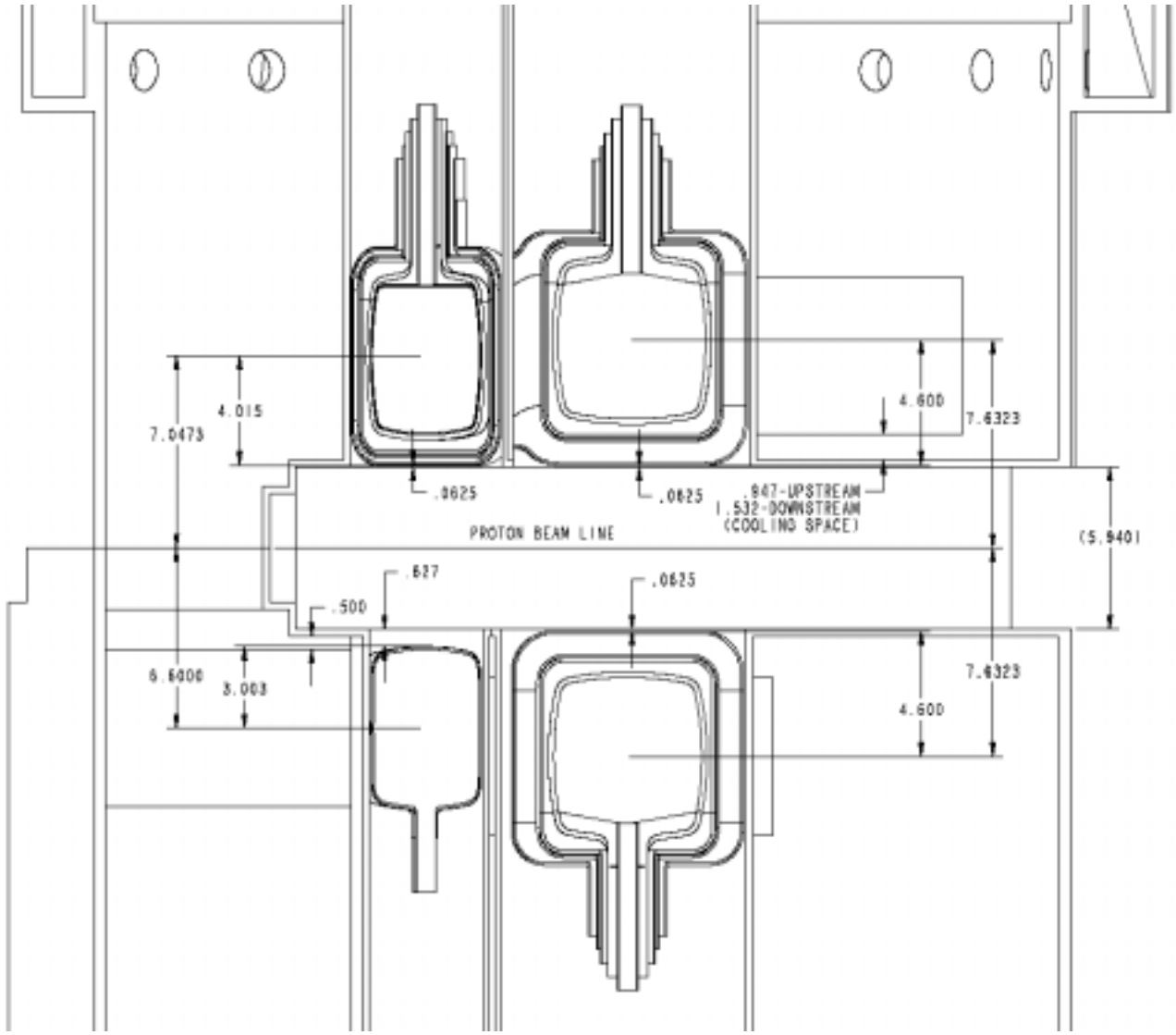

Fig. 2.2-4. Moderator positions (elevation view)

2.3 Interfaces with the Reflector Systems (WBS 1.6.3)

WBS 1.6 shall provide a vertically mounted plug that shall position the moderators and reflector material (beryllium and lead). The core vessel insert will extend into this region but will not have any physical connection to the reflector system. WBS 1.6 shall provide cadmium or other suitable absorber along the beam channel in the inner reflector plug (nominally between 0 to 19.5 inches from the moderator). The beam channel height has been established at 5.2 inch. This dimension has been derived from the 4.75 inch (120 mm) beam height and adding a fabrication tolerance of 0.125 inch, stack-up tolerance of 0.125 inch, and a 0.197 inch clearance to minimize reflections off the 0.030 inch thick cadmium that lines the neutron beam line.

The inserts in the reflector shall be sized and positioned for future changes in the vertical position of the moderators. Consequently, the centerline of all the inserts shall be 7.31 inches from the centerline of the target as shown Figure 2.3-1 for the single channel beam lines. The multi channel beam lines shall be similarly positioned and toleranced as shown for the single channel beamline.

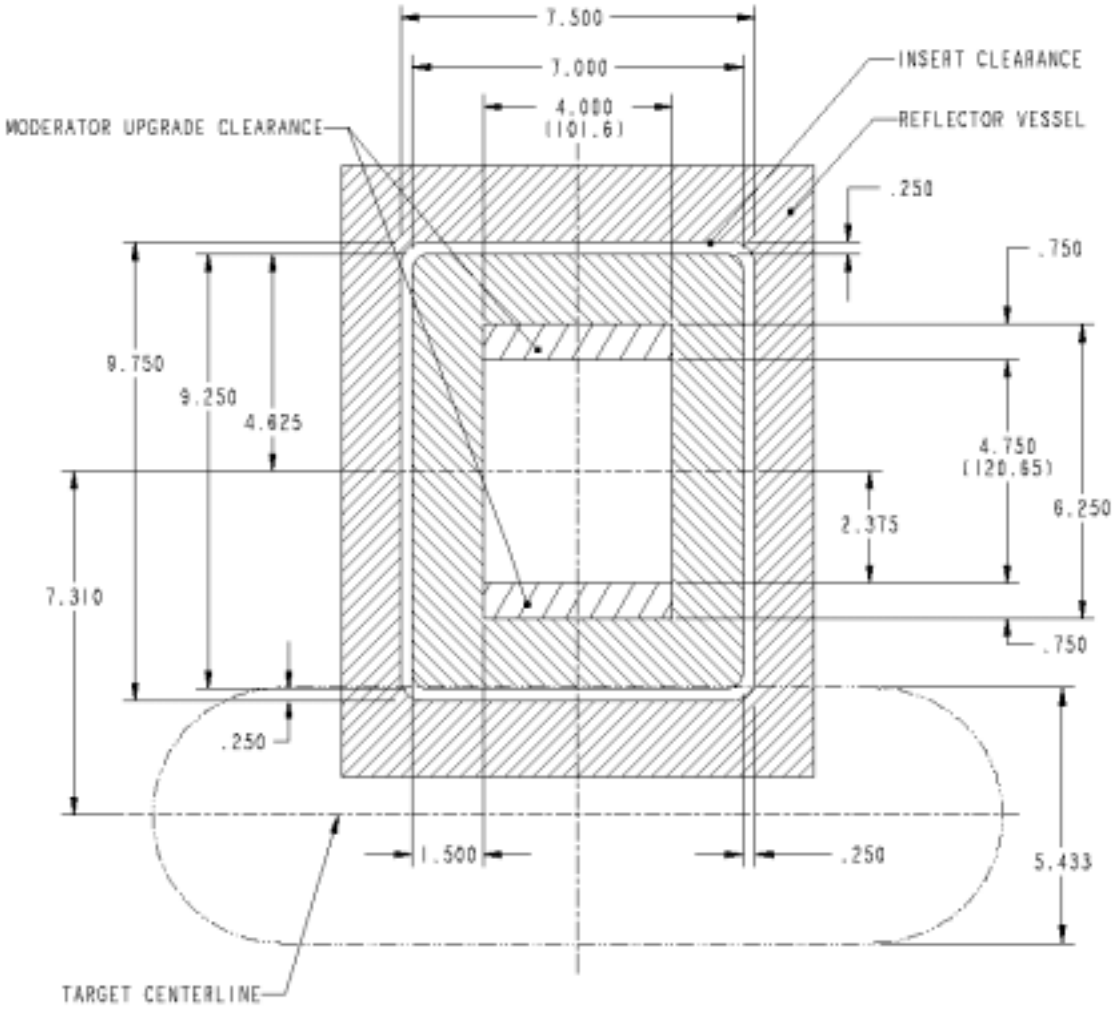

Figure 2.3-1. Configuration of the single channel vessel insert

2.4 Interfaces with the Vessel System (WBS 1.6.4)

WBS 1.6 shall provide a vessel designed to enclose the target, reflector plug and shielding out to the shutters. The vessel shall have ports designed to mount neutron beam inserts provided by WBS 1.7. The insert shall include a seal interface and neutron window as required to provide a pressure boundary. The vessel and insert shall be rated for –14.7 psig to 14.7 psig.

The vessel port and flange configurations are shown in Figures 2.3-1, 2.4-1 and 2.4-2. The dimensions noted in these figures indicate the maximum envelope reserved for neutron optical components within the core vessel inserts.

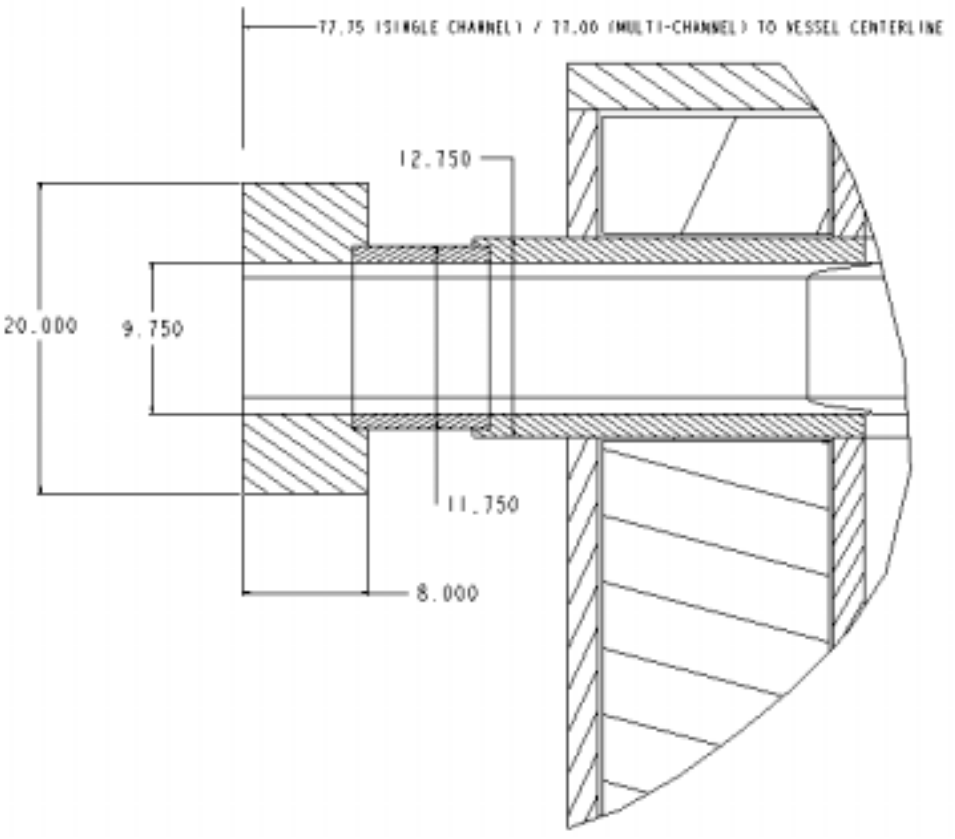

Figure 2.4-1 Elevation section view of the single and multi-channel core vessel port

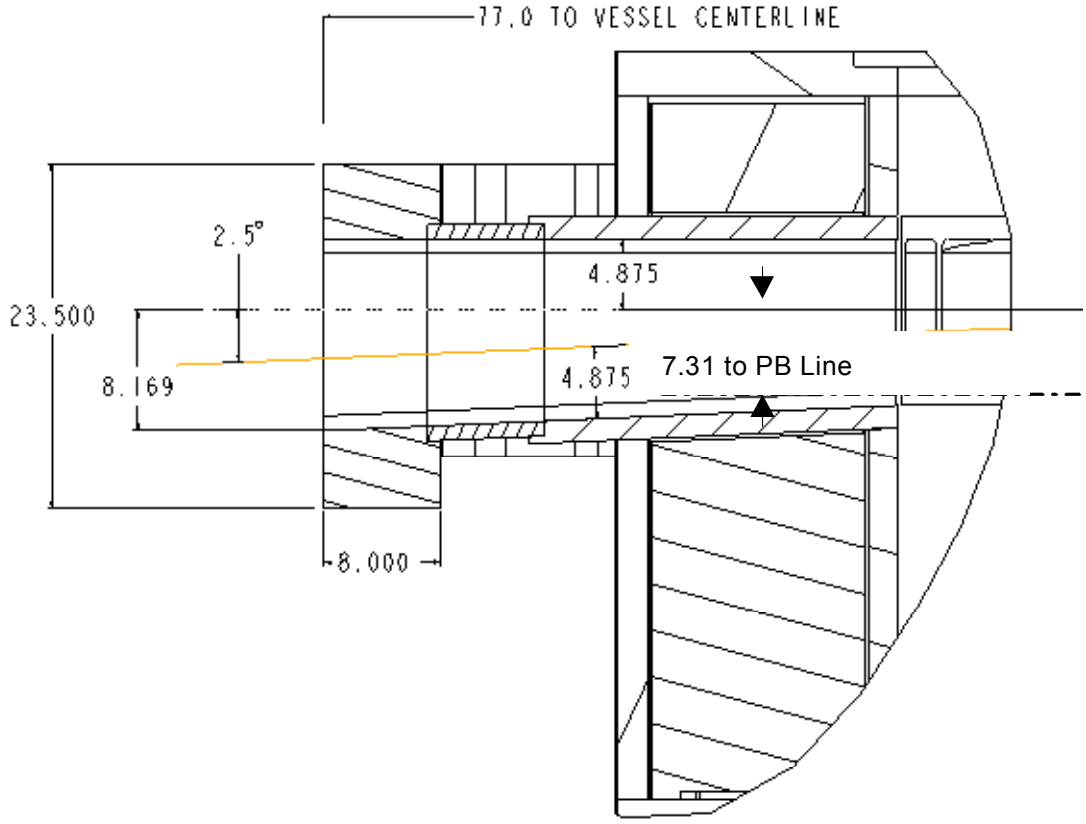

Figure 2.4-2 Elevation section view of the Beam Line 4 multi-channel core vessel port

WBS 1.6 shall design the vessel port flange and the mating insert flange with double sealing surfaces. WBS 1.7 shall design the associated shutter insert rest features that are integrated into the insert flange. The core vessel flange shall be capable of supporting approximately 50% of the weight of the shutter insert with a deflection not to exceed 0.01 inch at the flange face. A utility piping chase nominally 1 x 2 inches for utilities to the core vessel inserts shall be provided from the vessel flange to the top of the vessel. The maximum weight of the inserts is given in Table 2.4-1.

Table 2.4-1
Maximum Insert Weights

single channel core insert	1250 lb
multi-channel core insert	1900 lb
single channel shutter insert	3700 lb
multi-channel shutter insert	7700 lb
Beam line 4 core insert	TBD
Beam line 4 shutter insert	TBD

2.5 Interfaces with the Bulk Shield System (WBS 1.6.5)

2.5.1 General Information

WBS 1.6 shall provide adequate shielding to protect personnel in the target building. Table 2.5-1 provides overall shielding parameters.

Table 2.5-1 - Target station shielding parameters

Edge of primary iron shielding	198 in*
Edge of primary concrete shielding	250 in*
Inner edge of chopper arch	200 in*
Outer edge of chopper arch shielding	252 in*
Inner edge of neutron shutter	98 in*
Outer edge of neutron shutter	176 in*
Radiation dose rate in beam with shutter closed (at 10 m)	<2 mrem/hr
Radiation dose rate in instrument hall design basis for all routinely accessed areas	<0.250 mrem/hr

* Measured from target station centerline and are nominal

WBS 1.6 will provide a shutter for each neutron beam position. The inserts that go in these shutter openings are the responsibility of WBS 1.7. These inserts will travel up and down with the beam shutter.

The shutter drive system supplied by WBS 1.6 shall be capable of moving the shutter gates at a rate of 15 inches per minute. The shutter travel distances will be determined by the shielding calculations performed by WBS 1.6.

WBS 1.6 will provide a suitable channel in the beam shutter so that vacuum pumping lines or other lines that are an integral part of the shutter inserts (provided by WBS 1.7) can be accommodated. The shutter inserts include the flexible lines that allow for shutter gate travel. WBS 1.6 will provide a pipe chase nominally 1" x 2" for these lines and will provide routing through the shutter gap void for the flexible lines.

WBS 1.6 will provide helium and vacuum utility connections for the shutter inserts in the utility systems catch pan near the top of the core vessel. Utility access will be a stem along the outboard face of the shutter gate. The region of the neutron beam channel inboard and outboard of the shutter assemblies will have an air atmosphere and with no provision for vacuum or helium. The shutter inserts within the shutters and outboard inserts may require vacuum. Control of the atmosphere within the chopper archway and the external neutron beamline shielding is the responsibility of WBS 1.7.

WBS 1.7 will provide the outer guide including the window that attaches to the rectangular flanges on the Bulk Shielding Liner. This flange/ window combination provides the environmental barrier between the slightly activated air inside the liner and the air inside the chopper cavity. The Bulk Shield Liner drawings are listed in Appendix A.

2.5.2 Chopper Archway Interface

WBS 1.6 is responsible for providing appropriate shielding at the chopper archways adequate to block the radiation from any beam ports that are not instrumented. At least eight ports will be un-instrumented at the time of facility startup. The archway partitions are relatively narrow and shallow and support the concrete shielding above. The archway partitions consist of high-density concrete narrowly encasing the steel columns. At locations where no column exists then the partition is eliminated. The instrument using the beam line will provide reconfigurable shielding within the archway surrounding the neutron beam line equipment.

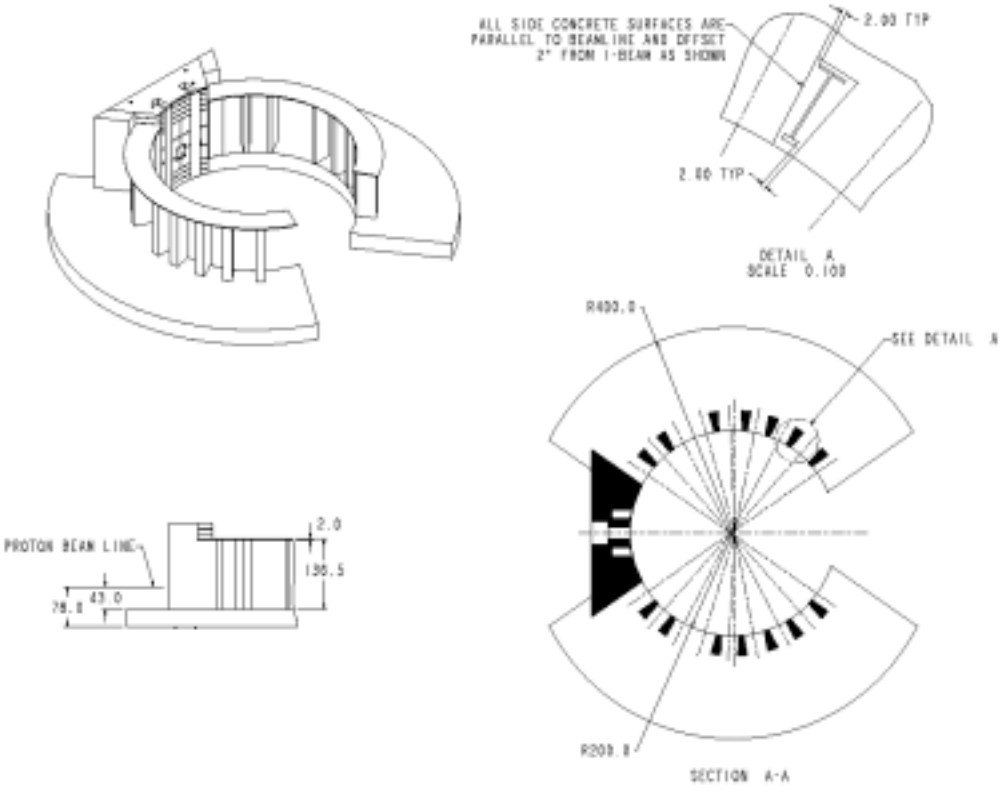

Figure 2.5-1 Chopper Archway Configuration

WBS 1.8 is responsible for providing suitable crane capabilities to remove or install the choppers and other components placed in this region.

Choppers and other equipment to be installed in this area are the responsibility of WBS 1.7, as are any special tracks or other mechanisms required to move the choppers to a desired location. Any special tooling required for chopper installation or removal (e.g., special tools to connect and disconnect water cooling lines or electrical signal or power lines) are the responsibility of WBS 1.7.

Neutron beam line shielding external to this archway is the responsibility of WBS 1.7.

The inside of the chopper archway interfaces to the liner flanges defined in assembly drawing 106050200-M8E8700A001 and its referenced detail drawings (provided by WBS 1.6. In all cases the aperture opening of the rectangular flanges will be preserved from the outboard side of the shutter gate to the inside of the liner. It will be responsibility of WBS 1.7 to provide shielding around the outer insert from the flange in to the shutter.

The outer insert (provided by WBS 1.7) will interface at the rectangular flanges on the liner and will incorporate the windows necessary to contain the desired atmosphere in the insert. It will also provide the barrier between the activated air inside the liner and the air in the instrument hall (about 0.5 psi differential pressure).

2.5.3 Single Channel Shutter Interface

A narrower shutter is designed for the single channel beamlines and the wider multi-channel shutter can accommodate at least two beamlines or beamlines that bend through the shutter. For the single channel shutter this is to be done by providing a large, stepped opening through the shutter, to be filled by the components provided as part of the instrument. The shutter insert in the single channel shutter is shown in Figure 2.5-2. The open region shown in the insert is the region available for the beamline that can bend or angle through the shutter zone. The actual opening for the neutrons shall be nominally 4 inches wide and 4.75 inches tall (100mm x 120 mm) similar to the opening shown in Figure 2.3-1. All other void volumes around the adjustment mechanisms and between the various guide layers shall also be filled with shielding materials to prevent neutrons from flowing through the shutter in parallel to the defined neutron channels. There will be provision to accurately support the shutter insert both inboard and outboard of the shutter so that the insert position is semi-independent of the shutter position. The core vessel insert flange provided by WBS 1.7 provides the inboard support. WBS 1.6 provides the outboard support.

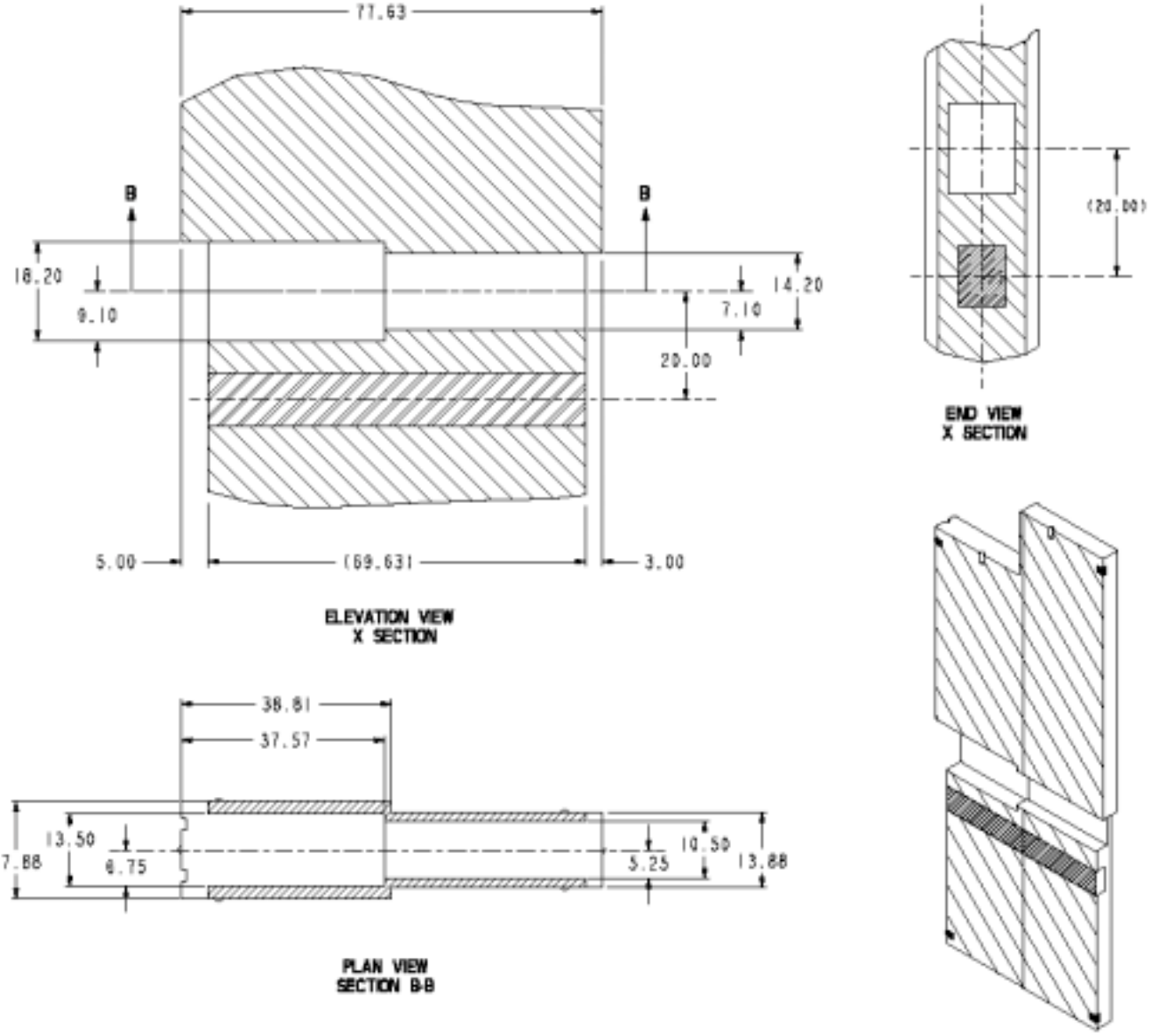

Figure 2.5-2 Single Channel Shutter Interfaces

2.5.4 Multi-Channel Shutter Interface

The multi-channel shutter gates will be segmented since the weight of a one-piece wide shutter gate will exceed the crane capacity. The portion of the shutter accommodating the neutron beam guides or apertures must be easily replaceable in case it is necessary to introduce a more complicated beam passage. For this reason the center segment of the multi-channel shutter will be the responsibility of

WBS 1.7. It is important to note that the drive system designed by WBS 1.6 will interface at the top of this segment

There are two different configurations of multi-channel shutter. Five of the shutters will be designated for beam channels that service instruments that lie on a horizontal plane. There will be one multi-channel shutter (Position 4TD) for liquid reflectometers that service instruments that can lie below the horizontal plane. This shutter segment will be deeper in the vertical direction to allow the beam lines to angle or bend through the shutter. The open region shown in the figures for the insert is the region available for the beamline that can bend or angle through the shutter zone. The actual opening for the neutrons shall be nominally 4 inches wide and 4.75 inches tall (100mm x 120 mm) similar to the opening shown in Figure 2.3-1. All other void volumes around the adjustment mechanisms and between the various guide layers shall also be filled with shielding materials to prevent neutrons from flowing through the shutter in parallel to the defined neutron channels.

The dimensional information for the center segment for the beamline 4 shutter is shown on figure 2.5-3.

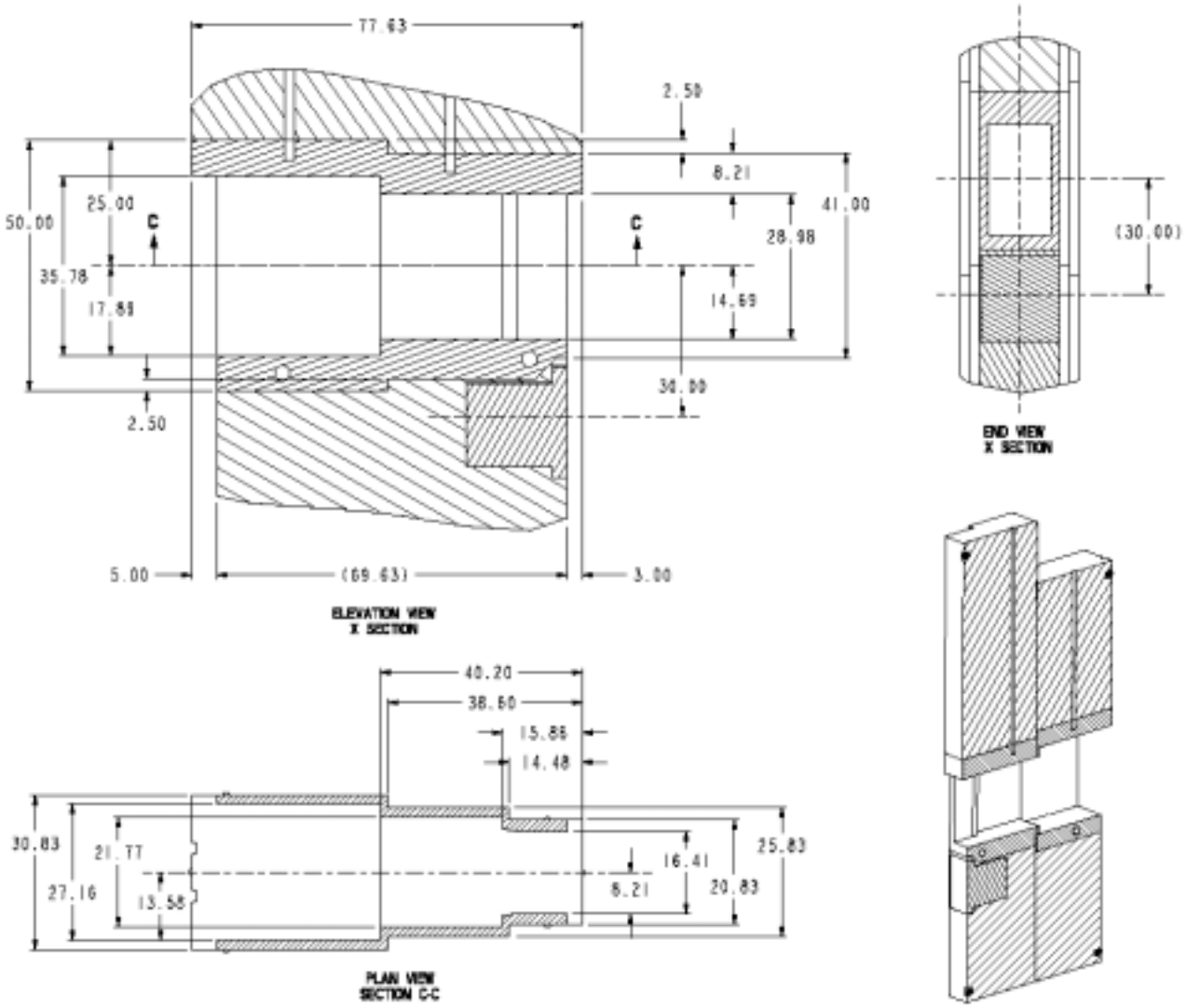

Figure 2.5-3 Beam 4TD Multi-Channel Shutter Interfaces

The dimensional information for the center segment for the five multi-channel shutters that service horizontal plane instruments is shown in Figure 2.5-4.

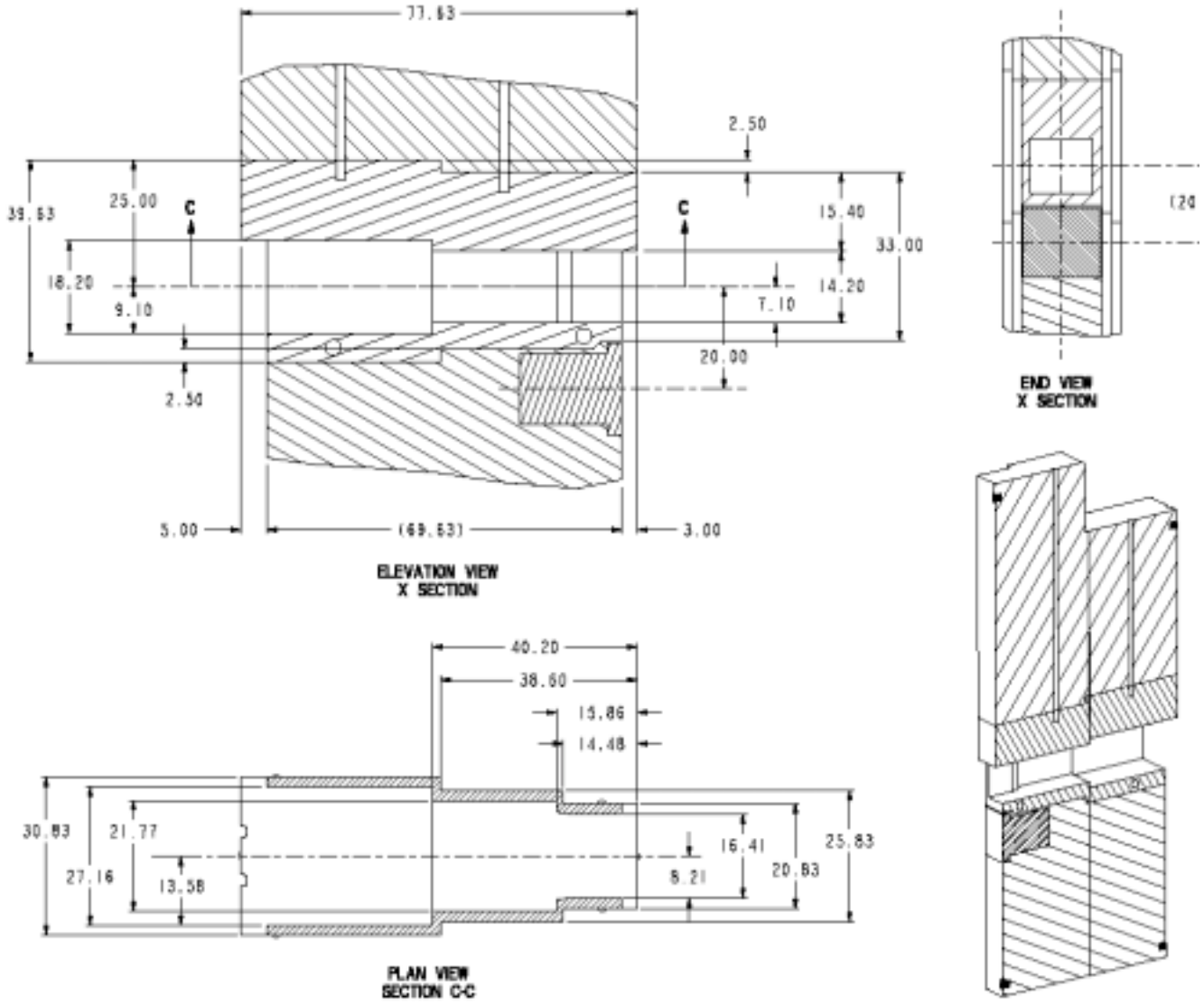

Figure 2.5-4 Horizontal Multi-channel Shutter Interfaces

2.6 Interfaces with the Target Station Utility Systems (WBS 1.6.6)

WBS 1.6 shall provide the helium, water, and vacuum utilities to all instrument components located inside the bulk shield liner accessed from the top of the shield stack. The core vessel inserts and the shutter inserts (provided by WBS 1.7) will provide the utility lines that terminate in the Utility systems catch pan (provided by WBS 1.6). The utility piping will interface at the top of the shield stack with manifolds and valves. There will not be any connections in the shield stack.

Utility lines to the vessel and shutter inserts (and associated valves, controls, and instrumentation) shall be provided under WBS 1.6 and 1.7 as described in Drawing 166J8E8700A23 (See Appendix A).

2.7 Interfaces with the Remote Handling System (WBS 1.6.7)

WBS 1.6 shall provide remote tools and fixtures to remove and replace the core vessel inserts and the shutters with inserts attached. The tooling will be designed to perform a change-out of a single insert and shutter combination during a 30 day SNS shutdown.

WBS 1.6 shall provide a mockup test stand in the target support building to verify the fit-up of the inserts and to train operators for the change-out process.

The shutter insert change-out operation will be based on pulling shutter gates (or shutter gate segments) vertically into shielding containers with the 50-ton high bay bridge crane. In most cases the shutter gate will be reused and the old insert will be extracted and a new insert installed in the gate on the high bay floor. The removed shutter will also be positioned with the high bay crane with the necessary shielding to protect personnel around the open shutter cavity.

For the case of the multi-channel shutter, the center segment containing the insert (or inserts) will be removed and a replacement segment will be installed. The used segment will be stored on the SNS for a sufficient period to permit “hands on” contact and reuse with a new shutter insert.

Core vessel inserts will be changed while the shutter cavity is vacant. A special purpose insertion tool will be used to both position the insert and tighten fasteners. The same tool will be used to loosen fasteners and retract a used insert. The used insert will be moved from the shutter cavity into a shielded housing and placed in a transfer container. The loaded container will then be moved to either the hot-cell or other appropriate location for transfer into a shipping container for off-site disposal.

Provisions will be made for handling and disconnecting utility service to the inserts during change-out operations.

2.8 Interfaces with the Target Station Controls System (WBS 1.6.8)

Status information for the accelerator and target systems, including the moderators and shutters will be provided on a plant network. Accelerator operation will be interlocked with radiation monitors and with interlocks on removable shielding pieces. Local or central control of the shutters will be possible with suitable safety interlocks.

1. WBS 1.6 will be responsible for identifying safety and operational standards to be met by all components to be inserted in the beam ports, beam shutters, and the chopper shield cavities,
2. Design approval by WBS 1.6 is required for any components inserted in the beam ports, beam shutters, or chopper shield cavities.
3. WBS 1.6 will review neutron scattering instrument shielding and beam stop designs to ensure compliance with SNS radiation-shielding standards.
4. Radiation environments, doses and activation are to be calculated by WBS 1.6. WBS 1.7 will provide sufficient radiation shielding around the neutron beam lines external to the bulk shield to meet the facility radiation dose requirements. General area radiation monitoring will the responsibility of WBS 1.6 and WBS 1.8. Monitoring sensors required for operations associated with a specific instrument will be the responsibility of that instrument. These sensors will connect to the general plant personnel safety system under WBS 1.8.

2.9 Interfaces with the Beam Dumps (WBS 1.6.9)

There are no interfaces with the beam dumps.

2.10 Interfaces with the Neutronics and Shielding Analysis (WBS 1.6.10)

1. Neutronics will provide shielding calculations for the Bulk shield region including the insert components.
2. Neutronics will provide checking and confirmation for other shielding calculations for equipment on the instrument floor.

Appendix A

Referenced Drawing List

The following drawings are issued approved and are in the SNS database.

1. 106050200-M8E8700-A001, Shielding Liner Assembly (3 sheets)
2. 106050201-M8E8700-A001, Shielding Liner Weldment
3. 106050201-M8E8700-A002, Lower Liner Weldment (2 sheets)
4. 106050201-M8E8700-A003, Upper Liner Weldment (3 sheets)
5. Withdrawn
6. 106050202-M8E8700-A001, Flange, Multi Channel, Weldment
7. 106050202-M8E8700-A002, Flange, Single Channel, Weldment
8. 106050202-M8E8700-A003, Flange, Multi Channel
9. 106050202-M8E8700-A004, Flange, Single Channel
10. 106050202-M8E8700-A005, Flange, Proton Beam Weldment

The following Drawings are attached:

1. 166J8E8700A023 Moderators/Shutters/Inserts Utilities, Piping and Instrumentation Diagram

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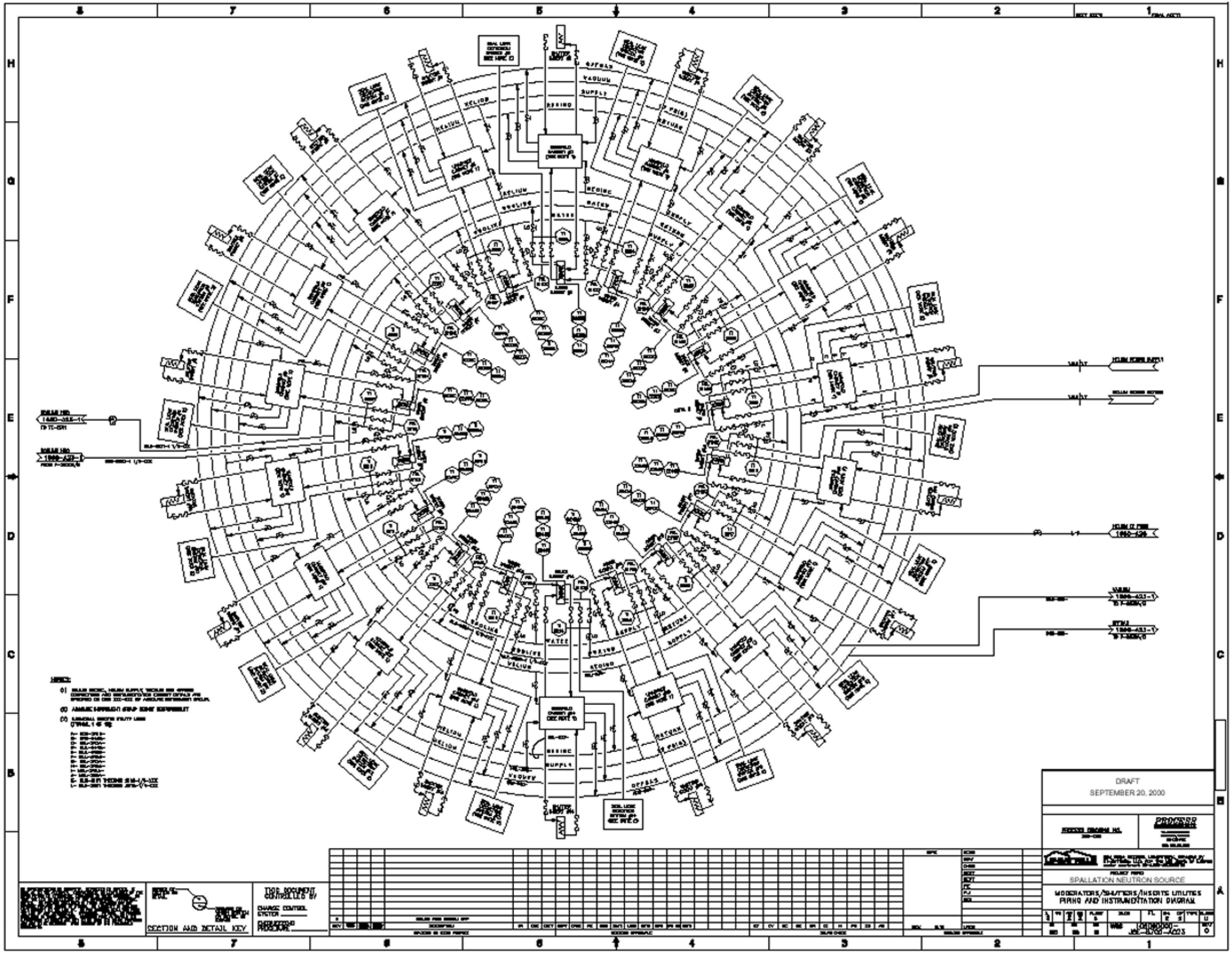
DRAFT
SEPTEMBER 20, 2000
SPALLATION NEUTRON SOURCE
MODERATORS/SHUTTERS/INSERTS UTILITIES
PIPING AND INSTRUMENTATION DIAGRAM
SECTION AND DETAIL KEY

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