Document title: System Description for HLW System HPH Canister Pour Handling

NOTE: The following SD sections are considered preliminary if left unchecked.

☑ Part 1 (SD Sections 1-4)

☑ Part 2 (SD Sections 5-10 and TAC) – WTP Facilities:
  □ BOF    ☑ HLW    □ LAB    □ LAW    □ PT

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## Acronyms and Abbreviations

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<tr>
<td>AISC</td>
<td>American Institute of Steel Construction</td>
</tr>
<tr>
<td>ALARA</td>
<td>As Low As Reasonably Achievable</td>
</tr>
<tr>
<td>ANSI</td>
<td>American National Standards Institute</td>
</tr>
<tr>
<td>APC</td>
<td>Additional Protection Class</td>
</tr>
<tr>
<td>ASME</td>
<td>American Society of Mechanical Engineers</td>
</tr>
<tr>
<td>ASTM</td>
<td>American Society for Testing and Materials</td>
</tr>
<tr>
<td>BMA</td>
<td>Bogie Maintenance Area</td>
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<tr>
<td>BNI</td>
<td>Bechtel National, Inc.</td>
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<td>BOD</td>
<td>Basis of Design</td>
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<tr>
<td>CCTV</td>
<td>Closed Circuit Television</td>
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<tr>
<td>CFM</td>
<td>Cubic Feet per Minute</td>
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<td>CMA</td>
<td>Crane Maintenance Area</td>
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<td>CMAA</td>
<td>Crane Manufacturers’ Association of America</td>
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<tr>
<td>CWF</td>
<td>Canistered Waste Form</td>
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<tr>
<td>DOE</td>
<td>US Department of Energy</td>
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<tr>
<td>DWP</td>
<td>Dangerous Waste Permit</td>
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<tr>
<td>FCT</td>
<td>Flange Conditioning Tool</td>
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<tr>
<td>FPM</td>
<td>Feet per Minute</td>
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<tr>
<td>GTAW</td>
<td>Gas Tungsten Arc Welding</td>
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<td>GTC</td>
<td>General Test Criteria</td>
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<tr>
<td>HDH</td>
<td>HLW Canister Decontamination Handling System</td>
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<tr>
<td>HEPA</td>
<td>High Efficiency Particulate Air (Filter)</td>
</tr>
<tr>
<td>HLW</td>
<td>High-Level Waste</td>
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<tr>
<td>HMP</td>
<td>HLW Melter Process System</td>
</tr>
<tr>
<td>HP</td>
<td>Health Physicist</td>
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<td>HPH</td>
<td>HLW Canister Pour Handling System</td>
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<td>HRH</td>
<td>HLW Canister Receipt Handling System</td>
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<tr>
<td>HSH</td>
<td>HLW Melter Cave Support Handling System</td>
</tr>
<tr>
<td>HVAC</td>
<td>Heating, Ventilating, and Air-Conditioning</td>
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<tr>
<td>IBC</td>
<td>International Building Code</td>
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<tr>
<td>ICD</td>
<td>Interface Control Document</td>
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<tr>
<td>ICN</td>
<td>Integrated Control Network</td>
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<td>IEEE</td>
<td>Institute Of Electrical and Electronic Engineers, Inc</td>
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IHLW  Immobilized High Level Waste
ISA  International Society of Automation
LAW  Low-Activity Waste
LOI  Local Operator Interface
MSD  Mechanical Sequence Diagram
MSM  Master Slave Manipulator
MTG  Metric Tonnes of Glass
NFPA  National Fire Protection Association
PPJ  Programmable Protection System
PSAR  Preliminary Safety Analysis Report
QAS  Quality Affecting Software
RLD  HLW Radioactive Liquid Waste Disposal System
RTD  Resistance Temperature Detector
RWH  HLW Radioactive Solid Waste Handling System
SC  Seismic Category or Safety Class
SPAD  Shielded Personnel Access Door
SRD  Safety Requirements Document
SSCs  Structures, Systems, and Components
SS  Safety Significant
TAC  Test Acceptance Criteria
UBC  Uniform Building Code
WAI  Waste Acceptance Impacting
WAPS  Waste Acceptance Product Specification
WASRD  Waste Acceptance System Requirements Document
WCP  Waste Form Compliance Plan
WQR  Waste Form Qualification Report
WTP  Hanford Tank Waste Treatment and Immobilization Plant
WVDP  West Valley Demonstration Project
1 Introduction

The primary purpose of High-Level Waste Facility (HLW) Canister Pour Handling (HPH) system is to transfer an empty canister to the glass pouring locations, weld a lid onto the glass filled canister, and then transfer the canister to the downstream HLW Canister Decontamination Handling (HDH) system.

2 Scope

The interfacing HLW Canister Receipt Handling (HRH) system transfers empty canister into the import tunnel that runs beneath the HPH system canister handling cave in the north-south direction. Empty canisters enter the HPH system canister handling cave through a hatch located at the north end of the import tunnel. On completion of canister operations in HPH, the glass filled canisters are transferred to the HDH system through a hatch that is located at the east end of the canister handling cave.

Operations performed in the HPH system include transporting empty canisters to and from the glass fill locations, measurement of glass fill height, taking of glass samples and welding a lid onto the canister. The glass fill process takes place in one of two pour tunnels located below the canister handling cave and accessed via hatches located in handling cave floor. On completion of the glass fill process the canisters are transferred to the canister handling cave cooling rack prior to being moved to the weld station where glass fill height measurements and glass sample are taken, and the lid closure weld completed. From the weld station canisters are moved to the buffer rack where they are stored until transferred to the HDH system. The buffer rack may also be used to store empty canisters after receipt from the HRH system.

The canisters are transported through the HPH system using one of two overhead head cranes that operate on a duty/standby principle. Each pour tunnel contains two bogies that are used to locate the canisters below the melter pour spouts; there are two pour spouts per melter. The glass fill process takes approximately 19 hours for a production rate of 7.5 metric tonnes of glass per day (MTG/day). The glass pour temperature is approximately 2100 °F. The current melter design is sized for a production of 6 MTG/day, however, to accommodate future increases the HPH system is required to support 7.5 MTG/day; see Section 6.3.3 of 24590-WTP-DB-ENG-01-001 Basis of Design.

The pour tunnels are insulated to maintain concrete temperatures within allowable limits. The insulation extends around the walls, floors, and ceiling. Insulation is also fitted in the canister handling cave on concrete that is adjacent to the cooling and buffer racks. A simplified diagram of the system is presented as Figure 2-1.

Solid waste generated by the HPH system, for example welding torch blocks, swabs, electrical cables etc., will be loaded into a solid waste basket and exported to the HLW Melter Cave Support Handling (HSH) system via the pour tunnels.
3 Functions

The primary function of System HPH is to receive empty canisters from system HRH, and export glass filled canisters to system HDH. The HPH system is sized to support a production rate of 7.5 MTG/day.

3.1 Receive Canister

The system receives empty canisters from System HRH.

3.2 Transport Canisters

- The system transports canisters to the buffer rack for staging.
- The system transports canisters to the pour tunnel to be filled.
- The system transports canisters to/from the melter pour spout.
- The system transports filled canisters to the cooling rack.
- The system transports filled canisters to the weld station.

3.3 Remove Glass

- The system removes glass from canister exterior (if necessary).

3.4 Measure Glass and Temperature

- The system measures canister glass level.
- The system measures canister surface temperature.
3.5 Collect Samples

The system collects glass samples.

3.6 Weld Canisters

The system welds primary and secondary lid onto canister.

3.7 Report Conditions

The system monitors and records all essential welding parameters.

3.8 Export Canisters

The system exports filled canisters to the HDH system for decontamination.

3.9 Export Solid Waste

The system transfers solid waste to the HSH system

4 Requirements

System requirements are derived from the following top-level project documents:

- 24590-WTP-DB-ENG-01-001, *Basis of Design* (BOD)
- 24590-HLW-WSF-ENG-07-002, *WTP HLW Canister Processing Activities*
- 24590-HLW-WSF-ENG-07-003, *WTP HLW Canister Handling*
- 24590-HLW-WSF-ENG-09-002, *WTP HLW Canister Lid Welding*

4.1 Service Provided

The following requirements pertain to the service provided by the system.

**IHLW Glass Samples.** The design shall include capability to obtain samples of IHLW glass to support process and product control needs for WTP. [C.7(a)(10), DOE-BNI Contract]

**High-Level Waste Canister Closure.** The HLW canister shall be sealed via welding process. [C.7(d)(2)(iv), DOE-BNI Contract]

**Vitrification Support.** The HLW facility systems shall support future operation of the HLW facility at a design capacity of up to 7.5 MTG/day including melter power supplies, pour cave cooling, and support for additional bubblers as necessary. The Immobilized High Level Waste (IHLW) shall be transferred from the melter to canisters for containment and cooling. The canisters shall be sealed, decontaminated,
and prepared for transport to an interim Hanford storage facility until they can be shipped to an offsite geologic repository for permanent disposal in accordance with the WASRD and ICD requirements. [Section 6.1.3, BOD]

**Fill Height Measurement.** System shall demonstrate the process for measuring the canister glass fill height. See section 6.5 of the screening form attachment. [Section 0, *WTP HLW Canister Processing Activities*]

In addition to the above WAI demonstration testing the following activities are designated as WAI [*WTP HLW Canister Processing Activities*]

- Removal of glass deposits from a canister external surface (section 6.4 of the screening form attachment).
- Monitoring of the canister filling process in the pour tunnel using infrared cameras (section 6.5 of the screening form attachment).
- Glass fill height measurement post pour at the weld station (section 6.5 of the screening form attachment).
- Obtaining glass product samples during cold commissioning (section 6.6 of the screening form attachment).
- Visual inspection of canister headspace prior to canister closure (section 6.8 of the screening form attachment)

**Canister Inspection after Filling for Presence of Water.** The presence of liquid water inside the canister could lead to localized corrosion (i.e., stress corrosion cracking) of 304 L stainless steel, especially if chlorine and fluorine leach from the glass. WTP design and operating procedures, however, are designed to mitigate this possibility by preventing the formation of liquid water in the canistered waste form. This will be done by inspecting the canisters after filling. [Section 5.2.1, *WTP HLW Canister Processing Activities*]

**Canister Fill Height.** The contract requires that the HLW canister be filled with glass to a minimum height equivalent to 87% of the volume of the canister. The average fill height is to be 95%. The canister fill heights equivalent to 87% and 95% will be determined by analysis. Minimum filled height, 87%, and the average fill height, 95%, are HLW WTP contract requirements only. Section 6.5.4 addresses the filled height WAI requirement. [Section 6.5.3, *WTP HLW Canister Processing Activities*]

4.1.1 Operability and Maintainability

The following requirements pertain to the operability and maintainability of the system.

**Hands-On Maintenance in a Dedicated C3/R3 Maintenance Area.** In-cell/cave handling equipment shall be maintained in a dedicated C3/R3 maintenance area or workshop after being decontaminated to a level that will allow hands-on maintenance. [Section 9.1, ORD]

**Clearance for Maintenance and Operation.** Adequate clearances around equipment shall accommodate maintenance and operation personnel and any encumbrances such as protective garments, respirators, portable lifting devices, and alignment equipment for pumps, etc. [Section 9.1, ORD]

**Equipment Transporting Mobility.** Space shall be provided to allow transport of the equipment to repair shops or to disposal. [Section 9.1, ORD]
Automation of Mechanical Handling Equipment. Mechanical handling equipment shall be designed with automation only as it adds value to the operation. Otherwise, equipment shall be operated directly. This will reduce the need for high maintenance on automated equipment. [Section 14.1, ORD]

Breathing Air System. The plant designs shall provide an installed breathing air system designed such that hose connections to breathing air manifolds and hoses are performed in a clean area and manner that minimizes the potential for contamination. Manifolds shall be protected when not in use to ensure a high level of cleanliness. Manifolds should accommodate potential need for an umbilical connection to a portable system that may be utilized when hose lengths would otherwise be exceedingly long. [Section 14.6, ORD]

Wall and Door Penetrations. Wall/door penetrations should be available to alleviate doors needing to be propped open and hoses potentially being pinched and damaged. [Section 14.6, ORD]

Second Door with Hose Access Ports. Protective access door should remain open while a second non-shielded door with access ports will allow hoses to be routed into area without being pinched. [Section 14.6, ORD]

Breathing Air System at Access Points to C3/C5 Areas. The plant designs shall provide an installed breathing air system at all access points to C3/C5 areas to support manned entries for equipment recovery/maintenance evolutions, both normal (preventive) and corrective. Additional stations may be added to account for changing or unknown conditions during the operation of the facilities. [Section 14.6, ORD]

Manifold Connections and Capacity. Manifolds should have connections and capacity for six personnel dressed out in full anti-contamination clothing up to and including non-breathing outer suits (i.e., vinyl) and hoods. Corrective maintenance entry is assumed to be two to three maintenance technicians, an HP in the area, and with a fully suited-up support person out of the area. Typical entry length is 1 to 4 hours depending on nature of work and work environment (such as consideration of temperature, contamination, and dose). [Section 14.6, ORD]

Disposal Routes for Contaminated Equipment. Remotely maintained cell building layouts (not including black cells) shall include disposal routes and shielding methods for packaging and shipping of failed contaminated equipment. [Section 14.8, ORD]

Equipment Positioning for Accessibility. Remotely maintained cell building layouts shall include optimization of equipment positioning to avoid dismantling for access (minimize stacking of jumpers and equipment). [Section 14.8, ORD]

Simplicity of Design. Remotely maintained cell building layouts shall include equipment designed for simplicity of operation and design. To aid in remote operations, equipment shall be arranged to provide unobstructed access and designed with proper handling devices. Mock-up and proof testing of design concepts prior to final design shall be considered for the laboratory hot cells and other locations where appropriate. [Section 14.8, ORD]

Laydown Space for Temporary Storage of Failed Equipment. Remotely maintained cell building layouts shall include laydown space for temporary storage of failed equipment. [Section 14.8, ORD]
Multi-Use Design of Lifting Beams and Yokes. Lifting beams, yokes, and fixtures for the installation, repair and removal of in-cell equipment shall be multi-use as much as possible in that single lifting fixtures can be used to perform a number of different duties. [Section 14.8, ORD]

Determination of Spare Electrical and Process Connections. Design shall determine the number and placement of spare electrical and process connections installed in-cell. [Section 14.8, ORD]

Packaging and Shipping Areas Adjacent to Contact Handled Maintenance Cells. Remotely maintained cell building layouts shall include packaging and shipping areas adjacent to contact handled maintenance cells. [Section 14.8, ORD]

Viewing Capabilities. Remotely maintained cell building layouts shall include viewing capabilities, either camera or window, from out-cell for surveillance of activities. Windows and/or cameras shall be used for cell maintenance areas. [Section 14.8, ORD]

Selection of Material for Construction. Selection of materials of construction shall be compatible with the in-cell chemical, radiological, and thermal environment to minimize maintenance requirements and dangerous waste generation. [Section 14.8, ORD]

Change-Out of Shielding Window. Temporary shields, when used during change-out at shielding windows, shall limit dose rates to ALARA. There shall be space for transfer of failed shielding windows for disposal as well as space for storage of shields. [Section 14.8, ORD]

Cable Termination Using Plugs and Sockets. Remotely maintained cell building layouts shall include cable termination using plugs and sockets suitable for the environment and compatible with remote maintenance tools. [Section 14.8, ORD]

Buffer Storage and Canister Rework Area. There shall be buffer store/container and canister re-work areas for over-packing and addressing out-of-specification glass or containers. [Section 14.12, ORD]

4.1.1.1 Component Requirements

The following requirements pertain to system components.

4.1.1.1 Bogies

Backup/Recovery Provisions In the Event of a Failure. Bogies shall include backup/recovery provisions in the event of a failure. Maximum loads shall be incorporated into the design of the recovery system. [Section 7.1, ORD]

Modular Components. Bogies shall include modular components where possible, such as wheel assemblies (assumed locked/failed wheel), to accommodate ease of maintenance. [Section 7.1, ORD]

4.1.1.2 Cranes

Cranes and Hoists Design for Modular Construction. In-cell/in-cave cranes and hoists shall be designed to be of modular construction to facilitate removal and replacement of failed components. Components shall be oriented such that the time for maintenance will be minimized. [Section 14.16, ORD]
Remote Control of CCTV Installed on Cranes. The CCTV cameras installed on cranes shall be operated from a remote control station and shall be used to operate the crane. [Section 14.16, ORD]

Operation of Cranes via Direct Observation Through Windows. Cranes shall be operated via direct observation through windows where cameras do not warrant proper safe operation of cranes and hoists. [Section 14.16, ORD]

Module Connectors. Modules shall have quick connectors to allow rapid reconnection of cabling or other services. [Section 14.16, ORD]

No On-Board Logic. Typically there shall be no on-board logic and all power and signal cables shall be marshaled off-board. [Section 14.16, ORD]

No Interference with Normal Operations of Process Cranes. Maintenance cranes shall be designed and installed such that there is no interference with normal operations of the process cranes. [Section 14.16, ORD]

Removal of Cranes and Hoists to Dedicated Maintenance Area. Cranes and hoists shall be designed to be removed to dedicated maintenance areas for replacement of mechanical equipment, controls, and other components. [Section 14.16, ORD]

Standardized Operator Controls. Standardized operator controls shall be provided as much as possible to avoid errors which might occur when moving from one crane to another. [Section 14.16, ORD]

Decontamination Agents. Provisions shall be made, where applicable, for decontamination using carbon dioxide, pressurized warm water, detergent solution, and steam. Facilities for the decontamination shall be provided, including disposal of the waste liquid. [Section 14.16, ORD]

Setting of Hoist Brakes on Power Off. Brakes on hoists shall be designed to set when power is off. [Section 14.16, ORD]

Illumination of Working Area. Lights shall be mounted on cranes to illuminate the working area below (except on single girder cranes with adequate lighting below). [Section 14.16, ORD]

Standardize Components. Components between cranes shall be standardized and interchangeable to the maximum extent possible. [Section 14.16, ORD]

Limits on Crane Automation. Cranes shall be designed with limited automation, as they will be primarily operated directly. [Section 14.16, ORD]

Retrieval of Failed Cranes. Features shall be included in the design to retrieve failed cranes to their maintenance areas. [Section 14.16, ORD]

Accessibility of Crane Lubrication Systems. Crane systems shall be designed with lubrication systems that are accessible for ease of maintenance. [Section 14.16, ORD]

4.1.1.3 Gloveboxes

Relative Pressure in Gloveboxes. Gloveboxes shall be held at negative pressure relative to their room location. A differential pressure indicator should be mounted to the gloveboxes. [Section 14.15, ORD]
4.1.1.4 Grapples

**Grapple and Lifting Flange Design.** The grapple and lifting flange shall satisfy the following design requirements. [Section 14.12, ORD]

- The grapple shall be capable of being remotely engaged and disengaged from the flange.
- The grapple, when attached to a suitable hoist and engaged with the flange, shall be capable of raising and lowering a container/canister in a vertical direction.
- The grapple, in the disengaged position, shall be capable of being inserted into and withdrawn in a vertical direction from a right-circular, cylindrical cavity with a diameter equal to that of the container/canister.
- The grapple shall include features that will prevent an inadvertent release of a suspended container/canister when the grapple is engaged with the flange.
- Compatible with the container/canister lifting flange and suitable for use at the repository

4.1.1.5 Master Slave Manipulators

**Removal of Master Slave Manipulators and Transport to Maintenance and Storage Areas.** Master/slave manipulators (MSM) shall be designed to allow for removal and transport to decontamination/maintenance areas and placement in a storage area for future repair/replacement. [Section 9.2, ORD]

**Use of a Special Removal Cart and/or Incell Crane.** MSMs shall be designed for removal through the in-cell wall to the operating gallery on a special removal cart and/or with the incell crane. [Section 9.2, ORD]

4.1.1.6 Shield Doors

**Decontamination of Shield Doors.** Shield Doors shall be designed and constructed for ease of decontamination. [Section 7.1, ORD]

**Control of Air Flow Around Shield Doors.** To control the spread of contamination, airtight seals for complete sealing, or an engineered gap provided to maintain sufficient air velocities at the interface shall be used. [Section 7.1, ORD]

**Provisions for Routing of Air Hoses.** Design of shield door assembly shall permit simultaneous control of contamination and routing of breathing air hoses. [Section 7.1, ORD]

**Fire Separation Requirements.** Buildings with mixed occupancies shall be designed in accordance with fire separation requirements of the IBC. Compartmentalization of buildings by fire barriers to limit the spread of fire and restrict the movement of smoke shall be as required by NFPA 101, Chapter 6, and specific occupancy chapters, and as required by each facilities fire hazard analysis. [Section 10.3.4.7, BOD]

**Fire Barriers for Mechanical and Electrical Penetrations.** Mechanical and electrical penetrations of fire barriers shall be fire stopped by materials listed in accordance with ASTM E814 or approved engineering evaluation and be of a fire rating not less than the barrier or enclosure. Fire barrier dampers and doors shall be rated as required in the UBC and in NFPA 101. [Section 10.3.4.7, BOD]
4.2 Nuclear Safety

The system, structure, and component safety classification scheme has been revised and no longer includes additional protection class (APC). APC requirements previously established in the PDSA will be removed from this system description after the facility PDSAs have been fully revised to eliminate or replace APC requirements. The action to revise the system description is being tracked on ATS 24590-WTP-ATS-QAIS-10-0995.

The following requirements pertain to the prevention or mitigation of radioactive releases.

C5 Area Canister Drop. The final control strategies selected to prevent or mitigate an IHLW canister drop shall be the design of cranes, grapples, bogies, and bogie restraints. [Section 3.4.1.5.1.6, PDSA - HLW Facility]

C5V Boundary Components. Specific C5V boundary components include select sealed SPADs that lead to occupied areas, and bridge beams and bridge beam mounting hardware and fasteners associated with HPH-DOOR-00002 and HPH-DOOR-00003. The concrete structure and embedments or other identified equipment supports will be designed and constructed to limit in-cave equipment failures due to seismic events. [Section 4.3.2.2, PDSA - HLW Facility] [Section 4.3.3.3, PDSA - HLW Facility]

4.2.1 Component Requirements

The following requirements pertain to system components.

SC System (Major Components). In the case where an item (e.g., manipulators, wall plugs, through-wall drives, shielded lights, cables, other control connections, camera plugs, joggle plugs, door recovery plugs, switch plugs, melter buss plugs) is normally present in a penetration, this designation applies to the SSC that holds the item in place or ensures that the body or the item remains intact. The remainder of the item is designated SS. The safety function is to provide confinement as part of the C5V boundary. [Appendix 4A, PDSA - HLW Facility]

SS System (Major Components). Shield hatches, shield doors, joggle penetrations, embedded piping, and other penetrations that provide an engineered air gap and/or shielding. In the case where an item (e.g., manipulators, wall plugs, through-wall drives, shielded lights, cables, other control connections, camera plugs, joggle plugs, door recovery plugs, switch plugs, melter buss plugs) is normally present in a penetration, this designation applies to the SSC that holds the part of the item not required to keep it in place or to ensure that the body or the item remains intact. The safety function is to ensure confinement of radioactive materials during normal conditions. Shield doors withstand impacts (not allow shine paths after impacts with loaded cranes and bogies). [Appendix 4A, PDSA - HLW Facility]

4.2.1.1 Actuators

Inspectability of Posting Port Door Actuation Operability. The system shall provide for the periodic verification that the posting port door-to-door interlocks actuation equipment is operable. [Section 5.5.8, PDSA - HLW Facility]

Gamma Detector Hatch Interlock. The system shall provide for periodic functional tests of the posting port gamma detector/shield door interlock. [Section 5.5.8, PDSA - HLW Facility]
Inspectability of the Gamma Detection Instrumentation. The system shall provide for periodic source checks of the gamma detection instrumentation. [Section 5.5.8, PDSA - HLW Facility]

Inspectability of Shield Door Actuation Operability. The system shall provide for the periodic verification that the shield door actuation equipment is operable. [Section 5.5.8, PDSA - HLW Facility]

4.2.1.2 Bogies

Safety Designation and Function of the Bogies and Restraints. Bogie and Bogie Restraints shall be safety designation APC. Bogie and/or bogie restraints shall be designed to maintain container and prevent overturning during normal operations. [Section 3.4.1.5.1.6, PDSA - HLW Facility] [Section 3.4.1.5.2.6, PDSA - HLW Facility] [Appendix 3A, PDSA - HLW Facility]

Seismic Category of Bogies. The seismic category of bogies whose failure (dropping off of the rails) could fail the C5V boundary or any SSC required to perform a safety function during a seismic event is SC-II for failure of C5 SC SSCs (including the C5V boundary) or SC SSCs. [Appendix 3A, PDSA - HLW Facility]

Safety Designation and Function of the Seismic Restraints for Bogies. Seismic restraints for bogies HPH-TRLY-00001/4/12/13 shall prevent bogie upset and potential canister drop in a seismic event. [Appendix 3A, PDSA - HLW Facility]

Safety Designation and Function of the Design Features on the Bogie Chain to Reduce Contamination. The bogie chain physical design features including deflector plate are APC to reduce contamination buildup on the bogie chain. [Appendix 3A, PDSA - HLW Facility]

4.2.1.3 Canister

Drop Canister Provide Containment. HLW Canister shall be safety designation APC. HLW canisters shall be designed to provide partial containment of radioactive material when dropped. [Section 3.4.1.5.1.6, PDSA - HLW Facility] [Section 3.4.1.5.2.6, PDSA - HLW Facility]

Canister Drop in C5 Ventilation Area. The canisters shall be required to provide partial containment of material when dropped. A possibly breached canister is expected to restrict production and release of aerosol into the ambient air by preventing exposure of most of the accident-generated fractured glass surface to turbulent air currents. [Section 3.4.1.5.1.6, PDSA - HLW Facility]

Canister Provides Confinement of Material. HLW Canister shall be safety designation APC. HLW canisters shall be designed to provide partial containment of radioactive material when dropped. [Section 3.4.1.5.2.6, PDSA - HLW Facility]

Breached Canister Provides Confinement of Material. The canisters shall be required to provide partial containment of material when dropped. A possibly breached canister is expected to restrict production and release of aerosol into the ambient air by preventing exposure of most of the accident-generated fractured glass surface to turbulent air currents. [Section 3.4.1.5.2.6, PDSA - HLW Facility]

4.2.1.4 Cranes

Safety Designation and Function of Hoisting Equipment. Hoisting equipment shall have safety designation APC. Hoisting equipment shall be designed appropriately (including parameters such as material selection, operating conditions, operating methods, operating speeds, controls and interlocks) to
minimize unplanned and uncontrolled load movement including load drops. [Section 3.4.1.1.6, PDSA - HLW Facility] [Section 3.4.1.5.2.6, PDSA - HLW Facility]

Normal Safety Function and Function in the Event of a Power Failure. All crane load supporting components must be able to support the maximum expected weight. The crane must be able to hold its load in the event of a power failure. [Section 3.4.1.5.1.6, PDSA - HLW Facility]

Durability in a High Radiation Environment. The crane/manipulator components shall be designed to operate in a high radiation environment. Drops are low energy events that do not pressurize the drop zone. [Section 3.4.1.5.2.6, PDSA - HLW Facility] [Section 3.4.1.5.1.6, PDSA - HLW Facility]

Safety Function of the Load Path Components of the Canister Handling Crane (HLW-MJ-HPH-CRN-00001 and HLW-MJ-HPH-CRN-00002). The load path components of the Canister Handling Crane (HLW-MJ-HPH-CRN-00001 and HLW-MJ-HPH-CRN-00002) shall be designed (including material selection, operating conditions, operating methods, operating speeds, controls, and interlocks) to minimize the occurrence of dropped loads. [Appendix 3A, PDSA - HLW Facility]

The safety designations of load path components for the Canister Handling Crane (HLW-MJ-HPH-CRN-00001 and HLW-MJ-HPH-CRN-00002) are as follows:

- **Safety Designation and Function of the Upper-Limit Switches.** The hoist shall have two APC upper-limit switches. [Appendix 3A, PDSA - HLW Facility]
- **Safety Designation and Function of the Hoist Drive Train.** The APC crane hoist drive train shall have a redundant load path. [Appendix 3A, PDSA - HLW Facility]
- **Safety Designation and Function of the Hoist Brakes.** The crane hoist drive train shall have APC fail-safe brakes. [Appendix 3A, PDSA - HLW Facility]
- **Safety Designation and Function of the Hoist Over-Speed Detection.** The crane hoist drive train shall have APC over speed detection to prevent a load drop if a barrel coupling or hoist drive train experiences a catastrophic failure. [Appendix 3A, PDSA - HLW Facility]
- **Safety Designation and Function of the Load-Sensing Devices.** The hoist ropes must have APC load-sensing devices to prevent an overload situation. [Appendix 3A, PDSA - HLW Facility]
- **Safety Designation and Function of the Hoist Drums Misreeving Detection.** The hoist drums shall have APC cable misreeving detection to reduce the probability of damage to the hoist ropes. [Appendix 3A, PDSA - HLW Facility]
- **Safety Designation and Function of the Crane Operating Speed Control.** The cranes shall have an APC speed control to keep the speed low enough such that swinging loads and impacts with walls, shield doors, and shield windows do not cause failure of the walls or doors. [Appendix 3A, PDSA - HLW Facility]

Cranes and Bogies Seismic Category. The seismic category of cranes HLW-MJ-HPH-CRN-00001 and HLW-MJ-HPH-CRN-00002 whose failure could fail the C5V boundary or any SSC required performing a safety function during a seismic event is SC-II for failure of C5 SC SSCs (including the C5V boundary) or SC SSCs. [Appendix 3A, PDSA - HLW Facility]

4.2.1.5 Grapples

Load path components shall be designed (including material selection, operating conditions, operating methods, operating speeds, controls, and interlocks) to minimize the occurrence of dropped loads. The following requirements pertain to the APC grapples for the Canister Handling Crane (HLW-MJ-HPH-CRN-00001 and HLW-MJ-HPH-CRN-00002) and lifting devices (load path components):
• **Sequential Mechanism.** The canister grapple must have a sequential mechanism that requires the canister to be set down two full times before the canister is disengaged. [Appendix 3A, PDSA - HLW Facility]

• **Load Capacity.** The canister grapple must be designed to a safe working load limit with a design factor of 3 based on material yield stress, or 5 based on ultimate stress, whichever is less. [Appendix 3A, PDSA - HLW Facility]

• **Requirement for Engagement.** The design of the canister grapple must be such that it will be fully seated on the canister for the mechanically operated jaws to engage. [Appendix 3A, PDSA - HLW Facility]

• **Fail Closed.** The canister grapple must fail in the closed position while holding a canister. [Appendix 3A, PDSA - HLW Facility]

• **Reliability Upon Impact with an Obstruction.** The design of the canister grapple must prevent release of a canister even if it hits an obstruction during transport. [Appendix 3A, PDSA - HLW Facility]

### 4.2.1.6 Glass Shard Transfer Flask

**Safety Designation and Function of the Glass Shard Sample Transfer Flask.** The safety designation of the glass shard sample transfer flask is APC to provide sufficient shielding and prevent loss of confinement due to any accident or off-normal event (e.g., drop, fire) during transport and handling. [Section 3.3.5.1.7, PDSA - HLW Facility] [Section 3.3.5.2.10, PDSA - HLW Facility] [Appendix 3A, PDSA - HLW Facility]

### 4.2.1.7 Hatches

**Shield Hatch Description.** The SS shield hatches and lids shall be motor-driven horizontal hatches mounted on rails. They serve as a movable cover over transfer ports used to move cylindrical containers from one elevation within the facility to another. When closed, the hatches provide an adjustable engineered ventilation air gap between their underside and the stainless steel penetration liners and prevent objects from falling into the transfer port. Exceptions are as follows: the clean canister import (SC), canister storage cave import (SC), and the drum swabbing and monitoring cask handling hatch (SC) provide both shielding and an engineered air gap adjustable to a nominal 1/8 inch (i.e., < 1/4 inch) between separate exhaust areas; the pour tunnel hatches to the melter caves do not provide shielding. The SS hatches also include additional cover thickness and liners that incorporate additional material denser than the surrounding concrete to function as a radiological shield. The horizontal shield hatches also incorporate (non-safety) proximity switches indicating the "closed" position. [Section 4.4.1.2, PDSA - HLW Facility]

**Safety Designation, Function, and Seismic Category of the Pour Tunnel 1 Hatch.** Pour Tunnel 1 Hatch shall be safety classification SS and seismic category: SC-II. The large hatches will remain in place to ensure that personnel are not exposed to significant radiation during evacuations for a seismic event. [Appendix 3A, PDSA - HLW Facility] [Section 4.4.1.1, PDSA - HLW Facility] [Section 4.4.1.2, PDSA - HLW Facility] [Section 4.4.1.3, PDSA - HLW Facility] [Appendix 4A, PDSA - HLW Facility]

**Safety Designation, Function, and Seismic Category of the Pour Tunnel 2 Hatch.** Pour Tunnel 2 Hatch shall be safety classification SS and seismic category SC-II. The large hatches will remain in place to ensure that personnel are not exposed to significant radiation during evacuations for a seismic event. [Appendix 3A, PDSA - HLW Facility] [Section 4.4.1.1, PDSA - HLW Facility] [Section 4.4.1.2, PDSA - HLW Facility] [Section 4.4.1.3, PDSA - HLW Facility] [Appendix 4A, PDSA - HLW Facility]
Materials of Construction. The SS equipment shield doors, hatches, and lids shall be constructed from steel that provide shielding and/or they are designed to provide an engineered air gap to limit airflows from adjacent areas. Shield doors and hatches shall be designed to maintain adequate shielding during credible accident events. [Section 4.4.1, PDSA - HLW Facility]

Standards for Shield Hatches. The shielded hatches shall be designed in accordance with DOE-STD-1020-94, ANSI/AISC N690, and AISC M016, ASD Manual of Steel Construction, as applicable. Typically ANSI/AISC N690 is applied to SC-I and SC-II SSCs and AISC M016 is applied to SC-III and SC-IV SSCs. DOE-STD-1020-94 is generally applicable to these SSCs (see PDSA General Information). [Section 4.4.1.4, PDSA - HLW Facility]

4.2.1.8 Interlocks

Prevent Simultaneous Opening of Doors and Hatches. The safety function of the interlock associated with the posting ports is to prevent multiple shield barriers from being open simultaneously. The posting port shield door on the hot side of the process is interlocked with the shield door at the cold side so that if one of these doors is open, the actuation mechanisms for the other door shall be interlocked to stay in the closed position. The interlock is used in conjunction with proximity switches (SS) to determine the position of the shield door (open or closed). [Section 4.4.5, PDSA - HLW Facility] [Section 4.4.22, PDSA - HLW Facility] [Section 4.4.22.1, PDSA - HLW Facility] [Section 4.4.22.2, PDSA - HLW Facility] [Section 4.4.22.3, PDSA - HLW Facility] [Section 4.4.22.5, PDSA - HLW Facility] [Appendix 4A, PDSA - HLW Facility]

Safety Designation and Function of the Shield Door Interlocks And Positional Switches. The safety designation of the posting port Shield Door Interlocks and Positional Switches is SS to prevent multiple shield barriers from opening at once. [Section 3.3.5.1.13, PDSA - HLW Facility] [Appendix 4A, PDSA - HLW Facility]

Safety Designation and Function of the Gamma Monitor Interlocks. The safety designation of the Gamma Monitors Interlocked with posting port out-cave shield doors is SS to prevent entry into a high radiation area. [Section 3.3.5.1.13, PDSA - HLW Facility] [Appendix 4A, PDSA - HLW Facility]

Standard and Codes for Interlocks and Switches. The following interlocks and proximity switches shall be designed and constructed in accordance with ISA S84.01, IEEE 338, IEEE 384, and IEEE 1023. [Section 4.4.22.4, PDSA - HLW Facility]

- Gamma detector interlocked with the posting port out-cave shield door
- Positional interlocks and proximity switches associated with posting port shield doors that prevent multiple shield barriers from opening.
- The effects of aging on normal and abnormal functioning are considered in the design and qualification of the safety electrical equipment in accordance with IEEE 323.
- The SSCs associated with interlocks (e.g., proximity switches) minimum mounting requirements are per the UBC.

Basis for the Standards and Codes for Interlocks. ISA S84.01 is applied for all automatically executed safety instrumented systems to provide the guidance to ensure the necessary reliability of these systems. A tailored version of IEEE 338 supplements ISA S84.01 in designing safety-instrumented systems so they can be tested to prove that they adequately perform their required safety functions. A tailored version of IEEE 384 supplements ISA S84.01 in design considerations for independence of safety systems. Finally,
a tailored version of IEEE 1023 is applied to all safety functions requiring indication and/or alarm at a safety qualified operator interface. [Section 4.4.22.5, PDSA - HLW Facility]

Prevent Opening When Source is Present. The gamma detector interlocks for the posting port out-cave shield door prevents operation of these SSCs when a high rad source is present on the hot side of the shield door. [Section 4.4.22.1, PDSA - HLW Facility] [Section 4.4.22.2, PDSA - HLW Facility]

Seismic Category of the Shield Door Interlocks. The seismic category of the shield door interlocks shall be SC-III. [Appendix 3A, PDSA - HLW Facility] [Section 4.4.22.3, PDSA - HLW Facility] [Section 4.4.5, PDSA - HLW Facility]

Canister Cooling Period in Pour Tunnel. The airlift valve that controls glass pours is interlocked to the bogie drive so that the canister cannot be removed from the pour tunnel until sufficient cooling has been achieved. The interlock allows for the pour to be completed and then ensures the bogie drive cannot be powered for a pre-determined period of time so that the canister can cool. Once the period is over, the interlock will allow power to the bogie drive. This interlock is Safety Significant. [Section 4.4.15.2, PDSA - HLW Facility] [Section 4.4.15.3, PDSA - HLW Facility] [Section 4.4.15.4, PDSA - HLW Facility]

4.2.1.9 Rails

Safety Designation and Function of the Canister Handling Crane Rails. The safety designation of the Canister Handling Crane rails is APC to prevent the crane from falling during a seismic DBE. [Appendix 3A, PDSA - HLW Facility]

Seismic Category of the Crane Rails. The seismic category of the crane rails is SC-II. [Appendix 3A, PDSA - HLW Facility]

Seismic Category of the Elevated Bogie Rails. The seismic category of the elevated bogie rails is SC-II. [Appendix 3A, PDSA - HLW Facility]

4.2.1.10 Racks

Administrative Cooling Prior to Rack Placement. The safety designation of the administrative control for a minimum of 4 hours of canister cooling in the Pour Tunnel is to prevent a canister over the design temperature of the HPH Canister Cooling rack or HPH Canister Buffer rack from being placed into the rack. [Appendix 3A, PDSA - HLW Facility]

Safety Function of the HPH Canister Cooling Rack and HPH Canister Buffer Rack. The safety function of the HPH Canister Cooling rack (HPH-MHAN-00014) and HPH Canister Buffer rack (HPHMHAN-00017) is to prevent multiple canisters from falling and/or impacting the structure during a seismic DBE. Racks whose canisters can subject the CSV boundary and rack to thermal hazards from the hot canisters (i.e., the HPH Canister Cooling rack and HPH Canister Buffer rack) shall be designed to withstand the temperature of the canister after the credited cooling period in the Pour Tunnel. Additionally, the position of canisters is maintained during normal operation and off-normal/accident events to ensure that the facility structure is maintained within the temperature requirement for the structure. HLW canisters are designed to provide partial confinement of radioactive material when dropped. [Section 4.4.10.1, PDSA - HLW Facility] [Appendix 4A, PDSA - HLW Facility] [Section 5.6.8, PDSA - HLW Facility]
**Canister Capacity.** The HPH Canister Cooling rack (HPH-MHAN-00014), and HPH Canister Buffer rack (HPH-MHAN-00017) shall hold the HLW canisters in an established geometry in the facility. The canister racks used for filled canisters of HLW glass, downstream of the pour tunnel (i.e., racks in the canister handling cave and canister storage cave that are designed to hold 24 or 46 canisters, respectively). [Section 4.4.10, PDSA - HLW Facility]

**Canister Spacing and Structural Integrity.** The HPH Canister Cooling rack and the HPH Canister Buffer rack shall provide sufficient spacing and structural integrity to ensure that the racks do not fail due to thermally induced cycling and that there are no unacceptable thermal impacts on the facility structure during normal operations, off normal events, and non-seismic accident events. The HPH Canister Cooling rack and the HPH Canister Buffer rack also prevent uncontrolled motion of multiple glass filled canisters that could impact the structural integrity of the structure. [Section 4.4.10.5, PDSA - HLW Facility]

**Seismic Category of the HPH Canister Buffer Rack.** The seismic category of the HPH Canister Cooling Rack (24 canisters) is SC-II (this is a C5V serviced area). [Appendix 3A, PDSA - HLW Facility]

**Seismic Category of the HPH Canister Cooling Rack.** The seismic category of the HPH Canister Cooling Rack (24 canisters) is SC-II (this is a C5V serviced area). [Appendix 3A, PDSA - HLW Facility]

### 4.2.1.11 Sensors

**Safety Designation and Function of the Cat Whiskers.** The safety designation of the "Cat Whiskers" sensor for cranes HPH-CRN-00001 and HPH-CRN-00002 is APC to annunciate in the appropriate area to prevent Crane-to-Crane and Crane-to-Load impacts. [Section 3.4.1.5.1.6, PDSA - HLW Facility] [Appendix 3A, PDSA - HLW Facility]

The reliability requirement for selected system sensors is as follows:

- **Gamma Detection Instrumentation.** The gamma detection instrumentation shall be operable. [Section 5.5.8, PDSA - HLW Facility]

### 4.2.1.12 Shield Doors

**Door Gearbox Prevents Structural Damage.** The safety designation of the Vertical Crane Shield Door auto-locking lead screw gearbox and load path components between the gearbox and the shield door panel (not applicable to SSCs required to meet the shielding safety function) is APC to prevent potential structural damage from falling caused by a design basis earthquake. [Appendix 3A, PDSA - HLW Facility]

**Safety Designation and Functions of Doors that Provide Shielding and Air gaps.** The shielded doors that provide radiation shielding shall also provide engineered air gaps from areas of lower contamination into areas of higher contamination. SSCs that are required to maintain shielding performance during a seismic event shall be SS, in other words, the attributes of the SSCs that ensure that the shielding is not compromised in a seismic event. Further, maintenance area equipment shield doors withstand impacts from loaded cranes or boggles, as applicable, without catastrophically failing and creating a direct shine path into the maintenance area. The attributes of the SSCs that provide shielding for normal operations, but are not impacted by accident events shall be SS design features. [Section 4.4.1.1, PDSA - HLW Facility] [Section 4.4.1.3, PDSA - HLW Facility] [Section 4.4.1.5, PDSA - HLW Facility] [Appendix 4A, PDSA - HLW Facility]
Safety Designation and Function of the Doors that are Part of C5V Confinement. Doors that impact the ability of the C5V to provide the required cascade inflow (i.e., confinement) between C5 and C2/C3 areas shall be seismic category SC-I including C3 areas that have been determined to be within the C5V boundary, as part of C5 areas. In the case where an item (e.g., door recovery plugs) is normally present in this penetration, this designation applies to the SSC that holds the item in place or ensures that the body of the item remains intact. Note: This seismic requirement is limited to the confinement function only. [Appendix 3A, PDSA - HLW Facility]

Configuration of the Doors that Provide Shielding and Air gaps. The SS shield doors provide a shielding function and an engineered air gap to maintain cascade airflow when closed. Shield doors can be in a horizontal or vertical configuration. For doors that provide an engineered air gap, a sufficient range of adjustment is incorporated into the door design to enable the door to provide the specified range of air gaps. A guide system or shield blocks (SS) will be utilized, as needed, at the bottom of shield doors to provide radiological shielding for shine paths created by gaps between the bottom of the door and the floor. SS doors and hatches include the following: [Section 4.4.1.2, PDSA - HLW Facility]

- **Vertical Shield Door, Crane Decontamination.** Vertical Shield Door, Crane Decontamination shall be safety classification SS and seismic category SC-II. [Section 4.4.1.2, PDSA - HLW Facility]
- **Vertical Shield Door, Bogie Maintenance Pour Tunnel 1.** Vertical Shield Door, Bogie Maintenance Pour Tunnel 1 shall be safety classification SS and seismic category SC-II. [Section 4.4.1.2, PDSA - HLW Facility]
- **Vertical Shield Door, Bogie Maintenance Pour Tunnel 2.** Vertical Shield Door, Bogie Maintenance Pour Tunnel 2 shall be safety classification SS and seismic category SC-II. [Section 4.4.1.2, PDSA - HLW Facility]
- **Horizontal Shield Door, Crane Decontamination.** Horizontal Shield Door, Crane Decontamination shall be safety classification SS and seismic category SC-II. [Section 4.4.1.2, PDSA - HLW Facility]
- **Horizontal Shield Door, Crane Maintenance.** Horizontal Shield Door, Crane Maintenance shall be safety classification SS and seismic category SC-II. [Section 4.4.1.2, PDSA - HLW Facility]
- **Vertical Shield Door, Crane Maintenance.** Vertical Shield Door, Canister Handling Cave Crane Maintenance shall be safety classification SS and seismic category SC-II. [Section 4.4.1.2, PDSA - HLW Facility]

No Impact to C5V Boundary During a Seismic and/or Loss of Power Event. The shield doors shall be designed so as not to adversely impact the performance of safety SSCs during off normal and accident conditions, including NPH events, and to maintain structural integrity during and after the design basis earthquake. The shield door mechanisms that protect the C5V boundary are considered SC-II including the associated loss of power events. The safety SSCs include the C5V boundary such as the floors and walls. The large shield doors will remain in place to ensure that personnel are not exposed to significant radiation during evacuations for a seismic event. This design requirement includes the protection of safety SSCs from damage by the shield doors during a loss of power event (e.g., protection of the C5V boundary from impacts that could fail the boundary). The shield doors shall be SC-II. [Appendix 3A, PDSA - HLW Facility] [Section 4.4.1.1, PDSA - HLW Facility] [Section 4.4.1.3, PDSA - HLW Facility] [Section 4.4.1.5, PDSA - HLW Facility]

Withstand Impacts from Loaded Cranes or Bogies. Shield doors that provide an engineered air gap and/or shielding shall ensure confinement of radioactive materials during normal conditions. Shield doors withstand impacts (not allow shine paths after impacts with loaded cranes and bogies). In the case where an item (e.g., door recovery plugs) is normally present in a penetration, this designation applies to the SSC that holds the part of the item not required to keep it in place or to ensure that the body or the item remains intact. [Section 4.4.1.5, PDSA - HLW Facility] [Appendix 4A, PDSA - HLW Facility]
Materials of Construction. The SS equipment shield doors, hatches, and lids shall be constructed from steel that provide shielding and/or they are designed to provide an engineered air gap to limit airflows from adjacent areas. Shield doors and hatches shall be designed to maintain adequate shielding during credible accident events.  [Section 4.4.1, PDSA - HLW Facility]

Standards. The shield doors and lids are designed in accordance with the following: [Section 4.4.1.4, PDSA - HLW Facility]
- The structural mounting components of the shield doors, shield lids, shield blocks, and shielded hatches are designed in accordance with DOE-STD-1020-94, ANSI/AISC N690, and AISC M016, *ASD Manual of Steel Construction*, as applicable.
- Typically ANSI/AISC N690 is applied to SC-I and SC-II SSCs and AISC M016 is applied to SC-III and SC-IV SSCs. DOE-STD-1020-94 is generally applicable to these SSCs (see PDSA General Information).

Design Standard for Doors that are Part of the C5V Confinement Boundary. The personnel access doors shall be designed in accordance with ANSI/AISC N690. [Section 4.3.2.4, PDSA - HLW Facility] [Section 4.3.3.4, PDSA - HLW Facility]

Safety Designation And Function of the Door Air Gap. The safety designation of the minimum 1/2 in. air gap between the door and the wall (on the East and West edges of doors) from the floor up a minimum of 1 ft for HPH-DOOR-00002 and HPH-DOOR-00003 is APC to allow a flow path through the door to minimize the potential for internal flooding events due to water systems piping failures to exceed the applicable floor loading. [Section 3.3.6.2.1.11, PDSA - HLW Facility] [Appendix 3A, PDSA - HLW Facility]

Safety Function of the Shield Hatches and Doors. The safety function of the shield hatches and shield doors shall be to provide shielding to prevent direct radiation exposure that may result in consequences to the facility workers above radiation exposure standards in the SRD. [Section 4.4.5.1, PDSA - HLW Facility]

Canister Swabbing and Handling Gamma Monitors Interlock with Post Ports. Canister Swabbing & Monitoring (HDH-TWDVC-00002) and Canister Handling Cave (HPH-TWDVC-00009) gamma monitors interlocked with post ports shall prevent operator exposure due to high radiation. [Appendix 4A, PDSA - HLW Facility]

Design Standard for Access Doors. The personnel access doors shall be designed in accordance with ANSI/AISC N690. [Section 4.3.3.4, PDSA - HLW Facility]

4.2.1.13 Shield Windows

Confinement Function. Cave walls have penetrations including shield windows. These penetrations are part of the C5V boundary only if in their absence the C5 cascade cannot be maintained. [Section 4.3.2.2, PDSA - HLW Facility]

Structural Stability. Shielded windows maintain gross structural stability and not fall from the imbedded anchors (cracking allowed). [Section 4.3.2.3, PDSA - HLW Facility]

Seismic Category of Windows that Are a Part of the C5V Boundary. Windows that impact the ability of the C5V to provide the required cascade inflow (i.e., confinement) between C5 and C2/C3 areas shall be seismic category SC-I including C3 areas that have been determined to be within the C5V boundary, as
part of C5 areas. Note: This seismic requirement is limited to the confinement function only. [Appendix 3A, PDSA - HLW Facility]

**Applicability of Confinement Function During Facility Operating Modes.** The structure including the shield windows shall ensure confinement of radioactive materials during normal, abnormal, and accident conditions preclude differential movement between structures and service connections or unacceptable settlement that could break or damage the connections and lead to a liquid spill, and provide sufficient volume for hydrogen dilution. [Appendix 4A, PDSA - HLW Facility]

**Seismic Category of Windows that Provide Shielding.** Windows and other structures that provide shielding, but do not impact the ability of the C5V to provide the required cascade inflow (i.e., confinement) between C5 and C2/C3 areas shall be seismic category SC-III. Note: this does not decrease the seismic category of SSCs for other functions not related to the maintenance of the C5V boundary. [Appendix 3A, PDSA - HLW Facility]

**4.2.1.14 Shielding**

**Cave Construction.** All caves/cells will be constructed of reinforced concrete with shielded steel access doors, as required to provide the appropriate level of shielding. The cave walls, ceiling, and floors shall be constructed so that the shielding function of these SSCs is not compromised by the doors and penetrations. The penetrations include shield windows, wall boxes, and/or wall modules that allow for piping and utilities, and ventilations penetrations for the C5V exhaust duct and in-bleed system as part of the design for normal operations. This function, as needed to meet the regulatory limit for facility workers, will be maintained during accident conditions, such as seismic events. [Section 4.4.1, PDSA - HLW Facility]

**Provide Shielding to Protect Worker.** The facility structure and cells provide C5V boundary. In addition these SSCs provide shielding to protect the facility worker from direct radiation associated with R5 or R3/R5 areas. The function of the general shielding SSCs is to provide adequate shielding to protect workers from unacceptable exposure to direct radiation, consistent with the SRD and the RPP. The general SS SSCs that provide this shielding function would include: [Section 4.4.2, PDSA - HLW Facility]

- Shield walls,
- Shadow shielding,
- Shield plugs,
- Shield plates,
- Internal shielding in through wall items,
- Supplemental shielding (i.e., Shielded lids as discussed in Section 4.4.1),
- Penetrations including joggles, and
- Embedded piping/tubing/ducting.

**4.3 Requirements to Keep Exposures ALARA**

The following requirements keep exposures as low as reasonably achievable (ALARA).

**4.3.1 Access to Contamination Areas.** Areas within the WTP shall be accessed and classified based on their potential for contamination, as well as the anticipated contamination levels. [Section 5.1.2, BOD]
4.3.2 **Utility System Connections.** Where appropriate, utility system connections to the process shall have properly engineered devices such as air gaps or adequate backflow preventers. [Section 7.1, ORD]

4.3.3 **Durability of Equipment Subject To Decontamination.** Equipment subject to decontamination shall be designed to withstand this process without any reduction of functionality through degradation of the electrical, mechanical, or any other components involved. [Section 9.1, ORD]

4.3.4 **Decontamination Agents.** Provisions shall be made, where applicable, for decontamination [of incell/ in-cave cranes and hoists] using carbon dioxide, pressurized warm water, detergent solution, and steam. Facilities for the decontamination shall be provided, including disposal of the waste liquid. [Section 14.16, ORD]

4.3.5 **Durability of Equipment Subject To Decontamination.** Electrical and mechanical parts and controls shall not be degraded as a result of decontamination. [Section 14.16, ORD]

4.3.6 **Remotely Maintained Cell Building Layouts.** Remotely maintained cell building layouts (not including black cells) shall include the following: Equipment to perform decontamination. Provisions for carbon dioxide, high pressure water, steam, and chemical washing shall be provided. [Section 14.8, ORD]

4.3.7 **Contact-Handled Maintained Cells.** Contact-maintained cell building layouts shall include the following: [Section 14.9, ORD]

- Stainless steel liners and washdown/decontamination capabilities (stainless steel versus epoxy for maintenance cell shall be evaluated case by case).
- Utilities to support maintenance activities

4.3.8 **In-Cave Decontamination Techniques.** Remotely maintained cell building layouts (not including black cells) shall incorporate in-cave decontamination techniques to minimize the spread or buildup of radioactive contamination. [Section 14.8, ORD]

4.3.9 **Disposal Routes for Waste.** Identification, minimization, and disposal routes for all waste streams, including mixed waste (hazardous and radioactive). [Section 20.0, ORD]

4.3.10 **Design Life of Non-Maintainable Equipment.** Mechanical equipment shall be designed for a nominal plant life of 40 years (Section C.7, WTP Contract No. DE-AC27-01RV14136). All non-maintainable items of equipment shall be designed to last the life of the facility. [Section 11.1.1, BOD]

4.3.11 **Simplification of Equipment.** In-cell equipment is simplified and minimized wherever practicable to improve reliability, operability, and maintainability. This philosophy also minimizes waste generated from associated disposal and decontamination. [Section 11.4.1, BOD]

4.3.12 **Remote Operations In-Cell and In-Cave.** In-cell and in-cave operations shall be performed remotely. The design incorporates features to facilitate this mode of operation. [Section 11.4.1, BOD]
4.3.13 **Placement of Components That Require a High Degree of Maintenance.** Where possible, components that require a high degree of maintenance or service should be placed out-cave. Motor drives and valve power actuators should be operated through the wall and be maintained external to the cells and caves. This improves maintenance operations and reduces meantime to repair. [Section 11.4.1, BOD]

4.3.14 **Remote Removal and Replacement of In-Cave Equipment.** In-cave equipment shall be designed to be remotely removable and replaceable. Consumable components of in-cave process or mechanical equipment shall also be remotely removable and replaceable, while minimizing the potential for the release of radioactive contamination to the cave environment. [Section 11.4.1,BOD]

4.3.15 **Selection of Materials of Construction.** Selection of materials of construction addresses the in-cave chemical, radiological, and thermal environment to minimize maintenance requirements. [Section 11.4.1, BOD]

4.3.16 **Remote-Handling Features of In-Cave Components.** In-cave components shall be designed to incorporate remote-handling features to facilitate handling by remote techniques (such as by in-cave cranes, power manipulators, or master-slave manipulators (MSMs). [Section 11.4.1, BOD]

4.3.17 **Leakage from Piping Connections.** Process and service piping connections shall be designed to minimize the potential for liquid waste leakage or seepage when disconnected. [Section 11.4.1, BOD]

4.3.18 **Decontamination of In-Cave Equipment.** In-cave equipment and components shall be designed to minimize the potential for radioactive contamination and include features to facilitate appropriate decontamination techniques. In-cave decontamination techniques shall be incorporated to minimize the spread or buildup of radioactive contamination. [Section 11.4.1, BOD]

4.3.19 **Maintainability.** HLW vitrification facilities contain highly radioactive wastes and hazardous materials that come in contact with various systems, structures, and equipment. Because of this contact, these systems, structures, and equipment require special design considerations for access, handling, and maintenance: [Section 11.3.2, BOD]

- The mechanical handling equipment is designed to be removable through dedicated maintenance areas.
- The maintenance area is shielded and maintained accessible for decontamination and operator access.
- Provisions shall be made in the layout for adequate maintenance areas to allow for the periodic replacement of mechanical equipment and components.

4.3.20 **Minimize Radiation.** Where radiation levels require, equipment will be designed to be remotely removable and replaceable. Consumable components of in-cave process or mechanical equipment will also be remotely removable and replaceable, to minimize the potential for release of radioactive contamination to the cave environment. [Section 5.2, ORD]

4.3.21 **Decontamination Features.** Equipment and components will be designed to minimize the potential for radioactive contamination and will include features to facilitate decontamination. [Section 5.2, ORD]
4.3.22 **Component Location.** Maintainable equipment components, such as drive motors, shall be located out of high radiation cave, cell, and bulge areas to the extent practical. [Section 7.1, ORD]

4.3.23 **Lubrication.** Permanently lubricated, sealed for life components shall be used wherever possible in order to reduce maintenance requirements. It is expected that components in high radiation areas shall require lubricated bearings. [Section 9.1, ORD]

4.3.24 **Recovery, Replacement and Redundancy.** Provisions will be made for the safe recovery, replacement, and/or redundancy of components subject to extreme service conditions to achieve a 40 year design life. [Section 14.1, ORD]

4.3.25 **Radiation Control.** There shall be an engineered method for removal of equipment from cells, caves, and bulges (except for black cells or cells with no access), taking into consideration containment and radiation control. [Section 8.1.3, ORD]

4.3.26 **Equipment Recovery.** Where there is potential for equipment failure within a high radiation area (not black cells), means shall be provided for recovery of that equipment. Recovery shall be accomplished by using either routine remote maintenance or, where permissible, manned intervention. Manned intervention will not be an acceptable means for routine maintenance, but the capability shall be designed into the facility for off-normal recovery operations, such as strategically located plugs in cave or cell walls, roofs with special lifting and handling equipment, specially designed systems, a means of isolation in the cell or cave, and equipment connections. [Section 9.1, ORD]

4.3.27 **Equipment Recovery.** In facilities where there is potential for equipment failure within a high radiation area (for example, pretreatment or HLW vitrification facilities), means shall be provided for recovery of that equipment. Recovery shall be accomplished by either using dedicated remote recovery facilities or, where permissible, manned intervention. Local intervention shall not be an acceptable means for routine maintenance, but the capability shall be designed into the facility for off-normal recovery operations. Local intervention means of recovery is normally accomplished by strategically located plugs in cave or cell walls and roofs with special lifting and handling equipment, specially designed systems and equipment connections, and a means of isolation in the cell or cave. Sufficient space shall be provided for removal and replacement of these plugs and the associated recovery operation. Access ports may be filled with rebar and concrete to the same design/construction standards as the remainder of the cells prior to hot operations. These areas of the cell wall and ceiling can be identified on the design/construction documents for future intervention access for remediation and deactivation work. [Section 11.3.2, BOD]

4.3.28 **Remotely Maintained Cell Building Layouts.** Remotely maintained cell building layouts (not including black cells) shall include the following: Recover Failed Equipment. Remote recovery of failed equipment to enable repair to be undertaken in the worst-case credible failure mode. Consideration shall be given to designing equipment to fail safe to allow recovery operations to be taken. [Section 14.8, ORD]

4.3.29 **Design Life.** Other equipment not having a design life of 40 years is specified for a cost-effective design life, taking into account current technology, as low as reasonably achievable (ALARA) exposure principles, and waste minimization. [Section 11.1.1, BOD]
4.3.30 **Equipment and Instrumentation Accessibility.** Equipment and instruments requiring personnel access for periodic calibration or maintenance shall be located in areas where personnel exposures shall be ALARA. [Section 9.1, ORD]

4.3.31 **Minimize Maintenance.** Work scope planning should minimize the need to dismantle a significant amount of equipment to maintain other equipment. [Section 9.1, ORD]

4.3.32 **Crane Maintenance.** The mechanical handling equipment shall be designed to be removable to dedicated maintenance areas for replacement of mechanical equipment, controls, and other components. These maintenance areas shall be shielded and maintained accessible for operator access. [Section 11.8.3.1, BOD] [Section 11.8.3.3, BOD]

4.3.33 **Maintenance Operations.** Process operations within the cell or cave are, generally performed by dedicated equipment. Any maintenance operations shall be carried out by maintenance equipment. Certain equipment, such as in-cave cranes, is used for both process and maintenance operations tasks and care is taken to avoid over-utilization or excessive duty. [Section 11.4.1, BOD]

4.3.34 **Minimize Repairs.** Recovery operations on failed in-cell and in-cave equipment shall be addressed in the design to enable repair to be undertaken in the worst-case credible failure mode. This ensures that meantime to repair and cost to production is kept to a minimum. [Section 11.4.1, BOD]

4.3.35 **Hands-On.** Material transport systems and in-cell handling equipment is maintained in purpose-built maintenance facilities, after being decontaminated in a decontamination facility to a contamination level that allows hands-on maintenance. [Section 11.5.1, BOD]

4.3.36 **Cranes.** Recovery features shall be provided in the equipment designs to retrieve failed cranes to their maintenance area or provisions for in-place maintenance shall be provided. Crane designs shall be kept standardized and common components shall be used to the extent practical. Maintainable crane components shall be of modular design with service disconnects to simplify replacement. Cranes and rails shall be of carbon steel construction. High reliability, mechanical sequencing grapples is used for crane handling of product containers. [Section 11.8.3.2, BOD]

4.3.37 **Remote Recovery.** Equipment within the caves is designed for remote maintenance, driven under its own power to a maintenance area, or recovered remotely by external means to a maintenance area. Equipment operating in a contaminated environment is monitored and, if necessary, decontaminated before maintenance. Equipment subject to decontamination is designed to withstand this process without any reduction of functionality through degradation of the electrical, mechanical, or any other components involved. This decontamination conditions the equipment sufficiently to allow hands-on maintenance to be possible. [Section 11.8.3.1, BOD]

4.3.38 **Crane Park Position.** HLW cranes shall be designed so that in the park position in the crane maintenance area, inspections can be performed in low radiation/contamination areas and without unsafe interferences occurring during the inspections. [Section 11.8.3.1, BOD]

4.3.39 **Cranes of Modular Construction.** Cranes shall be designed to be of modular construction and orientated to facilitate quick removal and replacement of failed components. These modules have quick connectors on flying leads to allow rapid reconnection of cabling or other services.
Areas where contamination can be trapped shall be minimized. [Section 11.8.3.1, BOD] [Section 11.8.3.3, BOD]

4.3.40 **Cranes and Hoists Design for Modular Construction.** In-cell/in-cave cranes and hoists shall be designed to be of modular construction to facilitate removal and replacement of failed components. In addition, components shall be oriented such that the time for maintenance will be minimized. [Section 14.16, ORD]

4.3.41 **Bogie Recovery System.** Bogie shall include backup/recovery provisions in the event of a failure. Maximum loads shall be incorporated into the design of the recovery system. [Section 7.1, ORD]

4.3.42 **Modular Bogie Components.** Bogie shall include modular components where possible, such as wheel assemblies (assumed locked/failed wheel), to accommodate ease of maintenance. [Section 7.1, ORD]

4.3.43 **Crane Maintenance.** Crane systems shall be designed with lubrication systems that are accessible for ease of maintenance. [Section 14.16, ORD]

4.3.44 **Crane Maintenance.** Cranes and hoists shall be designed to be removed to dedicated maintenance areas for replacement of mechanical equipment, controls, and other components. [Section 14.16, ORD]

4.3.45 **Crane Retrieval Features.** Crane features shall be included in the design to retrieve failed cranes to their maintenance areas. [Section 14.16, ORD]

4.3.46 **ALARA Standard for Cranes.** The crane systems for HLW, LAW, and PT shall be designed with an area that meets the ALARA criteria to enable inspection of all critical crane components prior to use. This may require platforms and catwalks. [Section 14.16, ORD]

4.3.47 **Direct Operation for Cranes.** The design of the WTP facilities shall ensure hoisting equipment designed into the facility to remove equipment designed to be replaced during the operating life of the facility. [Section 20.0, ORD]

4.3.48 **Bogie Selection Criteria.** HLW Bogies provide a means of transferring the product containers, on a pair of parallel rails from one location to another during process activities. The bogies shall be of modular design to facilitate quick removal and replacement of failed components, and shall be designed to minimize contamination traps. Bogies shall be primarily of carbon steel construction, with the exception of materials contacting the product containers, which are stainless steel. Bogies located in an environment with a high level of contamination shall be primarily of stainless steel construction. [Section 11.8.3.1, BOD]

4.3.49 **Hands-On Maintenance.** The equipment in the facilities shall be maintained with both hands-on (contact) and remote maintenance techniques. Corrective, preventive, and predictive maintenance on equipment that can be repaired in place or removed for repair will be based on the requirements of 24590-WTP-MN-ESH-01-001, Waste Treatment Plant Radiological Control Manual. Where contamination and radiation levels are within permissible levels, or are achievable through decontamination, hands-on maintenance shall be preferred. [Section 6.2, ORD]
4.3.50 Provide Confinement. The building envelope enclosing potentially radioactive areas (non C-1) of the process facilities shall be designed, in conjunction with the HVAC systems, to provide confinement for normal operations, anticipated operational occurrences, and accident conditions. [Section 10.3.4.10, BOD]

4.3.51 Minimum Opening between Pour Tunnel and Melter Cave. To ensure cascade ventilation from the pour tunnel is maintained given loss of flow in the embedded pour tunnel duct, the minimum opening between the pour tunnel and melter cave shall be 5.3 ft². [Section 4.3.2.3, PDSA - HLW Facility]

4.3.52 Negative Pressure. Air into the C5 caves/cells cascades from C2 areas through C2/C3 subchane rooms and from C3 areas into the cave/cell through gaps around shield doors or through engineered inlets. Alternatively, air may enter the cave/cell as infiltration. Air shall be induced by the negative pressure within the C5 exhaust system. Engineered inlets shall be sized to provide the required airflow rate against a system inlet frictional resistance equal to the differential pressure between the C5 boundary and adjacent areas. The volume of air entering the C5 areas, by infiltration from adjacent areas, shall be calculated based on negative pressure and the type of cell construction. [Section 12.4.4, BOD]

4.3.53 Controlling Crane Movements. CCTV cameras installed on cranes shall be operated from a remote control station and shall be used to operate the crane. [Section 14.16, ORD]

4.3.54 Direct Operation. Cranes shall be operated via direct observation through windows where cameras do not warrant proper safe operation of cranes and hoists. Typically there shall be no on-board logic and all power and signal cables shall be marshaled off-board. [Section 14.16, ORD]

4.3.55 Modular Connectors. Modules shall have quick connectors to allow rapid reconnection of cabling or other services. [Section 14.16, ORD]

4.3.56 Building Layout for Remotability Operations. Remotely maintained cell building layouts (not including black cells) shall include the following: Cables passing from out-cell to in-cell via offset tubes, or equivalent design, sealed at the out-cell side to facilitate cable removal and replacement, and to ensure containment. The out-cell termination point shall be higher than in-cell. [Section 14.8, ORD]

4.4 Environmental Safety

Environmental requirements addressing dangerous waste permitted (DWP) Containment Building and Secondary Containment (for ancillary equipment piping) design standards are addressed in the HLW Facility Description.

4.5 HLW Waste Acceptance

The following items are important to the acceptability of WTP glass products.

Canister Welding Strategy. Canister fabrication and welding will be performed in accordance with ASME Boiler and Pressure Vessel Code (ASME B&PVC) Section VIII and all welds be inspected by dye penetrant according to Section V of the ASME B&PVC. After fabrication, the canisters will be helium-leak tested to ensure leak-tightness to less than $1 \times 10^{-4}$ atm-cc/sec helium. The final canister closure will
consist of welding a primary closure lid in place using a remotely operated automatic GTAW process. The canister will be designed such that, if the primary lid cannot be welded to an acceptable quality, a secondary lid can be welded in place over the primary lid to meet the final closure leak-tightness requirements. The secondary lid will be welded using the welding process specified for the primary lid. The closure weld will be qualified under the ASME B&PVC - Section IX, Welding and Brazing Qualifications. Use of a welded closure eliminates the need for a tamper-indicating device. The closure welding process will be qualified such that a final leak test is not required on production canisters. [Section 4.2, IHLW Waste Form Compliance Plan]

**Canister Qualification Activities.** The WTP shall ensure that the following activities are accomplished to demonstrate compliance with this specification. [Section 4.2, IHLW Waste Form Compliance Plan]
- Prepare detailed design drawings and material procurement specifications for the IHLW canister that will ensure the fabricated canister and canister lids meet the requirements of this specification. These documents will detail the material, dimensional, labeling, fabrication, inspection, testing, documentation, and QA requirements that the canister fabricator shall comply with. Final closure of the lids will be in accordance with a weld closure design drawing and WTP procedures.
- Demonstrate in advance the final closure welding process on full-scale canisters. Welds performed during this qualification program will be helium leak-tested and will use the same welding methods to be used during production operations, such that confirmatory leak testing of production welds will not be required. The Waste Form Qualification report (WQR) will document the results of the WTP weld qualification program and the canister welding procedure.
- Conduct any required welding process qualification by use of metallographic examinations, tensile and/or bend tests on weld zone coupons, and helium leak tests.
- Measure leak-tightness using the helium mass spectrometer leak testing method in accordance with ASME Boiler and Pressure Vessel Code, Section V, Non-Destructive Examination (ASME B&PVC).
- Use visual inspection of the closure welds to augment weld parameter control as a means of assessing weld quality. The ability to visually resolve pores, cracks, spatter marks, and incomplete fusion under production operation viewing conditions will be demonstrated before hot commissioning.

The WQR will include the WTP canister fabrication and equipment specifications and the results of the closure weld development and qualification program.

**Canister Verification Inspections and Certifications.** The Production Records will certify the integrity of the final closure weld by reporting the important welding process parameter values from the closure operation and the visual inspection results. Results of canister verification inspections and required certifications will be included in the Production Records for each canister accepted for use by the WTP. [Section 4.2, IHLW Waste Form Compliance Plan]

**Ensure Foreign Material Removal.** Canister handling operations and the canister travel path in the HLW vitrification facility shall be reviewed to ensure foreign material will not enter the canister during processing. [Section 3.3, IHLW Waste Form Compliance Plan]

**Canister Waste Free of Liquids.** The Producer shall ensure that the canistered waste form does not contain detectable amounts of free liquids. [Section 4.3, IHLW Waste Form Compliance Plan]

**Free Liquid Compliance Strategy.** The WTP will demonstrate compliance to this specification through a combination of design control, administrative controls, and analysis of the vitrification process to ensure that liquids will not accumulate in the canisters before, during, and after production. Administrative controls will be developed to limit the use of excluded materials in canister handling areas and to ensure that free liquids are not in canisters upon receipt. The canister handling sequence from receipt through
closure will be evaluated to demonstrate that the addition of free liquids is not credible during normal operations. No direct measurement of free liquids will be made, so a detection limit is not assigned. [Section 4.3, IHLW Waste Form Compliance Plan]

**Prohibited Gases.** During production operations, the following activities shall be conducted to comply with this specification. [Section 4.3, IHLW Waste Form Compliance Plan]

- The WTP will control the canister closure process to ensure that prohibited gases are not allowed in the canister and that the canister pressure upon closure will be within the specification limit. The cell atmosphere during canister pouring, cooling, and closure will be air. The gas sealed in the canister will consist of air and may include a small quantity of the shield gas used during welding. Administrative controls will ensure that foreign materials do not enter the canister. The welding conditions will be controlled, based on conditions demonstrated during qualification runs, to ensure the pressure immediately after closure will not exceed the specification limit.
- Administrative controls will be implemented to ensure that prohibited gases are not stored or introduced in the area where canisters are filled and stored.

**Organic Materials.** After filling and before final closure of the IHLW canister, the headspace of the canister shall be visually inspected to confirm the absence of foreign materials. [Section 4.3, IHLW Waste Form Compliance Plan]

**Canister Water Corrosion.** The presence of liquid water inside the canister could lead to localized corrosion (i.e., stress corrosion cracking) of 304 L stainless steel, especially if chlorine and fluorine leach from the glass. WTP design and operating procedures, however, shall be designed to mitigate this possibility by preventing the formation of liquid water in the canistered waste form. This will be done by inspecting the canisters after filling. [Section 4.3, IHLW Waste Form Compliance Plan]

**Canister Fill Height.** Fill height shall be equivalent to at least 87 % of the volume of the empty canister. The average fill height over all the canisters shall be at least 95 % of the volume of the empty canister. This contract requirement is consistent with WAPS Specification 3.6. The details for compliance with this specification are addressed in Section 4 of this WCP. [C.3, IHLW Waste Form Compliance Plan]

**Measure Cooled Canister Fill Height.** During production operations, the WTP shall conduct the following activities to comply with this specification. Measure the fill height in each cooled canister. [Section 4.3, IHLW Waste Form Compliance Plan]

**Canister Waste Free of Liquids.** The Producer shall ensure that the canistered waste form does not contain detectable amounts of free liquids. [Section 4.3, IHLW Waste Form Compliance Plan]
4.5.1 Component Requirements

The following requirements pertain to system components based on the mechanical handling activities in the HLW Canister Waste Screening Form.

4.5.1.1 Welders

The following are WAI requirements for welders:

Demonstration testing. Demonstration testing of the canister primary and secondary lid welding is WAI [Section 7, WTP HLW Canister Lid Welding] [Section 0, WTP HLW Canister Lid Welding] [Section 6.1.1, WTP HLW Canister Lid Welding]

Welding process qualifications. Welding process qualifications by use of metallographic examinations, tensile and/or bending tests on weld zone coupons are WAI [Section 7, WTP HLW Canister Lid Welding] [Section 0, WTP HLW Canister Lid Welding] [Section 6.1.1, WTP HLW Canister Lid Welding]

Determination of the welding parameters. Determination of the critical welding parameters critical for the canister lid welding process is WAI. [Section 7, WTP HLW Canister Lid Welding] [Section 0, WTP HLW Canister Lid Welding] [Section 6.1.1, WTP HLW Canister Lid Welding] [Section 6.1.1, WTP HLW Canister Lid Welding]

Calibration of welder components. Calibration of welder components that measure the critical welding parameters is WAI. [Section 0, WTP HLW Canister Lid Welding] [Section 6.1.1, WTP HLW Canister Lid Welding] [Section 7, WTP HLW Canister Lid Welding]

Welding control Software. Software that controls the welding system is WAI [Section 7, WTP HLW Canister Lid Welding] [Section 0, WTP HLW Canister Lid Welding] [Section 6.1.1, WTP HLW Canister Lid Welding]

Independent verifications. Independent verifications that compare the results of the DAS reading to the actual readings obtained with independent calibrated measurement equipment is WAI and include:

- Current
- Voltage
- Shield gas flow
- Travel speed (rotation accuracy and speed)
- Rotation dwell
- Wire feed accuracy and speed

[Section 7, WTP HLW Canister Lid Welding] [Section 0, WTP HLW Canister Lid Welding] [Section 6.1.1, WTP HLW Canister Lid Welding]

System calibrations/verifications. System calibrations/verifications to calibrate the canister lid welding system is WAI. These calibrations/verifications include:

- Current calibration
- Voltage calibration
- Shield gas flow calibration
• Rotation accuracy verification
• Rotation speed verification
• Rotation dwell verification
• Wire feed accuracy verification

Welding procedures. Welding procedures detail the WAI elements of:
• Operational steps to be followed for performing a weld
• Weld machine calibration and maintenance
• Process for confirming welding parameters remained within allowed ranges during the welding process
• Visual inspection of the weld surface

Welding a primary or secondary lid onto a canister. Welding a primary or secondary lid onto a canister is WAI Section 6.1.3.2 [Section 7, WTP HLW Canister Lid Welding] [Section 0, WTP HLW Canister Lid Welding] [Section 6.1.3.2, WTP HLW Canister Lid Welding] [Section 6.1.3.2, WTP HLW Canister Lid Welding]

Positioning of the torch. Positioning of the torch to the correct settings (radial and angle) is WAI Section 6.1.3.2 [Section 7, WTP HLW Canister Lid Welding] [Section 0, WTP HLW Canister Lid Welding]

Replacement of the electrode. Replacement of the electrode is WAI Section 6.1.3.2 [Section 7, WTP HLW Canister Lid Welding]

Confirmation of weld quality. Confirmation of weld quality is WAI Section 6.1.3.3 [Section 7, WTP HLW Canister Lid Welding] [Section 0, WTP HLW Canister Lid Welding] [Section 6.1.3.3, WTP HLW Canister Lid Welding]

Rework of the canister lid weld area. Rework of the canister lid weld area for installation of a new primary or secondary lid is WAI Section 6.1.3.4 [Section 7, WTP HLW Canister Lid Welding] [Section 0, WTP HLW Canister Lid Welding] [Section 6.1.3.4, WTP HLW Canister Lid Welding] [Section 6.1.3.4, WTP HLW Canister Lid Welding]

Inspection of the milled weld area. Inspection of the milled weld area after use of the flange conditioning tool to ensure no foreign materials from the conditioning process are present on the weld surface area of the canister WAI Section 6.1.3.4 [Section 7, WTP HLW Canister Lid Welding] [Section 0, WTP HLW Canister Lid Welding]
Canister Lid Welder Assembly (East). Canister Lid Welder Assembly (East) 24590-HLW-HC-HPH-WELD-00004, is WAI-Passive Section 6.1.3.2 [Section 7, WTP HLW Canister Lid Welding] [Section 0, WTP HLW Canister Lid Welding] [Section 6.2, WTP HLW Canister Lid Welding]

Canister Lid Welder Assembly (West). Canister Lid Welder Assembly (West) 24590-HLW-HC-HPH-WELD-00010 WAI - Passive Section 6.1.3.2 [Section 7, WTP HLW Canister Lid Welding] [Section 0, WTP HLW Canister Lid Welding]

Electrode. Electrode is WAI - Passive Section 6.1.3.2 [Section 7, WTP HLW Canister Lid Welding] [Section 6.1.3.2, WTP HLW Canister Lid Welding]

Flange Conditioning Tool. Flange Conditioning Tool 24590-HLW-FH-HPH-TOOL-00007 is WAI - Passive Section 6.1.3.4 [Section 7, WTP HLW Canister Lid Welding] [Section 0, WTP HLW Canister Lid Welding]

Shield Gas. Shield Gas is WAI - Passive: Section 6.2 [Section 7, WTP HLW Canister Lid Welding] [Section 6.2, WTP HLW Canister Lid Welding]

Cage Assembly. Cage Assembly is WAI - Passive - Parts of the cage that contact the canister during the welding process shall have smooth surface and not damage the canister beyond minor surface scratches. [Section 6.1.3.2, WTP HLW Canister Lid Welding]

Canister Clamp Assembly. Canister Clamp Assembly is WAI - Passive- Parts of the clamp assembly that contact the canister during the welding process shall have smooth surface and not damage the canister beyond minor surface scratches [Section 6.1.3.2, WTP HLW Canister Lid Welding]

Torch Assembly. Torch Assembly is WAI - Passive [Section 6.1.3.2, WTP HLW Canister Lid Welding]

Weld Machine Testing. WAI demonstration testing shall be performed to confirm that HLW canister lid welders (24590-HLW-HC-HPH-WELD-00004 and 24590-HLW-HC-HPH-WELD-00010) produce a weld that meets the WCP leak test requirements, confirm that the weld machine software correctly reports the values of the welding parameters and to confirm that the weld cap can be visually inspected using remote cameras. [Section 6.1.1, WTP HLW Canister Lid Welding]

Demonstrate Welding Machine Operability. Demonstrate in advance the final closure welding process on full scale canisters. Welds performed during this qualification program will be helium leak tested and will use the same welding methods to be used during production operations, such that confirmatory leak testing of production welds will not be required. The WQR will document the results of the WTP project weld qualification program and the canister welding procedure. This demonstration test is WAI. [Section 5.1, WTP HLW Canister Lid Welding]

Welding Range Parameters. Confirmation of the correct operation of weld machine components that are used to confirm welding parameters remained within allowable ranges. This demonstration test is WAI. [Section 6.1.1, WTP HLW Canister Lid Welding]

Visually Inspect Welds. Shall provide for visual inspection of the closure welds to augment weld parameter control as a means of assessing weld quality. The ability to visually resolve pores, cracks,
spatter marks, and incomplete fusion under production operation viewing conditions shall be
demonstrated before hot Commissioning. Demonstration shall confirm that the weld station cameras
(PTJ-XT-3103 and 3104) and lighting allow visual inspection of the weld. This demonstration test is
WAI. [Section 6.1.1, WTP HLW Canister Lid Welding][Section 5.1, WTP HLW Canister Lid Welding]

Maintenance of Welding Machines. Demonstrate the procedural processes for maintenance and
calibration of the welding machine WAI components. This demonstration test is WAI. [Section 7.9.3,
WTP HLW Canister Processing Activities][Section 6, WTP HLW Canister Lid Welding][Section 6, WTP
HLW Canister Lid Welding][Section 6, WTP HLW Canister Lid Welding][Section 6, WTP HLW
Canister Lid Welding][Section 6.1.3.2, WTP HLW Canister Lid Welding] [Section 6.1.1 [WTP HLW
Canister Lid Welding][WTP HLW Canister Lid Welding][Section 6.1.1, WTP HLW Canister Lid
Welding] [Section 6.1.2 [WTP HLW Canister Lid Welding]

The following welding parameters are considered WAI:

- **Shield Gas Flow Rate.** Parameter Measured: Shield gas flow rate; Welder Component Measuring
  the Parameter: Mass flow controller [Section 6.1.1, WTP HLW Canister Lid Welding]
- **High & low pulse current.** Parameter Measured: High & low pulse current; Welder Component
  Measuring the Parameter: Current transducer [Section 7.9.4.2, WTP HLW Canister Processing
  Activities][Section 6.1.1, WTP HLW Canister Lid Welding]
- **High & low pulse voltage** Parameter Measured: High & low pulse voltage; Welder Component
  Measuring the Parameter: Voltage Transducer [Section 6.1.1, WTP HLW Canister Lid Welding]
- **Weld Head Travel Speed.** Parameter Measured: Weld head travel speed; Welder Component
  Measuring the Parameter: Travel Speed Resolver & Resolver to Digital Converter [Section 6.1.1,
  WTP HLW Canister Lid Welding]
- **High Pulse Dwell Time.** Parameter Measured: High pulse dwell time; Welder Component
  Measuring the Parameter: Travel Speed Resolver & Resolver to Digital Converter [Section 6.1.1,
  WTP HLW Canister Lid Welding]

Weld Machine Software. The WAI welding parameters need to remain within allowable ranges to
ensure that the weld is performed correctly. Out-of-range parameters could indicate that the lid was not
properly welded and that the resulting CWF is non-conforming. As these parameters are used to confirm
weld compliance, the software associated with recording these parameters and software used to indicate
whether or not the weld was successful is WAI, and is designated as QAS (IHILW) in accordance with
Software Life Cycle Management, 24590-WTP-GPP-JT-008, Rev. 2, Section 3.3. [Section 6.1.1, WTP
HLW Canister Lid Welding][Section 6.1.1, WTP HLW Canister Lid Welding][WTP HLW Canister Lid
Welding]

4.5.1.2 Bogies

The following canister bogie sleeves are considered WAI:

- **Canister Bogie Sleeve.** 24590-HLW-MQ-HPH-TRLY-00006; Description: Canister Bogie Sleeve (East)
  Pour Tunnel 1. [Screening Form, WTP HLW Canister]
- **Canister Bogie Sleeve.** 24590-HLW-MQ-HPH-TRLY-00007; Description: Canister Bogie Sleeve
  (West) Pour Tunnel 1. [Screening Form, WTP HLW Canister]
- **Canister Bogie Sleeve.** 24590-HLW-MQ-HPH-TRLY-00012; Description: Canister Bogie Sleeve (East)
  Pour Tunnel 2 [Screening Form, WTP HLW Canister]
- **Canister Bogie Sleeve.** 24590-HLW-MQ-HPH-TRLY-00013; Description: Canister Bogie Sleeve
  (West) Pour Tunnel 2. [Screening Form, WTP HLW]
Handling Equipment Construction of Material. To minimize potential damage to a canister, the following passive WAI attributes shall be built into the design of bogie sleeves HPH-TRLY-00006, HPH-TRLY-00007, HPH-TRLY-00012, and HPH-TRLY-00013. Parts of the bogie sleeves that contact the canister shall be manufactured from materials that are compatible with 304L stainless steel. This means that materials contacting the 304L stainless steel canister will not adversely impact the mechanical properties of 304L stainless or reduce its corrosion resistance. The design of the bogie sleeves shall include passive, fixed guides whose function is to facilitate loading a canister into the bogie. To minimize the possibility of damage, the guides shall be profiled and have a smooth surface finish to reduce scratching to a minimum. [Section 8.2.6, WTP HLW Canister Handling]

4.5.1.3 Cranes

The following cranes are considered WAI:

- **Canister Handling Cave Crane.** 24590-HLW-MJ-HPH-CRN-00001; Description: Canister Handling Cave Crane [Screening Form, WTP HLW Canister Handling]
- **Canister Handling Cave Crane.** 24590-HLW-MJ-HPH-CRN-00002; Description: Canister Handling Cave Crane [Screening Form, WTP HLW Canister Handling]

Leakage of Oil & Hydraulic Fluid. WAI drip trays shall be located on the cranes to collect any oil leakage from gearboxes to prevent oil entering a canister. [Section 8.1.5, WTP HLW Canister Handling]

4.5.1.4 Racks

The following racks are considered WAI:

- **Canister Cooling Rack.** 24590-HLW-MH-HPH-MHAN-00014; Description: Canister Cooling Rack [Screening Form, WTP HLW Canister Handling]
- **Canister Buffer Rack.** 24590-HLW-MH-HPH-MHAN-00017; Description: Canister Buffer Rack. [Screening Form, WTP HLW Canister Handling]

Canister Guides. To minimize potential impacts to a canister, the following passive WAI design features shall be built into the design of the racks. The design of the equipment shall include passive, fixed guides whose function is to facilitate loading a canister into the racks and weld station table. To minimize the possibility of damage, the guides shall be profiled and have a smooth surface finish to reduce scratching to a minimum. [Section 9.3.2, WTP HLW Canister Handling]

4.5.1.5 Grapples

The following grapples are considered WAI:

- **Canister Grapple.** 24590-HLW-FH-HPH-TOOL-00001; Description: Canister Grapple [Screening Form, WTP HLW Canister Handling]
- **Canister Grapple.** 24590-HLW-FH-HPH-TOOL-00017; Description: Canister Grapple [Screening Form, WTP HLW Canister Handling]
- **Canister Grapple.** 24590-HLW-FH-HPH-TOOL-00018; Description: Canister Grapple [Screening Form, WTP HLW Canister Handling]
Grapple Design. The Producer shall design a grapple, suitable for use in loading and unloading a transportation cask with a standard HLW canister at the repository, which satisfies the following requirements: [Section 4.3, IHLW Waste Form Compliance Plan]

- The grapple shall be capable of being remotely engaged and disengaged from the flange.
- The grapple, when attached to a suitable hoist, and when engaged with the flange, shall be capable of raising and lowering a (standard) canistered waste form in a vertical direction.
- The grapple shall be capable of engaging and disengaging the canister flange within a right-circular cylindrical cavity with a maximum diameter of 62.5 cm.
- The grapple shall be designed to prevent an inadvertent release of a suspended (standard) canistered waste form when the grapple is engaged with the flange.

The Producer shall describe the grapple in the WCP and provide the designs in the WQR.

Grapple Analysis, Inspection, and Demonstration. The following activities shall be performed to comply with this specification. [Section 4.3, IHLW Waste Form Compliance Plan]

- Perform an analysis of the grapple design under expected load conditions with the 4.5 m canister.
- Confirm that the IHLW canister grapple conforms to the design and evaluate the capabilities and operability of the IHLW canister grapple during acceptance testing.
- Verify canister maximum weight is within the grapple load limits by direct measurement of the weight of test canisters and by calculation.
- Evaluate the capabilities and operability of the grapple with the actual IHLW canister system during cold commissioning of the HLW vitrification building. The grapple system will be subjected to tests such as grasping and lifting an IHLW canister and manipulating a filled (or weighted) canister as though loading and unloading a repository shipping canister.

Canister Grapple Performance. Demonstration testing to show the correct operation of the HLW canister grapple is designated as WAI. See section 8.3.6 of the screening form attachment. [Screening Form, WTP HLW Canister Handling]

- Reposition Canister Vertically. The grapple, when attached to a suitable hoist and when engaged with the flange, shall be capable of raising and lowering a (standard) canistered waste form in the vertical direction. [Section 8.3.5, WTP HLW Canister Handling]
- Remote Engagement and Disengagement. The grapple shall be capable of being remotely engaged with and remotely disengaged from the HLW canister flange. [Section 8.3.6, WTP HLW Canister Handling]
- Spatial Limits of Engagement and Disengagement. The grapple shall be capable of being engaged or disengaged while remaining within the projected diameter of the waste form canister. [Section 8.3.6, WTP HLW Canister Handling]
- Prevention of Inadvertent Release. The grapple shall include features that prevent inadvertent release of a suspended canistered waste form [Section 8.3.6, WTP HLW Canister Handling]

Alignment Guides for the Grapple. The design of the grapple shall include passive, fixed alignment guides that assist the operator in locating the grapple onto the canister lifting flange. To minimize the possibility of damage, the guides shall be profiled and have a smooth surface finish to reduce scratching to a minimum. [Section 8.3.8, WTP HLW Canister Handling]
Materials of Construction - Grapple. Parts of the grapple that contact the canister shall be manufactured from materials that are compatible with 304L stainless steel. [Section 8.3.8, WTP HLW Canister Handling]

Grapple Calculations. Grapple calculations supporting the design of the grapple are designated WAI. [Section 8.3.5, WTP HLW Canister Handling]

Canister transfers inside the HLW facility. All canister transfers inside the HLW facility (downstream of the WAI inspection prior to the admitting the canister into HLW) are designated a WAI activity. See section 11.1.3 of the screening form attachment. [Section 0, WTP HLW Canister Handling] [Section 11.1.1, WTP HLW Canister Handling] [Section 11.1.3, WTP HLW Canister Handling]

4.5.1.6 Miscellaneous Equipment

Temperature measuring instrumentation. Canister surface temperature shall be measured using contact temperature measuring instruments (24590-HLW-MH-HPH-MHAN-00023 and 00038). [Section 6.9.3, WTP HLW Canister Processing Activities]

The following equipment is considered WAI:

- **Glass Removal Tool.** WAI - Passive 24590-HLW-FH-HPH-TOOL-00005; Description: Glass removal tool [Section 2.3.2, WTP HLW Canister Processing Activities]
- **Cleaning Tool.** WAI - Passive 24590-HLW-FH-HPH-TOOL-00003; Description: Canister flange cleaning tool [Section 2.3.2, WTP HLW Canister Processing Activities]

Materials of Construction. The following requirement applies to all of the above equipment; Parts of the tools that contact the canister shall be manufactured from materials that are compatible with 304L stainless steel. [Section 7.8.5, 7.10.5, WTP HLW Canister Processing Activities]

Equipment to measure the glass fill height. Equipment to measure the glass fill height shall be provided at the weld station in the canister handling cave. The glass fill height shall be measured using a glass level indicator, non WAI, (24590-HLW-MH-HPH-MHAN-00022 and 00037) that shall measure from the top of the canister to the glass surface. Glass fill height measurement post-fill at the weld station is a WAI activity. [Section 6.5.5, WTP HLW Canister Processing Activities] [Section 6.5.7, WTP HLW Canister Processing Activities] [WTP HLW Canister Processing Activities] [Section 6.5.6, WTP HLW Canister Processing Activities]

Exclusion of Foreign Materials in Canister Handling Areas. Operational procedures will control and limit the use of excluded materials in canister handling areas. The procedures are WAI. [Section 11.6, WTP HLW Canister Processing Activities]

Foreign Materials. Analysis will be performed to confirm that there is no pathway for foreign materials to enter the canister prior to closure. This analysis is WAI. [Section 11.7, WTP HLW Canister Processing Activities]
5 Reserved

6 Description

Section 6.1 contains a general description of the rooms that are part of the HPH system and a brief overview of the process operations taking place in each area. A detailed description of each piece of equipment is contained in Sections 6.2 through 6.6, while Section 7 contains a more detailed description of system process.

6.1 System HPH Layout and Overview

The HPH system equipment is located in the following 7 areas:

- Canister handling cave (room H-0136 C5/R5)
- Canister handling cave crane decontamination area (room H-0329 C3/C5/R3/R4/R5)
- Canister handling cave crane maintenance area (room H-0329A C3/R3)
- Pour tunnels 1 and 2 (rooms H-B032 and H-B005A C5/R5)
- Pour tunnels 1 and 2 bogie maintenance areas (rooms H-B044A and H-B050A C3/R3)

The above areas have contamination and radiation classifications based on anticipated contamination radiation levels. Glass filled open topped canisters will be handled in the pour tunnels and in the canister handling cave. Consequently high radiation doses and high contamination levels will be present in these areas, and equipment such as cranes and bogies operating in these areas will become contaminated during operations. This contamination could be transferred to the decontamination and maintenance areas when the cranes and bogies withdrawn from the C5/R5 areas for maintenance purposes. [4.3.1, 4.3.50]

Refer to the system mechanical handling drawings 24590-HLW-M7-HPH-00001001 through 1007 and equipment location drawings 24590-HLW-P1-P23T-00009, 00010, 00014, 00015, 00119 and 000120, 24590-HLW-P1-P23T-00213 through 214, 24590-HLW-P1-P23T-00218 through 220 for the general layout and arrangement of the primary pieces of equipment.

Non-maintainable equipment such as crane rails, bogie rails, weld station table and canister storage racks have been designed following nationally recognized structural standards for a 40 year life. There are no planned maintenance activities associated with these items. [4.3.10]

The HPH system is required to support a production rate of up to 7.5 metric tonnes glass/day (MTG/day) (24590-WTP-DB-ENG-01-001 Basis of Design, Section 6.3.3) which equates to a through put of 2.4 canisters per day based on 3.1 MTG/canister. To reach 7.5 MTG/day both melters must be running, and complete a glass pour in approximately 20 hours. Consequently, two canisters must be exported from the HPH system to the HDH system every 20 hours. The steps included in the 20 hour frame include removing the canister from the pour tunnel, measuring glass fill height, taking a glass sample (as required), the canister flange cooling to below 350°F, welding the lid and transferring the canister to the buffer store rack where it will cool until the surface temperature falls below 212°F.

It should be noted that the design capacity of the current melters is required to be 6 MTG/day, the increased production of 7.5MTG/day will be achieved with replacement second generation melters.
6.1.1 Canister Handling Cave (H-0136)

The radiation dose rate at a distance of 12 inches from a glass filled canister could be as high as 584 R/hr depending on the waste type (reference 24590-HLW-Z0C-30-00011). Consequently, to comply with ALARA requirements, all canister process operations taking place in the HPH system are performed remotely in order to protect personnel from the high radiation fields inside the C5/R5 canister handling cave. All handling operations in the canister handling cave are controlled remotely via Integrated Control Network (ICN) local operator interface (LOI) panels. [4.3.12]

The HLW canister is fabricated from stainless steel and is approximately 14’ 7” tall with an external diameter of 24”, and when filled with immobilized high level waste will weigh approximately 9000 lbs. The canister lid is welded to the body. An empty canister weighs approximately 1500 lbs. The canister is depicted in Figure 6-1. In order to meet repository requirements, the maximum glass filled canister weight is 9260 lbs.

![Figure 6-1 HLW Canister](image)

Empty canisters are imported into the C5/R5 canister handling cave from the C3/R3 canister import tunnel (part of the HRH system), and are then transferred to the canister buffer rack, or they maybe directly loaded into a pour tunnel bogie. The bogie then moves to the north end of the pour tunnel locating the empty canister below the melter pour spout. On completion of the glass fill and after cooling for a pre-determined period in the pour tunnel, the glass filled canister is removed from the pour tunnel bogie and transferred to the canister storage rack. The canister is then transferred to the welding station where the glass fill height is measured and, if required, a glass sample will be collected. The lid will then be welded onto the canister and, after confirmation of weld integrity, the glass filled canister will be transferred to the C3/C5/R3/R5 canister rinse tunnel, H-B039B (part of the HDH system). To prevent steam flash occurring in the canister rinse vessel (part of the HDH system), the surface temperature of the canister must be below 212 °F before it is transferred to the rinse vessel.

Shielded equipment access hatches inside the canister handling cave form the physical boundaries between the HPH and HRH, and HPH and HDH systems. Contamination control is maintained by cascading air from areas of low contamination potential to areas of higher contamination potential via engineered air gaps incorporated into the hatch designs. [4.3.52]

Inside the canister handling cave the primary canister processing operations take place at one of two duplicate welding stations located along the south wall of the cave. Each weld station is equipped with a canister lid welder mounted on movable weld station carriage, cameras for weld inspection, and equipment used to measure glass fill height, collect glass samples and place lids onto the HLW canister. To support welding operations each weld station is also equipped with a pair of MSM’s, a shield window and through-wall joggle penetrations housing compressed gas lines, power and control cables for the various pieces of weld station equipment. [4.3.12, 4.3.16]
The canister handling cave equipment also includes two 6 ton overhead cranes, canister grapples, canister storage racks, hatches to permit canister transfer to the pour tunnels and to systems HRH/HDH. A posting port is located adjacent to the weld table to allow canister lids, welding electrodes and small tools/equipment to be imported into the handling cave. The posting port, and its associated glove box, also support monitoring of swabs. [4.3.12, 4.3.25]

Solid waste generated in the HPH system will typically consist of welding electrodes, replacement switches and cables. The waste is placed in a disposal basket located at the weld station and transferred via the pour tunnels to the HSH system. From there the waste is transferred to the HLW Radioactive Solid Waste Handling (RWH) system. [4.3.9]

Glass samples will be collected on an as required basis at the weld station. Glass shards will be placed into a 25 ml collection bottle that will then be transferred to the crane decontamination area and placed in a shielded flask. The flask will then be exported to the Analytical Laboratory where analysis of the glass sample will be completed. To prevent the flask becoming highly contaminated it is not taken into the canister handling cave. [4.3.25]

Gas supplies for the welder are supplied from an out-cave gas bottle station located along the south wall of corridor HC0209 opposite the weld station shield windows. A process air manifold supplying compressed air to the weld station is also located on the same wall. Check valves fitted in the pipe work to prevent back flow from the canister handling cave. [4.3.2, 4.3.13]

The main walls of the canister handling cave have a partial epoxy finish, the floor and immediate areas surrounding the storage and buffer racks are clad in stainless steel. No finish coating is applied to metal deck ceiling.

Sumps are installed in the -3’0 elevation floor immediately below the storage and buffer racks. The sumps are part of the HLW Radioactive Liquid Waste Disposal system (RLD).

Closed circuit television cameras (CCTV) are located at the weld station to assist remote operations on the welder and are also fitted onto the two process cranes. Wall mounted lights are installed at various intervals along the north and south walls of the cave. [4.3.12]

The canister handling cave is permitted (Dangerous Waste Permit) as a Containment Building and also as a secondary containment area for ancillary equipment (piping) located in this room.

6.1.2 Crane Decontamination and Crane Maintenance Areas (H-0329 & H-0329A)

The crane decontamination (C3/C5/R3/R4/R5) area and crane maintenance (C3/R3) area are located at the western end of the canister handling cave. The crane maintenance area contains platforms to facilitate inspection and servicing of the process cranes and the maintenance crane. [4.3.19, 4.3.32, 4.3.35, 4.3.44, 4.3.46]

To comply with ALARA, shield doors are located between the canister handling cave and crane decontamination area, and between the crane decontamination and maintenance areas. To promote contamination control, ventilation air is cascaded via door engineered air gaps from the maintenance area to the decontamination area, and from the decontamination area to the C5/R5 canister handling cave. [4.3.50, 4.3.52]
Equipment contained in the decontamination area includes a pair of MSM’s, shield window, and a CCTV camera. Joggle plug penetrations located adjacent to the window allow services (for example, compressed air or water) to be piped into the decontamination area as required. The area has an epoxy finish on the floor, and a partial epoxy finish on the walls. A sump and associated pipe work, part of the RLD system, is installed in the south-east corner of the room. [4.3.7, 4.3.8, 4.3.16, 4.3.56]

The decontamination area will be used for decontaminating equipment (if required) prior to in-cave items being transferred to the maintenance area. The decontamination area is also used for placing glass shard samples into a shielded transport flask that is then exported from system HPH via the crane maintenance area before being transferred to the Analytical Laboratory for analysis. To support ALARA, a through wall gamma monitor (RS-1001) will be used to confirm that radiation field is low enough to allow personnel entry into the area in order to torque the bolts fixing the lid onto the shielded transport cask. [4.3.35, ALARA]

The crane maintenance area (CMA) houses a maintenance crane, crane maintenance platforms, crane cable reels that supply power and control signals to the two 6 ton over head system process cranes, a CCTV camera, and a continuous air monitor. An access plug is built into the floor of the CMA that allows large pieces of equipment to be imported/exported to/from the system. Personnel access into the area is via a shielded personnel access door (SPAD) located at the 37’ elevation. The area has an epoxy finish on the floor, and a partial epoxy finish on the walls. [4.3.7]

6.1.3 Pour Tunnels (H-B032 & H-B005A)

The HPH system contains two identical C5/R5 pour tunnels running in the north-south direction below the canister handling cave. Canisters are transferred into the pour tunnels from the canister handling cave via hatches and lowered onto bogies that then travel northwards to locate the empty canisters below the melter glass pour spout. One pour tunnel, containing two bogies, is dedicated to each melter. The glass pour takes approximately 20 hours to complete, if both pour tunnels are operational this equates to a production rate of 7.5 MTG/day. On completion of the glass pour and having cooled for a pre-determined period in the pour tunnel, the filled canisters are transferred back to canister handling cave and placed in the canister storage rack to cool. All handling operations in the pour tunnel are controlled remotely via ICN local operator interface panels. [4.3.12]

Each pour tunnel has a bogie decontamination station consisting of a shield window, lights, master slave manipulators (MSM’s), through-wall service penetrations and a decontamination lance. Decontamination will be performed prior to transferring a bogie into the bogie maintenance area. [4.3.6, 4.3.12, 4.3.18, ]

Through wall cameras and lights are located to allow remote viewing of the glass pour location, and also to permit viewing of the canister/bogie loading interface.

Thermal imaging cameras (HMP-LE-0816, 0820, 2816 and 2820) are located adjacent to the pour tunnel shield windows. The cameras provide the operators with a visual indication of the glass level in the canister.

To maintain the required airflow rate from the pour tunnels into the melter caves, the removable panels that form the physical boundary between the areas are designed to provide a minimum opening of 5.3 ft². The panels are part of the HSH system. [4.3.51]

The pour tunnels are permitted (Dangerous Waste Permit) as Containment Buildings. Pour tunnel 1 is also permitted as secondary containment for ancillary equipment (piping) located in this room.
Compliance with the DWP requires the floor, walls and ceiling of the pour tunnels to be clad in stainless steel. The floor is sloped to direct any decontamination liquids to a sump that is part of the RLD system. Insulation is fitted below the cladding to protect the concrete from the high thermal loading inside the tunnels.

6.1.4 Pour Tunnel Bogie Maintenance Areas (H-B044A & H-B050A)

Bogie maintenance areas (BMA) are located at the south end of each pour tunnel and provide a dedicated maintenance area for the pour tunnel bogies. To comply with ALARA, shield doors are located between each BMA and the C5/R5 pour tunnels. To control the spread of contamination the doors are provided with engineered air gaps that allow ventilation air to be cascaded from the maintenance areas into the pour tunnels. [4.3.19, 4.3.35, 4.3.50, 4.3.52]

The motive force for the bogies is supplied using a “push-pull” chains that are driven from the bogie maintenance area. The chains are wound and unwound from a cartridge in the BMA. For redundancy purposes, each bogie is fitted with two chains.

Each maintenance area contains shield windows, plugged 10.5” liners that may in the future be fitted with MSMs, joggled through-wall service penetrations, CCTV cameras, a continuous air monitor and a gamma area radiation monitor. A plug is located in the roof of the maintenance areas to allow removal of the bogie or “push-pull” chain cartridge should they have to be replaced. Each maintenance area is accessed through a SPAD. The area has an epoxy finish on the floor, and a partial epoxy finish on the walls [4.3.7, 4.3.16, 4.3.19].

6.2 Canister Handling Cave Equipment

6.2.1 Canister Handling Cave Cranes

The canister handling cave contains two 6 ton capacity overhead process cranes (24590-HLW-MJ-CRN-00001 and 24590-HLW-MJ-HPH-CRN-00002) operating on a duty/standby principle, that are used to transport canisters between various work stations, see Figure 6-2. Since the lower crane (24590-HLW-MJ-CRN-00001) has a shorter span, and is not able is not able to access the southern most buffer rack canister storage positions, the lower crane is designated as the standby unit. [4.3.33]
Both cranes (non-safety) are classified as seismic category II, the seismic safety function being that they must remain on the rails during and after a seismic event. There is no requirement for the cranes to be operable post-seismic.

Both cranes have a passive waste acceptance impacting (WAI) requirement that is met by installing drip trays (or using other design features as appropriate) to reduce the potential for organics to enter an unlidded canister. The sources of organics are the gearboxes and the hydraulically operated crane recovery system.

Power and control signals are fed to the cranes via cable reeling systems, one for each crane, that are located against the south wall of the crane maintenance area. To facilitate maintenance, the cable reel is powered by a through-wall shaft, the reel drive motor and slip-ring electrical and control connections being located in the adjacent C2/R2 corridor. A series of rollers fixed to the crane support steel work support the cable between the cable reel and the crane. There is no on-board logic, all power and control cables are routed to the crane control panel. The cranes would normally be controlled from Integrated Control Network (ICN) local operator interface (LOI) panels HPH-PNL-00013/00009 located in corridor HC0209, or from HPH-PNL-00008 located in corridor HC0208. All crane movements are initiated by the operator, there no automatic ICN control sequences associated with the cranes. [4.3.13, 4.3.22 ,4.3.54]

To prevent equipment damage an ICN interlock inhibits crane movement across the decontamination and maintenance shield door thresholds unless the crane trolley is aligned with the horizontal shield door opening, and the crane hook is raised. An anti-collision device prevents the lower crane colliding with a load being transported by the upper crane. The device consists of a trigger arm mounted on the upper crane that cuts power to the cranes if it contacts a target mounted on the lower crane. The ICN also uses a
series of fixed targets and crane mounted proximity switches to reduce bridge and trolley speed as ends-of-travel and shield door positions are approached.

Each crane is fitted with a powered rotating hook. Lights and cameras are fitted to the main gantry beams and trolleys to provide the crane operator with remote viewing capability. The cameras have pan/tilt and zoom capability. [4.3.53]

Recovery drives are fitted to the cranes to enable them to be retrieved from the C5/R5 canister handling cave in the event that the primary drives fail. Recovery drives are fitted to the hoist, trolley cross travel and bridge long travel functions. The trolley and bridge recovery wheel units are mounted on an eccentric cam and are deployed (rotated about the eccentric) hydraulically via the ICN. The recovery wheel drive motors are mounted to the crane bridge and are connected to the wheel units by universal couplings. In addition, the cranes may be winched back into the crane maintenance area using the cable reels. [4.3.26, 4.3.27, 4.3.28, 4.3.36, 4.3.37, 4.3.45]

Engineering Specification 24590-HLW-3PS-MJKG-T0003 contains the technical requirements for the cranes.

6.2.2 Grapple

The canister grapple (24590-HLW-FN-HPH-TOOL-00001, 24590-HLW-FN-HPH-TOOL-00017 and 24590-HLW-FN-HPH-TOOL-00018), see Figure 6-3, is three-jaw lifting device designed to engage the underside of the canister flange. The jaws are opened and closed mechanically by a combination of linkages, slides and a rotating ratchet assembly. The mechanism is actuated by a plate that contacts the canister flange as the grapple is lowered onto the top of the canister, causing the jaws to close. To retract the jaws, the weight of the canister has to be removed from the grapple twice before the jaws will retract and release the canister. This two “set-down” arrangement is designed to prevent inadvertent release of the canister should the canister be lowered onto an obstruction. A position indicator is provided on top of the grapple to show the operator where the grapple is in the “set-down” sequence. [4.3.11, 4.3.12]

An MSM operated override is provided to release the grapple from a canister should the sequencing mechanism fail to retract the jaws. The weld station MSM’s would be used to actuate the override. The grapple has a rated lifting capacity of 10,000 lbs.

The grapples have both passive and performance WA1 requirements. The passive requirement is met by fabricating the grapple from stainless steel and by using guides and smoothly profiled surfaces to minimize any potential damage to the canister during normal operations. To meet the WA1 performance requirements will be demonstrated by confirm the grapple can remotely engage and disengage the canister, and by confirming the correct operation of the two “set-down” design described above.

Three grapples are provided; one dedicated to each of the 6 ton process cranes, and one spare.

Engineering Specification 24590-WTP-3PS-MQL0-T0003 contains the technical requirements for the grapple.
Figure 6-3  HLW Canister Grapple
6.2.3 Canister Cooling Rack

The purpose of the canister cooling rack (24590-HLW-MIH-MIIAN-00014), see Figure 6-4, is to store hot glass filled canisters until they cool sufficiently to be transferred to the welding station. The rack is manufactured from stainless steel and is designed to store 24 glass filled canisters, each weighing a maximum of 9260 lbs. The canisters are stored in the northern side of the rack, the southern side of the rack structural steelwork is used to support the weld table. The rack is designed in two sections; the top section supports the canister laterally, the bottom section supports the canister weight and prevents lateral movement of the canister base. The upper and lower sections are not connected to each other. Due to the time taken to complete the glass pour (approximately 20 hours at 7.5 MTG/day), the canister surface temperature will be higher at the top than the bottom at the end of the glass pour. The rack is designed for a canister base temperature of 350 °F, and a top temperature of 700 °F. In order to protect the rack and concrete from thermal impacts, glass filled canisters are required to cool in the pour tunnel prior to being transferred into the canister handling cave. A Safety Significant interlock ensures that the canister has cooled sufficiently in the pour tunnel prior to being transferred to the racks, see Section 6.4.1.

The rack is classified as Safety Significant and seismic category II, its safety function is to remain upright during and after a seismic event in order to prevent multiple canisters from falling and impacting the C5 boundary (walls and floors of the canister handling cave). The rack is credited with maintaining structural integrity during normal operations that will expose the rack steelwork to fluctuating temperatures. The rack is also classified as WAI (passive). WAI compliance requires features (for example, smooth surfaces, canister guides) to be built into the rack design that will act to minimize any potential damage to the canister during normal operations.

There are no scheduled or routine maintenance requirements for the rack. However, to the extent possible, rack components that are not fixed to embed plates are designed to be remotely removable using the process cranes.

Engineering Specification 24590-HLW-3PS-30-T0001 contains the technical requirements for the racks.
6.2.4  Canister Buffer Rack

The purpose of the canister buffer rack (24590-HLW-MH-HPH-MHAN-00017), Figure 6-5, is to store lidded canisters prior to them being transferred to the HDH system. The rack has a capacity of 24 canisters and is designed to the same temperature, seismic, safety and WAI criteria as the cooling rack. The rack may also be used as a storage area for empty canisters.
6.2.5 Pour Tunnel Hatches

The pour tunnel hatches (24590-HLW-AD-HPH-HTCH-00001 and 00002), see Figure 6-6 are located on the boundary between the canister handling cave and the pour tunnels. To improve reliability and maintainability the hatch design is simplified to the extent possible. The hatches run on rails and are opened and closed by through-wall drives with the motors and position instrumentation located in the adjacent C2/R2 corridor. The hatch wheel modules are factory lubed, sealed-for-life components. The hatch is driven by a simple rack and pinion mechanism. A rack, attached to the underside of each hatch, runs on top of a pinion gear that is part of the through wall drive. Each hatch has a lifting bail that maybe used to transfer the hatch to the decontamination and maintenance areas if required, however, there are no planned maintenance activities for the hatch in-cave components. [4.3.11, 4.3.13, 4.3.14, 4.3.22]

The hatches are remotely controlled by ICN LOI panels HPH-PNL-00013/00009/00008. The pour tunnel transfer hatches are not required to provide radiological shielding.
Figure 6-6  Pour Tunnel Hatch

Provision for a manual override hand wheel is incorporated into the drive train design. The manual override enables personnel to manually operate the hatches through their entire range of motion from the adjacent corridor. A removable cover over the hand wheel and shaft assembly incorporates a motor cut-off switch that disables the hatch drive motor as it is removed. [ALARA]

Engineering Specification 24590-WTP-3PS-ADDC-T0002 contains the technical requirements for the hatches.

6.2.6  Weld Station Table

The weld station table (24590-HLW-MZ-HPH-BENCH-00004), see Figure 6-7, serves as a remote work area for the equipment required to measure glass fill height, collect glass samples, and complete canister lid welding and follow up weld inspection. The weld table is split into three section; the east and west sections support the east and west welding machines, while the center section interfaces with the weld station posting port and provides an area for tool storage. The weld station table is fabricated from stainless steel and is supported on the south side of the canister cooling rack steelwork. To facilitate maintenance requirements the table is modular in design, allowing each section to be lifted directly from the rack and transported into the decontamination and crane maintenance areas using the process cranes. However, there is no planned maintenance for the weld station table; its design life is 40 years. To
support remote welding operations, the east and west sections are located directly in front of a shield window and a pair of MSMS. Three through-wall cameras (PTJ-XT-3036, 3037 and 3038) provide remote viewing capability for the weld station. [4.3.10, 4.3.12]

Figure 6-7   Weld Station Table
(Plan view)

The east and west sections of the weld table are fitted with channel section rails in which the welding machine carriage runs, fixtures for managing the routing of through-wall power and controls cables, a recessed tool storage area, and a canister welding location. The center section contains two recessed storage areas, one of which houses a vacuum unit and one that houses a waste basket used to collect and export solid waste, for example spent welder torch blocks. The maximum capacity of the solid waste storage recess is 1000 lbs. A removable cover plate, designed to support a weight of 500 lbs, is provided for each location. In addition, the center section has a single canister storage position that would typically only be used to quarantine a canister if the lid weld failed inspection.

The weld table has a passive WAI function that is met by fabricating the table from stainless steel and by using guides and smoothly profiled surfaces to minimize any potential damage to the canister during normal operations.
Various miscellaneous tools will also be stored on the weld station table, these include a pneumatic needle gun and an electric or pneumatic wire brush that will be used to remove any glass that has adhered to the external surface of the canister.

Engineering Specification 24590-HLW-3PS-NW00-T0001 contains the technical requirements for the weld station.

6.2.7 Glass Level Detector

The glass level detectors (HPH-MHAN-00023 and 00038) are measuring rods used to measure the distance from the top of the canister flange to the glass surface. To comply with contractual requirements the average canister fill height must correspond to a fill volume of at least 95%; the minimum allowable fill volume is 87%. At 95% full, the glass level is approximately 12.1” below the top surface of the canister flange; an 87% fill volume equates to approximately 25.9” (refer to calculation 24590-HLW-M0C-30-00003). The level detector is handled using MSMs and when not in use is stored on the weld station table. The 100% fill level is at the weld between the top head and neck flange, a distance of approximately 2.25” below the top surface of the canister flange. Two glass level detectors are supplied, one for each weld station.

Engineering Specification 24590-HLW-3PS-NW00-T0001 contains the technical requirements for the glass level detectors.

![Glass Level Detector](image)

**Figure 6-8** Glass Level Detector
6.2.8 Glass Shard Sampling Equipment

Glass shard sampling equipment consists of a vacuum pick up tool, a shard sample tray and a consumable glass sample vial.

The vacuum pick up tools (24590-HLW-JA-HPH-SMPLR-00001 and 00003), see Figure 6-9, are compressed air driven eductor-type devices. The tools are designed to be operated using the weld station MSM’s. To collect glass shards the nozzle is inserted into the top of the canister and the three-way valve is opened to allow airflow to the eductor. The airflow creates a vacuum and causes glass shards to collect on a screen inside the nozzle. The glass shards are released from the nozzle and deposited into the sample tray by shutting off the airflow to the eductor. Glass shards will be generated as the glass cools and cracks, alternatively the nozzle maybe be used to create shards by chipping at the glass surface.

Two pick-up tools are provided, one at each weld station. The tools have an MSM compatible quick disconnect coupling that is connected to a compressed air line fed through-wall at the weld station. When not in use the tools are stored on the weld station carriages. In addition to extracting glass shards, the vacuum pickup assembly may be used to determine the glass level within the canister using a scale attached to the side of the tool.

Figure 6-9 Shard Sample Vacuum Pick-up Assembly

The shard sample vial tray (24590-HLW-JA-HPH-SMPLR-00002 and 00004) is used to place glass shards released from the eductor nozzle into sample vials. Up to three sample vials are placed into the tray and the hinged funnel assembly is then placed on top of the vials. The glass shards collected in the eductor nozzle are released into one of the funnels and drop into the sample vial below.
The stainless steel sample trays are designed for remote handling and operation using MSMs. A tether chain is attached to the assembly to prevent it from being dropped to the cave floor. When not in use, it is placed in a storage position on the weld station table. When in use, it is placed on the canister and supported by the canister flange. The tray weighs approximately 12 lbs.

Figure 6-10  Sample Vial Tray

The sample vials are sized and shaped to permit remote handling by MSMs. All samples are collected in the same type of vial. The sample vials are clear glass and capable of being sealed. The sample vials are approximately 1” diameter by 2.5” long and have a capacity of approximately 25 ml.

Sample vials containing the glass samples will be placed inside a sample vial sleeve at the weld station. An MSM will be used to place the lid on the sleeve, and the sleeve will then be transferred by one of the canister handling cave cranes to the crane decontamination area. Al tray hung from the crane hook will be required to transport the sleeve. The sample vial sleeve will then be removed from the tray and placed inside a shielded transfer flask (24590-HLW-HPH-00001), see the sectional view Figure 6-11. The crane will then be used to place the shielded lid onto the flask. The lid bolts will be secured manually, and the flask will then be transported to the Analytical Laboratory for analysis. The sample vial sleeve is a removable internal component that is part of the flask. The flask is 12” high (excluding the lifting bail), 10” in diameter and approximately weighs 400 lbs. The flask is sized to contain only 1 sample vial. To support ALARA the flask is not taken into the canister handling cave; this minimizes the potential for contaminating the outside surface of the flask. [4.3.25]

The flask will be transported manually to the Analytical Laboratory. It will be transferred out the HPH system via the hatch located in the floor of the crane maintenance area, and then lowered onto a transport cart. The flask shielding will protect personnel as the flask is transported to the Laboratory. [ALARA]
Figure 6-11  Glass Shard Sample Transfer Flask

Engineering Specifications 24590-HLW-3PS-NW00-T0001 and 24590-HLW-3PS-MQ00-T0001 contain the technical requirements for the glass shard sampling equipment.

6.2.9  Weld Station Carriage

The function of the weld station carriage (24590-HLW-HC-WELD-00005 and 24590-HLW-HC-HPH-WELD-00009), see Figures 6-12 and 6-13, is to position the welding machine onto the canister flange so that the canister closure weld may be completed. There are two weld station carriages, one serving the east weld station and one serving the west. The carriages run on rails mounted onto the weld station table. A rack is installed between the rails that interfaces with a motor driven pinion gear mounted onto the carriage, and provides the motive force to move the carriage between its park and weld positions. The welding machine is mounted to the carriage via a linear actuator that lowers the welder onto the canister, and raises the welder on completion of the lid weld.

The weld carriage movements are ICN controlled via local operator panels HPH-PNL-00013 and HPH-PNL-00009, both panels are located in corridor HC0209, adjacent to the weld station shield windows. To prevent equipment damage, the ICN inhibits movement of the weld carriage unless the vertical actuator is in the raised position. Lowering of the actuator is inhibited unless the carriage is at the weld position and the welder clamps are in the open position. Raising the actuator is inhibited unless the welder clamps are open, weld in progress signal is not-present, and the welder ready to lift signal is present. The welder clamp open and weld in progress signals are generated by instrumentation associated with the welding machine.
Power and control signal cables for the weld station are routed through joggles in the canister handling cave south wall adjacent to the weld station MSM’s and shield windows, see Figure 6-7. The cables are then routed along the top of the weld station table and onto a cable track before being terminated on the weld carriage. [4.3.56]

To facilitate in-cave maintenance, components that are likely to fail, including the carriage motor, linear actuator, proximity switches and all cabling, are designed to be remotely replaceable using the weld station MSMs. The modular design approach allows maintenance to be performed without having to transfer the welding carriage out of the canister handling cave. However, the design does permit the entire weld carriage to be removed from the weld station if required. The carriage unit, welder support fixings and the linear actuator slide are fitted with lifting bails to allow each major component to be removed from the weld station using the process cranes. All cabling is terminated using MSM compatible connectors. The design also incorporates MSM compatible fasteners and alignment to facilitate remote maintenance. [4.3.12, 4.3.14, 4.3.16, 4.3.19, 4.3.20, 4.3.24, 4.3.26, 4.3.27, 4.3.28, 4.3.33, 4.3.55]
Engineering Specification 24590-HLW-3PS-NW00-T0001 contains the technical requirements for the welding station.

### 6.2.10 Canister Lid Welder

The HLW canister lid welding machines welds a primary and secondary lid onto the canister. The primary lid consists of a flat circular plate that locates into a grooved recess machined into the canister top flange, the secondary lid, slightly larger in diameter than the primary lid, is only fitted to the canister if the primary lid weld fails inspection and cannot be repaired.

Two welding machines (24590-HLW-HC-HPH-WELD-00004 and 00010) are provided, one for the east weld station and one for the west. The welder is shown in Figure 6-14. The welding machine is attached via cables to the weld carriage linear actuator, the cables allow for slight mis-alignment between the canister and the carriage weld positions. The use of the cables avoids the need for additional powered actuators/drivers to align the welder with the canister flange. The weld machine is fitted with guides to center the machine on top of the canister, final positioning is accomplished using a clamp that is closed/opened using the weld station MSMS. The MSM operated clamp simplifies the design. [4.3.11, 4.3.16]

The primary weld is completed using an autogenous gas tungsten arc welding process. An autogenous weld process is one that does not require filler wire. The primary lid is placed onto the canister flange using the weld station MSMSs and the lid lifter (see section 6.2.12). The weld machine then tack welds the lid to the canister in several locations prior to completing a single pass to complete the weld. The weld is deemed acceptable if the welding parameters remained within their allowable ranges and if the weld passes a visual surface inspection. The surface inspection is carried out using the weld station cameras (see section 6.2.11). To prevent thermal distortion of the lid during the tack welding process a lid weight
(15 pounds) is placed on top of the lid prior to lowering the welder on to the canister flange. The weight is designed to be handled by the weld station MSMs.

The values of the welding parameters are reported by the welder control system. If the initial primary weld fails inspection then a secondary re-melt welding pass would be completed, if this second weld failed inspection then a number options would be considered. These include 'spot' repair of the failed weld areas, or fitting a secondary lid. The machine has the capability of performing the 'spot' repair autogenously, or alternatively the wire feed mechanism maybe fitted to the welder and used to complete any necessary repairs. The wire feed mechanism may also be used to perform a full cap pass.

The option of fitting a secondary lid would usually only be selected after exhausting all possible primary weld repair options. The secondary lid fits over the primary lid and requires a groove to be machined into the top of the canister flange. The flange conditioning tool (see section 6.2.16) is used to machine the flange. A secondary lid would then be placed into the machined groove using the weld station MSMs and lid lifter. The weld machine would then tack the secondary lid in place before completing an autogenous root pass followed by a wire feed cap pass. As with the primary weld, repair options for the secondary lid weld include an autogenous re-melt and using filler wire to perform 'spot' repairs or a complete cap pass.

The weld machine is controlled by vendor supplied control panels (24590-HLW-JC-HPH-PNL-00004 and 24590-HLW-JC-HPH-PNL-00018) that are located adjacent to the weld station shield windows. The ICN does not control the weld machine, but to prevent equipment damage an ICN interlock inhibits the
weld carriage actuator raising/lowering the welding machine unless the weld machine clamps are in the open position. The clamps are used to secure the welding machine to the canister and also act as an electrical ground. The welding parameters for each welding process are pre-programmed into the welder control system, a different set of parameters is used depending on the weld to be performed. The values of the welding parameters will be exported from the vendor data collection system and sent to the ICN.

Power and control signals are fed to the welder through joggles in the canister handling cave south wall adjacent to the weld station MSM's and shield windows, see Figure 6-7. The cables are then routed along the top of the weld station table and onto cable track before being terminated on the welding machine. The control of the welding machine, set-up steps required to perform each weld type, equipment recovery, and calibration requirements, are documented in 24590-CM-POA-HCHH-00004-12-00001 Operating Instructions for Bechtel HLW Canister Welding System and 24590-CM-POA-HCHH-00004-03-00005 Maintenance Manual for Bechtel HLW Canister Welding System. The automated software controlling the welding processes is documented in 24590-CM-POA-HCHH-00004-03-00004 Software Documentation for Bechtel HLW Canister Welding System. [4.3.56]

An argon/helium shield gas is used to prevent atmospheric contamination of the weld. The shield gas is supplied from bottle stations and is piped to the welder control panels; from the panels the gas is piped through a wall joggle to the welder. The bottle stations (24590-HLW-MHAN-HPH-MHAN-00004 and 24590-HLW-MHAN-HPH-MHAN-00035) are located on the south side of corridor HC0209. A compressed air supply is also piped to each welder to provide cooling for a camera (PTJ-XT-3119 and PTJ-XT-3120) that are used to monitor the weld process when filler wire is used. These cameras would not normally be installed, except when filler wire weld process is to be used. Both the shield gas lines and compressed air lines are fitted with non-return valves to prevent back-flow. [4.3.2, 4.3.56]

The welding machines are designed to be maintained remotely using the weld station MSMS. The weld machine is assembled using MSM compatible fasteners in a modular fashion allowing the drive motors, arc voltage control assembly, torch assembly, wire feed assembly, camera assembly and proximity switches to be replaced in-cave using the MSMS. The wire feed mechanism will only be used if the autogenous weld cap fails visual inspection; this is a not a normal event.

Cabling and gas supplies are terminated onto the welder with MSM compatible quick release couplings located on top of the welder for ease of access. If the welder cannot be remotely repaired it can be removed from the cave as a unit by disconnecting the cabling and gas supplies and disconnecting the welder and actuator as a unit from the weld carriage. The welder alignment clamp is MSM operable so that welder can be released from the canister should failure occur during the welding process. Regular maintenance is limited to changing the torch block electrode; the electrode should be replaced every ten welds (vendor recommendation) to maintain weld integrity. The torch block electrode is replaced remotely using MSMS. Remote removal of the assemblies, periodic maintenance and calibration requirements are documented in 24590-CM-POA-HCHH-00004-03-00005 Maintenance Manual for Bechtel HLW Canister Welding System. A DVD demonstrating remote maintenance was submitted by the weld machine vendor. [4.3.12, 4.3.14, 4.3.16, 4.3.19, 4.3.20, 4.3.24, 4.3.26, 4.3.28, 4.3.33, 4.3.29, 4.3.55]

Selection of components is fully described in 24590-CM-POA-HCHH-00004-08-00001 HLW Canister Welder Design Report. The report documents how each specification requirement was met.

The welding machines are designated as WAI equipment, having both WAI passive and WAI performance attributes. A number of WAI demonstration tests have to be completed to confirm that the welder functions as required. These include determination of the welding parameters for each weld.
process, demonstration of the primary and secondary lid welding processes and weld inspection. The full scope of WAI requirements applicable to the welding machines are documented on waste acceptance impacting screening form 24590-HLW-WSF-ENG-09-002.

Engineering Specification 24590-WTP-3PS-MV00-T0004 contains the technical requirements for welder.

6.2.11 Camera Bracket Assembly

The camera bracket (24590-HLW-MH-HPH-MHAN-00012 and 00034) supports the cameras used for confirming that no foreign objects have fallen into the canister prior to fitting the lid, and for visually inspecting the canister lid weld for surface defects. The camera can be removed from the bracket using the weld station MSMs. (4.3.16)

![Camera Bracket Assembly](image)

Figure 6-15 Camera Bracket Assembly
6.2.12 Canister Lid Lifter

The Canister Lid Lifter (24590-HLW-HC-HPH-LID-00002 and 00005) is an eductor-type vacuum suction cup mechanism used to lift a canister lid. The lid lifters have an MSM compatible quick disconnect coupling that is connected to a compressed air line fed through-wall at the weld station. The weld station MSM’s are used manipulate the lid lifter. [4.3.16]

Figure 6-16 Lid Lifter

6.2.13 Primary Lid Magazine

The primary lid magazines (245090-HLW-HC-HPH-LID-00004 and 00006) are used to store primary lids in-cave. The primary lid magazine is fitted with an air purge to prevent dust and other airborne debris collecting on the lid surface to maintain the cleanliness of the lid prior to welding.

Figure 6-17 Primary Lid Magazine
6.2.14 Canister Temperature Measuring Equipment

The canister temperature measuring equipment (24590-HLW-MH-HPH-MHAN-00023 and 00038) is used to measure the canister flange and surface temperature. The temperature of the canister flange must be below 350 °F prior to the lid being welded. The canister temperature must be lower than 212 °F prior to the canister being transported to the canister rinse vessel. This prevents flash-boiling of the water and stops the creation of steam from spreading possible contamination in the cave.

![Exploded View of Resistance Temperature Detector]

Figure 6-18   Exploded View of Resistance Temperature Detector

The canister temperature measuring equipment is a standard resistance temperature detector (RTD) that will be handled using the weld station MSMs. It can accommodate a temperature as high as 752 °F (400 °C). The RTD is wired directly to the ICN with radiation tolerant cables and MSM-compatible quick disconnects. [4.3.16]

6.2.15 Vacuum Unit

The vacuum unit (24590-HLW-MH-HPH-MHAN-00009), see Figure 6-19, is a modified, standard, industrial shop vacuum, which is used for general housekeeping and clean-up at the weld station.

The vacuum is generated with an air eductor located in the generator head. Compressed air enters through the inlet, and travels through a nozzle where it is converted to a high velocity stream. This stream decreases the air pressure in the suction chamber and creates the vacuum. The vacuum generator head has an in-line HEPA filter to prevent the spread of contamination.

The vacuum generator head is reused, however the drum and internal filter are disposed of and replaced remotely using MSMs. The vacuum generating head is removed and a disposal lid is fitted onto the top of the drum; the lid is imported into the cave at the time of disposal. The lidded drum is then placed in the waste bin located at the weld station. A new drum is brought in the cave using one of the process cranes. [4.3.16]
6.2.16 Glass Removal Tool

A pneumatic needle descaler (24590-HLW-FH-HPH-TOOL-00005) that is manually operated with an MSM will be used to remove glass from the canister external surface if required. The tool is classified as WAI (passive), the requirement being that the tool does not damage the canister surface beyond minor scratching. Refer to waste acceptance impacting screening form 24590-HLW-WSF-ENG-07-002. [4.3.16]

6.2.17 Flange Conditioning Tool

The flange conditioning tool (24590-HLW-FH-HPH-TOOL-00007) is a milling machine that will be used to machine a circular groove into the top of the canister flange to enable a secondary lid to be fitted onto the canister. The tool was procured as excess material from the West Valley Demonstration Plant.

The flange conditioning tool (FCT) is manually deployed using the canister handling cave process cranes. The FCT consists of the following components; turntable, drive, mill, mill indicator, electric motors, wire brush, a vacuum-sealed receptacle, and a control panel. The FCT is controlled from a local out-cave panel. The FCT and control panel will be installed on an as-needed basis.

The FCT utilizes the outside diameter of the canister flange as the physical location feature. The FCT is centered and clamped on the canister flange in such a way that it remains fixed during the milling.
operation. A chip vacuum is provided to collect chips when the end mill is cutting. To prevent free liquids from entering the canister, the FCT does not use cutting fluids.

The milling tool has the capability to be located at any position along the circumference. It has remote adjustable cutting depths and remote adjustable mill radial positions with positional indicators that are visible from the operators shield window and by CCTV cameras.

The FCT has been designated a WAI (passive) piece of equipment. Use of the FCT is designated a WAI activity. Demonstration testing of the FCT to confirm it operates correctly is designated as WAI testing. Refer to waste acceptance impacting screening form 24590-HLW-WSF-ENG-09-002.

6.2.18 Glovebox and Posting Port

The glovebox and posting port (24590-HLW-M0-HPH-GB-00001 and 24590-HLW-DD-HPH-TWDVC-00009), Figure 6-20, act as assembly to provide a safe method of controlling contamination when introducing small tools and materials into the canister handling cave, or when measuring the radioactivity on a swab. [ALARA]

The posting port is a transfer drawer that slides horizontally within a through-wall penetration and transfers items into the cave. The glovebox and posting port are located between the two weld stations to allow both sets of MSMs to reach the posted items. To facilitate maintenance, the drive motor for the tray assembly is located in the glovebox. To support decontamination the glovebox and posting port are fabricated from stainless steel. [4.3.13, 4.3.21, 4.3.22]

The posting port out-cave shield door is interlocked with gamma monitors (RS-3701 and RS-3801) located in the through-wall portion of the posting port that prevent the out-cave door opening if a high radiation source is detected by the gamma monitors; this interlock is Safety Significant. The in-cave and out-cave shield doors are interlocked to prevent both doors being open simultaneously; this interlock is Safety Significant. [ALARA] [4.3.30]

The glovebox has inner and outer air lock doors for tool and swab import, a bag-out port for export, and is vented to the filter cave to ensure air flow direction is into the CS/R5 filter cave. The ventilation path is provided by a stainless steel pipe connected between the bottom of the glove box and a joggle pipe penetrating the filter cave wall. The pipe also provides a drainage path into the filter cave should the glovebox internal fire suppression system activate. To promote contamination control, the inner and outer airlock doors are interlocked (Non-SAFETY) to prevent both doors being open simultaneously, and the inner air lock door is also interlocked (Non-safety) to the posting port out-cave shield door. [ALARA]

To support containment, the an air flow velocity of 100-150 fpm is required in the event that a glovebox breach occurs. Breach is defined as the loss of one glove from the glovebox leaving an open 8” diameter glove port. [ALARA] [4.3.50]

To facilitate maintenance, the drives and closure mechanisms for the in-cave shield door are located in the through wall portion of the posting port, those for the out-cave shield doors are located out cave. [4.3.13, 4.3.22]

The posting port and glovebox are controlled by a vendor supplied control system, panel HPH-PNL-00011. They are not controlled by the ICN.
Engineering Specifications 24590-WTP-3PS-M000-T0006 and 24590-WTP-3PS-M000-T0007 contain the technical requirements for the posting port and glovebox.

6.3 Canister Handling Cave Decontamination & Maintenance Area Equipment

6.3.1 Crane Decontamination Area & Maintenance Area Shield Doors

Shield doors (24590-HLW-AD-HPH-DOOR-00001 and 00004) located between the canister handling cave and the crane decontamination area allow the process cranes to travel between the two areas. The doors provide a shielding function and assist in contamination control in order to protect personnel from exposure to the C5/R5 environment of the canister handling cave. The shielding function is designated as Safety Significant. The shield doors aid contamination control by regulating the airflow from areas of lower contamination potential into areas of higher contamination potential. Air flow is controlled around the doors by adjustable air gap plates, these will be tuned to provide the required airflow for HVAC requirements. The shield doors are designated as seismic category II, which requires the doors to remain in place during and after a seismic event. The shield door arrangement is shown in Figure 6-21. [4.3.52]

The vertical door is raised and lowered on a pair of roller screws, driven by a single reversible electric motor. The motor is located in a personnel accessible area outside of the maintenance and decontamination areas, see Figure 6-21. The door raising and lowering operations are failsafe; a brake assembly being attached to each roller screw engages when power is lost to the drive system. The door is guided by vertically orientated rails located in the crane maintenance and crane decontamination areas. The bottom edge of the vertical door provides guidance and lateral support to the horizontal shield door,
this requires the vertical door to be in the lowered ‘closed’ position prior to the horizontal door being opened or closed. [4.3.13, 4.3.22]

The horizontal door is supported and guided by a rail located at the base of the door, and is also guided and provided with lateral support by the bottom edge of the vertical door. Drive is provided by a roller screw, driven by a single reversible electric motor located in the decontamination area, which is a personnel accessible area. (4.3.13, 4.3.22)

The doors are ICN controlled via local operator panels HPH-PNL-00009/00013/00008. An ICN interlock inhibits movement of the horizontal door unless the vertical door is in the closed position.

![Diagram of crane decontamination and crane maintenance shield doors](image)

**Figure 6-21  Crane Decontamination and Crane Maintenance Shield Doors**

The crane maintenance area shield doors (24590-HLW-AD-HPH-DOOR-00005 and 00008) located between the crane maintenance and crane decontamination areas allow the process cranes to travel between the two areas. The design, safety functions and control of the maintenance area doors is similar to that of the decontamination area doors.
Engineering Specification 24590-WTP-3PS-ADDH-T0006 contains the technical requirements for the shield doors.

6.3.2 Maintenance Area Crane

The canister handling cave maintenance crane (24590-HLW-MJ-HPH-CRN-00009) is located in the crane maintenance area H-0329A, see Figure 6-22. The crane is used to provide maintenance services for the main process cranes. The crane is rated at 7.5 tons and is controlled using a hand-held radio control system. The crane does not interface with the ICN. Platforms are provided to allow access to the crane for maintenance purposes, for example checking lubricant levels in gearboxes. Trolley and bridge wheels are permanently lubricated and sealed-for-life components. The crane design includes sight glasses, grease nipples and air vent holes for other components that require lubrication at regular intervals. [4.3.23, 4.3.43, 4.3.47]

![Crane Maintenance Area Layout](image)

Figure 6-22 Crane Maintenance Area Layout

6.3.3 Maintenance Area Shielded Personnel Access Door

Access to the crane maintenance area is through a shielded personnel access door (24590-HLW-AD-HPH-DOOR-00007) located at the 37' elevation. The shield door provides a shielding function to protect personnel from exposure to the R3/R4/R5 crane decontamination area when the crane maintenance area shield doors are open. The door is located on the C5/R5 boundary and is designated as Safety Class and seismic category I. [ALARA]

6.3.4 Crane Decontamination Area Equipment

Equipment provided in the crane decontamination area includes MSMs, and a shield window. These items will be used for placing a glass shard sample bottle into a shielded transport flask. A spray lance
(24590-HLW-FH-HPH-TOOL-00015) is provided to allow remote decontamination of equipment if necessary, however, where possible the preferred decontamination approach is "hands-on". [4.3.4, 4.3.12]

6.4 Pour Tunnel Equipment

6.4.1 Pour Tunnel Bogies

Process operations inside the pour tunnels are performed by bogies (24590-HLW-MQ-HPH-TRLY-00001, 00004, 00010 and 00011) that are used to transport canisters to the glass pour position at the north end of the pour tunnel. Each pour tunnel has two bogies (one for each pour spout) that operate independently. The canisters are carried inside an open framed canister sleeve (24590-HLW-MQ-HPH-TRLY-00006, 00007, 00012 and 00013) that is removable from the main bogie frame using the canister handling cave process cranes. The bogie and sleeve are depicted in Figure 6-23. [4.3.33]

![Pour Tunnel Bogie & Sleeve](image)

Figure 6-23 Pour Tunnel Bogie & Sleeve

Each stainless steel bogie is powered by 2 push/pull chains that are paid out from cartridges located inside the bogie maintenance area. The chain drive motors are also located in the bogie maintenance areas. For redundancy purposes, each bogie is equipped with 2 chains, however, only 1 is required to move a bogie loaded with a glass filled canister. The chains run in guides along the side of the bogie rails. The guides are fitted with covers to reduce contamination build-up on the chains. The bogie rails are fabricated from stainless steel and rail end stops are provided to limit bogie travel, the wheel assemblies are modular self lubricating components. Buffers are attached to the bogie to absorb the
impact load and prevent damage to the bogie, the shield door, and rail stops. [4.3.13, 4.3.22, 4.3.41, 4.3.48]

Bogie maintenance and inspection activities will be carried out in the bogie maintenance areas. The canister sleeve must be removed from the bogie in order to allow the bogie to pass through the bogie maintenance area shield door aperture. The sleeve will be removed from the bogie using the canister handling cave process cranes and will be stored on a rack fixed to the north wall of the canister handling cave. A lift beam (24590-HLW-MJ-HPH-LIFT-00001) is provided to handle the canister sleeve. The general arrangement of equipment in the maintenance area is depicted in Figure 6-24. Prior to being transferred into the maintenance area the stainless steel bogie will be decontaminated at the pour tunnel decontamination station. The decontamination process will not impact any electrical or control components since there are no control or electrical components mounted on the bogie. [4.3.3, 4.3.5]

The bogie can be pulled back into the bogie maintenance area using a manual hand-wind mechanism that interfaces with the drive mechanism inside the bogie maintenance area. [4.3.26, 4.3.27, 4.3.28, 4.3.37, 4.3.41]

Figure 6-24  Pour Tunnel Bogie and Drive

Control of the bogies is administered from ICN local operator panels HPH-PNL-00009/00013/00008. Encoders on the chain drive motors are used to accurately position the bogie to within ± 1/8 inch below the pour tunnel hatches and at the glass pour location. The canister is required to be located to within ± 1.125 inch of the pour spout centerline; the additional tolerance on the canister location is needed to account for loading clearances between the canister and bogie sleeve. At the glass pour location a through wall proximity switch signals that the bogie is located at the pour position, and allows the operator (via the ICN) to extend a through wall locking bolt that engages with the bogie chassis. An ICN interlock prevents the locking bolt being disengaged from the bogie unless the melter air-lift is “off” and glass pour has been completed.

To maintain the canister handling cave concrete and the canister racks within allowable temperature limits, glass filled canisters are required to cool in the pour tunnel before being transferred to the canister handling cave. A Safety Significant interlock prevents the bogie being moved beyond its cooling position that is 6’ south of the glass pour position until the required cooling period has expired. The cooling period is anticipated to be 8 hours; this 8 hour period is in addition to the 1 hour period the canister
spends below the pour spout on completion of a glass fill. This will be finalized once the interlock design has been completed. This 9 hour total, and the cooling location 6' south of the pour position were used as an input to calculation 24590-HLW-M8C-C5V-00006 that confirmed that the canister handling cave concrete would not exceed its temperature limits. This outstanding issue is tracked on 24590-WTP-ATS-QAIS-10-0995.

The bogie sleeve supports a filled canister weighing up to 9260 lbs and accurately positions the canister to prevent misalignment with the melter pour spout. The sleeve has an open design on its southern side to allow monitoring of the glass fill height by the HMP system glass fill-level infrared cameras located in the wall of the pour tunnels adjacent to the shield windows. The HMP system also includes a through-wall collimated gamma monitor that is used to detect a high canister glass level. The design elevation of the gamma monitor is 1' 9.5"; this equates to a glass level approximately 2.25" below the top surface of the canister flange.

Engineering Specification 24590-WTP-3PS-MQR0-T0002 contains the technical requirements for the bogies.

6.4.2 Bogie Decontamination Equipment

Each pour tunnel contains a bogie decontamination station equipped with a shield window, MSM’s, through-wall services penetrations, through-wall lights, and a decontamination spray lance (24590-HLW-FH-HPH-TOOL-00010 and 24590-HLW-FH-HPH-TOOL-00029). The lance is suitable for use with high pressure water, steam, detergent solution, CO₂, and compressed air. Services are piped into the pour tunnel through joggled pipe that is part of a 10.5" liner service plug. To prevent back-flow and minimize leakage, a check valve and a Staubli shut-off connector socket are fitted on the out-cave side of the joggle pipe. The canister sleeve will be removed from the bogie prior to decontamination. Waste liquid will be collected by sumps located in the floors of the pour tunnels and piped to the radioactive liquid disposal system. [4.3.4, 4.3.6, 4.3.8, 4.3.9, 4.3.16, 4.3.17]

6.5 Pour Tunnel Maintenance Area Equipment

6.5.1 Bogie Maintenance area Shield Doors

Shield doors (24590-HLW-AD-HPH-DOOR-00002 and 00003) located between the pour tunnels and the pour tunnel maintenance areas allow the bogies to travel between the two areas. The doors provide a shielding function and assist in contamination control in order to protect personnel from exposure to the C5/R5 environment of the pour tunnel. The shielding function is designated as Safety Significant. The shield doors aid contamination control by regulating the airflow from areas of lower contamination potential into areas of higher contamination potential. Air flow is controlled around the doors by adjustable air gap plates, these will be tuned to provide the required airflow for HVAC requirements. The door drive motors are located in a C2/R2 area. The shield doors are designated as seismic category II, which requires the doors to remain in place during and after a seismic event. The shield door arrangement is shown in Figure 6-25. [4.3.13, 4.3.22, 4.3.52]
Figure 6-25  Bogie Maintenance Shield Doors

The vertical doors are raised and lowered on a pair of roller screws, driven by a single reversible electric motor located in a personnel accessible area. The door raising and lowering operations are failsafe; a brake assembly attached to each roller screw engages when power is lost to the drive system. The door is guided by vertically orientated rails located in the maintenance area. The doors are ICN controlled via local operator panels HPH-PNL-00009/00013/00008.

Engineering Specification 24590-WTP-3PS-ADDH-T0001 contains the technical requirements for the shield doors.

6.5.2  Maintenance Cranes

The 3 ton capacity pour tunnel maintenance cranes (24590-HLW-MJ-HPH-CRN-00012 and 24590-HLW-MJ-HPH-CRN-00013) are located in the bogie maintenance areas, see Figure 6-26. The cranes will be used for general maintenance activities on the bogies, and to locate the bogies and drive chain cartridges below the access plug should they have to removed from the maintenance area. The cranes are pendant controlled; they do not interface with the ICN. [4.3.47]
6.5.3 Shielded Personnel Access Doors

Access to the bogie maintenance areas is through shielded personnel access doors (24590-HLW-AD-HPH-DOOR-00006 and 00009) located at the 5’ elevation. The shield doors provide a shielding function to protect personnel from exposure to the R5 pour tunnels when the bogie maintenance area shield doors are open. The door is located on the C5 boundary and is designated as Safety Class and seismic category I. [ALARA]

6.6 Export of Solid Waste

Solid waste generated in the canister handling cave is exported via the pour tunnels to the HSH system, from where it is transferred to the RWH system.

Solid waste will typically consist of welding electrodes, swabs, and any other replacement parts that will fit inside a solid waste basket, see Figure 6-27.
The waste basket is a consumable item that is approximately 19” in diameter, 32” tall and is designed to carry a maximum load of 1000 lbs. The lid has four tabs around its diameter that locate into cut-outs in the top of the basket. The lid is placed on (or removed from) the basket body using an MSM. The lid incorporates a lifting bail so that it may be handled remotely by the canister handling cave cranes in combination with a hook adapter.

Once the waste basket has been lidded, it will loaded into the waste basket transfer container (24590-HLW-MH-HPH-MHAN-00045). This operation will take place inside the canister handling cave. The waste basket transfer container will then be placed onto the pour tunnel bogie sleeve using one of the process cranes, see Figure 6-28. The waste container lifting bail is fitted on a pivot so that it maybe rotated to allow the waste basket to lifted out of the container. MSMs will be used to rotate the lifting bail.
Figure 6-28  Waste Basket & Transfer Container Loaded onto Bogie Sleeve

The pour tunnel bogie will then be located in front of the pour tunnel MSMs and the waste container lifting bail positioned to allow removal of the waste basket. The bogie will then be moved to the north end of the tunnel and located in the canister cooling position. The pour tunnel cover will then be removed by the HSH system crane, and the waste basket will be lifted into the melter cave. Due to melter cave jumper configuration, only the west bogie in each pour tunnel maybe used to transfer solid waste to the HSH system. Lidded waste baskets will be stored in the canister handling cave until the HSH system is ready to receive them. The pour tunnel MSMs will be used to place the container lifting bail in the upright position to allow engagement with the carne hook. [4.3.9]
7 Operations

7.1 System Startup

There are no automated ICN control sequences associated with the equipment in the HPH system. Each piece of ICN controlled equipment, for example shield doors, cranes etc., is operated autonomously from the LOI with each machine movement being operator initiated.

There are a number of ICN and Programmable Protection System (PPJ) equipment interlocks; these are addressed in Section 7.5.3.

The welding machines and posting port/glovebox are controlled by vendor supplied control systems; they are not ICN controlled. However, the values of the welding parameters will be exported from the vendor data collection system and sent to the ICN.

7.2 Normal Operations

This section should be read in conjunction with the system mechanical flow diagrams contained in Appendix A. The flow diagrams show the logical step-by-step operations that need to be completed in order to process a canister through the HPH system.

The following sections provide a brief description of the operational steps to be followed in the HPH system. All of the process equipment that operates in the C5/R5 pour tunnels or canister handling cave is operated remotely from ICN LOI panels or from vendor supplied control panels that are located in R2/C2 areas. [4.3.12]

The following contractual requirements are applicable to the glass fill process:

- System HPH is required to support a production rate of up to 7.5 MTG/day (Basis of Design 24590-WTP-DB-ENG-01-001, section 6.3.3). Based on a 3.1 MTG/canister this equates to a through-put of 2.4 canisters per day. To obtain this production rate the HPH system is required to process two canister in less than 20 hours after completion of the glass pour.
- The maximum permitted canister weight is 9260 lbs. The actual weight will depend on fill height and glass density which will be dependant on the waste stream contents. Given the glass density and canister volume it is not anticipated that the maximum weight will be exceeded. For reporting purposes the canister weight will be measured by equipment that is part of the HDH system.
- The average canister fill volume is required to be 95%, with a minimum fill volume of 87%. At 95% full, the glass level is approximately 12.1” below the top surface of the canister flange; an 87% fill volume equates to approximately 25.9” (refer to calculation 24590-HLW-M0C-30-00003).

7.2.1 Canister Handling

The HPH system process begins with the receipt of a clean canister from the HRH system. The canister handling cave process crane and grapple are used to raise a clean canister through the open canister import tunnel hatch and transfer it to the buffer rack. The import tunnel hatch is then closed.

When a canister is required for filling, it is removed from the buffer rack using the process crane and located above the pour tunnel hatch. The pour tunnel hatch is opened and the canister-handling cave
crane lowers the empty canister into the pour tunnel bogie. The pour tunnel hatch is then closed. Melter process operations will determine which pour tunnel bogie is to be used.

The bogie will then be transferred to the glass pour position. As the bogie moves into position beneath the pour spout, a cam on the bogie contacts a through-wall proximity switch that signals to the ICN that the bogie is located at the pour position. The operator is then able to lock the bogie in position by extending a through-wall locking rod that engages the bogie chassis. The locking bolt is controlled by the ICN. As the bogie moves into position below the pour spout, the canister contacts the pour spout drip tray and pushes the tray away from the pour spout. The drip tray runs on rails and is equipped with a proximity switch that signals to the melter process control system that a canister is located below the pour spout. This signal provides an ICN interlock that inhibits the melter airlift if a canister is not located below the pour spout.

The glass pour process then commences. The glass will be added to the canister in 12 or 13 batch pours. Based on a production rate of 7.5 MTG/day, the glass pour process will take approximately 20 hours (reference 24590-HLW-RPT-PE-07-001 High Level Waste Vitrification Plant Capacity Enhancement Study).

On completion of the pour, the canister will remain at the pour location for 1 hour to allow off-gases to be vented by the melter ventilation system. This time period also allows a "skin" form on the glass surface that fractures as it cools, causing small pieces of glass to be ejected from the canister. For the first hour these glass shards will be contained by the pour spout and fall back into the canister instead of spreading onto the bogie chassis. At the end of this 1 hour cooling period the bogie will be moved 6' south to a cooling position where it will cool for an additional 8 hours. Canister cooling data will be collected during commissioning, see Test Objectives section of this document. The purpose of collecting these data is to confirm that that at the end of the 9 hour cooling period in the pour tunnel (1 hour below the pour spout and 8 hours in the canister cooling position) the canister skin temperatures are below those calculated and shown in Figure 13 (3d steady state profile) of 24590-HLW-M8C-C5V-00006. Note that Figure 13 is based on pouring a canister in 19.2 hours (7.5 MTG/day) with very conservative glass properties. The canister temperature profile data from this calculation has been used to confirm that the concrete temperature in the canister handling cave remains within allowable limits. The calculated canister temperature profile was also used to set the design temperature limits on the canister cooling and buffer racks.

After the canister has cooled, the transfer bogie is moved south and located below the pour tunnel hatch. The hatch is opened and the canister is raised into the canister handling cave and the hatch is closed. The filled canister is then transferred to the canister cooling rack.

7.2.2 Weld Station Operations

The cooled canister is then transferred to one of the weld stations using one of the process cranes and canister grapple. As it is lowered into the weld station, the canister will be inspected using the shield window and CCTV cameras (which are positioned to provide 360° coverage of the canister) for glass deposits. Any glass detected on the canister exterior is removed by a pneumatic needle descaler that is used with MSMs.

The canister flange is then measured to confirm its temperature is within the allowable range for welding. This is done using the temperature detector located at each weld station. Once process knowledge has been established, this step may be eliminated. The canister flange must be below 350° F before the lid
can be welded onto the canister. Based on previous glass pour testing it is not anticipated that the flange will reach 350°F, see Section 6.1.

If required, a glass sample is taken at this point using the MSM operated shard sampling equipment and placed in sample vial. Prior to taking the sample the glass sample transport container will be moved into the crane decontamination area and be prepared to receive the glass shard sample bottle. The transport container will be located directly in front of the decontamination area shield window and within reach of the MSMs. The sample vial will be removed from the canister handling cave and placed inside the transport container using the decontamination area MSMs. The lid will then be placed onto the container using the process crane. Personnel will then enter the decontamination area to fasten the lid bolts. The container will then be transferred to the Analytical Laboratory for sample analysis.

A glass fill height measurement will be taken to confirm the glass level in the canister using the weld station MSMs and the glass level detector.

The next step is to visually inspect the inside of the canister to verify it is free of foreign debris. This inspection is performed using the welding station closed circuit television (CCTV) camera. The operator inspects the lid and the upper flange of the canister with a remote camera to verify both are clean enough for welding. If necessary, a motorized rotary wire brush, manually operated with MSMs, is used for cleaning the canister flange prior to fitting the lid.

The primary lid will then be placed onto the canister using the lid lifter and weld station MSMs. The weld carriage is then used to locate the welding machine onto the canister flange and the lid is welded to the body. Operating instructions for the welding machine are documented in vendor documents 24590-CM-POA-HCHH-00004-12-00001 Operating Instructions for Bechtel HLW Canister Welding System and 24590-CM-POA-HCHH-00004-03-00004 Software Documentation Bechtel HLW Canister Welding System. On completion of welding the weld cap is visually inspected using the weld station cameras, and values of the welding parameters are checked to confirm that they remained within allowable ranges during the welding process. Results of the visual inspection and the weld parameters are documented in the production records.

If the weld inspection requirements are met, then the canister will be removed from the weld station and transferred to the buffer rack where it will be stored and allowed to cool until the surface temperature falls below 212 °F (in order to prevent flash-boiling the water in the canister rinse vessel and creating steam that may spread possible contamination in the rinse tunnel cave). The lidded canister will then be transferred to the canister rinse vessel (part of the HDH System) via the canister handling cave export hatch. The weld station temperature instrument will be used to measure the canister surface temperature.

Should the welding parameter values fall outside of the allowable ranges, or should the weld fail visual inspection, weld re-work will be necessary. The process and procedures for weld repair have yet to be developed. Repair options are discussed in Section 6.2.10.
7.2.3 Operational Time

The following HLW mechanical handling cycle times for the HPH system specified in Table 69 of 24590-WTP-MDD-PR-01-001 (rev 10) Operations Research (WITNESS) Model Design Document.

Revision 10 of the above document demonstrates that with the existing melters a production rate of 6 MTG/day can be achieved. Step 12 allocates 498 minutes (8.3 hours) for the lid welding, collection of glass sample, and measuring the canister fill height. At 7.5 MTG/day, two canisters will be transferred into the canister handling cove approximately every 20 hours. The time period allocated to step 12 will allow the HPH system to meet the enhanced production rate.

Table 7-1  System HPH Operation Times

<table>
<thead>
<tr>
<th>No.</th>
<th>HPH Mechanical Handling Process</th>
<th>Time (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Handling cave overhead crane (HPH-CRN-00001) lifts the canister from the import bogie (HRH-TRLY-00002) and transfers it to an available pour tunnel bogie.</td>
<td>46</td>
</tr>
<tr>
<td>5b</td>
<td>If all of the pour tunnel bogies are in use, the canister is put into the handling cave buffer rack (HPH-MHAN-00017). There are 24 spaces available for storage.</td>
<td>38</td>
</tr>
<tr>
<td>5c</td>
<td>Handling cave overhead crane (HPH-CRN-00001) moves a canister from the handling cave buffer rack (HPH-MHAN-00017) to the pour tunnel bogie that is ready to receive a new one.</td>
<td>23</td>
</tr>
<tr>
<td>6</td>
<td>The pour tunnel bogie moves to the pour station.</td>
<td>8</td>
</tr>
<tr>
<td>7</td>
<td>The canister is filled with glass.</td>
<td></td>
</tr>
<tr>
<td>Note</td>
<td>The time for this step is derived from the required canister throughput of 6 MTG/day. A pour will occur every 2 hours and last for 30 minutes (REP-WTP-21002). The melter recovery time between pours is therefore 1 hour 30 minutes (90 minutes). Since two canisters will be filled every 24 hours at the rate of 6 MTG/day, the time from the start of a fill to the end of the last pour is 24 hours 90 minutes, or 1,350 minutes.</td>
<td></td>
</tr>
<tr>
<td>Note</td>
<td>The process of filling the next canister in the other pour line of the same melter will begin 1.5 hours after step 7 is completed in the first pour line. This sequence is identical for both melters.</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>The canister cools under the pour spout (90 min), then moves to the pour tunnel hatch where it continues to cool (8 hrs) in order to be moved by the crane.</td>
<td>90 + 488</td>
</tr>
<tr>
<td>9</td>
<td>The canister is picked up by handling cave overhead crane (HPH-CRN-00001) and is placed into one of the cooling racks (HPH-MHAN-00014). There are 24 spaces available for storage in the cooling racks.</td>
<td>27</td>
</tr>
<tr>
<td>10</td>
<td>The canister then cools.</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>When the canister has cooled, it is moved by the handling cave overhead crane to one of the two weld stations.</td>
<td>21</td>
</tr>
<tr>
<td>12</td>
<td>The glass level is measured, samples are taken when required, and the lid is welded on.</td>
<td>498</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No.</th>
<th>HLW Canister Decontamination Handling System (HDH)</th>
<th>Time (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>Handling cave overhead crane (HPH-CRN-00001) transports the canister to the canister rinse bogie vessel (HDH-VSL-00001/HDH-TRLY-00003).</td>
<td>26</td>
</tr>
</tbody>
</table>
7.2.4 Export of Solid Waste

Solid waste will typically consist of welding electrodes, swabs, and any other replacement parts that will fit inside a solid waste basket and be exported to system HSH via the pour tunnels.

The waste basket will be housed inside a recess fitted into the center section of the weld station table, see Section 6.2.6. The basket lid will be fitted using the weld station MSMs. The basket will then be loaded into the waste basket transfer container, and the container lowered through one of the pour tunnel hatches and placed on the bogie canister sleeve. Location and guide features on the transfer container are used to position the container on the canister sleeve.

The pour tunnel bogie will then be moved to the north end of the tunnel and located in the canister cooling position. The pour tunnel cover will be removed by the HSH system crane, and the waste basket will be lifted into the melter cave. Due to melter cave jumper configuration, only the west bogie in each pour tunnel maybe used to transfer solid waste to the HSH system. Lidded waste baskets will be stored in the canister handling cave until the HSH system is ready to receive them. Larger pieces of equipment, for example the welder or welding machine carriage will be removed from the canister handling cave via the crane decontamination and maintenance areas. Section 6.6 contains a more completed description of the solid waste export operation. [4.3.9, 4.3.25]

7.3 Off-Normal Operations

7.3.1 Failure of Vertical Shield Doors

To facilitate maintenance activities the drives for the vertical shield doors are located in personnel accessible C2/R2 areas. If the doors fail in the closed position all the drive components can be accessed. If the doors were to fail in the open position it maybe necessary to close the door prior to any maintenance work taking place. To close the doors a recovery system is provided. The recovery equipment will be installed out-cave on the door drive support bridge when required, e.g. failure of a lead screw. A series of recovery rods are connected in series (through a recovery penetration in the drive support bridge) and connected to the door recovery attachment mounted on the top edge of the door panel. Once the weight of the door has been taken through the recovery drive system, the brakes and other applicable drive train components will be disengaged and the recovery system will be used to lower the door to the closed position, allowing maintenance activities to be performed on the doors drive system. [4.3.26, 4.3.27, 4.3.34]

7.3.2 Failure of Horizontal Shield Doors

The drives for the horizontal shield doors are located in the crane maintenance and crane decontamination areas. In the event of drive motor failure with the doors in the closed position, personnel would be able to gain access to these areas. However, if failure of the decontamination area door occurred with the door in the open position, then the door would first have to be closed before personnel could access the drive motor. To close the door, a through-wall recovery system is provided. The system consists of a recovery plug permanently installed through a 10.5" liner adjacent to the door, and a mobile out cave recovery drive assembly. The recovery drive assembly will be deployed throughout the facility as required, and is therefore not permanently installed.

The recovery drive assembly (HSH-RCVY-00006) consists of an actuator for horizontal motion, and a series of extension rods that are connected one at a time, that advance the recovery plug forward until
engagement is made with a connection point on the shield door. When connection is made, the drive retracts the extension rods and door until the door is in its closed position. [4.3.26, 4.3.27, 4.3.34]

7.3.3 Recovery of In-Cave Cranes

The in-cave process cranes are provided with recovery mechanisms that will allow the cranes to be moved from the C5/R5 canister handling cave to the decontamination and maintenance areas in the event of drive failure. The trolley and bridge are supplied with hydraulically operated jack down wheels that are deployed in the event of drive failure or wheel seizure. The jack down wheels lift the failed wheel clear of the rail, and provide drive to return the crane to the CMA. The crane hoist is fitted with a secondary recovery drive. The cable reeling system can also be used to pull the crane out of the C5/R5 area and into the CMA. [4.3.24, 4.3.26, 4.3.27, 4.3.34, 4.3.36, 4.3.37]

7.3.4 Grapple Failure to Release Canister

If the sequencing grapple fails to release a canister, then the canister will transferred to the weld station where an MSM will be used to pull 3 release pins that causes the grapple jaws to retract and disengage the canister. The grapple will then be transferred out of the canister handling cave for maintenance. [4.3.26, 4.3.27, 4.3.34]

7.3.5 Recovery from a Dropped Canister

A recovery plan will be devised by operations in the unlikely event of dropping a filled production canister. A canister recovery tool (HEH-TOOL-RCVY-00005), see Figure 7-1 is provided to assist in canister recovery operations. The tool is will be hung from the process crane hook.

![Canister Recovery Tool](image)

Figure 7-1 Canister Recovery Tool

7.3.6 Bogie Recovery

The pour tunnel bogie drive motors are located in the bogie maintenance area and are, therefore, accessible for maintenance. Should the need arise, the bogies can be recovered from the pour tunnel to bogie maintenance area using a manually operated hand-wind mechanism that interfaces with the push/pull drive chain device. Each bogie has two chains, they are sized so they are able to recover a bogie that has 2 seized wheels. [4.3.26, 4.3.27, 4.3.33, 4.3.34, 4.3.41]
7.3.7 Hatches

Hatch drive motors are located out-cave and are, therefore, accessible for maintenance. Should the need arise, the hatches maybe opened and closed using a manually operated hand-wind mechanism that interfaces with the out-cave drive system. [4.3.34]

7.3.8 Out-of Specification Filled Canisters

Canisters that do not meet the glass fill volume requirements, or where the canister lid weld fails inspection, will be temporarily stored in the cooling or buffer rack. An approach for disposition of out of specification glass filled canisters has not yet been developed.

7.3.9 Ancillary Equipment

Ancillary equipment includes MSMs, lights, and through-wall cameras.

Through wall cameras and lights are located at the weld station and in the pour tunnel. These items will be removed from the wall using an extraction frames and then taken to the C2 work shop (H-A306) for maintenance as required. The design includes a lens fitted on the in-cave side that acts as a contamination cover, preventing contamination migrating out of the C5/R5 pour tunnels and canister handling cave and into the through wall light/camera.

Wall mounted lights provide general lighting in the rest of the canister handling cave. The process cranes and an off-set lifting beam will be used to lift the lights off the mounting fixture. The lights will then maintained in the crane decontamination or maintenance areas, or they may be transferred to the C3 work shop (H-0311B) as required. [4.3.24, 4.3.26, 4.3.27, 4.3.34, 4.3.37]

The pour tunnel MSM slave arms will be withdrawn through the wall into the out-cave area. An extraction cart will be used for this purpose. The weld station MSMs are a 3-part design. The process cranes and an off-set lifting beam will be used to remove the weld station MSM slave arms from the canister handling cave. The slave arms will then maintained in the crane decontamination or maintenance areas, or they maybe transferred to the C3 work shop (H-0311B) as required. [4.3.24, 4.3.26, 4.3.27, 4.3.34, 4.3.37]

7.4 System Shutdown

There are no automated ICN control sequences associated with the equipment in the HPH system. Each piece of ICN controlled equipment, for example shield doors, cranes etc, is operated autonomously from the LOI with each machine movement being operator initiated.

Automated control sequences for the welding machines are addressed in Section 7.5.4. The welding machines are controlled by vendor supplied software, and not by the ICN. The start-up procedure for the weld machines is documented in vendor documents, see Table 8-1 and Section 10.3.7.

7.5 Instrumentation and Controls

Except for the welding machines and the posting port and glovebox, the HPH system equipment is operated by the ICN via LOI's HPH-PNL-00008, 00009 and 00013. There are a number of ICN
interlocks associated with the system, these are documented in 24590-HLW-M1-HPH-00001 Mechanical Sequence Diagram (MSD) for HLW Vitrification System HPH Canister Pour Handling.

The control systems for the welding machines and the posting port and glove box are supplied by the vendor.

7.5.1 Remote Continuous Controls

Not applicable to the HPH system.

7.5.2 Remote Discrete Controls

Discrete controls applicable to the HPH system are identified in 24590-HLW-M1-HPH-00001 Mechanical Sequence Diagram (MSD) for HLW Vitrification System HPH Canister Pour Handling.

7.5.3 Trips and Interlocks

7.5.3.1 Safety Interlocks

<table>
<thead>
<tr>
<th>Equipment No.</th>
<th>Instrument No.</th>
<th>Properties</th>
<th>Function</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>HPH-TRLY-00001</td>
<td>TBD see note 1 below</td>
<td>SS</td>
<td>See note 1 below</td>
<td>None</td>
</tr>
<tr>
<td>Pour tunnel 1 bogie</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HPH-TRLY-00004</td>
<td>TBD see note 1 below</td>
<td>SS</td>
<td>See note 1 below</td>
<td>None</td>
</tr>
<tr>
<td>Pour tunnel 1 bogie</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HPH-TRLTY0010</td>
<td>TBD see note 1 below</td>
<td>SS</td>
<td>See note 1 below</td>
<td>None</td>
</tr>
<tr>
<td>Pour tunnel 2 bogie</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HPH-TRLTY0011</td>
<td>TBD see note 1 below</td>
<td>SS</td>
<td>See note 1 below</td>
<td>None</td>
</tr>
<tr>
<td>Pour tunnel 2 bogie</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HPH-TWDVC-00009</td>
<td>RS-3701 OR RS-3801</td>
<td>SS</td>
<td>Prevents the posting out-cave shield from opening on detection of a high radiation source</td>
<td>None</td>
</tr>
<tr>
<td>Posting port</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HPH-TWDVC-00009</td>
<td>ZS-3909 OR ZS-3910</td>
<td>SS</td>
<td>Prevents the out-cave shield door from opening unless the in-cave is locked in the closed position</td>
<td>None</td>
</tr>
<tr>
<td>Posting port</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HPH-TWDVC-00009</td>
<td>ZS-3904 OR ZS-3905</td>
<td>SS</td>
<td>Prevents the in-cave shield door from opening unless the out-cave door is closed</td>
<td>None</td>
</tr>
<tr>
<td>Posting port</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note 1: A Safety Significant interlock prevents the transfer of a poured canister between the pour tunnels and the canister handling cave unless the canister has had sufficient time to cool in the pour tunnel. The designated cooling position is 6' south of the glass pour position. The canister is to remain at this cooling location for 8 hours. This 8 hour time period is in addition to the 1 hour period the canister spends below the pour spout on completion of a glass fill. This interlock requirement is implemented by restricting the
movement of the pour tunnel bogies immediately after completion of the glass pour. The interlock design is not yet finalized; this outstanding issue is tracked on 24590-WTP-ATS-QAIS-10-0995.

7.5.3.2 Non-Safety Interlocks

Non-safety interlocks for the HPH system are documented in 24590-HLW-M1-HPH-00001 Mechanical Sequence Diagram (MSD) for HLW Vitrification System HPH Canister Pour Handling. The MSD identifies the interlock requirements, applicable component tag numbers and applicable instrument numbers.

To avoid upsetting the CSV ventilation system flow rates and pressures, and to maintain containment cascade airflow directions, Non-safety interlocks prevent multiple shield doors and hatches from being open at the same time. [ALARA]

7.5.4 Packaged Equipment - Local Control Only

Local controls associated with HPH system packaged equipment are identified in the table below.

Table 7-3 Packaged Equipment Local Controls

<table>
<thead>
<tr>
<th>Equipment No.</th>
<th>Instrument No.</th>
<th>Properties</th>
<th>Function</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>HPH-WELD-00004 &amp; HPH-WELD-00010</td>
<td>Refer to vendor operating manual 24590-CM-POA-HCHH-00004-12-00001</td>
<td>WAI</td>
<td>Refer to vendor operating manual 24590-CM-POA-HCHH-00004-12-00001</td>
<td>None</td>
</tr>
<tr>
<td>HPH-CRN-00013</td>
<td>Refer to vendor operating manual 24590-CM-POA-MJKG-00002-51-00008</td>
<td>N/A</td>
<td>Refer to vendor operating manual 24590-CM-POA-MJKG-00002-51-00008</td>
<td>None</td>
</tr>
<tr>
<td>HPH-CRN-00012</td>
<td>Refer to vendor operating manual 24590-CM-POA-MJKG-00002-51-01</td>
<td>N/A</td>
<td>Refer to vendor operating manual 24590-CM-POA-MJKG-00002-51-01</td>
<td>None</td>
</tr>
<tr>
<td>HPH-CRN-00009</td>
<td>Refer to vendor operating manual 24590-CM-POA-MJKG-00002-51-0001</td>
<td>N/A</td>
<td>Refer to vendor operating manual 24590-CM-POA-MJKG-00002-51-00011</td>
<td>None</td>
</tr>
<tr>
<td>HPH-GB-00001 &amp; HPH-TWDVC-00009</td>
<td>Refer to vendor operating manual 24590-QL-POA-M000-00002-TBD</td>
<td>SS</td>
<td>Refer to vendor operating manual 24590-QL-POA-M000-00002-TBD</td>
<td>Vendor operating manual not yet issued (Tracked on 24590-WTP-ATS-QAIS-10-0995)</td>
</tr>
</tbody>
</table>
7.5.5 Complex Control Schemes

There are no ICN control sequences associated with the HPH system. The vendor supplied control scheme for welding machines is described by the vendor manuals referenced in Table 8-1 and by the software life cycle documents referenced in Section 10.3.7.

8 Maintenance

8.1 General Maintenance Approach

The canister handling cave and pour tunnel areas of the HPH system are classified as C5/R5 which precludes personnel access into these rooms and complicates equipment maintenance. The system has been designed to minimize the quantity of maintainable equipment located in C5/R5 areas. Drive motors for hatches, bogies, glovebox, posting port, and equipment shield doors are located outside of the C5/R5 boundary. [4.3.13]

The pour tunnel bogie drives, bogie maintenance cranes and canister handling cave maintenance crane, operate in areas that are designed for personnel access. The canister handling cave maintenance area contains platforms allowing access to the maintenance crane. The rail elevation of the bogie maintenance area cranes is approximately 12' above floor level; access platforms are not provided for these cranes. Maintenance of this equipment will be “hands-on”. Routine maintenance on these cranes includes lubrication of trolley and bridge wheels (wheels have grease fitting) and checking gearbox oil levels. The gearboxes include filling plugs on the side of the casings. Permanently sealed for life bearings are not used on the maintenance cranes. [4.3.43]

Equipment operating in C5/R5 areas includes the pour tunnel bogies, over head process cranes, weld station carriages and welding machines. Maintenance for these items is addressed in Sections 8.2 through 8.6.

8.2 Maintenance of Canister Handling Cave Cranes

Routine inspections and maintenance on the in-cave process cranes will be performed in the crane maintenance area. The maintenance area contains platforms allowing access to the cranes. Bridge and trolley wheel modules are sealed for life and do not require regular lubrication. Gearboxes are also sealed for life. To facilitate maintenance activities, the main crane components (for example wheel assemblies) are modular in design, and quick release connectors have been used for cabling connections. When not in use the cranes will be parked in the maintenance area to avoid unnecessary exposure to contamination in the C5 cave. Breathing air is supplied to the sub-change room (H-0330) and maybe used to support entry into the maintenance areas as required. [4.3.19, 4.3.23, 4.3.32, 4.3.38, 4.3.39, 4.3.40, 4.3.43, 4.3.44]

8.3 Maintenance of Pour Tunnel Bogies

Routine inspections and maintenance of the pour tunnel bogies will be performed in the bogie maintenance areas. No control or electrical components are mounted on the bogies; each bogie being powered by a “push-pull” chain that is driven by motors located in the maintenance areas. The bogie wheel assemblies are modular self lubricating sealed-for-life components. Consequently, it is not anticipated that the bogies will have to be transferred into the maintenance areas on a routine basis. However, if it becomes necessary to transfer a bogie into the maintenance area it will first be decontaminated at the pour tunnel decontamination station. This operation is performed remotely.
Breathing air is supplied to the sub-change rooms (H-B044 and H-B050) and maybe used to support entry into the maintenance areas as required. [4.3.19, 4.3.22, 4.3.23, 4.3.32, 4.3.35, 4.3.42, 4.3.49]

8.4 Maintenance of Welding Carriages

The welding carriages operate inside the C5/R5 canister handling cave and are designed to be maintained remotely using the weld station MSMs. To facilitate in-cave maintenance, components that are likely to fail, including the carriage motor, linear actuator, proximity switches and all cabling, are designed to be remotely replaceable using the weld station MSMs. The modular design approach allows maintenance to be performed without having to transfer the welding carriage out of the canister handling cave. However, if required, the design does permit the entire weld carriage to be removed from the weld station using the process cranes. The carriage unit, welder support fixings and the linear actuator slide are fitted with lifting bails to allow each major component to be removed from the weld station using the process cranes. All cabling is terminated using MSM compatible connectors. The design also incorporates MSM compatible fasteners and alignment guides to facilitate remote maintenance. [4.3.12, 4.3.14, 4.3.16, 4.3.19, 4.3.20, 4.3.24, 4.3.26, 4.3.28, 4.3.29, 4.3.31, 4.3.32, 4.3.47, 4.3.55]

To improve reliability and reduce maintenance requirements, components with a life expectancy under 40 years have been selected to maximize service life taking into account the radioactive environment of the canister handling cave. For example, proximity switches have a life expectancy of 15 years, the weld carriage and actuator motors are radiation hardened with a life expectancy of 20 years, while power and control cables have a life expectancy of 10 years. [4.3.15]

8.5 Maintenance of Welding Machines

The welding machines operate inside the C5/R5 canister handling cave and are designed to be maintained remotely using the weld station MSMs. The weld machine is assembled using MSM compatible fasteners in a modular fashion allowing the drive motors, arc voltage control assembly, torch assembly, wire feed assembly, camera assembly and proximity switches to be replaced in-cave using the MSMs. Sufficient space is provided as required to allow MSM access. Components with a life expectancy under 40 years have been selected to maximize service life taking into account the radioactive environment of the canister handling cave. Proximity switches, torch assembly, and drive motors have an in-cave life expectancy of 10 years. In-cave cabling has a life expectancy in excess of 10 years; it is able to withstand $2 \times 10^6$ rads exposure. The weld machine camera has a life expectancy of only 6 months; however, the camera would only be fitted to the machine when the wire feed mechanism is being used. The wire feed mechanism will only be used if the autogenous weld cap fails visual inspection; this is not a normal event.

Cabling and gas supplies are terminated onto the welder with MSM compatible quick release couplings located on top of the welder for ease of access. If the welder cannot be remotely repaired it can be removed from the cave (using the process cranes) as a unit by disconnecting the cabling and gas supplies and disconnecting the welder and actuator as a unit from the weld carriage. The welder alignment clamp is MSM operable, rather that actuator driven, so that welder can released from the canister should failure occur during the welding process. [4.3.47]

Regular maintenance is limited to changing the torch block electrode; the electrode should be replaced every ten welds (vendor recommendation) to maintain weld integrity; new electrodes are imported into the cave via the posting port. The torch block electrode is replaced remotely using MSMs. Remote removal of the assemblies, periodic maintenance and calibration requirements are documented in 24590-CM-POA-HCHH-00004-03-00005 Maintenance Manual for Bechtel HLW Canister Welding System.
DVD demonstrating remote maintenance was submitted by the weld machine vendor. [4.3.12, 4.3.14, 4.3.15, 4.3.16, 4.3.19, 4.3.20, 4.3.24, 4.3.26, 4.3.28, 4.3.29, 4.3.31, 4.3.32, 4.3.55]

8.6 Maintenance Manuals

Preventive maintenance, corrective maintenance and in-service inspections are detailed in the vendor operating and maintenance manuals. Vendor supplied maintenance and operating manuals for major pieces of equipment are listed in Table 8-1.

<table>
<thead>
<tr>
<th>Document Number</th>
<th>Document Title &amp; Plant Item Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>24590-CM-POA-MJKG-00002-51-00008</td>
<td>Operating, Parts &amp; Maintenance Manual (HPH-CRN-00013)</td>
</tr>
<tr>
<td>24590-QL-POA-ADDH-00007-01-00007</td>
<td>Horizontal Door COTS Manual (HPH-DOOR-00004 &amp; 00005)</td>
</tr>
<tr>
<td>24590-QL-POA-ADDH-00007-01-00008</td>
<td>Vertical Door COTS Manual (HPH-DOOR-00001 &amp; 00008)</td>
</tr>
<tr>
<td>24590-QL-POA-ADDH-00006-09-00018</td>
<td>Maintenance and Inspection Manual for Pour Tunnel Number 1 Bogie Maintenance Shield Door (HPH-DOOR-00002)</td>
</tr>
<tr>
<td>24590-QL-POA-ADDH-00006-09-00020</td>
<td>Maintenance and Inspection Manual for Pour Tunnel Number 2 Bogie Maintenance Shield Door (HPH-DOOR-00003)</td>
</tr>
<tr>
<td>24590-CM-POA-HCHH-00003-01-00009</td>
<td>Maintenance and Preventative Maintenance Manual System HPH Canister Welding Station (All weld station equipment except the welding machines)</td>
</tr>
<tr>
<td>24590-QL-POA-ADDH-00003-01-00026</td>
<td>Maintenance Manuals Instructions (HPH-HTCH-00001 &amp; 00002)</td>
</tr>
<tr>
<td>24590-CM-POA-HCHH-00004-12-00001</td>
<td>Operating Instructions for Bechtel HLW Canister Welding System (HPH-WELD-00004 &amp; 00010)</td>
</tr>
<tr>
<td>24590-CM-POA-HCHH-00004-03-00005</td>
<td>Maintenance Manual for Bechtel HLW Canister Welding System (HPH-WELD-00004 &amp; 00010)</td>
</tr>
<tr>
<td>24590-CM-POA-HCHH-00004-08-00001</td>
<td>HLW Canister Welder Design Report</td>
</tr>
<tr>
<td>24590-CM-POA-HCHH-00004-03-00004</td>
<td>Software Documentation Bechtel HLW Canister Welding System. (HPH-WELD-00004 &amp; 00010)</td>
</tr>
<tr>
<td>24590-QL-POA-MJKG-00002-TBD</td>
<td>Operating and Maintenance Manual (HPH-CRN-00001 &amp; 00002) ~ not yet issued by vendor (tracked by ATS 24590-WTP-ATS-QAIS-10-0995)</td>
</tr>
<tr>
<td>24590-QL-POA-M000-00002-TBD</td>
<td>Operating and Maintenance Manual for Posting Port &amp; Glove Box ~ not yet issued by vendor (tracked by ATS 24590-WTP-ATS-QAIS-10-0995)</td>
</tr>
</tbody>
</table>
9 Interfacing Systems

This section contains a listing of all interfacing systems by the system number and identifies the nature of the interface.

Table 9-1 Interfacing Systems

<table>
<thead>
<tr>
<th>Interfacing System</th>
<th>Interface Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>HLW Canister Receipt Handling System (HRH)</td>
<td>HPH system receives empty canisters from the HRH system.</td>
</tr>
<tr>
<td>HLW Canister Decontamination Handling System (HDH)</td>
<td>HPH system transfers glass filled lidded canisters to the HDH system.</td>
</tr>
<tr>
<td>HLW Melter Cave Support Handling System (HSH)</td>
<td>HPH system transfers solid waste to the HSH system.</td>
</tr>
<tr>
<td>HLW Melter Process System (HMP)</td>
<td>HMP system pour spout proximity switch used to detect canister located at pour position</td>
</tr>
<tr>
<td>Mechanical Handling Control System (MHJ)</td>
<td>Provides control of system HPH equipment</td>
</tr>
<tr>
<td>Process and Mechanical Handling CCTV System (PTJ)</td>
<td>CCTV system cameras used for viewing in-cave operations</td>
</tr>
<tr>
<td>Programmable Protection System (PPJ)</td>
<td>PPJ system provides the safety interlock for the pour tunnel bogie cooling position</td>
</tr>
<tr>
<td>Instrument Service Air System (ISA)</td>
<td>Provides cooling air for weld machine cameras, provides air to operate weld station vacuum cleaner, glass shard sampling equipment and canister lid lifter, provides air for decontaminating pour tunnel bogies.</td>
</tr>
<tr>
<td>HLW Demineralized Water System (DIW)</td>
<td>Provides water for decontaminating pour tunnel bogies</td>
</tr>
<tr>
<td>C5 Ventilation System &amp; C3 Ventilation System (C5V &amp; C3V)</td>
<td>Provides adequate airflow and negative pressure for contamination control</td>
</tr>
<tr>
<td>Radioactive Liquid Waste Disposal System (RLD)</td>
<td>RLD receives liquid washdown effluent from the HPH system</td>
</tr>
</tbody>
</table>
10 Applicable Documents

10.1 Project Documents

The following documents form the basis for requirements and compliance statements incorporated into the system description.

<table>
<thead>
<tr>
<th>Document Number</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>DE-AC27-01RV14136</td>
<td>DOE/BNI Contract</td>
</tr>
<tr>
<td>24590-WTP-DB-ENG-01-001</td>
<td>Basis of Design</td>
</tr>
<tr>
<td>24590-WTP-RPT-OP-01-001</td>
<td>Operations Requirements Document</td>
</tr>
<tr>
<td>24590-WTP-PSAR-ESH-01-002-04</td>
<td>Preliminary Documented Safety Analysis to Support Construction Authorization; HLW Facility Specific Information</td>
</tr>
<tr>
<td>24590-PLW-PL-RT-07-0001</td>
<td>IHLW Waste Form Compliance Plan for the Hanford Tank Waste Treatment and Immobilization Plant</td>
</tr>
<tr>
<td>24590-WTP-GPP-SRAD-002</td>
<td>Application of ALARA in the Design Process</td>
</tr>
<tr>
<td>24590-WTP-PL-G-01-001</td>
<td>Functional Specification</td>
</tr>
</tbody>
</table>

10.2 Waste Screening Forms

<table>
<thead>
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<tr>
<td>24590-PLW-WSF-ENG-07-002</td>
<td>WTP HLW Canister Processing Activities</td>
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<tr>
<td>24590-PLW-WSF-ENG-07-003</td>
<td>WTP HLW Canister Handling</td>
</tr>
<tr>
<td>24590-PLW-WSF-ENG-09-002</td>
<td>WTP HLW Canister Lid Welding</td>
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10.3 System Documents

10.3.1 Facility General Arrangement Plans

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>24590-PLW-P1-P01T-00001</td>
<td>HLW Vitrification Building General Arrangement Plan at El. -21' -0' In.</td>
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<tr>
<td>24590-PLW-P1-P01T-00002</td>
<td>HLW Vitrification Building General Arrangement Plan at El. 0' -0' In.</td>
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<tr>
<td>24590-PLW-P1-P01T-00004</td>
<td>HLW Vitrification Building General Arrangement Plan at El. 30' -0' In.</td>
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10.3.2 Facility Equipment Location Drawings

<table>
<thead>
<tr>
<th>Document Number</th>
<th>Document Title</th>
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<tbody>
<tr>
<td>24590-PLW-P1-P23T-00009</td>
<td>HLW Vitrification Building Equipment Location Plan EL. -21'-0'/Area 9</td>
</tr>
<tr>
<td>24590-PLW-P1-P23T-00010</td>
<td>HLW Vitrification Building Equipment Location Plan EL. -21'-0'/Area 10</td>
</tr>
<tr>
<td>24590-PLW-P1-P23T-00014</td>
<td>HLW Vitrification Building Equipment Location Plan EL. -21'-0'/Area 14</td>
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<tr>
<td>24590-PLW-P1-P23T-00015</td>
<td>HLW Vitrification Building Equipment Location Plan EL. -21'-0'/Area 15</td>
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</tbody>
</table>
24590-HLW-P1-P23T-00119  HLW Vitrification Building Equipment Location Plan EL. 0'-0"/Area 119
24590-HLW-P1-P23T-00120  HLW Vitrification Building Equipment Location Plan EL. 0'-0"/Area 120
24590-HLW-P1-P23T-00213  HLW Vitrification Building Equipment Location Plan EL. 14'-0"/Area 213
24590-HLW-P1-P23T-00214  HLW Vitrification Building Equipment Location Plan EL. 14'-0"/Area 214
24590-HLW-P1-P23T-00215  HLW Vitrification Building Equipment Location Plan EL. 14'-0"/Area 215
24590-HLW-P1-P23T-00218  HLW Vitrification Building Equipment Location Plan EL. 14'-0"/Area 218
24590-HLW-P1-P23T-00219  HLW Vitrification Building Equipment Location Plan EL. 14'-0"/Area 219
24590-HLW-P1-P23T-00220  HLW Vitrification Building Equipment Location Plan EL. 14'-0"/Area 220

10.3.3 Mechanical Handling Diagrams

<table>
<thead>
<tr>
<th>Document Number</th>
<th>Document Title</th>
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</thead>
<tbody>
<tr>
<td>24590-HLW-M7-HPH-00001001</td>
<td>HLW Vitrification System HPH Mechanical Handling Diagram Canister Pour Handling Canister Handling Cave</td>
</tr>
<tr>
<td>24590-HLW-M7-HPH-00001002</td>
<td>HLW Vitrification System HPH Mechanical Handling Diagram Canister Pour Handling Canister Handling Cave</td>
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<tr>
<td>24590-HLW-M7-HPH-00001003</td>
<td>HLW Vitrification System HPH Mechanical Handling Diagram Canister Pour Handling Pour Tunnel 1</td>
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<tr>
<td>24590-HLW-M7-HPH-00001004</td>
<td>HLW Vitrification System HPH Mechanical Handling Diagram Canister Pour Handling Canister Weld Station</td>
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<tr>
<td>24590-HLW-M7-HPH-00001005</td>
<td>HLW Vitrification System HPH Mechanical Handling Diagram Canister Pour Handling Pour Tunnel 2</td>
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<tr>
<td>24590-HLW-M7-HPH-00001006</td>
<td>HLW Vitrification System HPH Mechanical Handling Diagram Canister Pour Handling System</td>
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<tr>
<td>24590-HLW-M7-HPH-00001007</td>
<td>HLW Vitrification System HPH Mechanical Handling Diagram Canister Pour Handling System</td>
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10.3.4 Mechanical Sequence Diagram

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<tbody>
<tr>
<td>24590-HLW-M1-HPH-00001</td>
<td>Mechanical Sequence Diagram for HLW Vitrification System HPH</td>
</tr>
</tbody>
</table>

10.3.5 Data Sheets & Design Proposal Drawings

Data sheets and design proposal drawings that formed the original design documents for equipment in system HPH are listed on equipment list 24590-HLW-M0X-M40T-00004.
10.3.6 P&ID’s and V&ID’s

<table>
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<th>Document Number</th>
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<tbody>
<tr>
<td>24590-HLW-M6-HPH-00001</td>
<td>P&amp;ID - HLW Mechanical Handling Canister Pour Handling Instrument Service Air System HPH</td>
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<tr>
<td>24590-HLW-M6-HPH-00002</td>
<td>P&amp;ID - HLW Mechanical Handling Canister Pour Handling Shield Gas Supply System HPH</td>
</tr>
<tr>
<td>24590-HLW-M6-RLD-00004</td>
<td>P&amp;ID - HLW Radioactive Liquid Waste Disposal System Miscellaneous Sumps</td>
</tr>
<tr>
<td>24590-HLW-M6-RLD-00016</td>
<td>P&amp;ID - HLW Radioactive Liquid Waste Disposal System Miscellaneous Sumps</td>
</tr>
<tr>
<td>24590-HLW-M6-RLD-20004</td>
<td>P&amp;ID - HLW Radioactive Liquid Waste Disposal System Miscellaneous Sumps Melter 2</td>
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<tr>
<td>24590-HLW-M8-C5V-00003001</td>
<td>HLW Vitrification Building System C5V Volumetric V&amp;ID Canister Operations Area</td>
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<tr>
<td>24590-HLW-M8-C5V-00001001</td>
<td>HLW Vitrification Building System C5V Volumetric V&amp;ID Melter Cave No. 1</td>
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<tr>
<td>24590-HLW-M8-C5V-00002001</td>
<td>HLW Vitrification Building System C5V Volumetric V&amp;ID Melter Cave No. 2</td>
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<tr>
<td>24590-HLW-M6-DIW-00001002</td>
<td>P&amp;ID HLW Demineralized Water System Demineralized Water Distribution</td>
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10.3.7 Engineering Specifications

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<tr>
<td>24590-WTP-3PS-MJKG-T0003</td>
<td>Engineering Specification for CMAA 70 High Integrity Cranes</td>
</tr>
<tr>
<td>24590-WTP-3PS-MJKG-T0002</td>
<td>Engineering Specification For CMAA 74 Top Running &amp; Under Running Single Girder &amp; CMAA 70 Top Running Bridge &amp; Gantry Type Multiple Girder EOT Cranes</td>
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<tr>
<td>24590-WTP-3PS-MQL0-T0003</td>
<td>Engineering Specification for Special Grapples and Lifting Devices</td>
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<tr>
<td>24590-HLW-3PS-30-T0001</td>
<td>Engineering Specification for HLW Canister Racks</td>
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<tr>
<td>24590-WTP-3PS-ADDH-T0006</td>
<td>Engineering Specification for QL Crane Maintenance Shield Doors for HLW and PTF</td>
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<tr>
<td>24590-WTP-3PS-MQR0-T0002</td>
<td>Engineering Specification for HLW Standardized Bogies</td>
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<tr>
<td>24590-WTP-3PS-ADDH-T0001</td>
<td>Engineering Specification for HLW/PTF Bogie Shield Doors</td>
</tr>
<tr>
<td>24590-WTP-3PS-ADDC-T0002</td>
<td>Engineering Specification for HLW/PT System Transfer Hatches, Hatch Drives, Hatch Pushrod Assemblies, and Floor Penetration Liner</td>
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<tr>
<td>24590-HLW-3PS-NW00-T0001</td>
<td>Engineering Specification for System HPH Canister Welding Station</td>
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<tr>
<td>24590-WTP-3PS-MV00-T0004</td>
<td>Engineering Specification for HLW Canister Welding Machine</td>
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<tr>
<td>24590-WTP-3PS-M000-T0006</td>
<td>Engineering Specification for WTP Facility Posting Port</td>
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<tr>
<td>24590-WTP-3PS-M000-T0007</td>
<td>Engineering Specification for WTP Facility Posting Port Glovebox</td>
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### 10.3.8 Project Equipment Drawings & Vendor Drawings

Project equipment drawings and vendor equipment drawings are listed 24590-HLW-M0X-M40T-00004 *Mechanical Handling Equipment List For HLW System HPH.*

### 10.3.9 Supplemental Documents

<table>
<thead>
<tr>
<th>Document Number</th>
<th>Document Title</th>
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<tbody>
<tr>
<td>24590-HLW-RPT-PE-07-001</td>
<td>High Level Waste Vitrification Plant Capacity Enhancement Study</td>
</tr>
<tr>
<td>24590-HLW-MSC-C5V-00006</td>
<td>Heat Release Data For An HLW Canister With Low Conductivity Glass In The HLW Pour Tunnel</td>
</tr>
<tr>
<td>24590-HLW-M0C-30-00003</td>
<td>HLW Canister Weight And Volume Calculations</td>
</tr>
<tr>
<td>24590-101-TSA-W000-0009-101-00007</td>
<td>RPP Pilot Melter Prototypic LAW Container and HLW Canister Glass Fill Test Results</td>
</tr>
<tr>
<td>24590-HLW-E8-LVE-00001</td>
<td>Electrical Load List HLW</td>
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<tr>
<td>24590-HLW-E21-LTE-00013</td>
<td>HLW Vitrification Building Canister Handling Cave Lighting Layout</td>
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<tr>
<td>24590-QL-POA-EL00-00002-04-00005</td>
<td>Lifting Beam Assembly Details (Lights)</td>
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<td>24590-QL-POA-EL00-00002-04-00006</td>
<td>Light Fixture Assembly Details</td>
</tr>
<tr>
<td>24590-HLW-PISW-ENG-05-0002</td>
<td>Life Cycle Document For Acquired Software Packaged With HLW Canister Welding Station Support Equipment</td>
</tr>
<tr>
<td>24590-HLW-PISW-ENG-06-0001</td>
<td>Life Cycle Document For Acquired Software Packaged With HLW/PTF Posting Port Equipment - not yet issued</td>
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<tr>
<td>24590-HLW-PISW-ENG-07-0004</td>
<td>Life Cycle Document For Software Acquired With HLW Canister Welder</td>
</tr>
<tr>
<td>24590-WTP-PISW-ENG-08-0001</td>
<td>Life Cycle Document For Non-Modifiable Configurable Firmware (NMCF) Acquired With Shield Doors Crane Maintenance</td>
</tr>
<tr>
<td>24590-HLW-PISW-ENG-08-0002</td>
<td>Life Cycle Document for In-Cave Process Cranes - not yet issued</td>
</tr>
<tr>
<td></td>
<td>Electrical Cable Block Diagrams - not yet issued (tracked by ATS 24590-WTP-ATS-QAIS-10-0995)</td>
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</table>
Appendix A ~ HPH System Mechanical Flow Diagrams
Mechanical Flow Diagram 2 (Level 2)

A. EMPTY CANISTER RECEIPT

B. TRANSFER EMPTY/NONCONFORMING CANISTER INTO CANISTER HANDLING CAGE BUFFER STORAGE AREA

C. TRANSFER EMPTY/NONCONFORMING CANISTER FROM THE BUFFER STORAGE AREA TO THE POUR TUNNEL

D. TRANSFER EMPTY CANISTER TO POUR STATION
Appendix B ~ Test Objectives
Appendix B - Test Objectives
System: HLW Canister Pour Handling System (HPH)

1.0 Purpose

This appendix identifies the test objectives for the HPH system.

2.0 Scope

Testing scope covers Test Acceptance Criteria (TAC), General Test Criteria (GTC) and Waste Acceptance Impacting (WAI) demonstration testing, and collection of baseline operating data.

Testing will be completed using permanent plant and equipment.

Testing need not necessarily be completed in the order that it is presented.

Prior to starting the WAI test work that is associated with the welding machine, the welding parameter values and acceptable ranges must already have been determined, and a weld procedure specification must be available. The determination of the welding parameter values and ranges is a WAI test, it is outside the scope of this system description.

2.1 Safety Interlocks (TAC)

- Demonstrate correct operation of posting port safety interlocks
- Demonstrate correct operation of pour tunnel bogie safety interlock

2.2 Equipment Recovery & Remote Maintenance (GTC)

- Confirm the correct operation of the canister handling process crane recovery system
- Demonstrate recovery of in-cave MSM slave arm
- Demonstrate recovery of in-cave wall mounted light
- Demonstrate recovery of shield window guards
- Demonstrate correct operation of the pour tunnel bogie recovery system
- Demonstrate alignment of canister and melter pour spout
- Demonstrate remote removal of bogie canister sleeve
- Demonstrate bogie decontamination in Pour Tunnel
- Demonstrate export route for removal of solid waste
- Demonstrate remote maintenance of the welding machine
- Demonstrate remote maintenance of the weld station carriage

2.3 GTC for WAI Testing & Demonstrations

- Demonstrate calibration of the welding machine components
- Demonstrate operation of the weld machine for a canister primary lid weld
- Demonstrate operation of the flange conditioning tool
- Demonstrate operation of the weld machine for a canister secondary lid weld
- Demonstrate the primary and secondary lid weld repair using the wire feed process
2.4 GTC for System Production Test

- Confirm system production rate
- Confirm the glove box ventilation flow rates
- Confirm shield door ventilation air gap flow rate

2.5 Baseline Operating Data

- Collect cooling data for glass filled canister

3.0 Support Systems

See Section 9 of the system description.
### HLW Canister Pour Handling System (HPH) Test Objectives

#### Table B-1: Functional Acceptance Criteria (FAC)

<table>
<thead>
<tr>
<th>Function / Performance Requirement (F&amp;R) (requiring testing)</th>
<th>Source</th>
<th>Acceptance Criteria (TAC or GFC)</th>
<th>Notes/Comments</th>
<th>Test Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operation of Posting Port Safety Interlocks</td>
<td>24590-WTP-PSAR-ESH-01-002-04 Table 4A-2</td>
<td>1. Demonstrate the safety shield door interlock prevents posting port (HPH-TWDVC-00009) in-cave and out-cave shield doors being in the open position at the same time (TAC)</td>
<td>1a) Close both shield doors  Open the out-cave shield door  Attempt to open the in-cave shield door  Confirm the safety interlock does not permit the in-cave shield door to open</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Demonstrate the safety gamma interlock prevents posting port (HPH-TWDVC-00009) out-cave shield door from opening if the gamma monitor (HPH-RS-3701 or HPH-RS-3801) detects a high radiation source (TAC)</td>
<td>1b) Close both shield doors  Open the in-cave shield door  Attempt to open the out-cave shield door  Confirm the safety interlock does not permit the out-cave shield door to open</td>
<td></td>
</tr>
<tr>
<td>Operation of Pour Tunnel Bogie Safety Interlock</td>
<td>24590-WTP-PSAR-ESH-01-002-04 Table 4A-2</td>
<td>1. On completion of a glass pour, demonstrate the safety interlock prevents the pour tunnel bogies (HPH-TRLY-00001, HPH-TRLY-00004, HPH-TRLY-00010 and HPH-TRLY-00011) moving more than 6' south of the glass pour position unless the canister has first cooled sufficiently (TAC)</td>
<td>This interlock is to be tested on each of the four bogies  This interlock is described in Section 6.4.1. The design of this Safety Significant interlock has not yet been completed. This issue is being tracked on ATS 24590-WTP-ATS-QAIS-16-0995</td>
<td></td>
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<table>
<thead>
<tr>
<th>Function / Performance Requirement (F&amp;R) (requiring testing)</th>
<th>Source</th>
<th>Acceptance Criteria (TAC or GTC)</th>
<th>Notes/Comments</th>
<th>Test Conditions</th>
</tr>
</thead>
</table>
| Process Crane Recovery System                               | 24590-WTP-RPT-OP-01-001 Section 14.16 | 1. Demonstrate that the process cranes (HPH-CRN-00001 and HPH-CRN-00002) bridge recovery jack-down wheels can be deployed and used to travel the full rail length (GTC)  
2. Demonstrate that the process cranes (HPH-CRN-00001 and HPH-CRN-00002) trolley recovery jack-down wheels can be deployed and used to travel the full length of the trolley rails (GTC)  
3. Demonstrate that the process cranes (HPH-CRN-00001 and HPH-CRN-00002) recovery hoist motors can be used to lower/raise the crane hook through its complete travel range (GTC) | “Full rail length” means from the full east-west travel distance of the cranes.  
There is no requirement for the crane to be carrying a load for these tests. | |
| Recovery of MSM In-Cave Slave Arms                          | 24590-WTP-DB-ENG-01-001 Section 11.4.1 | 1. Demonstrate that the upper in-cave process crane (HPH-CRN-00002) can be used to remove a weld station MSM slave arms and transport the arm into the crane maintenance area (GTC)  
2. Demonstrate that the upper in-cave process crane (HPH-CRN-00002) can be used to re-fit a weld station MSM slave arm. (GTC) | Testing 'may' be performed on one MSM only;  
Commissioning to select the MSM (HPH-MANIP-00008, HPH-MANIP-00009, HPH-MANIP-00010 and HPH-MANIP-00011) | |
| Recovery of in-cave wall mounted light                      | 24590-WTP-DB-ENG-01-001 Section 11.4.1 | 1. Demonstrate that the upper in-cave process crane (HPH-CRN-00002) can be used to remove an in-cave wall mounted light and transport the light into the crane maintenance area. Confirm crane can access all wall mounted lights. (GTC)  
2. Demonstrate that the upper in-cave process crane (HPH-CRN-00002) can be used to re-fit a wall mounted light. (GTC) | Testing 'may' be performed on one light only.  
Light lifting beam (LTE-LIFT-0000) or LTE-LIFT-00002 will be required to remove/re-fit the light | |
| Recovery of Weld Station Shield Window Guards               | 24590-WTP-DB-ENG-01-001 Section 11.4.1 | 1. Demonstrate that the upper in-cave process crane (HPH-CRN-00002) can be used to remove the weld station silent window guards. (GTC)  
2. Demonstrate that the upper in-cave process crane (HPH-CRN-00002) can be used to re-fit the weld station shield window guards. (GTC) | | |
| Pour Tunnel Bogie Recovery System                           | 24590-WTP-RPT-OP-01-001 Section 7.1 | 1. Demonstrate that the pour tunnel bogie manual hand-crank can be used to pull the bogie from the pour position to the pour tunnel hatch. (GTC) | Test to be performed on each bogie (HPH-TRLY-00001, HPH-TRLY-00004, HPH-TRLY-00010 and HPH-TRLY-00011)  
The bogies are to be loaded with a canister weighing approximately 9260 (max) lbs | |
| Alignment of Canister and Melter Pour Spout                 | System interface requirement CCN 650171 | Demonstrate that when the bogie is transferred to the glass pour location, the canister center line aligns with the pour spout center line to within +/- 1.125", and confirm the locking bolt can engage the bracket on the bogie chassis (GTC) | Test to be performed on each bogie (HPH-TRLY-00001, HPH-TRLY-00004, HPH-TRLY-00010 and HPH-TRLY-00011)  
The alignment is to be confirmed in the East-West and North-South directions | |
| Remote handling of Pour Tunnel Bogie Canister Sleeve        | 24590-WTP-DB-ENG-01-001 Section 11.4.1 | 1. Demonstrate that the pour tunnel bogie sleeve can be removed from the bogie and placed onto the canister sleeve storage rack (HPH-MHAN-000028) in the canister handling cave using the sleeve lifting beam (HPH-LIFT-00001) (GTC)  
2. Demonstrate that the canister sleeve can be removed from the canister handling cave storage rack and be placed onto the pour tunnel bogie (GTC) | Tests to be performed for each bogie canister sleeve (HPH-TRLY-00006, HPH-TRLY-00007, HPH-TRLY-00012 and HPH-TRLY-00013) | |
<table>
<thead>
<tr>
<th>Function / Performance Requirement (F&amp;R) (requiring testing)</th>
<th>Source</th>
<th>Acceptance Criteria (TAC or GTC)</th>
<th>Notes/Comments</th>
<th>Test Conditions</th>
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<tr>
<td>Bogie Decontamination in Pour Tunnel</td>
<td>24590-WTP-DB-ENG-01-001 Section 11.4.1</td>
<td>1. Demonstrate that when a bogie is located adjacent to the pour tunnel shield window, the pour tunnel MSM’s may be used to move the spray wand (HPH-TOOL-00010 or 00029) across the top surface of the bogie chassis. Using operational experience and engineering judgment confirm that the MSM and tooling has sufficient dexterity to decontaminate a bogie. (GTC)</td>
<td>Remove the canister sleeve from the bogie prior to starting this test. Test to be performed on both bogies in one pour tunnel only (HPH-TRLY-00001 and 00004 pour tunnel 1; HPH-TRLY-00010 and 00031 pour tunnel 2).</td>
<td>The test maybe performed with an empty waste basket and is to be performed using the west bogie in each pour tunnel (HPH-TRLY-00004 and HPH-TRLY-00011). Test 4 will require that the pour tunnel cover plates be removed prior to lifting the container into the melters cavities. The cover plates are part of the melter cavities handling system.</td>
</tr>
<tr>
<td>Remote Solid Waste Transfer to the HSH System</td>
<td>24590-WTP-RPT-OP-01-001 Section 20</td>
<td>1. Demonstrate that using weld station MSMs solid waste can be remotely loaded into a waste basket and the waste basket lid can be fitted (GTC) 2. Demonstrate that the waste basket can be remotely loaded into the waste basket transfer container (24590-ILW-MH-HPH-MHAN-00045) using the process cranes (HPH-CRN-00001 and 00002) (GTC) 3. Demonstrate that the process cranes (HPH-CRN-00001 and 00002) can be used to locate the waste basket transfer container onto the canister bogie sleeve (GTC) 4. Demonstrate that when the bogie is located at the north end of the pour tunnel the waste basket transfer container can be lifted into the melter cavity using the melter cavity cranes (HPH-MANIP-00010 and 00023) (GTC)</td>
<td></td>
<td>The installation/removal steps for components/modules are contained in the vendor maintenance manual 24590-CM-POA-HCHH-00004-03.0-00005 and in vendor design report 24590-CM-POA-HCHH-00004-08-00001. All in-cave work to be demonstrated using permanently installed MSMs and cranes. MSM compatible tooling will be required to complete this test work.</td>
</tr>
<tr>
<td>Remote Maintenance of welding machine</td>
<td>24590-WTP-DB-ENG-01-001 Section 11.4.1</td>
<td>Demonstrate that the following welding machine components/modules can be replaced remotely. The LAI number in brackets is the vendor part number: 1. Arc voltage control assembly (LAI-B3555-G01) (GTC) 2. Arc proximity switches (LAI-B3555-G03), canister clamp proximity switch (LAI-B3550-G02) &amp; home position proximity switch (LAI-B3563-004) (GTC) 3. Torch assembly (LAI-B3550-G01). (GTC) 4. Torch body &amp; electrode (sub-component of LAI-B3553-G01) (GTC) 5. Camera assembly (LAI-B3555-G01)(GTC) 6. Wire feed assembly (LAI-B3551-G01) (GTC) 7. Drive motor assembly (LAI-B3552-G01) (GTC) 8. Counterweight (GTC) 9. Record the time taken to perform the maintenance tasks (GTC)</td>
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<tr>
<td>Function / Performance Requirement (F&amp;R) (requiring testing)</td>
<td>Source</td>
<td>Acceptance Criteria (TAC or GTC)</td>
<td>Notes/Comments</td>
<td>Test Conditions</td>
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</tbody>
</table>
| Remote Maintenance of the Weld Station Carriage | 24590-WTP-DB-ENG-01-001 Section 11.4.1 | 1. Demonstrate that the welding carriage travel proximity switches can be replaced remotely (GTC)  
2. Demonstrate that the welding carriage actuator proximity switches can be replaced remotely (GTC)  
3. Demonstrate that all power and control cabling can be replaced remotely (GTC)  
4. Demonstrate that the weld carriage drive motor can be replaced remotely (GTC)  
5. Demonstrate that the weld station carriage can be remotely removed from the weld table (GTC)  
6. Demonstrate that the vertical actuator can be removed from the weld carriage remotely (GTC) | The installation/removal steps for remote maintenance are contained in the vendor maintenance manual 24590-CM-POA-HCHH-00003-0-00009  
All in-cave work to be demonstrated using permanently installed MSMs and cranes. MSM compatible tooling will be required to complete this test work. |  |
| Calibration of welding machine components | 24590-HLW-WSF-ENG-09-002 | Demonstrate that the following weld machine calibrations can be performed:  
1. Current calibration (GTC)  
2. Voltage calibration (GTC)  
3. Shield gas flow calibration (GTC)  
Demonstrate that verification can be performed on the following parameters:  
1. Rotation accuracy (GTC)  
2. Rotation speed (GTC)  
3. Rotation dwell (GTC)  
4. Wire feed accuracy (GTC)  
5. Wire feed speed (GTC)  
6. Power supply timing (GTC) | This testing is Waste Acceptance Impacting  
Welding machine calibration and verification is addressed in the vendor maintenance manual 24590-CM-POA-HCHH-00004-03-00005 |  |
| Demonstrate the Operation of the Welding Machine for a Primary Lid Weld | 24590-HLW-WSF-ENG-09-002 | Demonstrate that the weld machine produces a primary lid weld that:  
1. Meets the welding detail shown on drawing 24590-HL-W-M0-30-00001008 (GTC)  
2. Is leak tight to less than 10⁻⁶ atm·cc/sec helium in accordance with Section V of the ASME B&PVC (GTC)  
3. Meets the requirements of Section IX of the ASME B&PVC (GTC)  
Confirm the values of the critical welding parameters remained in the allowable ranges (GTC)  
Demonstrate that the weld surface can be visually inspected using the weld station cameras (GTC) | This testing is Waste Acceptance Impacting  
This is a full demonstration of the weld machine operability. The testing shall be performed under simulated operational conditions. The welding machine shall be fitted to the weld station carriage for this test.  
A pre-requisite to starting this test is the determination of the values & ranges of the critical welding parameters; this work is outside the scope of this system description. This open issue is tracked on 24590-WTP-ATS-QAR-10-0995  
The number of welds to be performed has yet to be determined. This open issue is tracked on 24590-WTP-ATS-QAR-10-0995  
Refer to vendor design report 24590-CM-POA-HCHH-00004-08-00001 and operating manual 24590-CM-POA-HCHH-00004-12-00001. |  |
<table>
<thead>
<tr>
<th>Function / Performance Requirement (F&amp;R) (requiring testing)</th>
<th>Source</th>
<th>Acceptance Criteria (TAC or GTC)</th>
<th>Notes/Comments</th>
<th>Test Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demonstrate the Operation of the flange conditioning tool</td>
<td>24590-HLW-WSF-ENG-09-002</td>
<td>Demonstrate that the flange conditioning tool (24590-HLW-FH-HPH-TOOL-00007) can be used remotely to machine a recess into the top of the canister that meets the requirements shown on drawing 24590-HLW-M0-30-00001008 (GTC)</td>
<td>This testing is Waste Acceptance Impacting</td>
<td>This is a full demonstration of the flange conditioning tool operability. The testing shall be performed under simulated operational conditions.</td>
</tr>
<tr>
<td>Demonstrate the Operation of the Welding Machine for a Secondary Lid Weld</td>
<td>24590-HLW-WSF-ENG-09-002</td>
<td>Demonstrate that the weld machine produces a secondary lid weld that: 1. Meets the welding detail shown on drawing 24590-HLW-M0-30-00001008 (GTC) 2. Is leak tight to less than 10⁻⁹ atm-cm/sec helium in accordance with Section V of the ASME B&amp;PVC (GTC) 3. Meets the requirements of Section IX of the ASME B&amp;PVC (GTC) Confirm the values of the critical welding parameters remained in the allowable ranges (GTC) Demonstrate that the weld surface can be visually inspected using the weld station cameras (GTC)</td>
<td>This testing is Waste Acceptance Impacting</td>
<td>This is a full demonstration of the weld machine operability. The testing shall be performed under simulated operational conditions; the welding machine shall be fitted to the weld station carriage for this test. A pre-requisite to starting these tests is the determination of the values &amp; ranges of the critical welding parameters; this work is outside the scope of this system description. This open issue is tracked on 24590-WTP-ATS-QAIS-10-0995 The number of welds to be performed has yet to be determined. This open issue is tracked on 24590-WTP-ATS-QAIS-10-0995 Refer to vendor design report 24590-CM-POA-HCHH-00004-08-00001 and operating manual 24590-CM-POA-HCHH-00004-12-00001.</td>
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| Demonstrate primary and secondary lid weld repair using the wire feed weld process | 24590-HLW-WSF-ENG-09-002 | 1. Demonstrate that the wire feed system can be used for repair purposes on the primary lid weld (GTC)  
2. Demonstrate that the wire feed system can be used for repair purposes on the secondary lid weld (GTC) | This testing is Waste Acceptance Impacting  
This is a full demonstration of the weld machine operability. The testing shall be performed under simulated operational conditions; the welding machine shall be fitted to the weld station carriage for this test.  
A pre-requisite to starting this test is the determination of the values & ranges of the critical welding parameters; this work is outside the scope of this system description. This open issue is tracked on 24590-WTP-ATS-QAIS-10-0995  
The number of welds to be performed has yet to be determined. This open issue is tracked on 24590-WTP-ATS-QAIS-10-0995  
Specific test acceptance criteria have not yet been developed. This open issue is tracked on 24590-WTP-ATS-QAIS-10-0995 | |
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| System Production Test                                      | 24590-WTP-DB-ENG-01-001 Section 6.3.3 | 1. Demonstrate, simulating operating conditions, that an empty canister can be transferred from the HRH system and run through the entire HPH system process. Confirm that the following process step times can be achieved (GTC):  
   - Demonstrate that a canister can be lifted from the import bogie (HRH-TRLY-00002) and transferred to pour tunnel bogie (HPH-TRLY-00011) in less than 46 minutes (GTC)  
   - Demonstrate that a canister can be lifted from the import bogie (HRH-TRLY-00002) and transferred to a storage location along the southern side the buffer rack (HPH-MHAN-00017) in less than 38 minutes (GTC)  
   - Demonstrate that a canister can be moved from the southern side of the buffer rack (HPH-MHAN-00017) and transferred to pour tunnel bogie (HPH-TRLY-00011) in less than 23 minutes (GTC)  
   - Demonstrate that pour tunnel bogie (HPH-TRLY-00011) can be transferred from the canister loading position to the glass pour position in less than 8 minutes (this includes engaging the bogie locking bolt) (GTC)  
   - Demonstrate that a canister can be removed from pour tunnel bogie (HPH-TRLY-00011) and be transferred to the southern side of the canister cooling rack (HPH-MHAN-00014) in less than 27 minutes (GTC)  
   - Demonstrate that a canister can be transferred from the cooling rack (HPH-MHAN-00014) to the east or west weld station in less than 21 minutes (GTC)  
   - Demonstrate that ALL of the following can be completed in less than 498 minutes:  
     a) Glass fill height can be measured (GTC)  
     b) A glass sample can be collected from the canister and placed into a sample vial (GTC)  
     c) A primary lid can be welded onto a canister (GTC)  
     d) The weld cap can be inspected and the values of the welding parameters can be confirmed (GTC) | The process times are taken from Step number 12, Table 69 of 24590-WTP-MDD-PR-01-001 rev 10. | Test 3: The bolts are tightened manually after the shielded lid has been fitted to the flask body. |
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| **Glove Box Ventilation**                                   | 24590-WTP-RPT-OP-01-001 Section 14.15 | 1. Demonstrate that the glove box (24590-HLW-M0-HPH-GB-00001) air flow rate is set at the correct value (GTC). Nominal flow rate 200 cfm.  
2. Demonstrate that the air velocity through a single open glove port of the glove box ((24590-HLW-M0-HPH-GB-00001)) is between 100-150 fpm. (GTC) | The glove box pressure and flow rate (including the range of permitted values) will set up as part of the C5 ventilation system balance. Refer to V&ID 24590-HLW-M8-CSV-00003001 and system description 24590-HLW-3YD-30-00002  
Test 2 simulates a breach of the glove box equivalent to the loss of one glove. This test will be performed as part of the C5 ventilation system balance. Refer to V&ID 24590-HLW-M8-CSV-000003001 and system description 24590-HLW-3YD-30-00002  
The air flow requirement is contained in 24590-WTP-3PS-M080-00007, Appendix B. Test 2 is to be added to the vent system description 24590-HLW-3YD-30-00002. This is being tracked by ATS 24590-WTP-ATS-QAIS-10-0995 | |
| **Shield Door Ventilation Air Gaps**                       | 24590-WTP-PSAR-ESH-01-002-04 Section 4.4.1.2 | 1. Demonstrate that the air gaps around the maintenance area and decontamination area vertical and horizontal shield doors are set, as required, to provide the correct containment air flow into the C5/R3 canister handling cave (TAC). Flow rate 2200 cfm. (TAC)  
2. Demonstrate that the air gaps around the pour tunnel bogie shield doors are set, as required, to provide the correct containment air flow into the C5/R3 pour tunnels (TAC). Flow rate 2250 cfm (TAC)  
3. Demonstrate that the vertical air gap between the edges of the pour tunnel bogie doors and the wall is a minimum of 0.5". This requirement extends from the base of the door to a height of 12" from the base of the door (TAC) | The air gaps and flow rate (including the range of permitted values) will be set up as part of the C5 ventilation system balance. Refer to V&ID 24590-HLW-M8-CSV-00003001, 24590-HLW-M8-CSV-00002001 and system description 24590-HLW-3YD-30-00002  
The requirement in Test 3 is to limit floor loading in the bogie maintenance area due to flooding | |

*Note: Test Acceptance Criteria (TAC) are requirements based on All documents and General Test Criteria (GTC) are requirements from other sources.*
<table>
<thead>
<tr>
<th>Function / Performance Requirement (F&amp;Rs) (requiring testing)</th>
<th>Source</th>
<th>Data to be Collected</th>
<th>Notes/Comments</th>
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</tr>
</thead>
</table>
| Canister Cooling Data                                       | Design requirement to confirm calculated results in 24590-HLW-M8C-C5V-00006 | The following data is to be collected:  
1. During the glass pour process collect canister skin temperature data at the base of the canister, at a distance of 10-12" below the top of the flange; at the flange neck, and at 3 positions along the length of the canister.  
2. On completion of the glass pour, collect canister cooling data at the same positions over a 25 hour time frame; start a second glass pour from the other melter pour spout as soon as possible after completion of the first glass fill. | It is suggested that thermocouples be used for collecting this data so a temperature-time history is available over the entire glass pour/cooling period, rather than using a hand-held instrument to collect “spot” readings. | The pour tunnel C3V ventilation system, including the air chilling units, is to be running in the balanced condition prior to collecting this data. Glass pour rate to be 6 MTH/day. |