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By Washington River Protection Solutions, LLC., PO Box 850, Richland, WA 99352
Contractor For U.S. Department of Energy, Office of River Protection, under Contract DE-AC27-08RV14800

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Low-Activity Waste Melter Replacement and Disposition Logistics Alternatives Analysis

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EXECUTIVE SUMMARY

The U.S. Department of Energy (DOE) Office of River Protection (ORP) has adopted the Direct-Feed Low-Activity Waste (DFLAW) Program, which will operate the Low-Activity Waste (LAW) Vitrification Facility to immobilize LAW years earlier than the rest of the Waste Treatment and Immobilization Plant (WTP) processing facilities. Heat up and start of joule-heated operation of the two LAW melters to support cold commissioning is scheduled for mid-fiscal year 2020. LAW melters have a design life and expected operating life of 5 years, after which replacement is anticipated.

To support continued operation of the LAW Vitrification Facility, the existing melters will need to be replaced and used melters will need to be prepared for disposal. The WTP Engineering, Procurement, Construction, and Commissioning (EPCC) contractor is responsible for procuring and storing the components necessary for a third melter. Contract direction has not been provided to any Hanford contractor assigning responsibility for procurement of melter components beyond a third melter; assembly, storage, or transport of any replacement LAW melters; or preparation of used LAW melters for disposal. The lack of planning for developing the capability to provide replacement melters has been identified as a significant risk to sustained LAW Vitrification Facility operations.

The objective of this analysis is to provide a recommended life-cycle management approach during the operational phase of the LAW Vitrification Facility for replacement and disposition of the used melters. This study documents the process of identifying and screening options to arrive at a set of alternatives for melter replacement and disposition using criteria important to successfully supporting LAW Vitrification Facility continued operation. The information assembled as part of this effort was presented to a workshop of individuals representing ORP, the Tank Operations Contractor (TOC), WTP Contractor, Plateau Remediation Contractor (PRC), and other contractors who jointly evaluated the information and arrived at a recommended approach to provide replacement melters and prepare used melters for disposal. The recommended path forward is to:

- Pursue off-site assembly and storage of replacement LAW melters, and for ORP to provide contract direction and authorization as soon as practical to implement the recommendation.
- Provide a treatment and storage pad at the Integrated Disposal Facility (IDF) to perform void filling and treatment (i.e., immobilization technology to meet land disposal restrictions) operations for used LAW melters, and for DOE Richland Operations Office (RL) to provide contract direction and authorization as soon as practical to implement the recommendation.
Comparison Case

To understand the logistics for providing replacement LAW melters and preparing used LAW melters for disposal, a “comparison case” was developed (Section 3.0 provides details). This comparison case is based on current contract scopes and direction, and the assumption that future contract direction will not be given to the (still to be determined) WTP Operating Contractor until the start of LAW Vitrification Facility operations (post-completion of hot commissioning and transition from the WTP EPCC contractor), authorizing them to provide for subsequent procurement, assembly, storage, and transport of replacement melters.

This comparison case approach results in replacement melters not being available until 4 years (first melter) and 6 years (second melter) beyond the 5-year design life. This approach is considered a significant risk to sustaining LAW Vitrification Facility operations.

Melter Replacement Alternatives

The LAW melter replacement alternatives analysis (described in Section 4.0) identifies options to mitigate the significant risk to sustained operations due to the unavailability of replacement LAW melters. From all the options considered for providing replacement melters, three alternatives were identified for detailed evaluation. These three options are:

- **R1 – Off-site assembly and storage.** Melters are assembled at an existing or purpose-built facility located off the Hanford Site, stored at this location until required for use, and then transported via road to WTP for installation.

- **R2 – On-site assembly and storage adjacent to the LAW Vitrification Facility pad.** Melters are assembled and stored immediately adjacent to the LAW Vitrification Facility at a purpose-built facility located south of the existing LAW Vitrification Facility pad.

- **R3 – On-site assembly and storage in the 200 Area.** Melters are assembled and stored at a location within the 200 Area of the Hanford Site but sufficiently distanced from WTP and other facilities such that assembly activities do not impact site operations, and vice versa.

The detailed information developed for each of these three alternatives was jointly evaluated by a team that included TOC, WTP, PRC and others during a facilitated workshop and scored against comparative criteria, which consisted of several subcriteria. Alternatives were scored against the subcriteria using a numeric rating system of 1, 3, or 5, with a score of 1 representing the best possible score. Scores for each subcriterion were summed to arrive at a total score for each alternative. Based on the workshop scoring, Alternative R1, Off-Site Assembly and Storage, is the recommended alternative (lowest score). The major discriminators favoring Alternative R1 are:

- Reduced nuclear safety and radiological risk compared to Alternative R2
- Earliest available means to start melter assembly and therefore, earliest available assembled spare melter
- Only alternative that provides two assembled melters by the end of the 5-year design life of the installed melters
- No impacts to ongoing construction or commissioning at WTP
• Eliminates need for an on-site melter assembly facility capital acquisition project by contracting for the service of melter assembly and storage.

The most significant concern regarding off-site assembly and storage is that the melters are subject to stringent lateral acceleration limits once assembled, which if exceeded could result in a significantly reduced melter life expectancy. A local transportation company with expertise in large component transportation attended the workshop and undertook a study to evaluate the route, concluding that melter transport to WTP from an off-site location was feasible with minimal risk. This alternative minimizes mission risks through early identification of a suitable contractor with off-site melter assembly and storage capability, and provides the earliest available replacement melters, with two replacement melters available by the end of the design life of the installed melters.

**Melter Preparation for Disposal Alternatives**

The IDF has been identified as the disposal location for used LAW melters. Waste acceptance criteria have not been established for used melters because the IDF is not currently permitted for used LAW melter disposal. The LAW melter disposition alternatives analysis (discussed in Section 5.0) identifies options that satisfy conditions for successful LAW melter disposal. From all the options considered for preparing used melters for disposal, four alternatives were identified for detailed evaluation. These four options are:

• **D1 – Disposal preparation in LAW Vitrification Facility gallery/airlock.** After a used melter is disconnected, but prior to removing it from the facility airlock, the used melter is void-filled and treated via an immobilization technology.

• **D2 – Disposal preparation at adjacent LAW pad/airlock/gallery.** After being disconnected and seal-welded, a used melter is moved to the adjacent set of rails or moved into one of the other two airlocks where the used melter is void-filled and treated via an immobilization technology.

• **D3 – Disposal preparation at a new IDF pad.** After being disconnected and seal-welded, a used melter is moved to a new treatment and storage pad at the IDF where the used melter is void-filled and treated via an immobilization technology.

• **D4 – Disposal preparation at a new WTP pad.** After being disconnected and seal-welded, a used melter is moved to a new treatment and storage pad at the WTP where the used melter is void-filled and treated via an immobilization technology.

The detailed information developed for each of these four alternatives was jointly evaluated by a team that included TOC, WTP, PRC, and others during a facilitated workshop and scored against the same comparative criteria and in the same manner as the melter replacement alternatives described above. Based on the workshop scoring, Alternative D3, Disposal Preparation at a New IDF Pad, is the recommended alternative (lowest score). This alternative has the least mission impact by moving the used melter out of the facility and away from WTP as soon as possible.
Near-Term Path Forward to Implement Recommended Alternatives

The following actions should be taken as soon as practical to implement the recommended replacement melter alternative, off-site assembly and storage:

• Perform demonstration test to verify an assembled melter can be moved from the Hanford 300 Area to the WTP site within acceleration limits
• Issue a request for information/expression of interest to determine level of interest, including facility or site availability, for melter assembly and storage
• DOE decide on replacement LAW melter alternative and issue a decision document
• DOE identify contractor responsibility and provide contract direction and authorization for proceeding with replacement melter procurement, assembly, and storage
• Develop a detailed strategy, including schedule of activities, outlining the approach for procurement, assembly, and storage of replacement melters.

The following actions should be taken as soon as practical to implement the recommended used melter preparation for disposal alternative, disposal preparation at a new IDF pad:

• DOE identify contractor responsibility and provide contract direction and authorization for proceeding with used melter preparation for disposal
• Determine uses for a treatment and storage pad at IDF and decide whether to incorporate used LAW melter preparation for disposal within the scope of the currently planned pad or to defer the scope to a separate pad permitted and designed at a later date
• Perform a void-fill study to determine what extent of void filling is required to comply with a 90 percent void-fill criterion. The study should include recommendations regarding providing access to voids within the melter.
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LIST OF TERMS

Abbreviations, Initialisms, and Acronyms

AASHTO American Association of State Highway and Transportation Officials
ALARA as low as reasonably achievable
BNI Bechtel National, Inc.
BOF balance of facilities
CFR Code of Federal Regulations
CHPRC CH2M HILL Plateau Remediation Company
DFLAW direct feed low-activity waste
DOE U.S. Department of Energy
DOH State of Washington Department of Health
DOT U.S. Department of Transportation
DSA documented safety analysis
DWPF Defense Waste Processing Facility
Ecology Washington State Department of Ecology
EFRT External Flowsheet Review Team
EIS Environmental Impact Statement
EPA U.S. Environmental Protection Agency
EPCC engineering, procurement, construction, and commissioning
FY fiscal year
HDPE high-density polyethylene
HEPA high-efficiency particulate air
HIC high-integrity container
HLW high-level waste
ICD interface control document
IDF Integrated Disposal Facility
ILAW immobilized low-activity waste
IP-1 Industrial Package Type 1
IP-2 Industrial Package Type 2
IP-3 Industrial Package Type 3
LAB Waste Treatment and Immobilization Plant Analytical Laboratory
LAW low-activity waste
LAWPS low-activity waste pretreatment system
LBL Waste Treatment and Immobilization Plant Analytical Laboratory, Balance of Facilities, and LAW Vitrification Facility
LDPE low-density polyethylene
LDR land disposal restrictions
LLBG low-level burial grounds
LLW low-level waste
LMH low-activity waste melter handling
LSH low-activity waste melter equipment support handling
MLLW mixed low-level waste
MSA Mission Support Alliance, LLC
NEPA National Environmental Policy Act
NOX nitrogen oxides
NRC U.S. Nuclear Regulatory Commission
NSR New Source Review
ORP U.S. Department of Energy, Office of River Protection
OTRS one-time request for shipment
PRC Plateau Remediation Contractor
PSSD package-specific safety document
PT pretreatment
RCRA Resource Conservation and Recovery Act
RL U.S. Department of Energy, Richland Operations Office
ROM rough order of magnitude
SARP safety analysis report for packaging
SEPA State Environmental Policy Act
SPA special packaging authorization
SSC structures, systems, and components
TC & WM Tank Closure and Waste Management
TCLP toxicity characteristic leaching procedure
TOC Tank Operations Contractor
TSD treatment, storage, and disposal
TSD transportation safety document
USQ unreviewed safety question
WAC Washington Administrative Code
WRPS Washington River Protection Solutions, LLC
WTCC Waste Treatment Completion Contractor
WTP Waste Treatment and Immobilization Plant

Units
°F degrees Fahrenheit
ft feet
ft² square feet
ft³ cubic feet
g acceleration of gravity
hr hour
in. inch
kg kilogram
L liter
lb pound
m³ cubic meter
mg milligram
mi mile
mL milliliter
mm millimeter
mrem millirem
MTG metric tons of glass
vol% volume percent
wt% weight percent
1.0 INTRODUCTION

The 177 underground storage tanks at the Hanford Site are estimated to contain approximately 56 million gallons of mixed radioactive and hazardous waste (ORP-11242, River Protection Project System Plan). A key aspect of implementing the U.S. Department of Energy (DOE) Office of River Protection (ORP) mission is to construct and operate the Waste Treatment and Immobilization Plant (WTP), which will immobilize the tank waste. The complexity of the waste itself as well as the WTP facilities has led to difficult technical issues primarily concerning the WTP Pretreatment (PT) Facility and to a lesser extent the WTP High-Level Waste (HLW) Vitrification Facility (DOE 2013). Because the original design of the WTP anticipated all of the waste first being processed through the PT Facility, immobilization of waste could not occur under the original plan until the technical issues involving the PT Facility could be resolved.

An alternative approach was identified and is being implemented to immobilize waste as soon as practicable, while simultaneously resolving the remaining technical challenges. ORP has adopted the direct-feed low-activity waste (DFLAW) option which allows the Low-Activity Waste (LAW) Vitrification Facility to begin immobilizing LAW years earlier than if work was deferred until full completion of the WTP. This approach consists of starting up portions of the WTP Analytical Laboratory (LAB), balance of facilities (BOF) necessary to support DFLAW, and the LAW Vitrification Facility, collectively referred to as the LBL. Key DFLAW activities include (1) completing tank farms infrastructure and an interim LAW pretreatment system (LAWPS) needed to directly feed the LAW Vitrification Facility; (2) completing, commissioning, and starting up the LAW Vitrification Facility and the balance of LBL necessary to support the LAW Vitrification Facility; and (3) final permitting of the Integrated Disposal Facility (IDF) for on-site disposal of LAW. To support continued operation of the LAW Vitrification Facility after startup, the existing melters (with a 5-year design life) will need to be replaced and the used melters will need to be disposed. This report evaluates logistical alternatives for providing replacement melters and dispositioning used melters.

This study is being performed under the RPP-51471, One System Charter, strategic objective regarding “…coordination and integration of programmatic activities need to more effectively and efficiently conduct…operations, initially focused on DFLAW program integration.”

1.1 OBJECTIVE

The objective of this study is to provide a recommended life-cycle management approach during the operational phase of the LAW Vitrification Facility for replacement and disposition of the used melters. This study provides a life-cycle evaluation of LAW melter replacement and disposition to help ensure the WTP facility can be efficiently operated during its operational phase. This study provides information and assessments to identify the necessary capabilities and capacities for LAW melter replacement and disposition.

1.2 SCOPE

The scope of this study encompasses activities associated with providing replacement melters and dispositioning used melters for the LAW Vitrification Facility. The timeframe of interest is the operational phase of the LAW Vitrification Facility.
The WTP contract covers engineering, procurement, construction, commissioning (EPCC), and transition support to the WTP Operating Contractor (DE-AC27-01RV14136, *Design, Construction, and Commissioning of the Hanford Tank Waste Treatment and Immobilization Plant*). As part of the WTP contract scope, ORP directed Bechtel National, Inc. (BNI) “…to erect temporary facilities for the assembly and installation of two melters…for…LAW, and the procurement/storage of one unassembled spare melter for…LAW utilizing existing appropriate storage facilities” (Williams 2009). DOE intends to select a WTP Operating Contractor who will operate and maintain the LAW Vitrification Facility and other operating portions of the WTP as specified in that future operating contract. It is assumed the WTP EPCC contractor shall transition to the WTP Operating Contractor after successful hot commissioning of the LAW Vitrification Facility by the WTP EPCC contractor. According to the current WTP contract, a facility transition plan shall be prepared by the WTP contractor no later than 12 months prior to the start of hot commissioning. The transition will include turnover of spare parts to the WTP Operating Contractor, as instructed by DOE. Based on current contract scope and direction, the WTP Operating Contractor at the beginning of operations will have two installed melters and one unassembled spare melter.

The scope of activities covering melter replacement and disposition described in this study are:

- Replacement LAW melters acquisition
  - Replacement LAW melter procurement (except for the first spare melter)
  - Replacement LAW melter assembly/storage
  - Assembled replacement LAW melter transport
  - Assembled replacement LAW melter installation
- Used LAW melters disposition
  - Used LAW melter removal
  - Used LAW melter disposal preparation
  - Used LAW melter transport
  - Used LAW melter disposal.

### 1.3 BACKGROUND

Discussions regarding the importance of identifying and evaluating alternatives for providing replacement LAW melters and dispositioning used LAW melters are provided in the following subsections. Descriptive information regarding the LAW melter is also provided in this section.

#### 1.3.1 Operational Phase Replacement Low-Activity Waste Melters

The original plans for melter assembly included a central, permanent BOF structure for on-site melter assembly, complete with an on-site transporter (24590-WTP-RPT-PM-09-001, *Melter Assembly Building Alternatives*). The building provided one bay each for assembly of the HLW melter and LAW melter. The permanent assembly building was eliminated from the WTP EPCC contractor design based on the expectation that the risk of premature failure is very unlikely (24590-WTP-RPT-PM-09-001).

---

1 DOE has not yet made a decision on how or when a WTP operating contractor will be selected nor who the WTP operating contractor will be. Transition of LBL in the DFLAW configuration is currently excluded from the cost and schedule of the WTP contract. It is assumed a WTP operating contractor will be selected to operate the LAW Vitrification Facility and portions of the Analytical Laboratory, and BOF necessary to support DFLAW operations, beginning operations within 90 days of completing hot commissioning of the LAW Vitrification Facility.
In November 2008, ORP amended the WTP contract directing BNI to “Conduct an analysis to determine the extent of differences between designing and constructing temporary versus permanent structures for assembly/installation of primary/spare low-activity waste and high-level waste melters” (DE-AC27-01RV14136, Modification M141). In response to that contract modification, BNI prepared 24590-WTP-RPT-PM-09-001, which detailed melter assembly building alternatives. The report identified two viable building options for melter assembly: permanent melter assembly buildings for HLW and LAW, and temporary melter assembly buildings for HLW and LAW. The permanent building approach provided for assembly, fit-up, and storage of an assembled spare melter but at increased cost, while the temporary building deferred assembly of spare melters to the WTP operations phase. Based on the evaluation of technical adequacy, technical risk, and estimated pricing, BNI’s recommendation for a permanent facility was providing standalone two-bay melter assembly buildings for both the LAW and HLW melter assembly. The LAW melter assembly building will be located south of the LAW Vitrification Facility. This option provides for an assembled and ready spare to mitigate any throughput concerns.

The study went on to state, “…if EFRT [External Flowsheet Review Team] recommendations are reconsidered and a[n assembled] spare is not required to be available at all times, an alternate approach involves use of temporary assembly provisions with scope for determination of permanent melter facilities made the responsibility of the future operating contractor, considering the options developed as part of the Value Engineering process.” ORP directed BNI (Williams 2009) to proceed with implementation of the current contract baseline option of using temporary melter assembly facilities for the first two melters and the procurement/storage of one unassembled spare melter for LAW. This decision to use temporary melter assembly facilities is a significant impetus to performing this alternatives analysis.

In 2015, DOE completed a WTP LAW Vitrification Facility design and operability review (15-WTP-0151, Attachment 2) in which several vulnerabilities were identified that were considered to be outside the scope of the WTP contract and will require DOE action to resolve. Two of these actions were related to LAW melter replacement and used LAW melter disposition. LAW melters are considered consumable items having a designed operating life of 5 years. The first action comes from the design and operability review recommendation related to the following opportunity for improvement, “Determine a schedule of need, a location for melter assembly, parts availability, and a method of transport for replacement melters.” The second action comes from the vulnerability that failed or spent melters may not meet the requirements of the WA 7890008967, “Hanford Facility Dangerous Waste Permit.” The related opportunity for improvement is, “Clarify the conditions to satisfy for successful LAW melter disposal.” This report was prepared at the request of DOE as part of the response to these vulnerabilities and opportunities for improvement.

Lengthy procurements of materials and components and the extended fabrication and assembly schedules experienced during acquisition of the first two LAW melters point to extended durations to assemble additional melters. Additionally, the potential need to acquire a new LAW melter assembly facility to perform LAW melter assembly could impart near-term schedule pressure and increase capital funding demands.
If action is not taken in a timely manner to provide assembled replacement LAW melters when needed, the LAW Vitrification Facility operational availability could be significantly impacted until assembled replacement LAW melters become available.

1.3.2 Operational Phase Used Low-Activity Waste Melter Disposition

Disposal of used LAW melters is planned for the IDF in the Hanford 200 East Area. The LAW melters will need to be prepared in a manner that complies with the disposal site waste acceptance criteria. The IDF currently is only permitted to accept immobilized LAW containers, demonstration bulk vitrification test waste, and waste generated at IDF. Waste acceptance criteria have not been established for used LAW melters. The current Tank Operations Contractor (TOC) is responsible for transporting used melters from WTP to the IDF. The current Plateau Remediation Contractor (PRC) is responsible for performing activities necessary to make IDF a fully operational facility. Specific areas of scope include modifying existing and developing new permits required to receive low-level waste (LLW)/mixed low-level waste (MLLW) for disposal, and completing facility startup reviews to support receipt and disposal of LLW/MLLW. The Plateau Remediation Contract states that the PRC shall receive waste for treatment from other generators only with prior DOE approval.

Process information for the LAW Vitrification Facility in the Hanford Dangerous Waste Permit (WA 7890008967), states that the used LAW melters “…will be classified as hazardous debris for land disposal restriction purposes.” The permit also states, “After a spent melter is deemed to meet criteria and regulations for onsite disposal, it will be placed in a welded carbon steel container (overpack) or other acceptable packaging in accordance with waste acceptance criteria for the receiving treatment, storage, and disposal (TSD) facility. Regulatory issues and permitting actions associated with onsite disposal of spent and/or failed melters will be addressed in the future” (WA 7890008967). The Hanford Dangerous Waste Permit further states, “…It is anticipated that LAW melters will require periodic replacement. When the end of a melter’s operational life is reached, as much residual molten glass as is practical will be removed as immobilized glass product. The LAW melter will be allowed to cool and then will be disconnected. Openings in the melter shell will be seal welded, and the melter shell will be decontaminated if required, and transported to an appropriate TSD facility (WA 7890008967).”

No clear definition of what is required to prepare the used LAW melter for disposition is available nor is there a clear indication of where such actions will take place. Limits associated with transporting the used LAW melter on the Hanford Site will place additional requirements on the used LAW melter. These requirements have not been established and could impact the required activities that must be performed to allow transport from the WTP to the IDF.

The numerous sources of requirements that could impact disposition of used LAW melters, the uncertainty regarding the specificity of these requirements, and the lack of contract direction to make disposition the responsibility of one or more contractors all factor into the need to coordinate and integrate associated programmatic activities to more effectively and efficiently conduct operations that apply to used LAW melter disposition.

1.3.3 Low-Activity Waste Melter Description

The LAW melter description presented in this section is derived from 24590-LAW-3ZD-LMP-00001, Low-Activity Waste Melter Process System Design Description, unless otherwise referenced.
The LAW melter processing system, consisting of the LAW melter and associated appurtenances, is designed to convert the mixture of pretreated LAW and glass-forming chemicals into glass, or immobilized low-activity waste (ILAW).

Melters are located on the +3-ft elevation (and higher) of the LAW Vitrification Facility in the melter gallery. Access to the melters is also available via a platform at the +6-ft elevation. Consumable changeouts (e.g., bubblers) will take place on top of the shielded lid of the melter. The melter gallery holds two melters, each with a design life of 5 years. Melters enter and exit the LAW Vitrification Facility through an airlock. An exterior melter assembly pad is present directly south of the airlock. These features of the LAW Vitrification Facility are shown in Figure 1-1. A LAW melter positioned in the melter gallery is shown in Figure 1-2, and a LAW melter on the melter assembly pad is shown in Figure 1-3.
Figure 1-2. Low-Activity Waste Melter in Melter Gallery

Figure 1-3. Low-Activity Waste Melter on Melter Assembly Pad
The melter design life is consistent with typical joule-heated melter performance, considering the nature of the feed, and is considered reasonable with respect to current technology, as low as reasonably achievable (ALARA) principles, and waste minimization. The melter is designed to withstand the corrosive environment caused by the melter feed, molten glass, and offgas for the component lifetimes.

There are four main sections to each melter: the melt pool, plenum, melter lid, and discharge chambers. The melt pool and plenum are surrounded by refractory that, combined with active cooling through water jackets, confines the glass to the interior of the melter and provides thermal and electrical insulation. The plenum is the space inside of the melter above the melt pool. Offgas, produced as the slurry melts, collects in the plenum and is continuously discharged through the primary offgas system. The melter lid provides access to the melter for feed nozzles and instrumentation, including the bubblers. The melter lid contains a cooling cavity with its own cooling system and refractory. Two discharge chambers are situated at the south end of each melter.

Each melter interfaces with the melter feed process system from which feed is distributed through a system of six feed nozzles onto the glass melt pool. Each melter also interfaces with the primary offgas system, to which offgas generated in the melter plenum is directed. Other systems that interface with the melter include the miscellaneous gases system (argon for airlift tube and level detectors), cooling water system, instrument service air system, plant service air system, C5 ventilation system, low-voltage electrical system, and medium-voltage electrical systems, grounding and lightning protection electrical system, LAW melter handling system, LAW container pour handling system, LAW melter equipment support handling system, process control system, programmable protection system, process and mechanical handling closed-circuit television system, and radioactive liquid disposal system. The power supplies for the melter electrodes, startup power supplies, discharge heater power supplies, and associated wiring are all considered part of the melters.

The following portions of the LAW melter are safety-significant: melter shell; feed nozzle cooling water flow valves; melter lid cooling cavity; melter lid cooling cavity overpressure protection components – pressure safety valves, restricting orifice on the makeup waterline, and surge tank overflow lines; melter lid cavity high temperature interlock; melter plenum pressure interlock; splash protection devices for safety-significant structures, systems, and components (SSC) located in pressure relief pathways; and through-penetrations of fire barriers by LAW melter process system components.

Figure 1-4 is a section view of the LAW melter and discharge chamber, with major components identified. A summary of the interior and exterior dimensions of the melter structure and refractory is given in Table 1-1. The pool and plenum columns in the table provide the as-assembled total cavity size. It is expected that melter operations will result in contacting refractory erosion and corrosion, and the Monofrax glass contact refractory could lose up to 1 in./year from erosion and corrosion.

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2 Monofrax is a registered trademark of Refractory Intellectual Property GmbH & Co. Kg, Vienna, Austria.
Figure 1-4. Low-Activity Waste Melter Section View with Major Components Identified

Table 1-1. Low-Activity Waste Melter Dimensions

<table>
<thead>
<tr>
<th>Direction</th>
<th>Melter enclosure</th>
<th>Refractory envelope</th>
<th>Internal cavity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Pool (melt line)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>East-West</td>
<td>30 ft–7 in.</td>
<td>20 ft</td>
<td>16 ft–2 in.</td>
</tr>
<tr>
<td></td>
<td>rails 28 ft–4 in.</td>
<td></td>
<td>17 ft–10 in.</td>
</tr>
<tr>
<td>North-South</td>
<td>21 ft–10 in.</td>
<td>10 ft–6 in. (pool)</td>
<td>6 ft–8 in.</td>
</tr>
<tr>
<td>Height</td>
<td>15 ft–10 in.</td>
<td>9 ft–5 in.</td>
<td>2 ft–6 in.</td>
</tr>
</tbody>
</table>

Glass pool is approximately 7,000 L (248 ft³) or 36,780 lb glass at 2.4 specific gravity.

- New melter, no material loss.
- Includes discharge chambers.
- Includes lid refractory.
1.4 APPROACH

This alternative evaluation relies on information regarding the cradle-to-grave lifecycle of a LAW melter. That information is used to determine how to approach acquiring new LAW melters and dispositioning used LAW melters during the life of the LAW Vitrification Facility. Due to the complexity of the issue being analyzed (i.e., logistics of new melter replacement and used melter disposition), it is useful to describe the approach used to organize the information presented in this document. Figure 1-5 identifies the information collected as part of this alternative analysis, the relationships between that information (i.e., how the information is used as part of the analysis), and where that information is located in the document.

The block at the top of the figure describes establishing the scope of the evaluation, identifying what major activities must be performed to provide replacement LAW melters and to disposition used LAW melters. The scope of the document is described in Section 1.2.

For each major activity identified as part of the scope of this analysis, a functional analysis is performed. The analysis determines the functions to be performed, and identifies demands and requirements associated with that function. Where needed information is not available, assumptions have been made to proceed with the alternatives evaluation. This functional analysis is presented in Section 2.0.

The current state of planning for LAW melter replacement and disposition is described in Section 3.0 as the comparison case. The comparison case is developed based on current plans for LAW melter replacement and disposition, with assumptions used where gaps exist in that planning. Because the current planning is not complete, several assumptions are made to cover these gaps in planning. The comparison case is used for comparison to the alternatives identified and evaluated later in the document.

Section 4.0 identifies options, evaluates alternatives, and compares the alternatives for melter replacement. In Section 4.1, a broad range of options are considered to establish a set of the most promising alternatives to be evaluated in more detail. Detailed evaluations of the selected alternatives are presented in Section 4.2. For each of the feasible alternatives presented in Section 4.2, the following information is developed:

- Alternative description
- Evaluation of safety considerations
- Mission impact analysis
- Regulatory and permitting assessment
- Rough order of magnitude (ROM) cost estimate
- Schedule evaluation.

Section 4.3 identifies the comparison criteria used to evaluate melter replacement alternatives and presents a comparative evaluation of the various alternatives against these criteria.

Section 5.0 is organized in a similar fashion to Section 4.0, addressing used melter disposition rather than melter replacement. Section 5.1 considers a broad range of options for melter disposition to establish a set of the most promising alternatives to be evaluated in more detail. Detailed evaluations of the selected alternatives are presented in Section 5.2, with the same types of information as presented in Section 4.2. Section 5.3 identifies the comparison criteria used to evaluate the melter disposition alternatives and presents a comparative evaluation of the alternatives against these criteria.
Results of the alternative evaluation, including recommendations and conclusions, are compiled in Section 6.0.

Figure 1-5. Report Information Flow and Approach to Performing Low-Activity Waste Melter Replacement and Disposition Evaluation
1.5 DEFINITIONS

Assembled melter – A melter that has been completely constructed to the point that it can be installed within the LAW Vitrification Facility.

Availability – The probability that an item is in an operable condition at a randomly selected point in time in the future (i.e., under given conditions, the probability that an item can perform its required functions). Availability is a measure of degree to which an item is in an operable condition (based on 24590-WTP-GPG-ENG-009, Design Guide: Reliability, Availability, Maintainability, and Inspectability (RAMI), p. 6). Mathematically, operational availability can be described as the ratio of uptime to total time, where uptime is the time during which the system was capable of performing all required functions in a given time interval (based on DoD 2005, p. 3-11).

Confinement – For consistency, regardless of usage elsewhere, confinement is used in this document to denote the controls used to prevent or minimize the release or migration of airborne contaminants, including aerosols, hazardous vapors, or gases (24590-LAW-3ZD-LMH-00001, LAW Melter Handling (LMH) System Design Description, p. 2).

Containment – For consistency, regardless of usage elsewhere, containment is used in this document to denote the controls used to prevent or minimize the release or migration of liquid or liquid-entrained contaminants (24590-LAW-3ZD-LMH-00001, p. 2)

Debris – Solid material exceeding a 60 mm particle size that is intended for disposal and that is a manufactured object, or plant or animal matter, or natural geologic material.

The following materials are not debris: Any material for which a specific treatment standard is provided in Title 40, Code of Federal Regulations, Part 268 (40 CFR 268), “Land Disposal Restrictions,” Subpart D (incorporated by reference in Washington Administrative Code [WAC] 173-303-140(2)(a), “Land Disposal Restrictions”); process residuals such as smelter slag and residues from the treatment of waste, wastewater, sludges, or air emission residues; and intact containers of hazardous waste that are not ruptured and that retain at least 75 percent of their original volume. A mixture of debris that has not been treated to the standards provided by 40 CFR 268.45, “Treatment Standards for Hazardous Debris,” and other material is subject to regulation as debris if the mixture primarily comprises debris, by volume, based on visual inspection (WAC 173-303-040, “Definitions”).

Failed melter – For the purposes of this document, this refers to a previously operating LAW melter that is unable to perform its operational function before the end of its 5-year design life.

Melter – All components inside of the melter enclosure, including the melter enclosure. In some documents, a melter may be referred to as a locally shielded melter.

Melter assembly – The task of assembling all melter parts (e.g., melter shell, melter lid, refractory) acquired via melter procurement into a melter that is ready for installation.

Melter assembly facility – A location where melter assembly is performed.

Melter enclosure – The metal shield lid and the metal walls that separate the annulus from the melter gallery. This assembly is also referred to as the melter shield box.
**Melter installation** – The task of moving the melter from the end of the assembly pad into the melter bay and coupling (connecting) it to all necessary LAW systems so the melter can operate according to its intended function.

**Melter lid** – The assembly of the shield lid (part of the melter enclosure), melter lid cooling cavity (part of the gas barrier), and gas barrier lid plates (part of the melter shell and gas barrier).

**Melter procurement** – The process of obtaining parts, equipment, or assemblies from the time the requisition is submitted to the time of delivery to a Hanford receipt location.

**Melter shell** – The inner confinement boundary comprising the gas barrier lid plates, gas barrier walls and support structures, and gas barrier base plate on top of the melter base. These are all welded together. The melter shell has the credited safety function of confining offgas to the plenum and routing offgas to the LAW primary offgas process system.

**Melter storage** – The task of storing an assembled melter awaiting installation. This is preferably climate controlled so the refractory is not negatively impacted by atmospheric conditions such as humidity.

**Melter storage facility** – A location where assembled melter storage is performed.

**Plenum** – The area of the melter that makes up the gas space directly above the melt pool.

**Primary confinement/containment** – The SSCs and associated boundaries that confine/contain airborne and liquid contaminants under normal conditions (24590-LAW-3ZD-LMH-00001, p. 2.)

**Secondary confinement/containment** – The SSCs or other design features that capture and prevent further spread or migration of airborne/liquid contaminants after they have escaped primary confinement or containment (24590-LAW-3ZD-LMH-00001, p. 2).

**Shield lid** – The lid section of the melter enclosure. The shield lid covers the melter lid cooling cavity. The shield lid supports all components mounted on and through it.

**Spent melter** – For the purposes of this document, this refers to a previously operating LAW melter that is unable to perform its operational function after the end of its 5-year design life.

**Used melter** – For the purposes of this document, this refers to a previously operating LAW melter that is unable to perform its operational function. Failed and spent LAW melters are subsets of used LAW melters.
2.0 FUNCTIONS, REQUIREMENTS, AND ASSUMPTIONS

This section provides high-level functions (Section 2.1) and requirements (Section 2.2) associated with providing replacement LAW melters and dispositioning used LAW melters during the operational phase of the LAW Vitrification Facility. Assumptions developed when necessary to perform this alternatives analysis are introduced in Section 2.3.

The functions and a portion of the requirements are based on the results of a current state mapping process performed in a series of workshops during December 2016 and January 2017 covering the various aspects of melter replacement and disposition. The results from those workshops are provided in Appendix A.

2.1 FUNCTIONAL ANALYSIS

This section identifies high-level functions associated with providing replacement LAW melters and dispositioning used LAW melters. The functions are preliminary in nature and have been developed to support the objective of this study. Therefore, the functions should not be considered complete or definitive. The LAW melter life cycle functions are illustrated in Figure 2-1. The LAW melter life-cycle functions regarding operation and maintenance of the melter, shown in gray in the figure, are not included in the scope of this evaluation.

2.1.1 Provide Replacement Low-Activity Waste Melters

The function, Provide Replacement Low-Activity Waste Melters (Provide LAW Melters), consists of performing activities to safely and efficiently acquire the necessary parts and equipment for assembly of LAW melters, assemble those parts into LAW melters ready for installation, store LAW melters until needed for operation, transport assembled LAW melters ready for installation to the place of operation, and install assembled melters ready for operation at the place of operation. The subfunctions described include:

- Procure replacement LAW melter parts
- Assemble replacement LAW melters
- Store assembled replacement LAW melters
- Transport assembled replacement LAW melters
- Install assembled replacement LAW melters.
Figure 2-1. Low-Activity Waste Melter Life-Cycle Functions

* Alternatives evaluated for installing assembled replacement LAW melters and removing used LAW melters may result in modifications to the interface between these two subfunctions.
2.1.1.1 Procure Replacement Low-Activity Waste Melters

The subfunction, Procure Replacement Low-Activity Waste Melters (Procure LAW Melters), consists of performing activities to procure all parts necessary to allow assembly of replacement LAW melters.

The Procure LAW Melters subfunction includes acquisition of the melter box, melter lid, melter components, refractory, and appurtenances. The melter box and lid will be fabricated offsite and delivered to Hanford Site. Receipt and inspection of the melter parts will be performed as part of the procurement subfunction.

This subfunction includes all resources and equipment necessary to procure the LAW melters, including managing the procurements, providing technical support during procurement activities, and providing quality assurance oversight as appropriate. The process includes:

- Reviewing previous melter procurement and engineering documentation, including change documentation, to obtain up-to-date information
- Preparing procurement documentation, including engineering specifications, documents, and drawings, for all melter components
- Issuing and managing vendor contracts to provide melter components from initial issuance through contract closeout
- Providing quality assurance oversight of melter component fabrication activities
- Providing engineering technical support during melter component fabrication, including design upgrades and configuration management
- Conducting factory testing of melter components, as appropriate
- Providing packaging for shipping, shipping, delivery, and receipt inspection of all melter components
- Delivering melter parts to the storage/assembly facility.

2.1.1.2 Assemble Replacement Low-Activity Waste Melters

The subfunction, Assemble Replacement Low-Activity Waste Melters (Assemble LAW Melters) consists of performing activities to assemble replacement LAW melters. The Assemble LAW Melters subfunction includes the activities necessary to prepare the melter for installation. This includes installation of the refractory in the melter shell and lid. Once complete, the melter lid is welded to the melter body and the remaining components installed.

This subfunction includes all resources and equipment necessary to assemble the LAW melters, including managing the assembly activities, providing technical support during assembly activities, providing quality assurance oversight as appropriate, and providing a temperature-controlled environment to facilitate proper material conditions, quality inspections, and measurements. The process includes:

- Staging needed materials adjacent to the melter shell
- Installing refractory into the melter shell
- Placing melter refractory in accordance with procedures, carefully adhering to tolerances
• Preparing pourable refractory for installation into the melter lid
• Placing the lid into the frame to allow for flipping once refractory is installed and cured
• Installing refractory into the lid and allowing to cure
• Using overhead cranes and the melter lid frame to flip the melter lid and place atop melter body
• Welding the lid to the melter body
• Installing melter components
• Performing necessary construction and operational acceptance testing, including form, fit, and function testing of assembled melter and components.

2.1.1.3 Store Assembled Replacement Low-Activity Waste Melters

The subfunction, Store Assembled Replacement Low-Activity Waste Melters (Store LAW Melters) consists of performing activities to store assembled replacement LAW melters.

The Store LAW Melters subfunction includes properly storing an assembled melter, melter shell, melter lid, refractory, and melter components.

• Storage of melter components
  – Receive, inspect, and place into safe and secure storage, including appropriate temperature and humidity control, all melter parts and components and all other items associated with melter replacement
  – Perform periodic inspection of received inventory.

• Storage of assembled melter
  – If storage is required for the assembled melter, the melter can be either placed into storage in the assembly location or moved to a storage location
  – Transport the assembled melter from the assembly location to the storage location in accordance with the requirements for transporting an assembled melter
  – Receive, inspect, and place assembled melter into safe and secure storage
  – Receive, inspect, and place replacement items associated with the assembled melter into safe and secure storage
  – Perform periodic inspection of the assembled melter
  – Perform any necessary maintenance activities on the stored melter
  – Move melter into and out of the storage location safely and compliantly
  – If deemed necessary, perform bake-out to stabilize refractory
  – Perform necessary operational readiness testing for stored melters prior to installing the assembled melter.
2.1.1.4 Transport Assembled Replacement Low-Activity Waste Melters

The subfunction, Transport Assembled Replacement Low-Activity Waste Melters (Transport Replacement LAW Melters) consists of performing activities to transport assembled replacement LAW melters from the assembly location to the storage location or from the assembly or storage location to the appropriate set of rails on the LAW Vitrification Facility melter assembly pad.

A transport system will be required to move the assembled melter. The transport system will need to interface with the location(s) where replacement melters are assembled and stored, and with the LAW melter rails on the LAW Vitrification Facility melter assembly pad.

2.1.1.5 Install Assembled Replacement Low-Activity Waste Melters

The subfunction, Install Assembled Replacement Low-Activity Waste Melters (Install Replacement LAW Melters) consists of performing activities to transfer the replacement LAW melter from the LAW Vitrification Facility melter assembly pad to its place of operation in the melter gallery and make necessary connections to allow for melter operation.

The Install Replacement LAW Melters subfunction of transferring an assembled LAW melter from the melter assembly pad to the melter operating gallery is performed by the LAW Vitrification Facility low-activity waste melter handling (LMH) system. These functions are described within 24590-LAW-3ZD-LMH-00001.

The functions to install assembled replacement LAW melters have previously been assessed by WTP but not documented in an issued report. The subfunctions to install an assembled replacement LAW melter were discussed at the current state mapping process workshops (Appendix A). A summary of the activities necessary to install the LAW melter once it is transferred into the melter gallery is provided below:

- Install seismic restraints
- Connect electrical bus to melter
- Install service connections to melter
- Install process connections to melter (e.g., feedlines, offgas)
- Install pour spout
- Install startup heaters
- Heat up melter
- Adjust refractory
- Add glass frit to melter
- Start joule heating of the melter.

Once joule heating of the melter is initiated, the melter is assumed to be turned over to Operations to bring the glass pool up to operating level, tune the melter operations, and start feeding waste to and pouring glass from the melter.
2.1.2 Disposition Used Low-Activity Waste Melters

The function *Disposition Used Low-Activity Waste Melters* (*Disposition LAW Melters*) consists of performing activities to safely and efficiently remove used LAW melters from the place of operation, prepare the used melters for disposal, transport the used LAW melters, and dispose of the used LAW melters. The subfunctions described below are:

- Remove used LAW melters
- Prepare used LAW melters for disposal
- Transport used LAW melters
- Dispose used LAW melters.

2.1.2.1 Remove Used Low-Activity Waste Melters

The subfunction, *Remove Used Low-Activity Waste Melters* (*Remove Used LAW Melters*) consists of performing activities to disconnect connections between the used LAW melter and the facility, and then transfer the used LAW melter from its place of operation to the south end of the rails on the LAW Vitrification Facility melter assembly pad.

The functions to disconnect used LAW melters have previously been assessed by WTP but not documented in an issued report. The subfunctions to disconnect a used melter were discussed at the current state mapping process workshops. A summary of the subfunctions necessary to disconnect the LAW melter are:

- Shut down melter
  - Stop feed and flush slurry lines and enclosure
  - Cool melter
  - Power down utilities
  - Isolate and flush offgas lines
- Perform radiological surveys and decontaminate as needed
- Remove connections to melter
- Drain and blowdown cooling water system
- Disconnect electrical bus
- Remove pour spout
- Seal-weld melter enclosure
- Manage waste generated from the process.

The *Remove Used LAW Melters* subfunction of transferring an assembled LAW melter from the melter operating gallery to the melter assembly pad is performed by the LAW Vitrification Facility LMH system. These functions are described in 24590-LAW-3ZD-LMH-00001.

2.1.2.2 Prepare Used Low-Activity Waste Melters for Disposal

The subfunction, *Prepare Used Low-Activity Waste Melters for Disposal* (*Prepare Used LAW Melters for Disposal*) consists of performing activities that will ensure that the used LAW melter is compliant with the requirements for transportation from the LAW Vitrification Facility and the waste acceptance criteria for the disposal facility.
The Prepare Used LAW Melters for Disposal subfunction includes properly void filling and treating the used melter to allow for its disposal. Void filling consists of incorporating material in the void spaces within the melter enclosure. Treating the used melter consists of performing an acceptable immobilization technology treatment for dangerous waste debris to allow for disposal in a dangerous waste landfill.

2.1.2.3 Transport Used Low-Activity Waste Melters

The subfunction, Transport Used Low-Activity Waste Melters (Transport Used LAW Melters) consists of performing activities to either transport used LAW melters from the south end of the LAW Vitrification Facility melter assembly pad: (1) to the location to prepare used LAW melters for disposal, or to the location to dispose used LAW melters; or, (2) from the location to prepare used LAW melters for disposal to the location to dispose used of LAW melters.

A transport system will be required to move the used melter. The used melter may or may not be void-filled and/or treated at the time it is transported. The transport system will need to interface with: (1) the LAW melter rails on the LAW Vitrification Facility melter assembly pad; (2) the locations where used melters are prepared for disposition; (3) a staging location at IDF (if applicable); and, (4) the disposal location within IDF.

2.1.2.4 Dispose Used Low-Activity Waste Melters

The Dispose Used LAW Melters subfunction consists of transferring a used melter that has completed preparation for disposal from the transport system to its staging location, if applicable (e.g., entry location to the disposal facility or treatment location at the disposal facility), and to the melter disposal location and then properly locating the melter in a disposal location.

2.2 REQUIREMENTS ANALYSIS

A requirements analysis was performed as part of this document. The requirements analysis identified high-level requirements associated with providing replacement LAW melters and dispositioning used LAW melters. The requirements are preliminary in nature. The requirements identified via this analysis are not a complete listing of requirements, rather they are related to the purposes of performing this alternatives analysis. Requirements identified as part of this study are generally used in three ways:

- As a means of eliminating an option from more detailed evaluation as an alternative; options that cannot meet all requirements are eliminated from further consideration
- To establish or bound the scope and therefore the cost and schedule associated with the alternatives evaluated in this report
- If setting a threshold (e.g., minimum or maximum limit), for comparison between alternatives if an alternative provides greater margin relative to the threshold.

The requirements are included in Appendix B.

2.3 ASSUMPTIONS

Key assumptions used in preparing this report are provided in Appendix C. The assumptions are tabulated and enumerated according to the functional analysis in Section 2.1.
3.0 COMPARISON CASE

To identify opportunities for managing the execution of LAW melter replacement and disposition activities, the current status is used as a comparison. This status is based on current contract commitments and takes no additional actions to melter assembly and procurement of replacement melters until the WTP operations contract is awarded.

To develop the comparison case and define the current status, a series of current state mapping workshops were held. During these workshops, the primary functions of the scope for this report were identified:

- Replacement LAW melters acquisition
  - Replacement LAW melter procurement (except for the first spare melter)
  - Replacement LAW melter assembly/storage
  - Assembled replacement LAW melter transport
  - Assembled replacement LAW melter installation

- Used LAW melters disposition
  - Used LAW melter removal
  - Used LAW melter disposal preparation
  - Used LAW melter transport
  - Used LAW melter disposal.

During the workshop, estimated durations were assigned to each function based on prior experience with the first two LAW melters and other DOE melters, primarily the Defense Waste Processing Facility (DWPF) at Savannah River Site.

In this report, the sequence that the melter will be procured, assembled, and installed is identified as Melter #1, Melter #2, Melter #3, and so forth, with Melter #3 being the first replacement melter. This numbering sequence should not be confused with the melter equipment identification.

BNI is currently under contract to install and startup the first two melters, Melter #1 and Melter #2. These two melters are currently located at the LAW Vitrification Facility and are being installed in the melter operating bays. BNI is also responsible for procuring the first replacement melter, Melter #3 in the replacement sequence. This procurement includes all components and equipment associated with a LAW melter; the melter box and lid fabrication, melter refractory, and melter appurtenances. The replacement melter is to be received and stored using an existing appropriate storage facility (yet to be determined). BNI has stated that the materials for Melter #3 body and lid fabrication have been procured and are being stored by Petersen, Inc. (the melter vendor), and the refractory has been procured and is currently stored at Energy Northwest facilities in Richland, Washington. DOE currently has not designated a contractor with responsibility for Melter #3 assembly.

BNI prepared 24590-WTP-RPT-PM-09-001, which compares several alternatives for temporary and permanent melter assembly capabilities. This report recommended that the first two melters be assembled using temporary capabilities, which was the approach implemented. The report also recommends that for future melter assembly needs, DOE may want to consider a permanent facility once the WPT Operating Contractor is available to accommodate specific project needs.
In August 2009, DOE provided BNI direction to proceed with the baseline options to use temporary melter facilities for the first two LAW melters, and to procure/store one unassembled spare melter using existing appropriate storage facilities (Williams 2009). No contractor is currently responsible for providing appropriate assembly capabilities for the LAW melters.

The first two melters were assembled in the melter bays at the LAW Vitrification Facility. A temporary construction crane was used to assemble the melters. This crane will be removed prior to melter operations, and a smaller crane will be installed that does not have capability to lift the refractory or install the melter lid. Without the available space that the operating melters occupy, assembly of future melters cannot be performed in this area. Performing assembly in the melter bay will also significantly delay installing the replacement melters. For this study, the melter assembly is assumed to require 2½ years to complete.

To develop the comparison case, the following bases and assumptions are used:

- Key dates for LAW melter operations, as identified in the May 2017 DFLAW Program Integrated Schedule, used in this alternatives evaluation include the following:
  - Pre-cold commissioning melter operations start (melter heat up) April 2020
  - LAW hot operations start (following hot commissioning) January 2022
- The following durations were used, as described in Section 2.3 and Appendix C. These durations are used in developing the LAW Melter Program management execution options.
  - Procurement – 4 years
  - Assembly – 2½ years
  - Melter changeout (disconnect, removal, and installation) – 6 months
  - Melter design life – 5 years
- The procurement of the first replacement melter, Melter #3 in the sequence, will be complete before the end of the BNI contract period, December 31, 2022. The replacement melter will then be placed into storage until assembly is initiated.
- The award of the WTP operations contract is assumed to be at the end of hot commissioning completion by the WTP EPCC contractor, with planning and the provision of assembly capabilities beginning at that time. In the worst case, up to 5 years is assumed to be necessary to provide assembly capabilities.
- Once the assembly capabilities are provided, assembly of the first replacement melter (Melter #3) will begin. An estimated 2½ years will be needed for assembly of a replacement melter.
- Procurement of the next replacement melter (Melter #4) will initiate upon award of the WTP operations contract. This melter will be procured, delivered, and then placed into storage until the melter assembly facility can accommodate a second melter. Some overlap in assembly activities is assumed, as shown in Figure 3-1.
- For subsequent replacement melters, including Melter #4 and beyond, assembly will be completed in time to allow for planned changeouts after 5 years of melter operations.
The used melter will be disconnected and prepared to be removed from the LAW Vitrification Facility, seal-welded, and removed from the melter bay to allow the replacement melter to be installed.

Preparation for disposal, void filling, and treatment will not impact the melter changeout and replacement process.

Transport of the used melter and assembled melter will occur consecutively. A heavy-duty transporter will be used to transport the used melter from the LAW Vitrification Facility to IDF. The same transporter will then load and transport the assembled melter from the assembly facility to LAW Vitrification Facility.

This information was used to develop a timeline (shown in Figure 3-1) that illustrates the current status to be used as a comparison case for execution options. Figure 3-1 can also be used to identify risks and benefits.

**Figure 3-1. Current Low-Activity Waste Melter Status used as Comparison Case**

**Risks:**

- As shown in the yellow portion of the timeline of Figure 3-1, the changeout of the initial melters (#1 and #2) is scheduled beyond the melter design life at 9 years and 11 years of operations, respectively.
- The current contractual 70 percent availability requirement is supported by the WTP operational research model based on a changeout of the first melter 2½ years after hot commissioning, with the second changeout after 5 years. At this point, the second melter will have been operating for 2 years beyond the design life, when the cold commissioning period is included after melter heat up but before hot commissioning start. This scenario is not supportable based on the timeline for spare melter procurement and assembly.
• As can be seen in Figure 3-1, if the melters do not operate beyond the design life of 5 years, the impact on melter availability could cause the facility to be unavailable for 5 of the initial 10 years of operation. This will require a significant level of facility recommissioning under active conditions, followed by restart operational readiness reviews than could result in additional multiple-year delays.

• Melter failures earlier than the 5-year melter design life could significantly delay hot commissioning or cause more significant delays to the mission, because no spare melter is available.

Benefits:
• Lessons learned from initial melter operations can be incorporated into the design of future melters.
• Costs for melters are deferred.
• Assembly activities are managed so that only one assembly facility is needed at a time, which also maintains a steady load and continuity of the assembly resources.

Operation Philosophy Precedence

At the Savannah River Site, HLW is currently being immobilized through vitrification. To meet contract requirement C.1.2.1 (below) for spare melter availability, the DWPF contractor has developed an operating philosophy of providing an assembled replacement melter and the components of an additional replacement melter to the extent practical during melter operations. To achieve this, an assembled melter is stored onsite in a configuration that can be quickly prepared for installation. The components for an additional replacement melter are also procured and available onsite such that once the assembled melter is put into service, the second replacement melter will be assembled and procurement of the next melter is initiated. In addition, the DWPF contractor has procured and is storing refractory for several melters.

C.1.2.1 Defense Waste Processing Facility Operations

The Contractor shall operate the DWPF to process sludge and salt feed streams into a vitrified waste form that meets or exceeds all requirements for interim storage at the Savannah River Site and all requirements set forth by EM and the DOE Office of Civilian Radioactive Waste Management (RW) regarding the acceptability of the vitrified waste form for disposal in a licensed Federal Repository. The Contractor shall endeavor to maximize DWPF waste throughput. The Contractor shall ensure the availability of a spare melter to affect a timely replacement of an operational melter in the event its failure. (Note: This requirement begins upon availability of [DWPF] Melter #4). The Contractor shall also provide for safe storage of failed melters by anticipating the need for and constructing failed melter boxes and Failed Equipment Storage Vaults (FESV).

This study assumes that a similar operating philosophy, to the extent practical, will be taken for the WTP LAW melters.
4.0 MELTER REPLACEMENT OPTIONS IDENTIFICATION AND ALTERNATIVE EVALUATION

As shown in Section 3.0, there are several risks to the program with the comparison case in providing replacement melters. Identifying and implementing improvements and opportunities will enable the LAW Melter Program to successfully provide replacement melters. This section identifies the options for melter replacement, evaluates those options, and develops melter replacement alternatives for further consideration. The options identification and alternatives evaluation process is illustrated in Figure 4-1.

Figure 4-1. Low-Activity Waste Melter Replacement Options and Alternatives Development and Evaluation Process

In developing LAW melter replacement options, two aspects of the LAW Melter Program were considered: the execution options and the approach options. The LAW Melter Program replacement execution options address the management approach to executing the replacement functions (e.g., procure, assemble, store, transport, and install a LAW replacement melter); specifically, how each of the functions will be sequenced to deliver a replacement melter to support the project needs. Taking into consideration the long durations of the replacement functions, proper planning will be critical in delivering a replacement melter.
The LAW Melter Program replacement approach options identify the methods that could be used to perform each of the replacement functions. The approach options look at what activities are needed to provide the function, the method (approach) of performing activities, the locations where the activities can be performed, and the timing of when the activities can be performed.

To narrow the options into potential alternatives, each option was compared against the requirements identified in Section 2.2 and provided in Appendix B. Additional selection criteria were considered in evaluating the execution options (i.e., meeting program schedule needs). The resulting options were incorporated into the potential LAW melter replacement alternatives.

During the LAW melter replacement and disposition alternatives evaluation workshop held in May 2017, each of the LAW melter replacement alternatives were evaluated against the agreed-on selection criteria. The results of this evaluation are discussed in Section 6.0.

### 4.1 MELTER REPLACEMENT OPTIONS

Both the LAW Melter Program execution options and approach options are described in this section. A brief description and the key risks and benefits are provided for each option.

#### 4.1.1 Low-Activity Waste Melter Program Execution Options

For the LAW Melter Program execution options, the comparison case discussed in Section 3.0 is used as a starting point. As the options were developed, improvements to the execution approach that would reduce risk or provide a benefit were incorporated into the next option.

All execution options are based on the same assumed durations for each function:

- 4 years for melter component procurement
- 2½ years for melter assembly
- 5-year design life for LAW melter.

Various approaches to sequencing the replacement functions were developed and evaluated. Table 4-1 provides a summary of the LAW melter execution options and the key risks and benefits for each. Additional details, including a timeframe for each option, are provided in Appendix D.
### Table 4-1. Low-Activity Waste Melter Execution Options (4 pages)

<table>
<thead>
<tr>
<th>Execution option description</th>
<th>Key risks</th>
<th>Key benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1</strong> Comparison Case, LAW Melter Current Status: Melters #1 and #2 installed, Melter #3 components in storage. Melter assembly capability and Melter #4 procurement provided after WTP contract award (early FY 2022). Melter #3 components stored until assembly capability available.</td>
<td>• Melter #1 changeout extends 4 years and Melter #2 changeout extends 6 years beyond the melter design life, as an assembled melter cannot be available before this time &lt;br&gt; • Melter availability less than 50% during DFLAW. In the first 10 years of hot operations, Melter #1 has a risk of not being available 4½ years, Melter #2 has a risk of 6½ years &lt;br&gt; • No replacement melter available in event of premature failure during operations</td>
<td>• Ease of lessons learned implementation &lt;br&gt; • Delay of assembly requirement &lt;br&gt; • Continuity of assembly resources &lt;br&gt; • Delay of melter procurement costs</td>
</tr>
<tr>
<td><strong>2</strong> Staggered planned changeout, assembly just in time for changeout: First changeout scheduled for 5 years, second for 7½ years. Procurement and assembly to be done just in time for planned changeout.</td>
<td>• To stagger the changeouts, Melter #2 changeout extends 2½ years beyond melter design life &lt;br&gt; • During DFLAW, Melter #1 has a risk of not being available 1 year, Melter #2 has a risk of 3 years &lt;br&gt; • No replacement melter available in event of premature failure during operations</td>
<td>• Ease of lessons learned implementation &lt;br&gt; • Storage requirements reduced &lt;br&gt; • Assembly requirement delayed &lt;br&gt; • Continuity of assembly resources</td>
</tr>
<tr>
<td><strong>3</strong> Staggered planned changeout, initial replacement melter assembled early: First changeout scheduled for 5 years, second for 7½ years. Procurement and assembly to be done just in time for planned changeout. Melter #3 assembled when received and placed into storage.</td>
<td>• To stagger the changeouts, Melter #2 changeout extends 2½ years beyond melter design life &lt;br&gt; • During DFLAW, Melter #1 has a risk of not being available 1 year, Melter #2 has a risk of 3 years. &lt;br&gt; • No replacement melter for 3 years for initial melters &lt;br&gt; • No replacement melters available for all subsequent melters</td>
<td>• Provides an assembled melter mid-way through Melter #1 operational life &lt;br&gt; • Ease of lessons learned implementation &lt;br&gt; • Storage requirements delayed</td>
</tr>
</tbody>
</table>
### Table 4-1. Low-Activity Waste Melter Execution Options (4 pages)

<table>
<thead>
<tr>
<th>Execution option description</th>
<th>Key risks</th>
<th>Key benefits</th>
</tr>
</thead>
</table>
| **4 Staggered planned changeout, initial replacement melter procurement extended to eliminate storage needs:** First changeout scheduled for 5 years, second for 7½ years. Procurement and assembly to be done just in time for planned changeout. Melter #3 procured and delivered just in time for assembly to support schedule needs, eliminating the need for storage. | • To stagger the changeouts, Melter #2 changeout extends 2½ years beyond melter design life  
• During DFLAW, Melter #1 has a risk of not being available 1 year, Melter #2 has a risk of 3 years  
• No replacement melter available in event of premature failure during operations | • Eliminates storage requirements  
• Ease of lessons learned implementation  
• Assembly requirements delayed  
• Continuity of assembly resources |
| **5 Consecutive changeout, assembly follows procurement just in time for changeout:** Melter #1 changeout starting at 5 years, followed by Melter #2 changeout at 5½ years. Assembly immediately follows procurement, just in time for installation. | • During DFLAW, Melter #1 has a risk of not being available 1 year, Melter #2 has a risk of 1 year (due to changeout)  
• No replacement melter available in event of premature failure during operations  
• Assembly resource needs doubled  
• No continuity of assembly resources  
• Early operational lessons learned difficult to incorporate until Melter #5 | • Does not require changeout beyond the design life  
• Eliminates storage requirements for initial replacement melter  
• Assembly requirement delayed |
| **6 Consecutive changeout, assembly planned to allow for assembly resources continuity:** Melter #1 changeout starting at 5 years, followed by Melter #2 changeout at 5½ years. Alternating approach to replacement melter assembly to allow for continuity of assembly resources. Melter #3 assembled and placed into storage until installation need. Melter #4 assembly immediately follows procurement, just in time for installation. Pattern continues for subsequent melters. | • During DFLAW, Melter #1 has a risk of not being available 1 year, Melter #2 has a risk of 1 year (due to changeout)  
• Replacement melters not available for first 3 years of operations  
• Early operational lessons learned difficult to incorporate until Melter #5 | • Does not require changeout beyond the design life  
• Allows for continuity of assembly resources  
• Provides an assembled replacement melter 3 years into melter operations |
### Table 4-1. Low-Activity Waste Melter Execution Options (4 pages)

<table>
<thead>
<tr>
<th>Execution option description</th>
<th>Key risks</th>
<th>Key benefits</th>
</tr>
</thead>
</table>
| **7** Staggered changeouts with replacement melter and components available during operations, starting with initial operations: Two melters installed, assembled melter and melter components available prior to melter operations, allows for backup melter at all times. At operations start and for each planned changeout, the next replacement melter (#3) has been assembled and placed into storage, the next melter (#4) components are in storage and assembled prior to Melter #3 changeout, and Melter #5 will be procured and components available onsite. | • To stagger the changeouts, Melter #2 changeout extends 2½ years beyond melter design life  
• During DFLAW, Melter #1 has a risk of not being available 1 year, Melter #2 has a risk of 3 years  
• Assembly of Melter #3 needs to begin in early FY 2018  
• Procurement of Melter #4 will not meet option’s schedule for initial operations  
• Increased storage costs  
• Costs incurred early  
• Early operational lessons learned difficult to incorporate into Melters #3 and #4 | • Provides an assembled melter mid-way through Melter #1 operational life  
• Provides an assembled melter for replacement if premature failure occurs  
• Allows for continuity in assembly resources after Melter #3 |
| **8** Staggered changeouts with replacement melter and components available at all times, starting with initial changeout: Two melters installed, assembled melter and melter components available prior to melter changeout, allows for backup melter at all times after initial changeout. At each planned changeout, the next replacement melter (#3) has been assembled and placed into storage, the next melter (#4) will be assembled prior to removal of Melter #3, and Melter #5 will be procured and components available onsite. | • To stagger the changeouts, Melter #2 changeout extends 2½ years beyond melter design life  
• During DFLAW, Melter #1 has a risk of not being available 1 year, Melter #2 has a risk of 3 years  
• No replacement melter available for initial 3 years  
• Assembly of Melter #3 needs to begin in early FY 2021  
• Procurement of Melter #4 needs to begin in early FY 2019  
• Increased storage costs  
• Costs incurred early  
• Early operational lessons learned difficult to incorporate into Melters #3 and #4 | • Provides an assembled melter for replacement if needed mid-way through Melter #1 operational life  
• Provides an assembled melter for replacement if premature failure occurs with subsequent melters  
• Allows for continuity in assembly resources for all replacement melters |
Table 4-1. Low-Activity Waste Melter Execution Options (4 pages)

<table>
<thead>
<tr>
<th>Execution option description</th>
<th>Key risks</th>
<th>Key benefits</th>
</tr>
</thead>
</table>
| 9 **Consecutive changeouts, supporting melters separately, replacement melter and components available at changeouts**: Each melter train’s replacement melters are managed separately, no planned sharing of replacement melters. For each melter train, an assembled melter in storage and components for the next replacement melter will always be available starting with the first changeout. | • No replacement melter available for initial 3 years  
• During DFLAW, Melter #1 has a risk of not being available for 1 year, Melter #2 has a risk of 1 year (due to changeout)  
• Increased costs from storage and melter procurement  
• Melter procurement costs incurred early  
• Early operational lessons learned difficult to incorporate | • Provides an assembled melter for replacement if needed mid-way through Melter #1 operational life  
• Provides an assembled melter for replacement if premature failure occurs for either operating melter, independently  
• Allows for continuity in assembly resources after the first 5 years of operations |
| 10 **Operate melters until near failure, procurement initiated with changeout decision**: Assembly immediately follows receipt of melter components, allowing an assembled melter to be available in 6½ years. Melter #3 procured and assembled on receipt and stored until changeout. Melter #4 procured on initial operations. Subsequent melters are procured, followed by assembly, based on changeout decision. | • Risk of no assembled melter being available for 3 years for Melter #1  
• Melters required to extend operations beyond their design life at a minimum of 1 year  
• No continuity of assembly requirements  
• No replacement melter available for 6 years  
• Early operational lessons learned difficult to incorporate into Melters #3 and #4 | • Costs may be deferred or avoided |

DFLAW = direct-feed low-activity waste.  
FY = fiscal year.  
LAW = low-activity waste.  
WTP = Waste Treatment and Immobilization Plant.

### 4.1.2 Low-Activity Waste Melter Program Execution Options Selection

To select the LAW Melter Replacement Program execution option that is feasible and most favorable, each option was compared against the requirements identified in Section 2.2 and provided in Appendix B. The execution options were compared against each requirement for compliance. Requirements that resulted in a noncompliance or discriminate between options are included in the evaluation summary in Table 4-2. The requirements include meeting 70 percent facility availability, maintaining the melter design life and operational lifespan of 5 years, and putting the melter into service within 1 year of assembly to eliminate additional moisture control requirements. The results of the evaluation are presented as high favorability (green), medium favorability (yellow), or does not meet the requirement (orange).

To narrow the options further, the execution options were also evaluated against LAW melter replacement execution selection criteria. The criteria were presented and agreed to by attendees at the LAW melter replacement and disposition alternatives evaluation workshop. Selection criteria that discriminate between options are also included in Table 4-2.
Table 4-2. Low-Activity Waste Melter Replacement Program Execution Options Evaluation Summary

<table>
<thead>
<tr>
<th>LAW Melter Program execution options</th>
<th>Melter replacement requirements (Section 2.2/Appendix B)</th>
<th>Melter replacement execution selection criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Meets 70% facility availability (lifecycle)</td>
<td>Melter design life / operational lifespan of 5 years</td>
</tr>
<tr>
<td>X 1: Comparison case: No action until needed</td>
<td>No</td>
<td>Extended to 7½ and 11½ years for first melters, 6½ years future melters</td>
</tr>
<tr>
<td>X 2: Staggered planned changeouts, assembly just in time for changeout</td>
<td>Yes</td>
<td>Melter #2 extended to 7½ years, all other melters at 5 years</td>
</tr>
<tr>
<td>X 3: Staggered planned changeouts, initial replacement melter assembled early</td>
<td>Yes</td>
<td>Melter #2 extended to 7½ years, all other melters at 5 years</td>
</tr>
<tr>
<td>X 4: Staggered planned changeouts, initial procurement planned to eliminate storage</td>
<td>Yes</td>
<td>Melter #2 extended to 7½ years, all other melters at 5 years</td>
</tr>
<tr>
<td>X 5: Consecutive changeouts, assembly follows procurement just in time for changeout</td>
<td>Yes</td>
<td>Yes, changeout at 5 years and 5½ years</td>
</tr>
<tr>
<td>✓ 6: Consecutive changeout, assembly planned to allow resource continuity</td>
<td>Yes</td>
<td>Yes, changeout at 5 years and 5½ years</td>
</tr>
<tr>
<td>X 7: Staggered changeout, replacement melter and components available at initial operations</td>
<td>Yes</td>
<td>Melter #2 extended to 7½ years, all other melters at 5 years</td>
</tr>
<tr>
<td>✓ 8: Staggered changeout, replacement melter and components available at changeouts</td>
<td>Yes</td>
<td>Melter #2 extended to 7½ years, all other melters at 5 years</td>
</tr>
<tr>
<td>X 9: Supporting melter separately, replacement melter and components available at changeouts</td>
<td>Yes</td>
<td>Yes, changeout at 5 years and 5½ years</td>
</tr>
<tr>
<td>X 10: Operate melters to near failure, procurement initiated with changeout decision</td>
<td>No</td>
<td>Melter #2 to 6½ years, all others at 6 years</td>
</tr>
</tbody>
</table>

Highly favorable | Medium | Does not meet
The selection criteria include the ability to meet schedule needs; availability of a backup replacement melter; the timing, size, resources, and continuity of the assembly capabilities needed; and the ability to implement operational lessons learned into the melter design.

Based on the evaluation results for each LAW Melter Program execution option, several options were not selected for further evaluation. The two options that were selected for additional consideration in this analysis are:

- 6: Consecutive changeout, assembly planned to allow resource continuity (Figure 4-2)
- 8: Staggered changeout, replacement melter and components available at changeouts (Figure 4-3).

These two options provide DOE with both a consecutive approach and a staggered approach to melter changeouts. This evaluation did not assess the impacts of a LAW Vitrification Facility processing reduction for 6 months every 2½ years (staggered changeouts) versus a processing reduction for 1 year every 5 years (consecutive changeouts) on both the LAW Vitrification Facility and the overall mission. An assessment of the impacts of the two options could give a preference of one option over the other. For this report, the consecutive changeout for planned assembly that allows for assembly resource continuity (LAW melter execution option #6) is being used for further evaluation.

Figure 4-2. Consecutive Changeout, Assembly Planned to Allow Resource Continuity
Low-Activity Waste Melter Execution Option #6
4.1.3 Low-Activity Waste Melter Replacement Approach Options

During the current state mapping workshops, the approach options were identified for each of the LAW melter replacement functions:

- LAW melters replacement functions
  - Replacement LAW melter procurement (except for the first spare melter)
  - Replacement LAW melter assembly/storage
  - Assembled replacement LAW melter transport
  - Assembled replacement LAW melter installation.

To develop the options for each replacement function, the possible approaches to the activities necessary to provide the function were identified. The options considered the method (approach) of performing activities, the locations where the activities can be performed, and the timing of when the activities can be performed.

Enhancements are also identified that could reduce risk to the LAW melter replacement. These enhancements are not currently incorporated into the options. This section discusses the options, highlights key risks and benefits, and identifies those options that warrant further consideration.

For each of the replacement functions, the approach, location, and timing is provided in the subsections that follow. The approach options identified are summarized in Figure 4-4. These options are evaluated in Section 4.1.4, with the results used to develop the LAW melter replacement alternatives.
Procurement includes acquisition of the melter box, melter lid, melter components, refractory, and appurtenances. The melter box and lid will be fabricated offsite and delivered to the Hanford Site. Receipt and inspection of the melter parts will be performed. Options for procurement approach, location, and timing are listed below, along with associated risks and benefits.

**Approach:**
- Perform in accordance with requirements. No options identified.
- Enhancement: Multiple melter suppliers could be used versus one supplier, which will allow for multiple fabrications of melters, if necessary.

**Location:**
- Enhancement: Local melter fabrication versus out of state. With local fabrication, interfacing with the supplier, performing inspections, and overseeing the work is easier. This lack of interface could increase potential rework.
- Enhancement: With the refractory being a specialized product, identifying an additional source or supplier will eliminate the risk of a single supplier.

**Timing:**
- Long-lead items could be procured early or stockpiled. This reduces the melter fabrication duration by up to 1 year, but costs are incurred early.
4.1.3.2 Low-Activity Waste Melter Assembly Options

Melter assembly includes installing the refractory in the melter body and lid, placing and welding the melter lid on the melter body, and connecting remaining components. The selected LAW Melter Program execution option requires that an assembled melter be stored while another melter is being assembled. For this evaluation, the melter storage capabilities will accommodate all of the melter parts, including the melter body, lid and components, and the lid and melter refractory. Melter assembly capabilities will include all of the equipment necessary to assemble the melter, adequate room to perform the assembly activities, and laydown necessary equipment and parts.

Melter Availability Approach

- **Assembled just in time for changeout** – Melter assembly is planned to be complete just as the melters are needed for the changeout. This will require no impacts to the schedule during assembly activities.

- **Available at all times** – An assembled replacement melter is available during all operations periods. This will require that an assembled replacement melter be placed in storage for 5 years or longer.

- **Assembled replacement melters stored for melter failure** – An assembled replacement melter is stored until the melter replacement decision is made. With the durations for procurement and assembly, planning for assembly resources is difficult.

Assembly Facility Design

- **Temporary assembly facility** – A temporary assembly facility, as described in 24590-WTP-RPT-PM-09-001, will be used for melter component storage, assembly, and assembled melter storage. In a temporary facility, the strict environmental control requirements may be difficult to meet. In addition, with the melter required to be built on a rail system similar to that located in the LAW Vitrification Facility bays, a temporary facility may not be feasible.

- **Permanent assembly facility** – A permanent assembly facility, as described in 24590-WTP-RPT-PM-09-001, will be used for melter component storage, assembly, and assembled melter storage. A permanent facility will allow for adequate environmental controls, adequate storage of components and the ancillary equipment and systems, and allow for a rail system to be used for building the melter and for melter movement, as appropriate.

- **Two-bay melter assembly building** – As described in 24590-WTP-RPT-PM-09-001, this option allows for an assembled melter to be stored while the next melter is being assembled. This option may not allow for installation of refractory in the melter lid and the melter body at the same time. This option may not allow for receipt of the next replacement melters parts while one melter is in storage and another is being assembled.

- **Three-bay melter assembly building** – As described in 24590-WTP-RPT-PM-09-001, this option allows for an assembled melter to be stored while the next melter is being assembled. This option allows for both the lid and the body to be assembled at the same time. This option also allows for the receipt of melter components during storage and assembly activities.
Assembly Timing:

- **Staggered/as-needed assembly** – Performing assembly activities in a staggered approach could result in loss of continuity of resources. If the changeouts are not planned, only being performed as needed, there is a possibility that two melters will need to be assembled at the same time. The assembly facility will either have to be sized for simultaneous assemblies or the replacement melter availability will be delayed.

- **Consecutive assembly** – Performing assembly activities consecutively allows for continuity in the assembly workforce and resources. The assembly facility design will only have to accommodate one assembly at a time, reducing the need for redundancies. This is the option that was found to be most favorable for this analysis.

- **Simultaneous assembly** – Performing assembly activities simultaneously requires a larger assembly facility and additional assembly resources (e.g., workforce, overhead lifting capabilities). If necessary to meet schedule, some overlap in assembly activities could be managed as space becomes available, which will not require the facility capabilities to be impacted.

- Durations of LAW melter assembly are based on BNI’s experience with the first two LAW melters
  - Melter body refractory installation duration is 1½ years
  - Melter lid refractory installation duration is 1 year
  - Component installation duration is 1 year
    - Refractory installation and component installation done consecutively requires 3½ years for assembly
    - Refractory installation and component installation done concurrently requires 2½ years for assembly. This option is considered in more detail in this report.

Assembly Location:

- **Off-site assembly and storage at subcontracted facility** – Off-site assembly eliminates the need for permanent on-site assembly and storage. Off-site melter assembly and storage will be provided by a subcontractor with a facility that will meet program needs. Transporting an assembled melter will be performed by heavy-haul equipment, as discussed in Section 4.1.3.4. The duration for procuring off-site assembly capabilities is estimated to be approximately 2 years.

- **On-site assembly and storage facility adjacent to LAW Vitrification Facility pad** – Similar to the option described in 24590-WTP-RPT-PM-09-001, this option provides a permanent facility near the LAW Vitrification Facility. In 24590-WTP-RPT-PM-09-001, the assembly facility is located over a portion of the existing LAW melter assembly pad. In this study, the assembly facility is located adjacent to the LAW Vitrification Facility pad, allowing transporter access from between the assembly facility and the LAW pad. This eliminates the need to transfer a used melter through the assembly facility.
A facility in this location allows for ease in transporting the replacement melter to the LAW melter bay. Construction of an assembly facility in this location will take place during LAW commissioning activities. Based on similar facility estimates, and taking into consideration the additional restrictions and complications of building a facility adjacent to an operating nuclear facility, an assembly building is estimated to be designed, built, and commissioned at this location in 5 years.

- **On-site assembly and storage facility in the 200 Area** – An assembly facility in the 200 Area will provide for assembly and storage of replacement melters within a few miles of the LAW Vitrification Facility. There are potential existing facilities that could be repurposed and retrofitted to accommodate the project needs, such as WTP buildings T43 and T47. If a new facility is required, construction of an assembly facility will not impact ongoing operations. Based on similar facility estimates, an assembly building is estimated to be designed, built, and commissioned at this location within 4 years. If an existing facility is retrofitted, the duration could be less.

- **Expansion of the LAW Vitrification Facility**, including assembly and storage:
  - As described in 24590-WTP-RPT-PM-09-001, this option expands the LAW Vitrification Facility to include the assembly capabilities. The assembly facility will be added to and integrated into the LAW melter bays.
  - This option requires that the used melter passes through the assembly/storage facility, which increases radiological control concerns.
  - This option was not recommended in 24590-WTP-RPT-PM-09-001 as it was determined to be the most expensive option without offering additional benefits over the other assembly building options. This option also requires construction during the LAW commissioning timeframe, which will impact the LAW startup schedule. This option is not evaluated further in this study.

- **LAW Vitrification Facility Bay 3 assembly**
  - This option will convert the LAW Bay 3 into an assembly location. The LAW Vitrification Facility will be upgraded to accommodate assembly activities, including adding lifting capabilities for refractory installation and lifting the melter lid.
  - Per the requirements provided in Appendix B, the LAW Vitrification Facility design should not preclude the installation of a third melter. Using Bay 3 for assembly and storage will require that bay to not be available. Using Bay 3 for assembly is not evaluated further in this study.

### 4.1.3.3 Low-Activity Waste Melter Storage Options

Melter storage includes the storage of melter components (e.g., melter shell, melter lid, refractory, and appurtenances) and an assembled melter. As described in Appendix B, the storage facility is required to be environmentally controlled.

- **Combined assembly and storage into one facility** – For this option, assembly and storage needs will be incorporated into one facility. This approach will minimize the need to transfer the melter after assembly to a storage facility. There are efficiencies in sharing equipment and resources with this option.
• **Separate assembly and storage facilities** – This option requires two separate facilities, one for assembly and one for storage. Each facility will require its own lifting capabilities, workforce, and equipment. With this option, there is an additional transport required; the melter will need to be transported after assembly to the storage facility. For these reasons, this option is not evaluated further in this study.

### 4.1.3.4 Assembled Replacement Melter Transportation Options

In addition to the size and weight of a fully assembled melter (Table 4-3), a key challenge for transporting an assembled melter is moving the melter without displacing any of the refractory placed in the melter. The refractory is placed in the melter in a specific pattern, with prescribed spacing between refractory brick as part of the assembly process.

<table>
<thead>
<tr>
<th>Melter type</th>
<th>Height</th>
<th>Length</th>
<th>Width</th>
<th>Fully assembled melter weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>LAW</td>
<td>15 ft-10 in. (190 in.)</td>
<td>30 ft-7 in. (367 in.)</td>
<td>21 ft-10 in. (262 in.)</td>
<td>656,700 lb</td>
</tr>
</tbody>
</table>

LAW = low-activity waste.

Figure 4-5 is a cross-section diagram along the east-west plane of a LAW melter with refractory. The figure shows the different layers of refractory in the melter.
Figure 4-6 is a cross-section diagram along the north-south plane of a LAW melter and includes a discharge chamber. The first two melters were transported from the fabricator directly to the LAW Vitrification Facility in 2010 and assembled in the melter bays. The first two assembled melters, therefore, did not require assembled transport.

To prevent refractory brick from shifting/tilting or toppling inside the assembled melter during transport, a 0.075 g acceleration limit has been established (24590-LAW-M2C-LMP-00014, LAW Melter Refractory Allowable Acceleration during Movement Operations). Washington River Protection Solutions, LLC (WRPS) commissioned Barnhart Crane & Rigging to conduct a transportation feasibility study to determine if a fully assembled LAW melter could be transported to the LAW Vitrification Facility on the WTP site without exceeding a required acceleration limit.

The transportation feasibility study, included in Appendix E, describes the load and proposed transporter, provides loading and unloading concepts, outlines the physical characteristics of the roads in question and recommends route options given melter assembly locations, and calculates the ability to remain below the lateral acceleration limitation of 0.075 g during melter transport. The salient points from the transportation feasibility study are summarized as follows:

- Barnhart recommends a nine-axle doublewide Goldhofer\(^3\) PST/SL-E to transport an assembled melter. The Goldhofer PST/SL-E is a heavy-haul self-propelled trailer with hydraulically driven axles powered by an attached motor and hydraulic reservoir (called a powerpack). The trailer can be leveled during travel and modulate speed as required.

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\(^3\) Goldhofer is a registered trademark of Goldhofer Aktiengesellschaft, Memmingen, Germany
during the haul. The axles are controlled via electronic remote control, which allows for a very high degree of maneuverability in terms of turn radius and direction of travel.
The PST/SL-E trailer can – among other maneuvers – drive forward, in reverse, crab, and carousel.

- Unloading methods at WTP can be achieved by vertical lifting with jacks and/or pull-up gantries, followed by horizontal sliding on a level track surface. Lifting, lowering, and sliding will be monitored with digital levels and accelerometers to ensure movement remains within melter acceleration limitations.

- Transport routes to the LAW Vitrification Facility were evaluated from potential melter assembly off-site locations, the Hanford 200 East and West Areas, and within or adjacent to the WTP project area. Except for a route along 19th street near the Camden Avenue intersection, the other transport routes evaluated appear to be feasible, with adequate traffic controls and resolution of existing overhead obstructions (e.g., wires, piping).

- Operational controls to ensure allowable acceleration and braking during transport include a maximum speed of 3.1 mi/hr, time to maximum speed of greater than or equal to 5 seconds, and time to decelerate to a complete stop from maximum speed of greater than or equal to 5 seconds. The acceleration and braking times include a safety factor of 2. These constraints indicate that considering operator fatigue, refueling stops, and transport slowing for adjustments, a haul will realistically take two 10-hour days from an off-site facility, with a natural stopping point after day one at the Wye Barricade. Haul duration from any location in the 200 Area to the LAW Vitrification Facility will likely account for no more than one 10-hour day.

- From surveys taken during the route analysis, the steepest slope measured of any feasible route was 5.7 percent along Route 4S to the 200 East Area. The Goldhofer transporter can remain level on a 4.24 percent slope. The difference between the worst-case slope (5.7 percent) and the Goldhofer leveling capability is 1.46 percent. At a 1.46 percent grade, the maximum acceleration that the Goldhofer could experience with the added forces as a result of the 1.46 percent slope not addressed by the leveling system is 0.06 g, which is less than the 0.075 g limit of acceleration, which represents the worst-case acceleration limit throughout the credible routes proposed.

Based on the results of the Barnhart report, the following actions appear warranted:

- Completion of an engineering study to support a decision regarding the optimal location for the melter assembly building – The study should consider transport risks and the costs for melter assembly building construction and transportation route preparation.

- An evaluation of the feasibility of bracing the refractory bricks inside the assembled melter prior to transport to reduce the risk of refractory shift/tilt.

- A haul demonstration along the possible routes evaluated to inform a decision regarding the location for the melter assembly building – This will provide early insights from lessons learned and prove that an assembled melter can be transported within the 0.075 g limit. The demonstration should include the trailer configuration, travel speed and duration, load weight and dimensions, and means testing of operational limits with accelerometers affixed to the load for verification.
4.1.3.5 Low-Activity Waste Melter Installation Options

Melter installation includes positioning the melters into the melter bays to allow connections to be made, electrical and mechanical connections and component installation, and any testing prior to startup. There were no options identified for LAW melter installation during the current state mapping workshops. Melter installation will be performed in accordance with established procedures.

4.1.4 Low-Activity Waste Melter Replacement Approach Options Selection

The LAW melter replacement approach options are summarized in Table 4-4. The options found to warrant further consideration are indicated with bold text. This section discusses the evaluation and selection process used to narrow the approach options.

Table 4-4. Low-Activity Waste Melter Replacement Approach Options Summary

<table>
<thead>
<tr>
<th>Function</th>
<th>Approach options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Procurement</td>
<td>None for this study</td>
</tr>
<tr>
<td>Assembly</td>
<td>• Just in time for changeout ✔</td>
</tr>
<tr>
<td></td>
<td>• Assembled melter available at all times ✔</td>
</tr>
<tr>
<td></td>
<td>• Assembled melter stored until failure</td>
</tr>
<tr>
<td></td>
<td>• Temporary facility</td>
</tr>
<tr>
<td></td>
<td>• Permanent facility ✔</td>
</tr>
<tr>
<td></td>
<td>• Two-bay facility</td>
</tr>
<tr>
<td></td>
<td>• Three-bay facility ✔</td>
</tr>
<tr>
<td></td>
<td>• Offsite ✔</td>
</tr>
<tr>
<td></td>
<td>• Adjacent to LAW pad ✔</td>
</tr>
<tr>
<td></td>
<td>• 200 Area ✔</td>
</tr>
<tr>
<td></td>
<td>• LAW Vitrification Facility</td>
</tr>
<tr>
<td></td>
<td>• Consecutively ✔</td>
</tr>
<tr>
<td></td>
<td>• Concurrently</td>
</tr>
<tr>
<td></td>
<td>• Staggered ✔</td>
</tr>
<tr>
<td>Storage</td>
<td>Supports assembly options</td>
</tr>
<tr>
<td></td>
<td>• Shared facility with assembly ✔</td>
</tr>
<tr>
<td></td>
<td>• Separate from assembly</td>
</tr>
<tr>
<td>Transport</td>
<td>Supports assembly options</td>
</tr>
<tr>
<td></td>
<td>• Supports assembly options</td>
</tr>
<tr>
<td>Installation</td>
<td>None for this study</td>
</tr>
</tbody>
</table>

LAW = low-activity waste.

To narrow the LAW melter replacement approach options, each option is compared against the requirements identified in Section 2.2 and provided in Appendix B. The approach options were compared against each requirement for compliance. Only those requirements that result in a noncompliance or discriminate between options are included in the evaluation summary in Table 4-5. The requirements include meeting 70 percent facility availability, maintaining the melter design life and operational lifespan of 5 years, providing environmental controls, providing a melter rail mock-up system for assembly, a laydown area adjacent to melter assembly, acceleration controls, putting the melter into service within 1 year of assembly to eliminate additional moisture control requirements, and controlling thermal cycling. The results of the evaluation are presented as high favorability (green), medium favorability (yellow), or does not meet the requirement (orange).
## Table 4-5. Low-Activity Waste Melter Replacement Program Approach Options Evaluation Summary

<table>
<thead>
<tr>
<th>LAW Melter Program replacement approach options</th>
<th>Melter replacement requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>PROCUREMENT</td>
<td>Meets 70% facility availability</td>
</tr>
<tr>
<td>ASSEMBLY</td>
<td></td>
</tr>
<tr>
<td>Melter Availability</td>
<td></td>
</tr>
<tr>
<td>✅ Assembled replacement melter available just in time for planned changeout</td>
<td>Yes</td>
</tr>
<tr>
<td>✅ Assembled replacement melter available at all times in case of a premature failure</td>
<td>Yes</td>
</tr>
<tr>
<td>✗ Assembled melters assembled/stored until failure occurs</td>
<td>No</td>
</tr>
<tr>
<td>Assembly Facility</td>
<td></td>
</tr>
<tr>
<td>✗ Temporary assembly facility</td>
<td>N/A</td>
</tr>
<tr>
<td>✅ Permanent assembly facility</td>
<td>N/A</td>
</tr>
<tr>
<td>✗ Two-bay assembly facility</td>
<td>N/A</td>
</tr>
<tr>
<td>✅ Three-bay assembly facility</td>
<td>N/A</td>
</tr>
<tr>
<td>Assembly Location</td>
<td></td>
</tr>
<tr>
<td>✅ Consecutive planned melter assembly</td>
<td>N/A</td>
</tr>
<tr>
<td>✗ Concurrent planned melter assembly</td>
<td>N/A</td>
</tr>
<tr>
<td>✅ Staggered planned melter assembly</td>
<td>N/A</td>
</tr>
<tr>
<td>Assembly Location</td>
<td></td>
</tr>
<tr>
<td>✗ Off-site assembly at subcontractor facility</td>
<td>N/A</td>
</tr>
<tr>
<td>✗ On-site assembly adjacent to LAW melter pad</td>
<td>N/A</td>
</tr>
<tr>
<td>✗ On-site assembly in 200 Area</td>
<td>N/A</td>
</tr>
<tr>
<td>STORAGE</td>
<td></td>
</tr>
<tr>
<td>✗ Provided in same facility as assembly</td>
<td>N/A</td>
</tr>
<tr>
<td>✗ Provided in separate location from assembly</td>
<td>N/A</td>
</tr>
<tr>
<td>TRANSPORTATION</td>
<td></td>
</tr>
<tr>
<td>INSTALLATION</td>
<td></td>
</tr>
</tbody>
</table>

No options identified for this study, to be performed as efficiently as possible in accordance with established procedures.
As shown in Table 4-5, the resulting LAW melter replacement approach options are:

- Providing an assembled melter just in time for planned changeout or at all times during operations in case of a premature failure; either option is acceptable and may be influenced by the execution option selected
- Providing a permanent assembly facility with a minimum of three bays
- Planning for consecutive or staggered melter assembly. Either option is acceptable and may be influenced by the execution option selected
- Assembling melter offsite, or onsite adjacent to the LAW Vitrification Facility pad, or onsite in the 200 Area
- Storing the melter in the same location as the assembly facility

4.2 MELTER REPLACEMENT ALTERNATIVES DEVELOPMENT

To develop the replacement alternatives, each of the resulting replacement approach options were incorporated into the selected execution approach. Of the approach options, the assembly facility location could be a discriminator for the LAW melter replacement alternatives. These include offsite at vendor location, onsite adjacent to the LAW Vitrification Facility pad, and onsite in the 200 Area. To incorporate these options into the execution option, the estimated durations for engineering, procurement, permitting, design, construction, and start-up activities for each were also incorporated into the execution option. Table 4-6 summarizes the LAW melter replacement alternatives and corresponding estimated planning durations. The basis for each planning duration is provided in Section 4.1.3.2.

Table 4-6. Low-Activity Waste Melter Replacement Alternatives
Assembly Planning Duration Summary

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Approach</th>
<th>Planning duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>LAW melter assembly and storage performed offsite at subcontractor facility</td>
<td>2 years</td>
</tr>
<tr>
<td>R2</td>
<td>LAW melter assembly and storage performed onsite adjacent to the LAW Vitrification Facility pad</td>
<td>5 years</td>
</tr>
<tr>
<td>R3</td>
<td>LAW melter assembly and storage performed onsite in the 200 Area</td>
<td>4 years</td>
</tr>
</tbody>
</table>

LAW = low-activity waste.

To develop the alternatives, the replacement alternatives durations are incorporated into the selected execution approach: consecutive changeout with assembly planned to allow resource continuity. Assuming that the assembly capabilities are available just before assembly is required to begin, assembly capabilities will be required by January 2021 (Figure 4-7).

As shown, the only replacement alternative that meets the schedule needs is Alternative R1, Off-site assembly at a subcontracted existing location. This will require that DOE be prepared to start procurement in early fiscal year (FY) 2019.
Additional evaluation of the execution approach was performed to identify innovative approaches to managing the initial melter assembly needs that will allow Alternative R2, On-site assembly adjacent to the LAW Vitrification Facility pad, and Alternative R3, On-site assembly in 200 Area, to be feasible. In identifying the modified approaches, minimizing risks and other impacts to the mission were taken into consideration.

Melter assembly management was first considered for potential modifications. During melter assembly, the refractory will be installed in the melter body and lid at the same time. Once complete, the lid is placed on the body, opening up space. The next melter assembly could begin at this point, allowing for concurrent, overlapping assembly activities on the next two melters. This approach, illustrated in Figure 4-8, would not require increasing the assembly capabilities and could delay assembly capability needs by up to 1 year.

By implementing this modification to assembly management, Alternative R3 could be feasible if initiated in early FY 2018. Alternative R2 is not feasible to meet schedule needs. Figure 4-8 shows this modification and highlights the impact to assembly planning needs.

Additional review of the execution approach for modifications that will enable Alternative R2 to be feasible was performed. Delaying the changeout of Melter #2 by approximately 1½ years beyond its design life will allow the assembly capability need to be delayed another year, as shown in Figure 4-9. This delay makes Alternative R2 feasible. There is an increase of risk with this approach from extending the changeout beyond the melter design life.

All subsequent melter changeouts will be planned for after 5 years of melter operations, 1 year apart, allowing for some flexibility in changeout planning.
Figure 4-8. Melter Replacement Alternatives Timeframe with Overlapping Assembly

Figure 4-9. Melter Replacement Alternatives Timeframe with Overlapping Assembly and Melter Changeout Delay
4.2.1 Alternative R1 – Off-Site Assembly and Storage

LAW melter replacement alternative, R1, includes off-site assembly and storage at a subcontractor facility. This alternative includes the following functions:

- **Procurement**: Identify multiple suppliers of critical items such as melter fabrication and refractory, to the extent practical. Local and regional suppliers increase the ability for quality assurance oversight.
- **Assembly and storage**: Perform off-site melter assembly and storage at a subcontractor facility that meets program needs.
- **Assembled melter transport**: Transport the assembled melter from the off-site subcontractor facility to the LAW Vitrification Facility using a heavy-haul transporter.
- **LAW melter installation**: Perform melter installation as efficiently as possible in accordance with established procedures.

Implementing the modified execution approaches is not required for Alternative R1 to meet schedule needs. With assembly and storage planning starting in FY 2019, this alternative could be implemented without the need to do assembly activities concurrently or accept the risk of delaying the changeout beyond the melter design life.

4.2.1.1 Alternative R1 Description

This alternative provides for an execution approach that uses off-site assembly and storage via a service subcontract. The subcontractor would provide adequate space to accommodate receipt, assembly, and storage of the melters as needed. The facility would also be provided with the environmental controls and equipment as described in 24590-WTP-RPT-PM-09-001. Assembled melters will be transported from an off-site location to the LAW Vitrification Facility. To minimize the transportation risk, a subcontractor facility located near Richland, Washington, is preferred.

To eliminate the need to plan a changeout beyond the melter design life, consecutive changeouts will be planned to start after 5 years of melter operations. In this alternative, assembly of the replacement melter is complete when needed for installation. To help manage the assembly resources and require only one assembly scheduled at a time, the first melter procured will be assembled and placed into storage while the next replacement melter is being assembled. Both melters will be ready to support the first changeouts beginning after 5 years of operations. This approach will continue with all subsequent melters, as shown in Figure 4-10.

When the assembled melter is required for installation, the transport subcontractor will load, transport from the subcontractor facility, and off-load onto the rails at LAW Vitrification Facility. Appropriate measures are required to ensure that the acceleration of the assembled melter is less than 0.075 g due to concerns with shifting/tilting of the stacked refractory.
A transportation feasibility study conducted by Barnhart Crane & Rigging (Appendix E) evaluated the transport routes to WTP from two potential off-site assembly locations. The first potential assembly location is east of Route 4S and north of 300 Remediation Access Road; the second is located west of the intersection of Route 4S and Smartpark Street. Travel to WTP from either location would be via Route 4S to the Wye Barricade and then continue to WTP via Route 4S or alternatively Route 2S.

The significant terrain feature along Route 4S to the 200 East Area is a 5.7 percent slope at approximately mile 19. The slope includes a 3.6 percent superelevation as the route turns to the west. The route uses the southern WTP entrance.

Route 2S comprises two lanes per direction, with a gravel median at the elevation of the roadway along much of its length. The significant terrain feature along Route 2S is a 5.7 percent slope at approximately mile 25. All slopes along Route 2S incorporate superelevations that are less than 1 percent. Rail crossings occur along the length of the route but do not change the slope of the roadway in any significant way. The road edges are occasionally marked with potholes not more than 1.5 ft in diameter and 4 in. in depth.

The Barnhart study indicates that the proposed Goldhofer PST/SL-E can self-level the load so that the 0.075 g limit is not exceeded under the worst-case slope of 5.7 percent on Route 4S, with a safety factor of 2. The total travel time to deliver a melter from offsite to WTP under the operating constraints of the transporter is estimated to be 2 days.

Once placed onto the rails at the LAW Vitrification Facility, the melters will be slid into the melter bay for installation in accordance with procedures and processes developed by the WTP EPCC contractor.
Planning for providing off-site assembly is estimated to require 2 years. During this period, all procurement and readiness activities (e.g., system testing, submittals, and approvals) will occur. With this melter replacement execution approach, assembly capabilities are needed mid-FY 2021, which will require planning to begin mid-FY 2019.

4.2.1.2 Safety Aspects

Constructing and operating an industrial facility away from the Hanford Site will eliminate any possible impacts or concerns related to nuclear safety. The melter assembly building will have no nuclear safety requirements imposed on that facility as a result of working on a nuclear-licensed site or immediately adjacent to a Category II nuclear facility during construction or operation. Typical industrial safety requirements will apply to the melter assembly building during construction and operation.

4.2.1.3 Mission Impacts

The alternative was evaluated in several areas where potential impacts to the mission exist. A description of how this alternative may impact the mission is provided, along with the potential risks and benefits identified for each of the categories.

Schedule risk – This alternative can be implemented without modifying the execution approach.

Transporting the assembled melters from offsite increases the transportation duration and increases the potential of shifting/tilting the refractory and requiring rework. Weather and road conditions or work could impact the ability to deliver the assembled melter in accordance with schedule needs.

As the used melter requires several months to be removed, planning for assembled melter transport will occur during this timeframe and should not increase schedule risk.

By having an off-site vendor provide assembly and storage, the planning schedule for these capabilities is greatly reduced as a new facility onsite is not needed. Of the three, this alternative has the lowest impact on schedule as it does not require a new on-site facility.

Availability – During the DFLAW Program, the melters will each experience two planned changeouts of 6 months each. During this time, the melter will not be available. This will result in each melter not being available for 1 year during the 10-year DFLAW Program.

The changeout cycle will continue for the duration of the facility, with consecutive changeouts scheduled every 5 years of melter operations.

Impacts to ongoing operations – Performing assembly and storage at an off-site location will not impact ongoing operations.

Resource requirements – This alternative allows for continuity in assembly resource (workforce and facility) needs, while eliminating the need for multiple simultaneous assembly and storage capabilities.

Failure response (duration without replacement melter available) – The availability of an assembled melter in the event of a premature melter failure can greatly impact the mission. The program execution alternative determines the ability to respond to a melter failure.
For this alternative, one backup melter will be available 3 years after each changeout, or approximately 40 percent of the time during LAW Vitrification Facility operations. The procurement, assembly, and storage options of this alternative do not impact failure response.

**Planned changeout** – For this alternative, the planned changeouts support the melter design life of 5 years and will be scheduled consecutively starting at 5 years of operations.

**Implementation of lessons learned** – For the first two replacement melters, implementation of early operational lessons learned in subsequent melter design is limited. Melter #3 will be procured, and Melter #4 will be substantially into the procurement cycle within the first year of operations.

**Melter procurement schedule** – Approximately every 3 years, the next replacement procurement will initiate, with the first two replacement melters (Melter #3 and #4) in procurement prior to pre-cold commissioning activities. Melter #4 procurement should be initiated mid-FY 2019.

**Assembly capabilities timing** – Assembly capabilities will be required mid-FY 2021. With approximately 2 years required to procure assembly capabilities, planning should begin in early FY 2019.

**Storage needs timing** – The approach for storage is to incorporate the need into the assembly facility. Storage of an assembled melter is needed in FY 2023.

### 4.2.1.4 Regulatory Implications

In support of Alternative R1, an evaluation of federal and state environmental requirements was performed. Potential regulatory implications to support Alternative R1 are discussed in this subsection.

**Resource Conservation and Recovery Act**

In Alternative R1, off-site melter assembly and storage will be provided by a subcontractor with a facility meets the program needs. If melter assembly activities result in the generation of hazardous or dangerous waste, the subcontractor will be regulated under Resource Conservation and Recovery Act of 1976 (RCRA) authority pursuant to the State of Washington Department of Ecology (Ecology) Dangerous Waste Regulations (WAC 173-303). The subcontractor will be required to provide notification of dangerous waste activities by obtaining a U.S. Environmental Protection Agency (EPA)/state ID # and submitting a Dangerous Site Identification Form (WAC 173-303-060, “Notification and Identification Numbers”) of the location and general description of hazardous waste management activities, and of the characteristic and/or listed hazardous waste handled. The activity must be completed before dangerous waste can be managed (i.e., accumulate, treat, store, dispose, or transport). Conditionally exempt small quantity generators (less than 220 lb of hazardous waste per month) are an exception to this rule.

**Air Permit**

Off-site melter assembly could result in non-radiological emission non-point (fugitive emissions) and point source emission units in support of melter assembly activities. Nonhazardous emissions are regulated under WAC 173-400, “General Regulations for Air Pollution Sources.”
A New Source Review (NSR) will determine the need to modify existing processes or buildings to accommodate melter assembly. The following scenarios trigger the need for NSRs:

- Establishing a new source or modifying an existing source of air emissions, as identified in WAC 173-400
- Establishing a new source or modifying an existing source of toxic air emissions, as identified in WAC 173-460, “Controls for New Sources of Toxic Air Pollutants”
- Constructing, modifying, or relocating a portable source except those relocating in compliance with WAC 173-400-036, “Relocation of Portable Sources”
- Making a major modification to an existing major stationary source, as identified in WAC 173-400-720, “Prevention of Significant Deterioration (PSD)” (i.e., a source that has a prevention of significant deterioration permit).

The results of the NSR review will determine if further action is required by the subcontractor (operator of the off-site facility) to modify existing or establish a new source of toxic air emissions, including obtaining a toxic air emissions permit. For planning purposes, the NSR and permit modifications (if necessary) are expected to require 6-12 months to complete.

Radioactive air emissions do not apply to melter assembly activities.

**National Environmental Policy Act**

DOE/EIS-0391, *Final Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington* DOE/EIS-0391 (TC & WM EIS), analyzed a melter assembly and storage building at the WTP. Since this option includes assembly and storage at an existing facility, *National Environmental Policy Act of 1969* (NEPA) requirements are not anticipated to be an issue. However, since federal funding is supporting this alternative, additional NEPA documentation may be required to provide NEPA support of this option. DOE has the responsibility to determine if further NEPA action is required. For planning purposes, a NEPA action to support this alternative is not expected to adversely affect the project schedule.

**4.2.1.5 Cost**

The life-cycle cost estimate for Alternative R1 is based on the details associated with the alternative description presented in this section. The cost estimates are developed using various sources of information, including estimates from previous alternative evaluations, resource estimates, and engineering estimates. The identified costs are present dollar values that are developed by escalating costs to the year work is performed and then applying a discount rate for the time value of money. The cost estimate is developed in accordance with the requirements of TFC-PRJ-PC-C-05, “Estimating,” by the WRPS Estimating group. The cost estimates are at a preconceptual/magnitude estimate level or Class 5 estimate (i.e., ROM estimate). The estimate is useful for concept screening, concept feasibility evaluation, and budget estimate magnitude comparisons but is not at a level of accuracy appropriate for budget authorization. All cost estimates for this study are included in WRPS Estimate Number 4407, *Est 4407 Melter Replacement Readiness Assessment 2017-06-15b*. 
Costs are based on a 40-year operating life for the LAW Vitrification Facility. The costs associated with the two assembled melters already installed at the LAW Vitrification Facility are not included nor are the parts for a third melter that will be turned over to the WTP operations contractor. Cost estimates include organizational costs (e.g., management, engineering, quality assurance) to manage LAW melter replacement activities, assembly/storage facility annual lease costs, melter shell and component procurement for 13 LAW melters, refractory procurement for 13 LAW melters, melter assembly for 14 LAW melters, assembled melter transport for 14 melters to the LAW Vitrification Facility, and the cost to install the 14 LAW melters.

The present value acquisition, operating, and total life-cycle costs are presented in Table 4-7 for Alternative R1. Because this alternative is based on contracting with an off-site entity to assemble the LAW melters, there is no need to build an on-site assembly/storage facility; therefore, there is no acquisition cost associated with this alternative. All costs, including procurements for the melter shells and components (including the refractory), are considered operating costs.

The annual cost profile is shown in Figure 4-11. The peak years for operating cost are associated with concurrent procurement of melter shells and components during the fiscal year, along with a melter installation. Average annual operating cost over the 40-year facility operating life is roughly $15 million.

### Table 4-7. Present Value Acquisition, Operating, and Total Life-Cycle Cost (Low-Activity Waste Vitrification Facility Mission) for Alternative R1, Off-Site Assembly/Storage Facility

<table>
<thead>
<tr>
<th>Category</th>
<th>Alternative R1 – Off-site assembly/storage facility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acquisition cost</td>
<td>$ 0</td>
</tr>
<tr>
<td>Operating cost</td>
<td>$ 603,000,000</td>
</tr>
<tr>
<td>Total life-cycle cost</td>
<td>$ 603,000,000</td>
</tr>
</tbody>
</table>

* Operating cost includes procurement of melter shell, components, and refractory.
Figure 4-11. Annual and Cumulative Cost Profile for Alternative R1

4.2.1.6 Schedule

A preliminary schedule, shown in Figure 4-12, was developed to highlight potential risks and opportunities to the schedule. For Alternative R1, planning for off-site assembly procurement should begin in early FY 2019. The schedule shows that this alternative can be accomplished with the execution approach selected.
Figure 4-12. Melter Replacement Alternative R1 Schedule

4.2.2 Alternative R2 – On-Site Assembly and Storage Adjacent to the Low-Activity Waste Vitrification Facility Pad

This replacement alternative, R2, includes on-site assembly and storage at a new facility located adjacent to the LAW Vitrification Facility pad. This alternative includes the following functions:

- **Procurement**: Identify multiple suppliers of critical items such as melter fabrication and refractory, to the extent practical. Local and regional suppliers increase the ability for quality assurance oversight.

- **Assembly and storage**: Provide a new facility for assembly, storage, and melter removal adjacent to the LAW Vitrification Facility pad. Additional storage of components may be required.

- **Assembled melter transport**: Transport the assembled melter from the on-site facility adjacent to the LAW Vitrification Facility pad using a rail system. This mode of transport results in the least risk of a potential shift/tilt in melter refractory.

- **LAW melter installation**: Perform melter installation as efficiently as possible in accordance with established procedures.
A modified execution approach is required to implement Alternative R2, On-site assembly and storage adjacent to LAW Vitrification Facility pad. Overlapping the assembly efforts and delaying the melter changeout are required for Alternative R2 to meet schedule needs. To implement this alternative, DOE will need to take action in early FY 2018.

### 4.2.2.1 Alternative R2 Description

This alternative uses on-site assembly and storage located adjacent to the LAW Vitrification Facility pad. A new facility would be designed and built to provide adequate space to accommodate receipt, assembly, and storage of the melters as needed. The assembly and storage building would have three bays: one bay to assemble, one bay to store the assembled melter, and one bay to receive and store melter components. This facility would also include environmental controls and equipment, as described in 24590-WTP-RPT-PM-09-001.

In this alternative, assembly of the replacement melter is complete when needed for installation. To help manage the assembly resources and require only one assembly scheduled at a time, the replacement melter (starting with Melter #5 and alternating thereafter) will be procured, assembled, and placed into storage while the next replacement melter is being assembled. Both melters will be ready to support the planned changeouts.

Due to the design/build duration of a new facility immediately adjacent to the LAW Vitrification Facility, modifications to the execution sequencing are needed. As shown in Figure 4-13, the modifications include the overlap of assembly activities for Melters #3 and #4 and delaying changeout of Melter #2. Subsequent melters are assembled without the need to overlap, with changeouts planned for every 5 years of operations.

![Figure 4-13. Replacement Alternative R2 – Assembly and Storage Adjacent to Low-Activity Waste Vitrification Facility Pad Approach](image_url)
To accommodate used melter removal, avoiding the need to move the used melter through the assembly facility and having to maintain an open bay, the building can be placed near the end of the LAW Vitrification Facility pad. A driving lane for the transporter between the assembly facility and the pad enables used melters to be removed and assembled melters to be transferred between bays. This lane will be lowered to allow the transporter bed to be at elevation with the LAW assembly pad. A rail system integrated into the transporter will be aligned with the rails at the assembly facility, and the assembled melter will be positioned onto the transporter and moved to the appropriate bay. The transporter will then be aligned with the rails on the assembly pad and the melter moved to the pad. This approach eliminates the need to lift the assembled melter. The distance that assembled melters may need to travel on the transporter is a few feet. Figure 4-14 illustrates the concept for this alternative.

Figure 4-14. Low-Activity Waste Melter Replacement Alternative R2, Assembly Adjacent to Low-Activity Waste Vitrification Facility Pad Concept
Appropriate measures are required to ensure that the acceleration of the assembled melter is less than 0.075 g, due to concerns with shifting/tilting of the stacked refractory.

Once placed onto the rails at the LAW Vitrification Facility, the melters will be slid into the melter bay for installation in accordance with established procedures.

Planning for on-site assembly adjacent to the LAW Vitrification Facility pad is estimated to require 5 years. During this period, all procurement, design, build, startup, and readiness activities (e.g., system testing, submittals, and approvals) will occur. With this melter replacement execution approach, assembly capabilities are needed by FY 2023, which will require planning to begin mid-FY 2018.

4.2.2.2 Safety Aspects

For this alternative, construction of a melter assembly building south of the LAW Vitrification Facility will begin mid-FY 2020 and end mid-FY 2023 (Figure 4-16, Section 4.2.2.6). The construction period is longer for this alternative due to the added requirements associated with performing construction within the boundary of a nuclear facility. DOE approval of the LAW Vitrification Facility documented safety analysis (DSA) revision to incorporate DFLAW is currently scheduled to be completed near the end of FY 2018, before construction of the melter assembly building begins. The LAW Vitrification Facility DSA will have to be updated (e.g., annual revision) to account for the addition of the melter assembly building.

Constructing and operating an industrial facility (i.e., the melter assembly building) adjacent to a nuclear facility has increased requirements for nuclear safety. At a minimum, the unreviewed safety question (USQ) process will be invoked during construction and operation of the industrial facility. The USQ process is designed to ensure that the safety basis remains intact and that new activities, equipment, and facilities do not interfere with the controls in place to protect the public, workers, and environment. Qualified USQ reviewers will need to consider construction (short-term) and operational activities (long-term) that could have an impact on the nuclear facility. For example, during construction activities, if a crane collapses and falls on the adjacent nuclear facility and damages the structure, that safety feature may be prevented from performing as designed. If the new facility plans to use hazardous materials (e.g., natural gas or aboveground storage tanks for combustible liquids), consideration must be given to how these systems may fail and cause a fire and/or explosion and consequently cause damage to the adjacent nuclear facility and its operations. Similarly, chemical usage will need to be reviewed for impacts to the adjacent nuclear facility and its operations. Facilities located near a nuclear facility may also be required to meet a more robust structural/building design. There are many factors that must be considered such as traffic patterns, underground utilities, overhead utilities, operational activities, nearby waste transfers, and special permitting.

If the addition of the melter assembly building is considered a major modification, as specified in DOE-STD-1189, Integration of Safety into the Design Process, even greater requirements are placed on the construction project and/or operation of the facility depending on the hazards associated with the facility construction or operation. A major modification determination is not performed as part of this analysis because the scope of the modification is currently not mature enough to perform a meaningful review and evaluation. For this evaluation, the melter assembly building adjacent to the LAW Vitrification Facility pad is assumed to not be considered a major modification per DOE-STD-1189.
4.2.2.3 Mission Impacts

The alternative was evaluated in several areas where potential impacts to the mission exist. A description of how this alternative may impact the mission is provided, along with the potential risks and benefits identified for each of the categories.

Schedule risk – Without modifying execution, this alternative does not meet schedule needs. To meet schedule needs, assembly of the first two replacement melters will need to overlap and the changeout of Melter #2 will need to be delayed for up to 1½ years, which is beyond the design life of the melter.

Due to the added complexity and interferences of constructing an assembly facility in this location, this option has high schedule risk and the longest estimated design/build duration of 5 years.

Transporting the assembled melters from a location adjacent to the LAW Vitrification Facility has the lowest transportation risk of the three alternatives. Transportation can be accomplished without a vertical lift, and the transport distance is the shortest of the alternatives as the melter is moved between the assembly bay and the LAW pad.

Availability – During the DFLAW Program, the melters will each experience two planned changeouts of 6 months each. During this time, the melter will not be available. In addition to the planned changeouts, delay of the Melter #2 changeout will increase the risk of having that melter not available for 1½ years. During the 10-year DFLAW Program, this will result in Melter #1 not being available for 1 year and Melter #2 not being available for 2½ years.

For subsequent melters, changeouts are scheduled for every 5 years of melter operations.

Impacts to ongoing operations – To meet schedule needs, planning for the assembly/storage facility will need to begin in FY 2018, assuming a 5-year planning/design/build/startup duration. Building the assembly facility at this location will require that construction be ongoing during the LAW Vitrification Facility pre-cold commissioning. Construction within the defined boundary of a nuclear facility takes longer to perform due to additional controls and scrutiny and can also impact or delay ongoing commissioning or operations at the nuclear facility.

Resource management/requirements – The first two melters assembly activities will need to overlap to meet the project schedule. This overlap should be accomplished without the need to expand the melter assembly capabilities.

For all subsequent replacement melter assemblies, only one assembly will be scheduled at a time, with each assembly scheduled to begin as the previous assembly is completed. This alternative allows for continuity of resource needs, while eliminating the need for multiple simultaneous assembly and storage capabilities.

Failure response (duration without replacement melter available) – The availability of an assembled melter in the event of a premature melter failure can greatly impact the mission. The program execution alternative determines the ability to respond to a melter failure. For this alternative, one backup melter will be available 3 years after each changeout, or approximately 40 percent of the time during LAW Vitrification Facility operations. The procurement, assembly, and storage options of this alternative do not impact failure response.
Planned changeout – For this alternative, the planned changeout for Melter #2 will be delayed by 1½ years beyond the melter design life. All other melters will be scheduled for changeout after 5 years of operations.

Implementation of lessons learned – For the first replacement melters, implementation of early operational lessons learned in melter design is limited. Melter #3 will be procured. Melter #4 procurement will allow for very early operational lessons learned to be implemented. All subsequent melters could have lessons learned incorporated in the designs.

Melter procurement schedule – Approximately every 3 years, the next replacement procurement is initiated, with the first replacement melter procured prior to pre-cold commissioning activities. Melter #4 procurement is initiated in FY 2020.

Assembly capability timing – Assembly capabilities will be required mid-FY 2023. With approximately 5 years required to design/build a new assembly building, planning should begin no later than FY 2018.

Storage needs timing – The approach for storage is to incorporate the need into the assembly facility. This alternative does not plan for storage during the first two replacement melters. Storage of an assembled melter is needed in FY 2029.

4.2.2.4 Regulatory Implications

In support of Alternative R2, an evaluation of federal and state environmental requirements was performed. Potential regulatory implications to support Alternative R2 are discussed in this subsection.

Resource Conservation and Recovery Act

In Alternative R2, on-site melter assembly and storage will be performed at a new assembly and storage building inside the boundary of the WTP adjacent to the LAW Vitrification Facility pad. Waste management activities will be performed in accordance with WTP procedures and in compliance with DOE O 435.1, Radioactive Waste Management; DOE M 435.1-1, Radioactive Waste Management Manual; and WAC 173-303.

Air Permit

On-site melter assembly at a newly constructed building could result in non-radiological emission non-point (fugitive emissions) and point source emission units in support of melter assembly activities. Non-hazardous emissions are regulated under WAC 173-400. An NSR will determine the need to modify existing processes or buildings to accommodate melter assembly. The following scenarios trigger the need for NSRs:

- Establishing a new source or modifying an existing source of air emissions, as identified in WAC 173-400
- Establishing a new source or modifying an existing source of toxic air emissions, as identified in WAC 173-460
- Constructing, modifying, or relocating a portable source except those relocating in compliance with WAC 173-400-036
• Making a major modification to an existing major stationary source, as identified in WAC 173-400-720 (i.e., a source with a prevention of significant deterioration permit).

The results of the NSR will determine if further action is required to modify existing or establish a new source of toxic air emissions. If a determination is made that a nonradioactive air permit is required, a permit application will need to be prepared and approved by Ecology prior to starting construction of the building. For planning purposes, the NSR and permit modification (if necessary) are expected to require 6-12 months to complete.

Radioactive air emissions do not apply to melter assembly activities.

**National Environmental Policy Act**

The TC & WM EIS (DOE/EIS-0391) analyzed a melter assembly and storage building at the WTP. For this alternative, the construction of a new assembly building is covered by the current EIS and no further action is required.

**4.2.2.5 Cost**

The life-cycle cost estimate for Alternative R2 is based on the details associated with the alternative description presented in this section. The cost estimates are developed using various sources of information, including estimates from previous alternative evaluations, resource estimates, and engineering estimates. The identified costs are present dollar values that are developed by escalating costs to the year work is performed and then applying a discount rate for the time value of money. The cost estimate is developed in accordance with the requirements of TFC-PRJ-PC-C-05 by the WRPS Estimating group. The cost estimates are at a preconceptual/magnitude estimate level or Class 5 estimate (i.e., ROM estimate). The estimate is useful for concept screening, concept feasibility evaluation, and budget estimate magnitude comparisons but is not at a level of accuracy appropriate for budget authorization.

Costs are based on a 40-year operating life for the LAW Vitrification Facility. The costs associated with the two assembled melters already installed at the LAW Vitrification Facility are not included nor are the parts for a third melter that will be turned over to the WTP operations contractor. Cost estimates include organizational costs (e.g., management, engineering, quality assurance) to manage LAW melter replacement activities, construction of an assembly/storage facility adjacent to the LAW Vitrification Facility and its annual operation, melter shell and component procurement for 13 LAW melters, refractory procurement for 13 LAW melters, melter assembly for 14 LAW melters, assembled melter transport for 14 melters to the LAW Vitrification Facility, and the cost to install the 14 LAW melters.
The present value acquisition, operating, and total life-cycle costs are presented in Table 4-8 for Alternative R2. Acquisition cost is for the melter assembly/storage facility. Operating costs include procurements for the melter shells and components (including the refractory), assembly of the melters, and installing the assembled melters in the LAW Vitrification Facility.

The annual cost profile is shown in Figure 4-15. The peak years for operating costs are associated with concurrent procurement of the melter shells and components during the fiscal year, along with a melter installation. Acquisition cost is incurred from FY 2018 to FY 2022. The average annual operating cost over the 40-year facility operating life is roughly $15 million.

Table 4-8. Present Value Acquisition, Operating, and Total Life-Cycle Cost (Low-Activity Waste Vitrification Facility Mission) for Alternative R2, Assembly/Storage Facility Adjacent to Low-Activity Waste Vitrification Facility Pad

<table>
<thead>
<tr>
<th>Category</th>
<th>Alternative R2 – Assembly/storage facility adjacent to LAW Vitrification Facility pad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acquisition cost</td>
<td>$60,000,000</td>
</tr>
<tr>
<td>Operating cost $^a$</td>
<td>$595,000,000</td>
</tr>
<tr>
<td>Total life-cycle cost</td>
<td>$655,000,000</td>
</tr>
</tbody>
</table>

$^a$ Operating cost includes procurement of the melter shell, components, and refractory.

LAW = low-activity waste.

Figure 4-15. Annual and Cumulative Cost Profile for Alternative R2
4.2.2.6 Schedule

A preliminary schedule, shown in Figure 4-16, was developed to highlight potential risks and opportunities to the schedule. For Alternative R2, several modifications to the execution approach will be needed to meet schedule needs.

- Overlapping the melter assembly activities for the first two replacement melters delays the requirement for assembly needs by 1 year.
- Delaying the first melter changeouts by 1½ years results in delaying the requirement for assembly needs by another 1½ years.

Implementing these modifications will enable Alternative R2 to meet the schedule, with planning beginning in early FY 2018.

| ID | Task Name | 2018 O1 | 2019 O1 | 2019 O3 | 2020 O1 | 2020 O3 | 2021 O1 | 2021 O3 | 2022 O1 | 2022 O3 | 2023 O1 | 2023 O3 | 2024 O1 | 2024 O3 | 2025 O1 | 2025 O3 | 2026 O1 | 2026 O3 | 2027 O1 | 2027 O3 | 2028 O1 | 2028 O3 |
|----|-----------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| 0  | Alternative R2 - On-site Assembly and Storage Adjacent to the LAW Facility Pad |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| 1  | LAW Melter Pre-commissioning start |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| 2  | LAW melter 5-year design life |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| 3  | Replacement Assembly Planning |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| 4  | Design assembly capabilities |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| 5  | Build assembly capabilities |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| 6  | Procurement |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| 7  | Procure melter #1 components |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| 8  | Procure melter #1 refractory (in storage at Hanford) |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| 6  | Procure melter #4 components |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| 10 | Procure melter #4 refractory (in storage at Hanford) |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| 11 | Replacement Melter Assembly |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| 12 | Assemble melter #3 body refractory |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| 13 | Assemble melter #3 lid refractory |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| 14 | Assemble melter #4 components/Instrumentation |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| 15 | Assemble melter #4 body refractory |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| 16 | Assemble melter #4 lid refractory |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| 17 | Assemble melter #4 components/Instrumentation |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| 18 | Replacement Melter Transport |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| 19 | Load, transport, offload melter #3 |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| 20 | Load, transport, offload melter #4 |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| 21 | Replacement Melter Installation |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| 22 | Melter #1 Changeout |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| 23 | Melter #1 Disconnect |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| 24 | Install melter #3 at LAW facility |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| 25 | Melter #2 Changeout |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| 26 | Melter #2 Disconnect |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| 27 | Install melter #4 at LAW facility |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |

Figure 4-16. Melter Replacement Alternative R2 Schedule

4.2.3 Alternative R3 – On-Site Assembly and Storage in the 200 Area

This replacement alternative, R3, includes on-site assembly and storage at a new or existing facility located in the 200 Area. This alternative includes the following functions:

- **Procurement**: Identify multiple suppliers of critical items such as melter fabrication and refractory to the extent practical. Local and regional suppliers increase the ability for quality assurance oversight.
- **Assembly and storage**: Provide a new or existing facility for assembly and storage in the 200 Area.
- **Assembled melter transport**: Transport the assembled melter from the on-site facility located in the 200 Area to the LAW Vitrification Facility using a heavy-haul transporter.
• **LAW melter installation**: Performed melter installation as efficiently as possible in accordance with established procedures.

A modified execution approach is required to implement Alternative R3, On-site assembly and storage of new or existing facility in the 200 Area. By overlapping assembly efforts, Alternative R3 could be implemented if DOE takes action in early FY 2018.

### 4.2.3.1 Alternative R3 Description

This alternative uses an on-site assembly and storage facility located in the Hanford Site 200 Area. This alternative could use either an existing facility upgraded to meet the melter assembly requirements or a new assembly and storage facility. The facility will be designed and built to provide adequate space to accommodate receipt, assembly, and storage of the melters as needed. The assembly and storage building will have three bays: one bay to assemble, one bay to store the assembled melter, and one bay to receive and store melter components. If an existing facility is used, adequate space will be required to accommodate assembly and storage needs. This facility will also include environmental controls and equipment, as described in 24590-WTP-RPT-PM-09-001.

To eliminate the need to plan a changeout beyond the melter design life, consecutive changeouts will be planned to start after 5 years of melter operations. In this alternative, assembly of the replacement melter is complete when needed for installation. To help manage the assembly resources and require only one assembly scheduled at a time, the first melter procured will be assembled and placed into storage while the next replacement melter is being assembled. Both melters will be ready to support the first changeouts after 5 years of operations.

Due to the design/build duration of a new facility in the 200 Area, modifications to the execution sequencing are needed. As shown in Figure 4-17, the modifications will include the overlap of assembly activities for Melters #3 and #4. Subsequent melters are assembled without the need to overlap, with changeouts planned for every 5 years of operations.

When the assembled melter is required for installation, the transport subcontractor will load the assembled melter, transport from the LAW melter assembly/storage facility, and off-load onto the rails at LAW Vitrification Facility. Appropriate measures are required to ensure that the acceleration of the assembled melter is less than 0.075 g, due to concerns with shifting/tilting of the stacked refractory.
A transportation feasibility study conducted by Barnhart Crane & Rigging (Appendix E) evaluated the feasibility of transportation routes to WTP from potential assembly locations in the 200 East and West Areas. For both areas, possible routes within the 200 East and West Areas and between the 200 East and West Areas to WTP enabled the transporter to remain within the 0.075 g horizontal acceleration limit, with a safety factor of at least 2. The total travel time to deliver a melter from any 200 Area location under the operating constraints of the transporter is estimated to be 1 day.

The feasibility study did not provide a detailed evaluation of assembly locations and haul routes within the WTP boundary due to changing road and facility construction activities. However, the study indicates that melter assembly at WTP will be ideal, as there are likely to be fewer obstructions and WTP roads do not exceed 1 percent slope. Current roadways are two lanes of asphalt and gravel (in places) with 24 ft of useable roadway width that provide access directly to the LAW Vitrification Facility. A detailed analysis for WTP does not seem feasible until construction activities are complete.

Once placed onto the rails at the LAW Vitrification Facility, the melters will be slid into the melter bay for installation in accordance with established procedures.

Planning for on-site assembly in the 200 Area is estimated to require 4 years. During this period, all procurement, design, construction, startup, and readiness activities (e.g., system testing, submittals, and approvals) will occur. With this melter replacement execution approach, assembly capabilities are needed mid-FY 2023, which will require planning to begin mid-FY 2018.
4.2.3.2 Safety Aspects

Constructing and operating an industrial facility outside the confines of a nuclear facility in a manner that does not impact the nuclear facility (e.g., locating the industrial facility far enough away to not pose an impact) will have no nuclear safety requirements imposed on that facility during construction or operation. Typical industrial safety requirements will apply to the melter assembly building, but additional requirements associated with nuclear safety will not. The construction period is shorter for this alternative, as the requirements associated with performing construction within the boundary of a nuclear facility will not be imposed on the melter assembly building.

4.2.3.3 Mission Impacts

The alternative was evaluated in several areas where potential impacts to the mission exist. A description of how this alternative may impact the mission is provided, along with the potential risks and benefits identified for each of the categories.

Schedule risk – Without modifying execution, this alternative does not meet schedule needs. To meet schedule needs, assembly of the first two replacement melters will need to overlap. Careful planning and coordination will be required to accommodate the overlapping activities to avoid schedule impacts.

Based on previous estimates of similar projects, the estimated design/build duration for a melter assembly facility is 4 years. If an existing facility can be upgraded to meet the melter assembly and storage needs, this duration may be shorter.

Availability – During the DFLAW Program, the melters will experience two planned changeouts of 6 months each. During this time, the melter will not be available. This will result in each melter not being available for 1 year during the 10-year DFLAW Program.

The changeout cycle will continue for the duration of the facility, with consecutive changeouts scheduled every 5 years of melter operations.

Impacts to ongoing operations – There are no impacts to ongoing LAW Vitrification Facility operations from the construction or operations of an assembly facility in the 200 Area.

Resource management/requirements – This alternative allows for continuity of resource needs while eliminating the need for multiple simultaneous assembly and storage capabilities. Only one assembly will be scheduled at a time, with each assembly scheduled to begin as the previous assembly is being completed.

Failure response (duration without replacement melter available) – The availability of an assembled melter in the event of a premature melter failure can greatly impact the mission. The program execution alternative determines the ability to respond to a melter failure. For this alternative, one backup melter will be available for approximately 40 percent of the time during LAW Vitrification Facility operations.

Planned changeout – For this alternative, the planned changeouts support the melter design life of 5 years and will be scheduled consecutively starting at 5 years of operations.
Implementation of lessons learned – For the first two replacement melters, the implementation of early operational lessons learned in subsequent melter design is limited. Melter #3 will be nearly procured, and Melter #4 will be substantially into the procurement cycle within the first year of operations.

Melter procurement schedule – Approximately every 3 years, the next replacement procurement will initiate, with the first two replacement melters in procurement prior to pre-cold commissioning activities. Melter #4 procurement should be initiated mid-FY 2019.

Assembly capabilities timing – Assembly capabilities will be required mid-FY 2021. With approximately 4 years required to procure assembly capabilities, planning should begin in early FY 2018.

Storage needs timing – The approach for storage is to incorporate the need into the assembly facility. The ability to store a melter is not required until FY 2024.

4.2.3.4 Regulatory Implications

In support of Alternative R3, an evaluation of federal and state environmental requirements was performed. Potential regulatory implications to support Alternative R3 are discussed in this subsection.

Resource Conservation and Recovery Act

In Alternative R3, melter assembly and storage will be performed at a new assembly and storage building inside the boundary of the WTP or at a location within the 200 Area of the Hanford Site. Waste management activities will be performed in accordance with WTP procedures and in compliance with DOE O 435.1, DOE M 435.1-1, and WAC 173-303.

Air Permit

On-site melter assembly at a newly constructed building could result in non-radiological emission non-point (fugitive emissions) and point source emission units in support of melter assembly activities. Non-hazardous emissions are regulated under WAC 173-400.

An NSR will determine the need to modify existing processes or buildings to accommodate melter assembly. The following scenarios trigger the need for NSRs:

- Establishing a new source or modifying an existing source of air emissions, as identified in WAC 173-400
- Establishing a new source or modifying an existing source of toxic air emissions, as identified in WAC 173-460
- Constructing, modifying, or relocating a portable source except those relocating in compliance with WAC 173-400-036
- Making a major modification to an existing major stationary source, as identified in WAC 173-400-720 (i.e., a source with a prevention of significant deterioration permit).
The results of the NSR will determine if further action is required to modify existing or establish a new source of toxic air emissions. If a determination is made that a nonradioactive air permit is required, the permit application will need to be prepared and approved by Ecology prior to starting construction of the new building. For planning purposes, the NSR and permit modification (if necessary) are expected to require 6-12 months to complete.

Radioactive air emissions do not apply to melter assembly activities.

**National Environmental Policy Act**

The TC & WM EIS (DOE/EIS-0391) analyzed a melter assembly and storage building at the WTP. Since this option includes a new assembly and storage building at the 200 Area of the Hanford Site, further NEPA analysis is required. To construct a similar building, as described in the EIS, will likely not initiate an in-depth NEPA analysis. The physical location of a new assembly and storage building will require a NEPA evaluation to identify possible locations, and to reduce mitigation as required under the TC & WM EIS. DOE has the responsibility to determine if further NEPA action is required. For planning purposes, a supplemental analysis or an environmental assessment will provide a conservative basis (from a scheduling perspective) to support this alternative.

### 4.2.3.5 Cost

The life-cycle cost estimate for Alternative R3 is based on the details associated with the alternative description presented in this section. The cost estimates are developed using various sources of information, including estimates developed in previous alternative evaluations, resource estimates, and engineering estimates. The identified costs are present dollar values that are developed by escalating costs to the year work is performed and then applying a discount rate for the time value of money. The cost estimate is developed in accordance with the requirements of TFC-PRJ-PC-C-05 by the WRPS Estimating group. The cost estimates are at a preconceptual/magnitude estimate level or Class 5 estimate (i.e., ROM estimate). The estimate is useful for concept screening, concept feasibility evaluation, and budget estimate magnitude comparisons but is not at a level of accuracy appropriate for budget authorization.

Costs are based on a 40-year operating life for the LAW Vitrification Facility. The costs associated with the two assembled melters already installed at the LAW Vitrification Facility are not included nor are the parts for a third melter that will be turned over to the WTP operations contractor. Cost estimates include organizational costs (e.g., management, engineering, quality assurance) to manage LAW melter replacement activities, construction of an assembly/storage facility in the 200 Area of the Hanford Site and its annual operation, melter shell and component procurement for 13 LAW melters, refractory procurement for 13 LAW melters, melter assembly for 14 LAW melters, assembled melter transport for 14 melters to the LAW Vitrification Facility, and the cost to install the 14 LAW melters.
The present value acquisition, operating, and total life-cycle costs are presented in Table 4-9 for Alternative R3. Acquisition cost is for the melter assembly/storage facility. Operating costs include procurements for the melter shells and components (including the refractory), assembly of the melters, and installing the assembled melters in the LAW Vitrification Facility.

The annual cost profile is shown in Figure 4-18. The peak years for operating costs are associated with concurrent procurement of the melter shells and components during the fiscal year, along with a melter installation. Acquisition cost is incurred from FY 2018 to FY 2021. The average annual operating cost over the 40-year operating life is roughly $15 million.

Table 4-9. Present Value Acquisition, Operating, and Total Life-Cycle Cost Low-Activity Waste Vitrification Facility Mission) for Alternative R3, Assembly/Storage Facility at the 200 Area

<table>
<thead>
<tr>
<th>Category</th>
<th>Alternative R3 – Assembly/storage facility at the 200 Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acquisition cost</td>
<td>$41,000,000</td>
</tr>
<tr>
<td>Operating cost(^{a})</td>
<td>$593,000,000</td>
</tr>
<tr>
<td>Total life-cycle cost</td>
<td>$634,000,000</td>
</tr>
</tbody>
</table>

\(^{a}\) Operating cost includes procurement of the melter shell, components, and refractory.

Figure 4-18. Annual and Cumulative Cost Profile for Alternative R3
4.2.3.6 Schedule

A preliminary schedule, Figure 4-19, has been developed to highlight potential risks and opportunities to the schedule. For Alternative R3, assembly activities for the first two replacement melters will need to overlap to meet schedule needs. Planning for Alternative R2 will need to begin in early FY 2018 to meet the schedule.

![Figure 4-19. Melter Replacement Alternative R3 Schedule](image)

Figure 4-19. Melter Replacement Alternative R3 Schedule

4.3 MELTER REPLACEMENT ALTERNATIVES COMPARISON

To evaluate and provide a recommendation for LAW melter replacement, each replacement alternative was assessed for potential risks in the following comparison criteria:

- Safety aspects
- Mission impacts
- Regulatory aspects
- Cost
- Schedule
- Transportation risks.

The following subsections detail the results of the comparison for each alternative. The results of this comparison will be further evaluated to identify the recommended alternative.
4.3.1 Safety Aspects Comparison

Each LAW melter replacement alternative was assessed for the following safety measures:

- Nuclear/radiological safety risk
- Chemical safety risk
- Industrial safety risk
- Safety documentation.

Safety concerns with the assembly activity and the impact from nearby activities and facilities were considered in this comparison. The results of the comparison for each safety measure are provided in Table 4-10.

### Table 4-10. Comparison of Safety Aspects of Low-Activity Waste Melter Replacement Alternatives (2 pages)

<table>
<thead>
<tr>
<th>Safety measure</th>
<th>Alternative R1 – Assembly offsite</th>
<th>Alternative R2 – Assembly adjacent to LAW pad</th>
<th>Alternative R3 – Assembly in 200 Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nuclear/radiological safety risk</td>
<td>Hazard: None</td>
<td>Hazard: Low to moderate</td>
<td>Hazard: None</td>
</tr>
<tr>
<td></td>
<td>Risk: None</td>
<td>Risk: Indeterminate but likely low with similar risk.</td>
<td>Risk: None</td>
</tr>
<tr>
<td></td>
<td>Assembly and storage facility located off the Hanford Site.</td>
<td>Need to evaluate interaction with the LAW Vitrification Facility from a nuclear/radiological safety risk standpoint. The total risk is indeterminate because existing risk for an established facility must be considered in addition to this new mission.</td>
<td>Assembly and storage facility sited at a distance that does not interact with the WTP or other nuclear facilities.</td>
</tr>
<tr>
<td>Chemical safety risk</td>
<td>Hazard: Low</td>
<td>Hazard: Low to moderate</td>
<td>Hazard: Low</td>
</tr>
<tr>
<td></td>
<td>Risk: Low</td>
<td>Risk: Indeterminate but likely low with similar risk.</td>
<td>Risk: Low</td>
</tr>
<tr>
<td></td>
<td>Potential risk to facility workers from welding and work with refractory. Airborne respiratory protection may be required.</td>
<td>Need to evaluate interaction with the LAW Vitrification Facility from a chemical safety risk standpoint. The total risk is indeterminate because existing risk for an established facility must be considered in addition to this new mission.</td>
<td>Potential risk to facility workers from welding and work with refractory. Airborne respiratory protection may be required.</td>
</tr>
</tbody>
</table>
Table 4-10. Comparison of Safety Aspects of Low-Activity Waste Melter Replacement Alternatives (2 pages)

<table>
<thead>
<tr>
<th>Safety measure</th>
<th>Alternative R1 – Assembly offsite</th>
<th>Alternative R2 – Assembly adjacent to LAW pad</th>
<th>Alternative R3 – Assembly in 200 Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial safety risk</td>
<td>Hazard: Low</td>
<td>Hazard: Low</td>
<td>Hazard: Low</td>
</tr>
<tr>
<td></td>
<td>Risk: Low</td>
<td>Risk: Low</td>
<td>Risk: Low</td>
</tr>
<tr>
<td>Safety documentation</td>
<td>Effort: None</td>
<td>Effort: Moderate Indeterminate but update to documented safety analysis or USQ process at a minimum; may require compliance with DOE-STD-1189.</td>
<td>Effort: Low Hazard Analysis</td>
</tr>
</tbody>
</table>


LAW = low-activity waste.  
USQ = unreviewed safety question.  
WTP = Waste Treatment and Immobilization Plant.

4.3.2 Mission Impacts Comparison

Each LAW melter replacement alternative was assessed for the following mission impacts:

- Availability
- Schedule/timing
- Ongoing operational impact
- Resource requirements

The results of the comparison for each mission impact are provided in Table 4-11.

Table 4-11. Comparison of Mission Impacts of Replacement Alternatives (2 pages)

<table>
<thead>
<tr>
<th>Mission impact</th>
<th>Alternative R1 – Assembly offsite</th>
<th>Alternative R2 – Assembly adjacent to LAW pad</th>
<th>Alternative R3 – Assembly in 200 Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Melter availability</td>
<td>During DFLAW Program, each melter not available for 1 year due to planned changeouts. Low to moderate risk of delayed receipt of an assembled melter on time due to weather or road condition considerations in comparison to other alternatives. Least risk of assembled melter not being available in time for first replacement.</td>
<td>During DFLAW Program, each melter not available for 1 year due to planned changeouts. Melter #2 potentially not available for 1 year due to changeout delay. Lowest risk of delayed receipt of an assembled melter on time due to weather condition considerations in comparison to other alternatives. Highest risk of assembled melter not being available in time for first replacement.</td>
<td>During DFLAW Program, each melter not available for 1 year due to planned changeouts. Low risk of delayed receipt of an assembled melter on time due to weather condition considerations in comparison to other alternatives. Low risk of assembled melter not being available in time for first replacement.</td>
</tr>
</tbody>
</table>
### Table 4-11. Comparison of Mission Impacts of Replacement Alternatives (2 pages)

<table>
<thead>
<tr>
<th>Mission impact</th>
<th>Alternative R1 – Assembly offsite</th>
<th>Alternative R2 – Assembly adjacent to LAW pad</th>
<th>Alternative R3 – Assembly in 200 Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schedule/Timing</td>
<td>No modifications to execution approach to meet schedule. Shortest duration to implement and meet schedule needs Off-site facility should not impact schedule or timing provided adequate space is available near the Hanford Site.</td>
<td>Requires modifications to execution approach to meet schedule: assembly overlap and Melter #2 changeout delay. Requires earliest start of design to complete on time. Longest construction duration due to interferences and congestion at WTP. Schedule to install an assembly/storage building adjacent to LAW Vitrification Facility is very tight. Highest risk to complete on time.</td>
<td>Requires modifications to execution approach to meet schedule: assembly overlap. Must start early for design to complete on time. Second longest schedule for design and construction. Aggressive design and construction schedule assumed. Risk of not completing on time.</td>
</tr>
<tr>
<td><strong>Failure response</strong></td>
<td>First replacement melter available after 3 years of operations.</td>
<td>No replacement melter available during first 5 years of operations.</td>
<td>First replacement melter available after 4 years of operations.</td>
</tr>
<tr>
<td>Planned changeout</td>
<td>First changeouts at 5 years of operations, and every 5 years after.</td>
<td>Melter #1 at 5 years and Melter #2 at 6½ years, every 5 years after.</td>
<td>First changeouts at 5 years of operations, and every 5 years after.</td>
</tr>
<tr>
<td><strong>Ongoing Operational Impact</strong></td>
<td>Should not impact ongoing operations.</td>
<td>Constructing assembly/storage building near LAW Vitrification Facility will impact ongoing commissioning activities.</td>
<td>Should not impact ongoing operations.</td>
</tr>
<tr>
<td>Impacts to ongoing operations</td>
<td>Operational lessons learned difficult for Melters #3 and #4.</td>
<td>Operational lessons learned difficult for Melter #3, Melter #4 can incorporate early operations lessons.</td>
<td>Operational lessons learned difficult for Melters #3 and #4.</td>
</tr>
<tr>
<td>Implementation of lessons learned</td>
<td>Continuity of resources for single melter assembly activity.</td>
<td>Overlapping assembly activities require an additional assembly crew during this timeframe. Continuity of resources for subsequent assemblies.</td>
<td>Overlapping assembly activities requires an additional assembly crew during this timeframe. Continuity of resources for subsequent assemblies.</td>
</tr>
</tbody>
</table>

**DFLAW** = direct-feed low-activity waste.  
**FY** = fiscal year.  
**LAW** = low-activity waste.  
**WTP** = Waste Treatment and Immobilization Plant.
4.3.3 Regulatory Comparison

Each LAW melter replacement alternative was assessed for the following regulatory aspects:

- NEPA
- RCRA
- Air emissions

The results of the comparison for each regulatory measure are provided in Table 4-12.

**Table 4-12. Comparison of Regulatory Implications of Replacement Alternatives**

<table>
<thead>
<tr>
<th>Regulatory aspect</th>
<th>Alternative R1 – Assembly offsite (building available for use)</th>
<th>Alternative R2 – Assembly adjacent to LAW pad</th>
<th>Alternative R3 – Assembly at 200 Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEPA</td>
<td>No new analysis anticipated</td>
<td>No new analysis anticipated</td>
<td>Requires additional analysis due to physical location of new building outside WTP</td>
</tr>
<tr>
<td>RCRA</td>
<td>May require subcontractor to obtain EPA/state ID number</td>
<td>In accordance with current DOE waste management plans</td>
<td>In accordance with current DOE waste management plans</td>
</tr>
<tr>
<td>Air emissions</td>
<td>New source review for toxic air emissions Rad air: N/A</td>
<td>New source review for toxic air emissions Rad air: N/A</td>
<td>New source review for toxic air emissions Rad air: N/A</td>
</tr>
</tbody>
</table>

*DOE = U.S. Department of Energy.*
*EPA = U.S. Environmental Protection Agency.*
*ID = identification.*
*LAW = low-activity waste.*
*N/A = not applicable.*

4.3.4 Cost Comparison

Each LAW melter replacement alternative was assessed for the following cost aspects:

- Acquisition costs
- Operating costs
- Life-cycle costs

The results of the cost comparison are provided in Table 4-13.

**Table 4-13. Present Value (Unescalated, Non-Discounted) Cost Comparison for Replacement Alternatives**

<table>
<thead>
<tr>
<th>Cost</th>
<th>Alternative R1 – Assembly offsite</th>
<th>Alternative R2 – Assembly adjacent to LAW pad</th>
<th>Alternative R3 – Assembly at 200 Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acquisition</td>
<td>$ 0</td>
<td>$ 60,000,000</td>
<td>$ 41,000,000</td>
</tr>
<tr>
<td>Operating</td>
<td>$ 603,000,000</td>
<td>$ 595,000,000</td>
<td>$ 593,000,000</td>
</tr>
<tr>
<td>Life-cycle</td>
<td>$ 603,000,000</td>
<td>$ 655,000,000</td>
<td>$ 634,000,000</td>
</tr>
</tbody>
</table>

*LAW = low-activity waste.*
### 4.3.5 Schedule Comparison

The primary factor in comparing schedules between the melter replacement alternatives is the ability to start assembling melters in time to support the replacement of the first two melters at the end of their design lives. Based on the two LAW melters starting up in March 2020 and a 5-year melter life, the melters will be at the end of their design life by March 2025. Removal of each melter will require three months, with the first melter removed by June 2025 and a new melter installation then starting. Assuming the second melter will last 5½ years, the second melter will be installed 6 months later in December 2025. A 2½-year assembly duration is required for each melter.

As discussed in Section 4.2, with the execution approach selected, only Alternative R1 (assembly off-site) meets the schedule with no modification to the approach. For Alternative R2, at least a 2-year delay in requiring assembly capabilities is needed to meet the schedule. This can be accomplished with overlapping melter assembly of the first two replacement melters, completing assembly on the first replacement melter in time for installation, and extending melter operations of one of the first melters by 1½ years beyond its design life. Alternative R3 (assembly at 200 Area) requires a 1-year delay in requiring melter assembly to meet the schedule. Overlapping assembly of the first two replacement melters will enable Alternative R3 to meet the schedule. Table 4-14 summarizes the actions needed to meet the schedule for each replacement alternative. The results of this comparison are included in the schedule aspects of the mission impacts discussed in Section 4.3.2.

<table>
<thead>
<tr>
<th>Schedule</th>
<th>Alternative R1 – Assembly offsite</th>
<th>Alternative R2 – Assembly adjacent to LAW pad</th>
<th>Alternative R3 – Assembly in 200 Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Additional action to meet schedule needs</td>
<td>None</td>
<td>Overlapping Melter #3 and #4 assembly activities by 1 year AND Extending Melter #2 operation 1½ years beyond design life</td>
<td>Overlapping Melter #3 and #4 assembly activities by 1 year</td>
</tr>
<tr>
<td>Planning start by timeframe</td>
<td>Early FY 2019</td>
<td>Early FY 2018</td>
<td>Early FY 2018</td>
</tr>
</tbody>
</table>

FY = fiscal year  
LAW = low-activity waste.

### 4.3.6 Transportation Risk Comparison

Each LAW melter replacement alternative was assessed for risks associated with transporting the assembled melter. The results of the comparison for each transportation risk are provided in Table 4-15.
Table 4-15. Comparison of the Transportation Risks for Replacement Alternatives

<table>
<thead>
<tr>
<th>Transportation Risk</th>
<th>Alternative R1 – Assembly offsite</th>
<th>Alternative R2 – Assembly adjacent to LAW pad</th>
<th>Alternative R3 – Assembly in 200 Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transporting assembled melters</td>
<td>Transport from an off-site location requires use of a heavy-duty hauler traveling the greatest distance of the alternatives. Highest risk from transporting assembled melter a longer distance and on a route grade with some hills.</td>
<td>Transport from adjacent to LAW Vitrification Facility pad location requires use of a rail system to transport assembled melter the shortest distance of the alternatives. Lowest risk from transporting shortest distance with no grade.</td>
<td>Transport from 200 Area location requires use of heavy-duty hauler traveling less than Alternative R1, but greater than Alternative R2. Medium risk from transporting mid-range distance and route grade relatively flat.</td>
</tr>
</tbody>
</table>

LAW = low-activity waste.
5.0 MELTER DISPOSITION OPTIONS IDENTIFICATION AND ALTERNATIVE EVALUATION

This section identifies options for used LAW melter disposition, evaluates those options against pertinent requirements to assess viability, establishes a set of alternatives from the viable options, develops information for each of the alternatives, and provides a comparison of the alternatives against criteria considered important to successfully disposition used melters. Option identification (Section 5.1) is performed at the subfunction level, as described in Section 2.1.2:

- Remove used LAW melters
- Prepare used LAW melters for disposal
- Transport used LAW melters
- Dispose used LAW melters.

For this report, option identification and alternative evaluation only pertain to Prepare Used LAW Melters for Disposal (Disposal Preparation). This is consistent with the previously identified need in Section 1.3.1: “Clarify the conditions to satisfy for successful LAW melter disposal.” Approach options consider different methods of complying with land disposal restriction (LDR) requirements (Figure 5-1). Location options consider where to perform activities necessary to prepare the used LAW melters for disposal. Each alternative is developed in enough detail (Section 5.2) to perform a comparative evaluation between the alternatives. A summary of the comparative similarities and differences between the alternatives is provided in Section 5.3.

5.1 MELTER DISPOSITION OPTIONS

Melter disposition begins after a melter has reached its design life, or a melter has failed before reaching its anticipated design life. In either scenario, a series of activities are initiated to support used melter disposition. As illustrated in Figure 5-2, used melter disposition functions include: Remove Used LAW Melter, Prepare Used LAW Melter for Disposal, and Dispose Used LAW Melter. Disposition functions will be performed by various Hanford contractors and subcontractors specializing in various activities such as void-fill, treatment, transportation, and disposal.
Figure 5-2. Melter Disposition Activities

Options on how (approach), where (location), and when (timing) Remove Used LAW Melter, Prepare Used LAW Melter for Disposal, and Dispose Used LAW Melter are to occur are described in the following subsections.

5.1.1 Remove Low-Activity Waste Melter Options

Removing the LAW melters will follow a required operational order, with significant oversight and control during the entire process to ensure that the work is performed safely and efficiently in as timely a manner as possible. Melter removal includes an orderly shutdown of melter operation, and disconnecting all feed connections and glass discharge connections (pour spout). Disconnecting services include electrical, cooling water, air, instrumentation, offgas, and other feeds to the melter, and seal welding closure ports on used melters prior to removal from the LAW Vitrification Facility. Decontamination of the exterior of the melter will be required as removal activities occur. Melter removal will be supported by capabilities within the LAW Vitrification Facility, including the LAW melter equipment support handling (LSH) system cranes and the LMH system.

Seal Welding Options

Seal welding is an element of the melter removal process. The current State of Washington Department of Health (DOH) radioactive air permit and Ecology dangerous waste permit for the LAW Vitrification Facility require the used LAW melter to be seal-welded within the melter gallery before being moved out of the facility. No options are identified for where seal welding will be performed.

Figure 5-3 identifies the radioactive air emissions and RCRA permit requirements that require seal welding when disconnecting a melter from service and beginning melter disposition functions.
The DOH radioactive air permit requires (Martell 2017):

“When the melter have reached the end of its operating life, it shall be disconnected from all systems and all penetrations on the existing enclosures shall be welded or closure plates shall be welded to the LAW melter before it shall be moved out of the LAW vitrification facility on rollers. This shall result in an airtight sealed source that shall not produce radioactive emissions. The melter shall then be exported from the building and shipped to Hanford Site burial ground (disposal at IDF). If the LAW melter is to be transported immediately for macroencapsulation, it shall be prepared for transportation before removal from the LAW vitrification facility.”

The Hanford RCRA permit requires (WA 7890008967):

“The LAW Melters are designed to include a roller or wheel assembly that travels on rails that will be used to move the melters in and out of the containment building. Spent LAW Melters will be disconnected from the offgas system, feed lines, electrical lines, and instrumentation. Open ports will be seal welded. The sealed exterior of the melter will be decontaminated, if needed, prior to removal from the containment building.”

Based on these existing WTP permit conditions, seal welding must be completed before the melters leave the LAW Vitrification Facility. Seal welding is not a form of treatment or a function performed solely to meet LDR requirements. Seal welding is performed to create an airtight container to mitigate emissions release or contamination from used melters during transportation and disposition functions. Figure 5-4 illustrates melter ports that will require seal welding before the melter can leave the LAW Vitrification Facility. Further information regarding treatment for LDR requirements is provided in subsequent sections.
The approach regarding the extent of seal welding and configuration (e.g., number and size of sheets or plates covering penetrations/open ports) is too detailed for this study and is not addressed here. Only a high-level summary of the seal welding process is presented in this section.

No options regarding the approach, location, or timing for removing the LAW melters have been identified as part of this evaluation. When appropriate to perform detailed planning of the approach to remove a LAW melter and develop work control documentation, alternatives that make the most efficient use of time should be explored. That effort is beyond the scope of this analysis.

### 5.1.2 Prepare Low-Activity Waste Melters for Disposal Options

A series of options for preparing LAW melters for disposal were generated based on required melter preparation activities. Major activities associated with preparing LAW melters for disposal are:

- Void-filling used LAW melters to meet DOE LLW requirements
- Treating used LAW melters to meet RCRA LDR requirements.

---

**Figure 5-4. Seal Weld Closure Plates on Used Melters**

The approach regarding the extent of seal welding and configuration (e.g., number and size of sheets or plates covering penetrations/open ports) is too detailed for this study and is not addressed here. Only a high-level summary of the seal welding process is presented in this section.

No options regarding the approach, location, or timing for removing the LAW melters have been identified as part of this evaluation. When appropriate to perform detailed planning of the approach to remove a LAW melter and develop work control documentation, alternatives that make the most efficient use of time should be explored. That effort is beyond the scope of this analysis.

### 5.1.2 Prepare Low-Activity Waste Melters for Disposal Options

A series of options for preparing LAW melters for disposal were generated based on required melter preparation activities. Major activities associated with preparing LAW melters for disposal are:

- Void-filling used LAW melters to meet DOE LLW requirements
- Treating used LAW melters to meet RCRA LDR requirements.
5.1.2.1 Void Fill Method/Material Options

Waste subject to LDR requirements under the Washington dangerous waste regulations (WAC 173-303-140) must be demonstrated to meet all applicable treatment standards. In addition to LDR requirements, landfill requirements must be achieved before used melters can be placed in IDF for final disposal.

IDF waste acceptance criteria are being developed, with the landfill requirements anticipated to be similar to other Hanford TSDs. HNF-EP-0063, Hanford Site Solid Waste Acceptance Criteria, provides succinct criteria for waste disposed at the low-level burial grounds (LLBG) TSD. Physical limits apply to packaged waste to ensure structural stability for disposal in the LLBG TSD to mitigate potential subsidence. One mitigation option is the use of high-integrity containers (HIC), although this provision is only available to meet the requirements of DOE O 435.1. The Hanford Site maintains an inventory of HICs, none of which will be large enough to accommodate a LAW melter. If a waste generator needs a waste package to qualify as a HIC, the generator provides package information to the landfill operator waste services organization for evaluation. The waste generator could request that the used melter itself meet HIC requirements if necessary to meet a disposal requirement at IDF. Further evaluation is required to determine if used melters will qualify as a HIC, and whether qualification as a HIC is beneficial.

Used LAW melters could possibly qualify as a HIC, but HICs cannot be substituted to meet compaction requirements of RCRA Subtitle C landfills (RCRA has no provision to allow HICs). The RCRA landfill regulations for 90 percent full containers in WAC 173-303-665(12), “Special Requirements for Containers,” do not provide a process to demonstrate equivalency through the disposal package integrity. As a result, a 90 percent full container may not need the pedigree as a HIC to be disposed of in IDF.

WAC 173-303-665(12)(a) and the current IDF Permit Condition III.11.I.1.a requires that containers be “at least ninety percent full when placed in the landfill” and “all containers/packages shall meet void fill space requirements pursuant to WAC 173-303-665(12),” respectively. As a result, void filling is required to meet landfill requirements. A strategy for meeting the 90 percent full requirements needs to be developed (e.g., what voids need to be addressed to reach the 90 percent limit). The need for a void-fill strategy was discussed during the melter workshop with representatives from WTP, WRPS, and PRC. Further evaluation is required to identify what voids (i.e., plenum, annulus, discharge chambers) could be targeted to meet landfill requirements.

A variety of materials can be considered for void filling the used LAW melters. Possible material options, including those identified during the current state mapping workshops, that could be used to void-fill melters are:

- Grout
- Sand
- Perlite
- Polyurethane pour foam (expanding foam) designed for void filling.
The physical size of the melters and the weight increase of the melters after void-fill must be considered during the planning process. For the purposes of this evaluation, the assumption is made that polyurethane expanding foam will be used to perform void-fill on used LAW melters. Void-fill operations are expected to require 3 to 4 weeks to perform, assuming that void-fill ports are provided on the used melter.

**Air Emissions During Void Filling**

Waste management disposition activities, including void filling prior to disposal, are considered routine occurrences at the Hanford Site. Void filling melters could result in non-radiological emission non-point (fugitive emissions) and point source emission units in support of disposal activities. Nonhazardous emissions are regulated under WAC 173-400.

An NSR will determine the need to modify existing processes or buildings to support void filling activities. The following scenarios initiate the need for NSRs:

- Establishing a new source or modifying an existing source of air emissions, as identified in WAC 173-400
- Establishing a new or modifying an existing source of toxic air emissions, as identified in WAC 173-460
- Constructing, modifying, or relocating a portable source except those relocating in compliance with WAC 173-400-036
- Making a major modification to an existing major stationary source as identified in WAC 173-400-720 (i.e., a source that has a prevention of significant deterioration permit).

The results of the NSR review will determine if further action is required to modify existing or establish a new source of toxic air emissions, including obtaining a toxic air emissions permit.

Radioactive air emissions during void filling are regulated under WAC 246-247, “Radiation Protection-Air Emissions.” Void filling the LAW melters could potentially result in a revised radioactive air emissions permit. For planning purposes, current procedures are expected to be followed that will allow for injection of void-fill material and ventilation through a high-efficiency particulate air (HEPA) filter or other abatement technology (or as defined in specific workscope documents). For planning purposes, a permit modification is expected to require 6-12 months to complete.
5.1.2.2 Land Disposal Treatment Approach Options

Options in this section are identified and described based on the waste management approach to meet LDR requirements. Melters meet the definition of hazardous debris, as defined in WAC 173-303-040. Under Ecology’s dangerous waste regulations, debris is defined as:

“...solid material exceeding a 60 mm particle size that is intended for disposal and that is: A manufactured object; or plant or animal matter; or natural geologic material. However, the following materials are not debris: Any material for which a specific treatment standard is provided in 40 CFR Part 268 Subpart D (incorporated by reference in WAC 173-303-140 (2)(a)); process residuals such as smelter slag and residues from the treatment of waste, wastewater, sludges, or air emission residues; and intact containers of hazardous waste that are not ruptured and that retain at least seventy-five percent of their original volume. A mixture of debris that has not been treated to the standards provided by 40 CFR 268.45 and other material is subject to regulation as debris if the mixture is comprised primarily of debris, by volume, based on visual inspection.”

A simple, conservative computation can be used to determine that melters comprise primarily debris by volume. The volume of glass in the melter is the volume of the melt pool. The dimensions of the melt pool are provided in 24590-LAW-3ZD-LMP-00001, Table 4-3, and the glass pool volume is given as 7,000 L or 7 m$^3$. The empty weight of the melter is 650,000 lb, or 295,000 kg. Void space within the melter cannot be used to calculate the volume of the debris. The melter is made up of metals and refractory. The various metals have higher material densities (around 8 kg/m$^3$) than the refractory (around 3 kg/m$^3$). If all materials used to make up the melter are considered to have the higher density, the result in estimating the volume of the melter material is at a lower value than the actual volume.

\[
\text{Volume of "Construction Material" in Melter} = 650,000 \text{ lb} \times \frac{1 \text{ kg}}{2.2045 \text{ lb}} \times \frac{m^3}{8 \text{ kg}} = 37 \text{ m}^3
\]

Therefore, the melter is 37 m$^3$/(37 m$^3$ + 7 m$^3$) or 84 vol% debris, which meets the definition.

Treatment standards for hazardous debris require that the melter either be treated according to alternative treatment standards for hazardous debris, as specified in 40 CFR 268.45, or must meet waste-specific treatment standards for the waste contaminating the debris. Therefore, the two options are to treat as debris, or treat to meet waste-specific treatment standards.

**Treat to Meet Waste-Specific Treatment Standards**

A treatment option exists to use the waste-specific dangerous waste treatment standards in lieu of the alternative treatment standards for debris; however, this option was not pursued after determining additional toxicity characteristic leaching procedure (TCLP) testing will be necessary to implement the option. To pursue this option further, the project will need to complete a thorough review of the composition of all melter materials and perform TCLP testing on the remaining potentially dangerous melter components to show the materials are non-dangerous. This option could be viable option if after TCLP testing, the ILAW is the only dangerous component in the failed melter waste package.
A generator of a solid waste is required to: (1) classify the waste as debris or non-debris based on the definition of debris in WAC 173-303-040; (2) complete a waste designation in accordance with WAC 173-303-070, “Designation of Dangerous Waste” (Items [3] and [5]); and (3) if designated as a dangerous waste, determine applicable LDR requirements according to WAC 173-303-140, which incorporates 40 CFR 268 by reference. For the failed melter, the computation above shows the LAW melter waste package to be primarily debris. The waste package is designated a dangerous waste due to the ILAW contained in the melter from the treatment of Hanford tank waste (e.g., waste codes F001 through F005).

Other potentially dangerous melter components (in addition to the ILAW) identified from reviewing various information include the following:

- **K-3 refractory brick** to be used to line the melter (approximately 27 wt% Cr₂O₃). TCLP testing was performed on a 1/100th scale failed mini-melter at the Savannah River Site, with the highest result reported at 0.984 mg/L (Jantzen et al. 2000).

- **E refractory brick** to be used in the melter discharge chute (approximately 60-100 wt% spinel group minerals, aluminum-chromium-iron-magnesium). Monofrax E refractory brick is manufactured by Monofrax LLC in New York. The company performed TCLP testing on their product, which passed with a result of 2.53 mg/L (Selkregg 2017)

- **Bubbler tubes and protector sleeves** (Inconel⁴ 690, approximately 27-31 wt% Cr). The Thermocouple Technology, Inc. contact checked with their sources and could not find any TCLP data. No TCLP results were found from an internet search.

To pursue the option of using the waste-specific dangerous waste treatment standards, TCLP testing on the protector sleeves and the bubbler tubes will need to be performed and shown to be non-dangerous. A more complete review of materials present in the LAW melter at the time of disposition will also be necessary to determine if any other materials could potentially be dangerous. If radioactive and hazardous materials occupy the annulus and refractory package (i.e., feed spills/leakage and offgas particulate), this treatment option becomes more problematic. In this situation, the melters will be treated following alternative debris treatment standards that are discussed in the following section.

Debris waste packages designated as dangerous (hazardous debris) are subject to the LDR requirements in 40 CFR 268.45. In most cases, hazardous debris treatment standards found in 40 CFR 268.45, Table 1, “Alternative Treatment Standards for Hazardous Debris,” are typically easier to meet than the waste-specific dangerous waste treatment standards because the alternative standards for debris are implemented without having to obtain a representative sample of the debris. However, 40 CFR 268.45(a) allows a generator to choose which standard will be used which states:

“(a) Treatment standards. Hazardous debris must be treated prior to land disposal as follows unless EPA determines under §261.3(f)(2) of this chapter that the debris is no longer contaminated with hazardous waste or the debris is treated to the waste-specific treatment standard provided in this subpart for the waste contaminating the debris” [emphasis added]

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⁴ Inconel is a registered trademark of Huntington Alloys Corporation, Huntington, West Virginia
If there are no dangerous debris components in the waste disposal package and the ILAW is the only dangerous constituent, the disposal package will not need to meet an alternative treatment standard for hazardous debris (e.g., 40 CFR 268.45 immobilization technology). Operation of a properly designed LAW melter, coupled with an LDR treatability variance approved by Ecology, is the strategy being employed to facilitate the ILAW meeting the waste-specific dangerous waste treatment standards. No further treatment of the failed melter waste package will be needed if the ILAW is the only dangerous component of the waste package. However, void-fill to meet the dangerous waste landfill requirements in WAC 173-303-665(12) and DOE M 435.1-1, Change 2, Chapter IV, will still be required independent of meeting the LDR requirements.

Treat as Debris

Alternative debris treatment standards apply to any material defined as debris that is either contaminated with (contains) a listed waste or exhibits a characteristic. To meet the alternative debris standards, specific constituents must be treated before the debris can be land disposed. Once a determination is made regarding what constituents must be treated in the debris, the next step is determining what type of treatment or combination of treatment will address all of the constituents.

Hazardous debris that includes LAW melters will be eligible for the technology-based treatment standards identified in Table 1 of 40 CFR 268.45. Table 1 identifies three categories of technology treatment standards: extraction technologies, destruction technologies, and immobilization technologies. Immobilization technologies do not have contaminant restrictions and therefore can be used for meeting hazardous debris treatment standards.

There are many ways to meet the alternative treatment standards for hazardous debris. The following list of materials is included in Table 1 of 40 CFR 268.45, or is used to meet immobilization treatment technologies:

- Low-density polyethylene (LDPE) encapsulation (LDPE is heated and made more fluid by an extruder, and the fluid LDPE is poured over the hazardous debris to encapsulate it)
- High-density polyethylene (HDPE) encapsulation
- Welded stainless steel container macroencapsulation
- Grout encapsulation
- Epoxy compounds
- Silicone
- Urethane compounds (paint may not be used as a sealant).

The material selection to meet performance standards identified in Table 1, along with the technology used to meet alternative treatment standards for hazardous debris, will be selected later and is outside the scope of this evaluation. Note that EPA correspondence states (Kinch 1995):

“...merely placing hazardous debris in a tank or container, except under special circumstances where the container is made of noncorroding materials (e.g., stainless steel), would not fulfill the macroencapsulation treatment standard.”
The melter package (i.e., the outer melter enclosure, including shielded lid after being seal-welded, is considered to be the debris container) is made of carbon steel and does not qualify as an immobilization technology to meet treatment standards identified in Table 1 of 40 CFR 268.45. EPA’s position clearly identifies “welded stainless steel” as noncorroding materials that are required as a minimum to meet immobilization technology treatment standards.

The LAW melters are approximately 700,000 lb (698,500 lb, including glass) prior to treatment. Treatment, including grout or stainless steel containers, would significantly increase the treated volume and weight of the melters. Immobilization technologies (e.g., the application of polymeric organics or urethane compounds) meet treatment standards and mitigate excessive increases in treated volume and weight. The 340 vault at the Hanford Site was treated with “the use of polyurea coating” prior to disposal in Environmental Restoration Disposal Facility (WCH-539, Treatment Plan for Macroencapsulation of 300-FF-2 Operable Unit Debris). The 340 vault is one example of how a treatment technology has been used at the Hanford Site to meet technology and performance standards listed in 40 CFR 268.45. Immobilization technologies offer the following benefits when treating large debris streams such as LAW melters.

- Treatment is achieved by applying a coating of aromatic polyurea (60 mL to meet existing Hanford waste acceptance criteria).
- Aromatic polyurea material weight is 6 lb/ft$^3$ (vs. 148 lb/ft$^3$ for concrete, and 708 lb/ft$^3$ for lead).
- Landfill space requirements are decreased by at least 35 percent.
- Aromatic polyurea provides 400 percent stretch elongation (substantially reducing surface exposure and resistant to degradation).

Note that the application of coatings in the open air will be limited by weather and could require extended outside storage.

For the purposes of this evaluation, the immobilization technology-based treatment standards identified in 40 CFR 268.45 will serve as the baseline for meeting treatment standards. Application of an appropriate material that meets the technology and performance standards of 40 CFR 268.45 will be applied to the container to meet treatment standards. This position is based on the size of the melters (dimensions and weight) and existing Hanford experience applying treatment technologies to large waste packages to meet LDR requirements.

### 5.1.2.3 Timing and Location of Preparation for Disposal

Options identified as potential locations to perform the void filling and treatment to meet LDR requirements include:

- The LAW melter gallery where the LAW melter operated (permitted containment building)
- The adjacent set of melter rails (i.e., adjacent to where the used melter had been operating) on the melter assembly pad or airlock at the LAW Vitrification Facility
- A new mixed waste treatment and storage pad located at the IDF
- A new mixed waste treatment and storage pad located at or near the WTP site.
Although void filling is not considered a RCRA treatment, with the used melters being mixed waste exiting a RCRA-permitted facility, any additional downstream management (e.g., void filling and treatment of melters) must occur in RCRA-permitted facilities. Disposal options that involve adding void-fill after exiting the LAW Vitrification Facility will require permit modifications to the LAW Vitrification Facility to support void filling outside the facility. A total of seven location options were identified and considered for LAW melter preparation for disposal. Table 5-1 identifies the options and location of the preparation activities.

Table 5-1. Low-Activity Waste Melter Preparation for Disposal Execution Options

<table>
<thead>
<tr>
<th>Options</th>
<th>Void fill used LAW melters</th>
<th>Treatment of used LAW melters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LAW Vitrification Facility gallery/airlock</td>
<td>Adjacent pad/gallery/airlock</td>
</tr>
<tr>
<td>1</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>

IDF = Integrated Disposal Facility. LAW = low-activity waste. WTP = Waste Treatment and Immobilization Plant.

Table 5-2 provides a brief description of each melter preparation for disposal option and the key risks and benefits associated with the options.
### Table 5-2. Melter Disposition Options, Key Risks, and Benefits (2 pages)

<table>
<thead>
<tr>
<th>Preparation for disposal option description</th>
<th>Key risks</th>
<th>Key benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1 In place at WTP gallery or airlock</strong>&lt;br&gt;Activities include:&lt;br&gt;• Seal-weld in place&lt;br&gt;• Void-fill in place&lt;br&gt;• Treatment in place</td>
<td>• Delays the installation of new melter while void fill/treatment activities are performed&lt;br&gt;• Delays related to disposition activities (e.g., contractor delays)&lt;br&gt;• Reduces overall facility availability, just meeting 70% goal&lt;br&gt;• RCRA permit modification required to support melter treatment&lt;br&gt;• Potential air permit modifications (toxic and radioactive) for void filling and treatment of melters</td>
<td>• Controlled environment in LAW Vitrification Facility&lt;br&gt;• Limits moving and transport of melter&lt;br&gt;• Floor hatch supports treatment activities&lt;br&gt;• Allows void-fill to occur before seal welding, reducing the time required for void filling</td>
</tr>
<tr>
<td><strong>2 Void-fill and treatment at LAW Vitrification Facility on other rails in adjacent pad/gallery/airlock</strong>&lt;br&gt;Activities include:&lt;br&gt;• Seal-weld in place&lt;br&gt;• Void-fill at adjacent pad/gallery/airlock&lt;br&gt;• Treatment at adjacent pad/gallery/airlock</td>
<td>• Facility delays related to disposition activities at LAW Vitrification Facility (e.g., contractor delays)&lt;br&gt;• Disposal activities close to new melter installation activities&lt;br&gt;• RCRA permit modification required to support melter treatment&lt;br&gt;• Potential air permit modifications (toxic and radioactive) for void filling and treatment of melters</td>
<td>• Controlled environment in LAW Vitrification Facility&lt;br&gt;• Opens up bay for installation of new melter (not waiting on void-fill or treatment)&lt;br&gt;• Floor hatch supports treatment activities&lt;br&gt;• LAW pad currently exists</td>
</tr>
<tr>
<td><strong>3 Void fill and treatment at new IDF pad</strong>&lt;br&gt;Activities include:&lt;br&gt;• Seal-weld in place&lt;br&gt;• Void-fill at new IDF treatment/storage pad&lt;br&gt;• Treatment at new IDF treatment/storage pad</td>
<td>• Transport of melter to IDF&lt;br&gt;• RCRA permit modification to support new treatment and storage pad&lt;br&gt;• Construction of a new melter treatment and storage pad&lt;br&gt;• NEPA mitigation may be required for construction of new treatment and storage pad, and perhaps to accommodate new or expanding roads</td>
<td>• Opens up bay for installation of new melter (not waiting on void-fill or treatment)&lt;br&gt;• Separates installation activities at LAW Vitrification Facility from IDF disposal activities&lt;br&gt;• Activity currently being tracked on DFLAW Integrated Schedule</td>
</tr>
<tr>
<td><strong>4 Void fill and treatment at new WTP pad</strong>&lt;br&gt;Activities include:&lt;br&gt;• Seal-weld in place&lt;br&gt;• Void-fill at new WTP treatment/storage pad&lt;br&gt;• Treatment at new WTP treatment/storage pad</td>
<td>• New pad not being tracked on any schedule&lt;br&gt;• RCRA permit modification to support new WTP treatment and storage pad&lt;br&gt;• Identification of new pad location&lt;br&gt;• Construction of new storage pad&lt;br&gt;• Potential air permit modifications (toxic and radioactive) for void filling and treatment of melters</td>
<td>• Opens up bay for installation of new melter (not waiting on void-fill or treatment)&lt;br&gt;• Separates installation activities at LAW Vitrification Facility from disposal activities at new WTP pad&lt;br&gt;• NEPA coverage and no mitigation required</td>
</tr>
</tbody>
</table>
Table 5-2. Melter Disposition Options, Key Risks, and Benefits (2 pages)

<table>
<thead>
<tr>
<th>Preparation for disposal option description</th>
<th>Key risks</th>
<th>Key benefits</th>
</tr>
</thead>
</table>
| 5 Seal-weld/void-fill in place, treatment at LAW melter assembly pad or other airlock | • Delays the installation of new melter while void-fill activities are performed  
• Delays related to void-fill activities (e.g., contractor delays)  
• Impacts overall facility availability  
• RCRA permit modification to support new treatment and storage pad  
• Potential air permit modifications (toxic and radioactive) for void filling and treatment of melters | • Controlled environment in LAW Vitrification Facility  
• Limits moving and transport of melter  
• Void-fill could occur before seal welding, reducing timeline  
• LAW pad currently exists |
| Activities include:  
• Seal-weld in place  
• Void-fill in place  
• Treatment at LAW pad or other airlock | | |
| 6 Seal-weld/void-fill in place in WTP, treatment at IDF | • Delays the installation of new melter while void-fill activities are performed  
• Delays related to void-fill activities (e.g., contractor delays)  
• Impacts overall facility availability  
• Transport of melter to IDF  
• RCRA permit modification to support new treatment and storage pad  
• Construction of a new melter treatment and storage pad | • Separates installation activities at LAW Vitrification Facility from IDF disposal activities  
• Activity currently being tracked on DFLAW Integrated Schedule |
| Activities include:  
• Seal-weld in place  
• Void-fill in place  
• Treatment at new IDF treatment/storage pad | | |
| 7 Seal weld/void fill in place in WTP, treatment at new WTP pad | • New pad not being tracked on any schedule  
• Delays the installation of new melter while void-fill activities are performed  
• Delays related to void-fill activities (e.g., contractor delays)  
• Impacts overall facility availability  
• RCRA permit modification to support new treatment and storage pad  
• Identification of new melter treatment and storage pad location  
• Construction of a new melter treatment and storage pad  
• Potential air permit modifications (toxic and radioactive) for void filling and treatment of melters | • Separates installation activities at LAW Vitrification Facility from IDF disposal activities |
| Activities Include:  
• Seal-weld in place  
• Void-fill in place  
• Treatment at new WTP treatment/storage pad | | |

DFLAW = direct feed low-activity waste.  
IDF = Integrated Disposal Facility.  
LAW = low-activity waste.  
NEPA = National Environmental Policy Act.  
WTP = Waste Treatment and Immobilization Plant.
5.1.3 Dispose Low-Activity Waste Melter Options

Disposing the LAW melters will need to meet all disposal requirements, with appropriate oversight and control during the entire process to ensure that the work is performed safely and efficiently. Melters will be disposed at the IDF. No other locations are considered for used LAW melter disposal. No options regarding the approach (method) of disposing the used LAW melters have been identified as part of this evaluation. When appropriate to perform detailed planning of the approach to dispose of a LAW melter, alternatives that make the most efficient use of disposal space and consider operational impacts should be explored. That effort is beyond the scope of this analysis.

Two options are identified for disposing the LAW melters. The first option is to store used LAW melters prior to disposal, and the second option is to directly dispose used LAW melters (Figure 5-5). The IDF will need the ability to stage/store melters prepared for disposal or be prepared to directly dispose of a used LAW melter at the time of transport. During the current state mapping process workshops, the need for requiring staging at the IDF until the melter can be disposed of was discussed. The consensus was that the timeframe from when a decision is made to remove a LAW melter and when the melter will be ready to be disposed (at least 3 months, not including time to void-fill or treat to meet LDR requirements) was adequate for preparations at IDF to allow the used LAW melter to be directly disposed without requiring staging. This approach does not negate the option of staging or storing the used LAW melter at IDF prior to disposal.

There could be operational advantages to not directly disposing the used LAW melters, such as operational flexibility and waiting for improved environmental conditions (e.g., wind, snow, ice). Large volumes of secondary solid waste are expected to be generated during removal of a used LAW melter, in addition to the melter, so deferring disposal until a later time could reduce the demands on the IDF at that time.

![Used LAW Melter Disposal at the Integrated Disposal Facility (IDF)](image)

**Figure 5-5. Used Low-Activity Waste Melter Disposal at Integrated Disposal Facility**
5.1.3.1 Melter Disposal Options Summary

The LAW melter disposition approach options were used in developing the LAW melter disposition alternatives. These approach options are summarized in the Table 5-3.

Table 5-3. Melter Disposition Options Summary

<table>
<thead>
<tr>
<th>Function</th>
<th>Options</th>
<th>Location</th>
<th>Timing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Removal</td>
<td>None for this study</td>
<td>None for this study</td>
<td>None for this study</td>
</tr>
</tbody>
</table>
| Preparation for disposal | None for this study | • At operating location ✓  
• At LAW Vitrification Facility ✓  
• At WTP ✓  
• At IDF ✓  
• At other location | Supports preparation options |
| Transport             | Supports preparation options | Supports preparation options | Supports preparation options |
| Disposal              | None for this study   | None for this study               | • On demand  
• Store, then dispose several at once |

IDF = Integrated Disposal Facility.  
LAW = low-activity waste.  
WTP = Waste Treatment and Immobilization Plant.

The location for melter preparation for disposal offers the only multiple approach options, as indicated in the table. These location options were used in developing the alternatives. All other options are assumed to be the selected approach and integrated into the alternative.

5.1.4 Used Melter Transport

An evaluation of options for transporting the used LAW melters from WTP to the IDF was performed in 2014 and documented in RPP-RPT-58204, *Spent/Failed Low-Activity Melter Transport Evaluation Report*. RPP-RPT-58204 recommends a combination of low-profile jacks and pull-up gantries to place the used melter onto a transporter (e.g., a Goldhofer PST/SL-E). The report also confirmed the adequacy of a proposed transport route to the IDF, as described in RPP-20437, *Immobilized Low-Activity Waste Transportation Optimization Study*. Unloading the used LAW melter at IDF was also evaluated; however, the off-loading equipment options are dependent on the IDF configuration at the time of the unloading operation. A recent study performed by Barnhart Crane & Rigging (Appendix E) confirmed the results of RPP-RPT-58204.

Shipment of radioactive material such as the ILAW melter to the IDF on the Hanford Site is regulated by the U.S. Department of Transportation (DOT) and/or DOE. Radioactive shipments regulated under DOT are shipped in compliance with 49 CFR 173, “Transportation – Shippers General Requirements for Shipments and Packagings,” and 10 CFR 71, “Packaging and Transportation of Radioactive Material.” The ILAW melter should be a Type B quantity of radioactive material (based on ILAW container calculations), which under DOT regulations will require the development and implementation of a Type B safety analysis report for packaging (SARP), with approval from the Package Certification Authority (i.e., DOE or the U.S. Nuclear Regulatory Commission [NRC]).
Radioactive materials are packaged in containers using a graded approach. Higher concentrations of radioactivity in the material require a higher-rated, stronger, and more expensive package. Packages used to ship radioactive materials include: Excepted Package, Industrial package Type 1 (IP-1), Industrial package Type 2 (IP-2), Industrial package Type 3 (IP-3), Type A package, and Type B package. The Excepted Package is the least stringent, with the Type B package being the most robust. The difference in the package ratings is testing and certification – performing various tests and confirming that the contents of package have not leaked any radioactive material. Certification criteria for IP-1 include testing for vibration, impulse event, braking event, hard set down, package tiedown attachments, package lift points, and thermal extreme. The IP-2 criteria adds a free drop test and a stacking test to the IP-1 testing regimen. The Type A certification adds even more criteria than the IP-2 package, with a penetration test, water spray test, pressure test, containment test, and many more. Each higher rating of packaging drives up the cost due to the increased testing and certification required.

Shipments on the Hanford Site (i.e., not in commerce) can use the transportation safe harbor identified in Table 2 of 10 CFR 830, “Nuclear Safety Management.” 10 CFR 830 includes a provision for the development and implementation of a transportation safety document (TSD). This TSD is a mechanism to facilitate relief from the regulatory requirements specified by DOT for radioactive shipments made in commerce. The TSD for the Hanford Site is DOE/RL-2001-36, Hanford Sitewide Transportation Safety Document. The TSD makes provision for shipments under the following authorization basis methods:

- **Package-specific safety document (PSSD)** – An on-site TSD that is similar in content to a DOT SARP.
- **One-time request for shipment (OTRS)** – Similar to a justification for continued operation or on-site TSD, where DOE assumes greater risk.
- **Special package authorization (SPA)** – A unique authorization basis resulting from decontamination and decommissioning activities where package configurations may vary widely. The SPAs authorize transport of a specifically defined payload in an authorized packaging system, where the packaging system comprises multiple containment and confinement boundaries and supporting engineered and administrative controls.

The PSSD/SPA process defines controls within the TSD to provide an equivalent degree of safety without purchasing and maintaining expensive packages or casks and developing the SARPs. It is expected that the ILAW melters will be shipped under a PSSD or SPA per DOE/RL-2001-36.

### 5.2 MELTER DISPOSITION ALTERNATIVES

The LAW melter disposition alternatives are based on the location where void filling and treatment (immobilization technologies) will occur. The seven disposition options meet the requirements identified in Section 2.2 and provided in Appendix B of this evaluation. LAW melter disposition options were down-selected to a set of alternatives based on the key risks and benefits specific to each option identified in Table 5-4.
Table 5-4. Used Low-Activity Waste Melter Disposition Options for Further Evaluation

<table>
<thead>
<tr>
<th>Options</th>
<th>Void fill used LAW melters</th>
<th>Treatment of used LAW melters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LAW Vitrification Facility gallery/airlock</td>
<td>Adjacent pad/gallery/airlock</td>
</tr>
<tr>
<td>1</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>

IDF = Integrated Disposal Facility.  
LAW = Low-Activity Waste.  
WTP = Waste Treatment and Immobilization Plant.

A key risk is the mission impact to the overall availability of the LAW Vitrification Facility. Options that reduce the availability are considered detrimental, especially for options that do not carry the same risk to the overall availability of the LAW Vitrification Facility. Reduced facility availability, along with the other risks identified in Table 5-2, provide a basis for eliminating the following options from further consideration:

- Option #5 – Seal-weld/void-fill in place in WTP, Treatment at LAW pad or other airlock
- Option #6 – Seal-weld/void-fill in place in WTP, Treatment at IDF
- Option #7 – Seal-weld/void-fill in place in WTP, Treatment at new WTP pad.

Table 5-4 illustrates disposal preparation options that will carry forward for further evaluation:

- Option #1 – In place at WTP (baseline planning option)
- Option #2 – Void-fill and treatment at adjacent pad/gallery/airlock at LAW Vitrification Facility
- Option #3 – Void-fill and treatment at new IDF RCRA treatment and storage pad
- Option #4 – Void-fill and treatment at new WTP RCRA treatment and storage pad.

The four disposal alternatives for used melters are:

- Alternative D1, Disposal preparation in LAW Vitrification Facility gallery/airlock (Section 5.2.1.1, Figure 5-6)
- Alternative D2, Disposal preparation at the adjacent pad/gallery/airlock (Section 5.2.2.1, Figure 5-9)
- Alternative D3, Disposal preparation at a new IDF pad (Section 5.2.3.1, Figure 5-12)
- Alternative D4, Disposal preparation at a new WTP pad (Section 5.2.4.1, Figure 5-15).
The alternatives have two important elements in common:

- Seal welding closure plates will occur as part of used melter removal in the LAW Vitrification Facility melter gallery/airlock location where the melter requires replacement. Seal welding closure plates on used melters is required (see Section 5.1.1) before leaving the LAW Vitrification Facility. Melters will have approximately 130 ports/hatches that will require seal welding. Figure 5-4 (Section 5.1.1) illustrates the seal welding process.

- Final disposal of used LAW melters will occur at IDF.

The following disposal preparation activities will also be required prior to disposal of used melters:

- Void filling of used melters is required prior to final placement and disposal. For planning purposes, void filling is anticipated to be completed with the use of an expanding foam product to meet current Hanford compaction and void-fill requirements. Preparation and application of expanding foam to perform void-fill on used melters is expected to require 1 month to complete the activity. Section 5.1.2.2 provides additional landfill information.

- Treatment of used melters is required to meet RCRA LDR requirements. For planning purposes, treatment standards are anticipated to be achieved by the immobilization technologies identified in Table 1 of 40 CFR 268.45. Treatment of used LAW melters is expected to require 1 month to complete the activity. Section 5.1.2.3 provides additional treatment information.

### 5.2.1 Alternative D1 – Disposal Preparation in Low-Activity Waste Vitrification Facility Gallery/Airlock

#### 5.2.1.1 Alternative Description

Alternative D1, Disposal Preparation in LAW Vitrification Facility Gallery/Airlock, will be completed at the LAW Vitrification Facility. Figure 5-6 illustrates elements necessary to support this option. For this alternative, used LAW melters will be removed from service. In addition to the activities required to remove the melter from the facility, void filling and immobilization will be performed in the melter gallery/airlock where the melter requires replacement.

Table 5-5 describes the disposition activities that will be performed on used melters under this option.

<table>
<thead>
<tr>
<th>Void-fill used melters</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Void filling used melters will occur at the LAW Vitrification Facility gallery/airlock (where the melter requires replacement)</td>
<td>Treatment of used melters will occur at the LAW Vitrification Facility gallery/airlock (where the melter requires replacement)</td>
</tr>
</tbody>
</table>

LAW = low-activity waste.
Figure 5-6. Alternative D1 – Disposal Preparation in Low-Activity Waste Vitrification Facility Gallery/Airlock

Several key benefits offered by this alternative include:

- Controlled environment in LAW Vitrification Facility
- Limits moving and transport of melter
- Floor hatch supports treatment activities
- Allows void-fill to occur before seal welding, reducing the time required for void filling.

Key risks associated with this option include:

- Delays the installation of a new melter while void-fill/treatment activities are performed in the LAW Vitrification Facility gallery/airlock where the melter requires replacement
- Delays due to preparation for disposition activities (e.g., contractor delays, regulatory delays)
- Reduces overall facility availability, just meeting 70 percent goal
- Requires RCRA permit modification to support melter treatment
- Potential air permit modifications (toxic and radioactive) for void filling and treatment of melters
In this option, used melters will be transported using heavy-duty modular trailers and hydrostatically powered modular transporters (e.g., a Goldhofer). Specific information regarding used melter transport is provided in Section 5.1.4.

5.2.1.2 Safety Aspects

Safety aspects considered for this alternative are nuclear, radiological, chemical, and industrial safety. For this alternative, the operational activities performed to remove the used melter, prepare the used melter for disposal, and dispose the used melter will need, at a minimum, to go through the USQ process or be analyzed and described as part of the DSA for the LAW Vitrification Facility or IDF, as appropriate. The USQ process is designed to ensure that the safety basis remains intact and that new activities, equipment, and facilities do not interfere with the controls in place to protect the public, workers, and environment. Qualified USQ reviewers will need to consider the operational activities that could have an impact on the nuclear facility. If the activity plans to use hazardous materials, the use of those chemicals will need to be reviewed for impacts to the nuclear facility and its operations.

Industrial and chemical safety associated with placing the void-fill material and treatment material will need to be reviewed with appropriate industrial safety and industrial hygiene personnel.

From a radiological safety perspective, Alternative D1 is considered to have a lower risk of personnel exposure due to the greater containment control provided by the LAW Vitrification Facility building and ventilation system. Alternative D1 is considered to have a moderate risk to chemical and industrial exposures. This moderate risk is due to performing the disposal preparation activities within the LAW Vitrification Facility, which has more chemical and industrial hazards than a standalone pad.

5.2.1.3 Mission Impacts

The alternative was evaluated in several areas where potential impacts to the mission exist. A description of how this alternative may impact the mission is provided, along with the potential risks and benefits identified for each of the categories.

Schedule risk – This alternative:

- Delays installation of a new melter while used melter disconnect and disposal activities occur
- Requires that RCRA LDR and landfill requirements are achieved prior to removal of used melters from the LAW Vitrification Facility gallery/airlock. Unexpected delays associated with disposition activities will increase overall melter downtime.

Availability – Melter disposition activities will extend the melter downtime by 1 to 2 months, or more, depending on the activity in the LAW Vitrification Facility melter gallery and airlock. The extended melter downtime will adversely affect the overall availability of melters.

Permit requirements

- A RCRA permit modification is required to support this alternative (anticipated to be a Class 3 permit modification).
• A toxic air NSR will determine if further action is required to modify existing or establish a new source of toxic air emissions.
• A radioactive air emissions permit modification is expected to support this alternative.

5.2.1.4 Regulatory Impacts

In developing melter disposition alternatives, an evaluation of federal and state environmental requirements was performed. The specific activities required to support Alternative D1 are discussed in this subsection.

National Environmental Policy Act

The TC & WM EIS (DOE/EIS-0391) analyzed programmatic areas, including the disposal of Hanford LLW and MLLW (including used melters) in the IDF. The TC & WM EIS was prepared with the EPA and Ecology as cooperating agencies. Washington State Environmental Policy Act (SEPA) compliance is in accordance with WAC 197-11, “SEPA Rules,” and Ecology’s adoption commitment in the TC & WM EIS.

Used LAW melters were analyzed in the TC & WM EIS for on-site treatment and on-site disposal in the IDF. To support this disposal alternative, the activities of on-site melter treatment at the WTP and on-site disposal at IDF have NEPA coverage under the TC & WM EIS. Further NEPA action is not expected to be required to support this disposal alternative.

Resource Conservation and Recovery Act Permit Modification

In Alternative D1, the treatment of used melters will occur at the LAW Vitrification Facility gallery/airlock. Due to the uncertainty of what permit modification classification Ecology would approve, a RCRA Class 3 permit modification, the most rigorous, is used to support treatment via immobilization technologies of LAW melters. For planning purposes, 2 years are anticipated to be required to complete a Class 3 permit modification at the WTP to support Alternative D1.

Nonradioactive Air Emissions (Toxic Air Emissions)

Waste management disposition activities are a routine occurrence at the Hanford Site. This activity includes void filling the used melters prior to treatment and final disposal. Void filling and treatment of melters could result in non-radiological emission non-point (fugitive emissions) and point source emission units in support of disposition activities. Non-hazardous emissions are regulated under WAC 173-400.

An NSR will determine the need to modify existing processes or buildings for void filling activities to support this option. The following scenarios initiate the need for NSRs:

• Establishing a new source or modifying an existing source of air emissions, as identified in WAC 173-400
• Establishing a new or modifying an existing source of toxic air emissions as identified in WAC 173-460
• Constructing, modifying, or relocating a portable source except those relocating in compliance with WAC 173-400-036
• Making a major modification to an existing major stationary source, as identified in WAC 173-400-720 (i.e., a source that has a prevention of significant deterioration permit).

The results of the NSR review will determine if further action is required to modify existing or establish a new source of toxic air emissions, including obtaining a toxic air emissions permit.

**Radioactive Air Emissions**

To support this disposal alternative, void filling and treatment of LAW melters will likely result in a revised radioactive air emissions permit for the LAW Vitrification Facility. Void-fill and treatment are routine waste management activities performed at the Hanford Site. For planning purposes, current procedures are expected to be followed that support treatment, allow for injection of void-fill material, and control ventilation through a HEPA filter or other abatement technology (or as defined in specific workscope documents). For planning purposes, a permit modification is expected to require 6-12 months to complete.

Table 5-6 identifies regulatory implications that are required to support Alternative D1.

**Table 5-6. Summary of Environmental Permit Requirements**

<table>
<thead>
<tr>
<th>Permit/regulatory agency</th>
<th>Permit reference</th>
<th>Permit requirements</th>
</tr>
</thead>
</table>
| Department of Health Radioactive Air Emissions *Construction of the WTP LAW Vitrification Plant Rev. 4A* | AIR 17-422 | • All penetrations on the existing enclosures shall be welded or closure plates shall be welded to the LAW melter before it shall be moved out of the LAW Vitrification Facility on rollers.  
• The melter shall then be exported from the building and shipped to Hanford Site burial ground (disposal at IDF).  
• It shall be prepared for transportation before removal from the LAW Vitrification Facility. |
| Hanford RCRA Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste | WA 7890008967 Chapter 04 | • (Melter) open ports will be seal welded. |
| Hanford RCRA Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste | WA 7890008967a | • Prepare Class 3 permit modification to support melter treatment in LAW Vitrification Facility gallery/airlock. |
| Department of Health Radioactive Air Emissions *Construction of the WTP LAW Vitrification Plant Rev. 4A* | a | • Revise air permit to support void-fill and treatment of used LAW melters. |

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a Permit modification required to support this melter disposition alternative.

IDF = Integrated Disposal Facility.  
LAW = low-activity waste.  
WTP = Waste Treatment and Immobilization Plant.
5.2.1.5 Cost

The life-cycle cost estimate for Alternative D1 is based on the details associated with the
alternative description presented in this section. The cost estimates are developed using resource
estimates and engineering estimates. The identified costs are present dollar values that are
developed by escalating costs to the year work is performed and then applying a discount rate for
the time value of money. The cost estimate is developed in accordance with the requirements of
TFC-PRJ-PC-C-05 by the WRPS Estimating group. The cost estimates are at a
preconceptual/magnitude estimate level or Class 5 estimate (i.e., ROM estimate). The estimate
is useful for concept screening, concept feasibility evaluation, and budget estimate magnitude
comparisons but is not at a level of accuracy appropriate for budget authorization. All cost
estimates for this study are included in WRPS Estimate Number 4407, Est 4407 Melter
Replacement Readiness Assessment 2017-06-15b.

Costs are based on a 40-year operating life for the LAW Vitrification Facility and a nominal
5-year operating life of a LAW melter. During the 40-year operating life, there will be 14 melter
changeouts. The cost for dispositioning the melters in place at the end of the 40-year operating
life of the LAW Vitrification Facility is not included in this estimate. Estimates include the cost
to disconnect and remove the melters from the operating gallery, including seal welding the
melter shell, void filling the used melters, treatment of the used melters, transporting the used
melters, and disposing the used melters at IDF.

The present value acquisition, operating, and total life-cycle costs are presented in Table 5-7 for
Alternative D1. Because this alternative is based on performing all preparatory activities for melter
disposal within the melter gallery location where the used melter was previously operating, there is no
need to build a treatment pad. Therefore, there is no acquisition cost associated with this
alternative. Costs for removing the used melter, seal welding, void filling, treatment, and disposing the used melter are considered operating costs.

The annual cost profile is shown in Figure 5-7. The cost to disposition a used melter is
approximately $3 million. Costs in FY 2023 and FY 2024 cover preparation and approval of a
PSSD to allow transport of the used melter from the LAW Vitrification Facility to the IDF.

<table>
<thead>
<tr>
<th>Category</th>
<th>Alternative D1 – Preparation for disposition where melter operated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acquisition cost</td>
<td>$ 0</td>
</tr>
<tr>
<td>Operating cost</td>
<td>$ 42,500,000</td>
</tr>
<tr>
<td>Total life-cycle cost</td>
<td>$ 42,500,000</td>
</tr>
</tbody>
</table>
5.2.1.6 Schedule

A RCRA Class 3 permit modification is required to support Alternative D1. The permit modification will allow melter treatment at the LAW Vitrification Facility melter gallery/airlock. For planning purposes, a Class 3 permit modification is anticipated to take approximately 2 years to complete. In the schedule, RCRA permit activities begin in 2021, with the Class 3 permit approval in 2023. There is sufficient time to complete a RCRA permit modification to support this alternative prior to 2025. Figure 5-8 provides schedule details specific to this disposition alternative.

Air emissions activities are also required to support this disposal alternative. A nonradioactive NSR will be required to determine the need to modify existing or establish a new source of toxic air emissions, including obtaining a toxic air permit. This disposal alternative will likely require a revised radioactive air emissions permit for the LAW Vitrification Facility.

The air emissions permit modifications are expected to require 6-12 months to complete. For planning purposes, the air emissions permit modification activities are scheduled to begin in 2022, with DOH approval in 2023.
5.2.2 Alternative D2 - Disposal Preparation at the Adjacent Pad/Gallery/Airlock

5.2.2.1 Disposal Alternative D2 Description

Alternative D2, Disposal Preparation at the Adjacent Pad/Gallery/Airlock, will be completed at the LAW Vitrification Facility. Figure 5-9 illustrates the disposal elements that are necessary to support this option. For this alternative, used LAW melters will be removed from service and placed at the following locations to perform void-fill (not a treatment activity) and treatment via an immobilization technology (RCRA treatment activity):

- At the LAW pad
- Adjacent gallery/airlock (such as Bay 2 or Bay 3)
- Or a combination of the adjacent pad/gallery/airlock.

Table 5-8 lists disposition activities that will be performed on used melters under this option.

<table>
<thead>
<tr>
<th>Void Fill: LAW gallery/airlock</th>
<th>Task Name</th>
<th>Project Summary</th>
<th>Disposition Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment: LAW gallery/airlock</td>
<td>Preparation for alternative D2 disposal</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5-8. Alternative D2 – Disposal Preparation at the Adjacent Pad/Gallery/Airlock

<table>
<thead>
<tr>
<th>Void-fill used melters:</th>
<th>Void filling used melters will occur at the adjacent pad/gallery/airlock.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment:</td>
<td>Treatment of used melters will occur at the adjacent pad/gallery/airlock.</td>
</tr>
</tbody>
</table>

LAW = low-activity waste.
Several key benefits offered by this alternative include:

- Controlled environment in the LAW Vitrification Facility
- Opens bay for installation of new melter (not waiting on void-fill or treatment)
- Floor hatch supports treatment activities
- LAW pad and high bay are constructed and in operating condition.

Key risks associated with this option include:

- Facility delays due to disposition activities at the LAW Vitrification Facility (e.g., contractor delays, regulatory delays)
- Disposal activities close to new melter installation activities
- RCRA permit modification required to support melter treatment
- Potential air permit modifications (toxic and radioactive) for void filling and treatment of melters.
In this option, used melters will be transported using heavy-duty modular trailers and hydrostatically powered modular transporters (e.g., a Goldhofer). Alternative D2 offers the flexibility to perform disposition activities adjacent to Bay 1, on the rails at the pad, Bay 2, or Bay 3 (gallery/airlock). The LAW pad does not currently extend east to include the area required for access to Bay 3. In addition, Bay 3 does not include a rail system used for moving melters in and out of the LAW Vitrification Facility (rail system installed and operational in Bay 1 and Bay 2). For planning purposes, no facility modifications or upgrades are assumed to be required to support this alternative, and the transportation system will move used melters into the Bay 3 gallery/airlock to perform void-fill and treatment. Specific information regarding used melter transport is provided in Section 5.1.4.

5.2.2.2 Safety Aspects

For this alternative, the safety aspects considered are identical to those for Alternative D1, as described in Section 5.2.1.2 (for the case where disposal preparation occurs within an airlock/melter gallery), with one exception. Alternative D2 requires the melter transport system to transfer used LAW melters from the gallery/airlock to the adjacent pad/gallery/airlock, and then subsequently move the melter to the IDF disposal cell. Moving used LAW melters on and off the melter transport system another time may present additional safety risk that was not part of Alternative D1. The risk associated with performing one additional transfer to and from the melter transport system is considered a minor discriminator.

5.2.2.3 Mission Impacts

The alternative was evaluated in several areas where potential impacts to the mission exist. A description of how this alternative may impact the mission is provided, along with the potential risks and benefits identified for each of the categories.

Schedule risk – Schedule impacts are limited to melter disconnect activities (i.e., void-fill and treatment are completed away from new melter installation activities).

Availability – Impacts to melter availability already include melter disconnect activities.

Permit requirements:
- A RCRA permit modification is required to support this alternative (anticipated to be a Class 3 permit modification).
- A toxic air NSR will determine if further action is required to modify existing or establish a new source of toxic air emissions.
- A radioactive air emissions permit modification is expected to support this alternative.

5.2.2.4 Regulatory Impacts

In developing melter disposal alternatives, an evaluation of federal and state environmental requirements was performed. The specific activities required to support Alternative D2 are discussed in this subsection.
NEPA

The TC & WM EIS (DOE/EIS-0391) analyzed on-site melter storage and treatment for on-site disposal in the IDF. To support this disposal alternative, the activities of on-site melter treatment at the WTP and onsite disposal at the IDF have NEPA coverage under the TC & WM EIS. No further NEPA action is expected to be required to support this disposal alternative.

Resource Conservation and Recovery Act (Permit) Modification

In Alternative D2, the treatment of used melters will occur at the adjacent pad/gallery/airlock, or a combination of the areas. Due to the uncertainty of what permit modification classification Ecology would approve, a RCRA Class 3 permit modification, the most rigorous, is used to support treatment via immobilization technology of LAW melters. For planning purposes, 2 years are anticipated to be required to complete a Class 3 permit modification at the WTP to support Alternative D2.

Nonradioactive Air Emissions (Toxic Air Emissions)

Waste management disposition activities are a routine occurrence at the Hanford Site. This activity includes void filling of used melters prior to treatment and final disposal. Void filling and treatment of melters could result in non-radiological emission non-point (fugitive emissions) and point source emission units in support of disposal activities. Non-hazardous emissions are regulated under WAC 173-400.

An NSR will determine the need to modify existing processes or buildings for void filling activities to support this option. The following scenarios initiate the need for NSRs:

- Establishing a new source or modifying an existing source of air emissions, as identified in WAC 173-400
- Establishing a new or modifying an existing source of toxic air emissions, as identified in WAC 173-460
- Constructing, modifying, or relocating a portable source except those relocating in compliance with WAC 173-400-036
- Making a major modification to an existing major stationary source, as identified in WAC 173-400-720 (i.e., a source that has a prevention of significant deterioration permit).

The results of the NSR review will determine if further action is required to modify existing or establish a new source of toxic air emissions, including obtaining a toxic air emissions permit.

Radioactive Air Emissions

To support this disposal alternative, void filling and treatment of LAW melters will likely result in a revised radioactive air emissions permit for the WTP. Void-fill and treatment are routine waste management activities performed at the Hanford Site. For planning purposes, current procedures are expected to be followed to support treatment, allow for injection of void-fill material, and control ventilation through a HEPA filter or other abatement technology (or as defined in specific workscope documents). For planning purposes, a permit modification is expected to require 6-12 months to complete.
Table 5-9 identifies the regulatory agency and permits that are required to support Alternative D2.

### Table 5-9. Summary of Environmental Permit Requirements

<table>
<thead>
<tr>
<th>Permit/regulatory agency</th>
<th>Permit reference</th>
<th>Permit requirements</th>
</tr>
</thead>
</table>
| Department of Health Radioactive Air Emissions Construction of the WTP LAW Vitrification Plant Rev. 4A | AIR 17-422 | - All penetrations on the existing enclosures shall be welded or closure plates shall be welded to the LAW melter before it shall be moved out of the LAW Vitrification Facility on rollers.  
- The melter shall then be exported from the building and shipped to Hanford Site burial ground (disposal at IDF).  
- It shall be prepared for transportation before removal from the LAW Vitrification Facility. |
| Hanford RCRA Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste | WA 7890008967 Chapter 04 | - (Melter) open ports will be seal welded. |
| Hanford RCRA Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste | WA 7890008967 | - Prepare Class 3 permit modification to support melter storage and treatment in the adjacent pad/gallery/airlock. |
| Department of Health Radioactive Air Emissions Construction of the WTP LAW Vitrification Plant Rev. 4A | a | - Revise air permit to support void fill and treatment of used LAW melters. |

* Permit modification required to support this melter disposition alternative.

IDF = Integrated Disposal Facility.  
LAW = low-activity waste.  
WTP = Waste Treatment and Immobilization Plant.

#### 5.2.2.5 Cost

The cost profile for Alternative D2 is similar to Alternative D1, with the exception of the added transfer of used melters using the transport system.

The life-cycle cost estimate for Alternative D2 is based on the details associated with the alternative description presented in this section. The cost estimates are developed using resource estimates and engineering estimates. The identified costs are present dollar values that are developed by escalating costs to the year work is performed and then applying a discount rate for the time value of money. The cost estimate is developed in accordance with the requirements of TFC-PRJ-PC-C-05 by the WRPS Estimating group. The cost estimates are at a preconceptual/magnitude estimate level or Class 5 estimate (i.e., ROM estimate). The estimate is useful for concept screening, concept feasibility evaluation, and budget estimate magnitude comparisons but is not at a level of accuracy appropriate for budget authorization.
Costs are based on a 40-year operating life for the LAW Vitrification Facility and a nominal 5-year operating life of a LAW melter. During the 40-year operating life, there will be 14 melter changeouts. The cost for dispositioning the melters in place at the end of the 40-year operating life of the LAW Vitrification Facility is not included in this estimate. Estimates include the cost to disconnect and remove the melters from the operating gallery, including seal welding the melter shell, transferring the seal-welded melters to the other set of rails on the melter assembly pad via the melter transport system, void filling the used melters, treatment of the used melters, transporting the used melters to IDF, and disposing the used melters at IDF.

The present value acquisition, operating, and total life-cycle costs are presented in Table 5-10 for Alternative D2. Because this alternative is based on performing all preparatory activities for melter disposal using the existing melter assembly pad, gallery, or airlock at the LAW Vitrification Facility, there is no need to build a treatment pad. Therefore, there is no acquisition cost associated with this alternative. Costs for removing the used melter, seal welding, void filling, treatment, and disposing the used melter are considered operating costs.

The annual cost profile is shown in Figure 5-10. The cost to disposition a used melter is approximately $3 million. Costs in FY 2023 and FY 2024 cover preparation and approval of a PSSD to allow transport of the used melter from the LAW Vitrification Facility to the IDF.

### Table 5-10. Present Value (Unescalated and Non-Discounted) Acquisition, Operating, and Total Life-Cycle Cost (Low-Activity Waste Vitrification Facility Mission) for Alternative D2, Disposal Preparation at the Adjacent Pad/Gallery/Airlock

<table>
<thead>
<tr>
<th>Category</th>
<th>Alternative D2 – Disposal preparation at the adjacent pad/gallery/airlock</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acquisition cost</td>
<td>$0</td>
</tr>
<tr>
<td>Operating cost</td>
<td>$42,500,000</td>
</tr>
<tr>
<td>Total life-cycle cost</td>
<td>$42,500,000</td>
</tr>
</tbody>
</table>
5.2.2.6 Schedule

A RCRA Class 3 permit modification is required to support Alternative D2. The permit modification will allow for melter storage and treatment at the adjacent pad/gallery/airlock, or a combination of the locations. For planning purposes, a Class 3 permit modification is anticipated to take approximately 2 years to complete. In the schedule, RCRA permit activities begin in 2021, with permit approval in 2023. There is sufficient time to complete a RCRA permit modification to support this alternative prior to 2025. Figure 5-11 provides schedule details specific to this disposal alternative.

Air emissions activities are required to support this disposal alternative. A nonradioactive NSR will be required to determine the need to modify existing or establish a new source of toxic air emissions, including obtaining a toxic air permit. This disposal alternative will likely also require a revised radioactive air emissions permit for the LAW Vitrification Facility.

The air emissions permit modifications are expected to require 6-12 months to complete. For planning purposes, air emission permit modification activities are scheduled to begin in 2022, with DOH approval in 2023.
5.2.3 Alternative D3 – Disposal Preparation at a New Integrated Disposal Facility Pad

5.2.3.1 Disposition Alternative D3 Description

Alternative D3, Disposal Preparation at a New IDF Pad, will be completed at the IDF treatment/storage pad. Figure 5-12 illustrates the disposition elements that are necessary to support this option. For this alternative, used LAW melters will be removed from service and placed at the following location to perform void-fill (not a treatment activity) and treatment via immobilization technologies (RCRA treatment activity):

- At the IDF treatment/storage pad

Table 5-11 lists disposition activities that will be performed on used melters under this option.

Table 5-11. Alternative D3 – Disposal Preparation at a New Integrated Disposal Facility Pad

| Void-fill used melters:* | Void filling used melters will occur at the IDF treatment/storage pad. |
| Treatment via immobilization technologies: | Treatment of used melters will occur at the IDF treatment/storage pad. |

* WTP radioactive air emissions and RCRA permit modifications are required to implement a void-fill access port design change to support this disposition alternative.

IDF = Integrated Disposal Facility.
WTP = Waste Treatment and Immobilization Plant.
Several key benefits offered by this alternative include:

- Melter bay available for installation of new melter (not waiting on void-fill or treatment)
- Separates installation activities at LAW Vitrification Facility from disposition activities at IDF
- Treatment/storage pad currently being tracked on DFLAW Integrated Schedule
- The need for a treatment and storage pad at IDF has already been identified. Design and permitting of this pad is not scheduled to begin until late FY 2018. There is time to determine the waste streams and the treatment and storage activities to be accommodated by the pad, including used melter treatment and storage. The pad can be designed to include melter treatment and storage.

Key risks associated with this option include:

- RCRA permit modification to support new treatment and storage pad. Including melter treatment in near-term permitting actions could impact permitting of ILAW container cooling.
- Potential air permit modifications (toxic and radioactive) for void filling and treatment of melters.
In this option, used melters will be transported using heavy-duty modular trailers and hydrostatically powered modular transporters (e.g., a Goldhofer). Specific information regarding used melter transport is provided in Section 5.1.4.

5.2.3.2 Safety Aspects

Safety aspects considered for this alternative are nuclear, radiological, chemical, and industrial safety. For this alternative, the operational activities performed to remove the used melter, prepare the used melter for disposal, and dispose the used melter will need, at a minimum, to go through the USQ process or be analyzed and described as part of the DSA for the LAW Vitrification Facility or IDF, as appropriate. The USQ process is designed to ensure that the safety basis remains intact and that new activities, equipment, and facilities do not interfere with the controls in place to protect the public, workers, and environment. Qualified USQ reviewers will need to consider the operational activities that could have an impact on the nuclear facility. If the activity plans to use hazardous materials, the use of those chemicals will need to be reviewed for impacts to the nuclear facility and its operations.

Industrial and chemical safety associated with placing the void-fill material and treatment material will need to be reviewed with appropriate industrial safety and industrial hygiene personnel.

From a radiological safety perspective, Alternative D3 is considered to have a moderate risk of personnel exposure due to the lesser containment control related to performing disposal preparation activities at an outdoor treatment pad instead of inside a ventilated building.

Alternative D3 is considered to have a lower risk to chemical and industrial exposures. This lower risk is due to performing the disposal preparation activities at a standalone pad where surrounding chemical and industrial hazards are expected to be much less than within the LAW Vitrification Facility.

Alternative D3, like Alternative D2, requires one additional evolution with the melter transport system (in comparison to Alternative D1) to transfer used LAW melters from the gallery/airlock to the treatment and storage pad, and then subsequently move the melter to the IDF disposal cell. Moving used LAW melters on and off the melter transport system another time may present additional safety risk that is not part of Alternative D1. The risk associated with performing one additional transfer to and from the melter transport system is considered a minor discriminator.

5.2.3.3 Mission Impacts

This alternative was evaluated in several areas that could have mission implications.

Schedule risk – This alternative is not expected to have any adverse schedule impacts. The used melter disposition activities occur at IDF away from new melter installation activities.

Availability – Melter downtime is mitigated with disposition activities occurring at the IDF.

Permit requirements – A RCRA permit modification is required to support this alternative (anticipated to be a Class 3 permit modification).
5.2.3.4 Regulatory Impacts

In developing melter disposition alternatives, an evaluation of federal and state environmental requirements was performed. The specific activities required to support Alternative D3 are discussed in this subsection.

NEPA

The TC & WM EIS analyzed on-site melter storage and treatment. NEPA is not expected to adversely affect the project schedule to support this alternative. However, the physical location of the new IDF treatment and storage pad could require mitigation (vegetative restoration that returns some land to more natural conditions), as defined under the TC & WM EIS.

Resource Conservation and Recovery Act Permit modification

For Alternative D3, the treatment of used melters will occur at the IDF treatment and storage pad. Due to the uncertainty of what permit modification classification Ecology would approve, a RCRA Class 3 permit modification, the most rigorous, is used to support treatment (via immobilization technologies) of LAW melters. The June 2017 DFLAW integrated schedule includes permit activities specifically to provide treatment/storage capability for melters at the IDF. Under the current schedule, 2.5 years are required to complete and approve the Class 3 RCRA permit modification to support Alternative D3.

Nonradioactive Air Emissions (Toxic Air Emissions)

Waste management disposition activities are a routine occurrence at the Hanford Site. This activity includes void filling of used melters prior to treatment and final disposal. Void filling and treatment of melters could result in non-radiological emission non-point (fugitive emissions) and point source emission units in support of disposition activities. Non-hazardous emissions are regulated under WAC 173-400.

An NSR will determine the need to modify existing processes or buildings for void filling activities to support this option. The following scenarios initiate the need for NSRs:

- Establishing a new source or modifying an existing source of air emissions, as identified in WAC 173-400
- Establishing a new or modifying an existing source of toxic air emissions, as identified in WAC 173-460
- Constructing, modifying, or relocating a portable source except those relocating in compliance with WAC 173-400-036
- Making a major modification to an existing major stationary source, as identified in WAC 173-400-720 (i.e., a source that has a prevention of significant deterioration permit).

The results of the NSR review will determine if further action is required to modify existing or establish a new source of toxic air emissions, including obtaining a toxic air emissions permit.
Radioactive Air Emissions

To support this disposition alternative, void filling and treatment of LAW melters will likely result in a revised radioactive air emissions permit for the LAW Vitrification Facility. Void-fill and treatment are routine waste management activities performed at the Hanford Site. For planning purposes, current procedures are expected to be followed that support treatment, allow for injection of void-fill material, and control ventilation through a HEPA filter or other abatement technology (or as defined in specific workscope documents). For planning purposes, a permit modification is expected to require 6-12 months to complete.

Table 5-12 identifies the regulatory agency and permits that are required to support Alternative D3.

<table>
<thead>
<tr>
<th>Permit/regulatory agency</th>
<th>Permit reference</th>
<th>Permit requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Department of Health Radioactive Air Emissions</td>
<td>AIR 17-422</td>
<td>• All penetrations on the existing enclosures shall be welded or closure plates shall be welded to the LAW melter before it shall be moved out of the LAW vitrification facility on rollers.  • The melter shall then be exported from the building and shipped to Hanford Site burial ground (disposal at IDF).  • It shall be prepared for transportation before removal from the LAW Vitrification Facility.</td>
</tr>
<tr>
<td>Hanford RCRA Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste</td>
<td>WA 7890008967 Chapter 04</td>
<td>• (Melter) open ports will be seal welded.</td>
</tr>
<tr>
<td>Hanford RCRA Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste</td>
<td>WA 7890008967</td>
<td>• Prepare Class 3 permit modification to support melter treatment/storage at new IDF pad.</td>
</tr>
<tr>
<td>WTP Department of Health Construction of the WTP LAW Vitrification Plant Rev. 4A</td>
<td>a</td>
<td>• Revise air permit to support void-fill and treatment of used LAW melters.</td>
</tr>
</tbody>
</table>

a Permit modification required to support this melter disposition alternative.

IDF = Integrated Disposal Facility.
LAW = low-activity waste.
WTP = Waste Treatment and Immobilization Plant.
5.2.3.5 Cost

The life-cycle cost estimate for Alternative D3 is based on the details associated with the alternative description presented in this section. The cost estimates are developed using resource estimates and engineering estimates. The identified costs are present dollar values that are developed by escalating costs to the year work is performed and then applying a discount rate for the time value of money. The cost estimate is developed in accordance with the requirements of TFC-PRJ-PC-C-05 by the WRPS Estimating group. The cost estimates are at a preconceptual/magnitude estimate level or Class 5 estimate (i.e., ROM estimate). The estimate is useful for concept screening, concept feasibility evaluation, and budget estimate magnitude comparisons but is not at a level of accuracy appropriate for budget authorization.

Costs are based on a 40-year operating life for the LAW Vitrification Facility and a nominal 5-year operating life of a LAW melter. During the 40-year operating life, there will be 14 melter changeouts. The cost for dispositioning the melters in place at the end of the 40-year operating life of the LAW Vitrification Facility is not included in this estimate. Estimates include the cost to build a new treatment and storage pad at the IDF, disconnect and remove the melters from the operating gallery (including seal welding the melter shell), transporting the seal welded melters to the IDF, void filling the used melters, treatment of the used melters, transferring the used melters to IDF, and disposing the used melters at IDF.

The present value acquisition, operating, and total life-cycle costs are presented in Table 5-13 for Alternative D3. Building the treatment and storage pad at IDF is considered an acquisition cost. Costs for removing the used melter, seal welding, void filling, treatment, and disposing the used melter are considered operating costs.

The annual cost profile is shown in Figure 5-13. The cost to disposition a used melter is approximately $3 million. Costs in FY 2023 and FY 2024 cover preparation and approval of a PSSD to allow transport of a used melter from the LAW Vitrification Facility to the IDF and the design and construction of a treatment and storage pad at the IDF.

Table 5-13. Present Value (Unescalated and Non-Discounted) Acquisition, Operating, and Total Life-Cycle Cost (Low-Activity Waste Vitrification Facility Mission) for Alternative D3, Disposal Preparation at a New Integrated Disposal Facility Pad

<table>
<thead>
<tr>
<th>Category</th>
<th>Alternative D3 – Preparation for disposition on new pad at IDF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acquisition cost</td>
<td>$500,000</td>
</tr>
<tr>
<td>Operating cost</td>
<td>$42,500,000</td>
</tr>
<tr>
<td>Total life-cycle cost</td>
<td>$43,000,000</td>
</tr>
</tbody>
</table>

IDF = Integrated Disposal Facility.
5.2.3.6 Schedule

A RCRA Class 3 permit modification is expected to require 2.5 years to complete. Table 5-14 identifies RCRA permit activities that are prerequisites to construction activities to build a new treatment and storage pad at the IDF.

### Table 5-14. Integrated Disposal Facility Resource Conservation and Recovery Act Class 3 Permit Activities Storage and Treatment Pad

<table>
<thead>
<tr>
<th>Activity #</th>
<th>Activity name</th>
<th>Start</th>
<th>Finish</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Class 3 Part A</td>
<td>July 2018</td>
<td>November 2018</td>
</tr>
<tr>
<td>2</td>
<td>Class 3 Design Drawings</td>
<td>July 2018</td>
<td>March 2019</td>
</tr>
<tr>
<td>3</td>
<td>Class 3 Waste Analysis Plan</td>
<td>September 2018</td>
<td>January 2019</td>
</tr>
<tr>
<td>4</td>
<td>Class 3 Process Information</td>
<td>November 2018</td>
<td>April 2019</td>
</tr>
<tr>
<td>5</td>
<td>Hazard Prevention Procedures</td>
<td>January 2019</td>
<td>May 2019</td>
</tr>
<tr>
<td>6</td>
<td>Personnel Training</td>
<td>March 2019</td>
<td>July 2019</td>
</tr>
<tr>
<td>7</td>
<td>Class 3 Closure Plan</td>
<td>May 2019</td>
<td>September 2019</td>
</tr>
<tr>
<td>8</td>
<td>Class 3 Permit Approval</td>
<td>September 2019</td>
<td>January 2021</td>
</tr>
</tbody>
</table>

Source: Direct-Feed Low-Activity Waste Integrated Schedule, June 2017.
The IDF RCRA Class 3 permit is scheduled for approval in January 2021 (DFLAW Integrated Schedule, June 2017). Figure 5-14 provides schedule details specific to this disposal alternative.

**Figure 5-14. Schedule for Alternative D3 – Disposal Preparation at a New Integrated Disposal Facility Pad**

Melter void fill and treatment at IDF pad allows for replacement melter installation as soon as possible (approximately 90 days from decision to perform changeout):
- New used LAW melter preparation facility (pad) is needed
- Planning should begin mid FY 2018
5.2.4 Alternative D4 – Disposal Preparation at a New Waste Treatment and Immobilization Plant Pad

5.2.4.1 Alternative D4 Description

Alternative D4, Disposal Preparation at a New WTP Pad, will be completed at the WTP treatment and storage pad (new construction). Figure 5-15 illustrates the disposition elements that are necessary to support this option. For this alternative, used LAW melters will be removed from service and placed at the following location to perform void-fill (not a treatment activity) and treatment via an immobilization technology (RCRA treatment activity):

- At the new WTP treatment and storage pad.

Table 5-15 lists disposition activities that will be performed on used melters under this option.

Table 5-15. Disposition Alternative D4 – Preparation Disposal Preparation at a New Waste Treatment and Immobilization Plant Pad

<table>
<thead>
<tr>
<th>Void-fill used melters:</th>
<th>Void filling used melters will occur at the WTP pad.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment via immobilization technologies:</td>
<td>Treatment of used melters will occur at the WTP pad.</td>
</tr>
</tbody>
</table>

* WTP radioactive air emissions and RCRA permit modifications are required to implement a void fill access port design change to support this disposition alternative.

WTP = Waste Treatment and Immobilization Plant.
Several key benefits offered by this alternative include:

- Opens bay for installation of new melter (not waiting on void-fill or treatment)
- Separates new melter installation activities at the LAW Vitrification Facility from disposition activities at a new WTP pad
- NEPA coverage and no mitigation required (already completed within WTP boundary).

Key risks associated with this option include:

- New pad not being tracked on any schedule
- RCRA permit modification to support new WTP treatment and storage pad
- Funding to support design and construction of WTP treatment and storage pad
- Identification of new pad location
- Construction of new storage pad
- Potential air permit modifications (toxic and radioactive) for void filling and treatment of melters.

In this option, used melters will be transported using heavy-duty modular trailers and hydrostatically powered modular transporters (e.g., a Goldhofer). Specific information regarding used melter transport is provided in Section 5.1.4.

5.2.4.2 Safety Aspects

For this alternative, the safety aspects are considered identical to those described for Alternative D3 in Section 5.2.3.2.

5.2.4.3 Mission Impacts

This alternative was evaluated in several areas that could have mission implications.

Schedule risk – This alternative is not expected to have any adverse schedule impacts. The used melter disposition activities occur at the WTP pad away from new melter installation activities.

Availability – Melter downtime is mitigated with disposition activities occurring at the WTP pad.

Permit requirements – A RCRA permit modification is required to support this alternative (anticipated to be a Class 3 permit modification).

5.2.4.4 Regulatory Impacts

In developing melter disposal alternatives, an evaluation of federal and state environmental requirements was performed. The specific activities required to support Alternative D4 are discussed in this subsection.
NEPA

The TC & WM EIS (DOE/EIS-0391) analyzed on-site melter storage and treatment for on-site disposal in the IDF. To support this disposition alternative, the activities of on-site melter treatment at the WTP and on-site disposal at the IDF have NEPA coverage under the TC & WM EIS. No further NEPA action is expected to be required to support this disposition alternative (mitigation at the WTP is complete, so new pad construction will not involve new mitigation requirements).

Resource Conservation and Recovery Act Permit Modification

For Alternative D4, the treatment of used melters will occur at the WTP treatment and storage pad. Due to the uncertainty of what permit modification classification Ecology would approve, a RCRA Class 3 permit modification, the most rigorous, is used to support storage and treatment (immobilization technologies) of LAW melters. For planning purposes, 2 years are anticipated to be required to complete a Class 3 permit modification at the WTP to support Alternative D4.

Non-Radioactive Air Emissions (Toxic Air Emissions)

Waste management disposition activities are a routine occurrence at the Hanford Site. This activity includes void filling of used melters prior to treatment and final disposal. Void filling and treatment of melters could result in non-radiological emission non-point (fugitive emissions) and point source emission units in support of disposition activities. Non-hazardous emissions are regulated under WAC 173-400.

An NSR will determine the need to modify existing processes or buildings for void filling activities to support this option. The following scenarios initiate the need for NSRs:

- Establishing a new source or modifying an existing source of air emissions, as identified in WAC 173-400
- Establishing a new or modifying an existing source of toxic air emissions, as identified in WAC 173-460
- Constructing, modifying, or relocating a portable source except those relocating in compliance with WAC 173-400-036
- Making a major modification to an existing major stationary source, as identified in WAC 173-400-720 (i.e., a source that has a prevention of significant deterioration permit).

The results of the NSR review will determine if further action is required to modify existing or establish a new source of toxic air emissions, including obtaining a toxic air emissions permit.
Radioactive Air Emissions

To support this disposition alternative, void filling and treatment of LAW melters will likely result in a revised radioactive air emissions permit for the WTP. Void-fill and treatment are routine waste management activities performed at the Hanford Site. For planning purposes, the current procedures are expected to be followed to perform treatment, allow for injection of void-fill material, and control ventilation through a HEPA filter or other abatement technology (or as defined in specific workscope documents). For planning purposes, a permit modification is expected to require 6-12 months to complete.

Table 5-16 identifies the Regulatory Agency and permits that are required to support Alternative D4.

Table 5-16. Summary of Environmental Permit Requirements

<table>
<thead>
<tr>
<th>Permit/regulatory agency</th>
<th>Permit reference</th>
<th>Permit requirements</th>
</tr>
</thead>
</table>
| Department of Health Radioactive Air Emissions Construction of the WTP LAW Vitrification Plant Rev. 4A | AIR 17-422 | • All penetrations on the existing enclosures shall be welded or closure plates shall be welded to the LAW melter before it shall be moved out of the LAW vitrification facility on rollers. 
• The melter shall then be exported from the building and shipped to Hanford Site burial ground (disposal at IDF). 
• It shall be prepared for transportation before removal from the LAW Vitrification Facility. |
| Hanford RCRA Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste | WA 7890008967 Chapter 04 | • (Melter) open ports will be seal welded. |
| Hanford RCRA Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste | WA 7890008967a | • Prepare Class 3 permit modification to support melter treatment storage at WTP pad. |
| Department of Health Radioactive Air Emissions Construction of the WTP law Vitrification Plant Rev. 4A | a | • Revise air permit to support void-fill and treatment of used LAW melters. |

a Permit modification required to support this melter disposition alternative.

IDF = Integrated Disposal Facility. 
LAW = low-activity waste. 
WTP = Waste Treatment and Immobilization Plant.

5.2.4.5 Cost

The cost profile for Alternative D4 is similar to Alternative D3, with a slightly higher cost for acquisition of the storage and treatment pad.
The life-cycle cost estimate for Alternative D4 is based on the details associated with the alternative description presented in this section. The cost estimates are developed using resource estimates and engineering estimates. The identified costs are present dollar values that are developed by escalating costs to the year work is performed and then applying a discount rate for the time value of money. The cost estimate is developed in accordance with the requirements of TFC-PRJ-PC-C-05 by the WRPS Estimating group. The cost estimates are at a preconceptual/magnitude estimate level or Class 5 estimate (i.e., ROM estimate). The estimate is useful for concept screening, concept feasibility evaluation, and budget estimate magnitude comparisons but is not at a level of accuracy appropriate for budget authorization.

Costs are based on a 40-year operating life for the LAW Vitrification Facility and a nominal 5-year operating life of a LAW melter. During the 40-year operating life, there will be 14 melter changeouts. The cost for dispositioning the melters in place at the end of the 40-year operating life of the LAW Vitrification Facility is not included in this estimate. Estimates include the cost to build a new treatment and storage pad at the WTP, disconnect and remove the melters from the operating gallery (including seal welding the melter shell), transporting the seal-welded melters to the IDF, void filling the used melters, treatment of the used melters, transferring the used melters to IDF, and disposing the used melters at IDF.

The present value acquisition, operating, and total life-cycle costs are presented in Table 5-17 for Alternative D4. Building the treatment and storage pad at WTP is considered an acquisition cost. Costs for removing the used melter, seal welding, void filling, treatment, and disposing the used melter are considered operating costs.

The annual cost profile is shown in Figure 5-16. The cost to disposition a used melter is approximately $3 million. Costs in FY 2023 and FY 2024 cover preparation and approval of a PSSD to allow transport of the used melter from the LAW Vitrification Facility to the IDF and the design and construction of a treatment and storage pad at WTP.

<table>
<thead>
<tr>
<th>Category</th>
<th>Alternative D4 – Preparation for disposition at a new pad at WTP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acquisition cost</td>
<td>$ 600,000</td>
</tr>
<tr>
<td>Operating cost</td>
<td>$ 42,500,000</td>
</tr>
<tr>
<td>Total life-cycle cost</td>
<td>$ 43,100,000</td>
</tr>
</tbody>
</table>

WTP = Waste Treatment and Immobilization Plant.
A RCRA Class 3 permit modification is required to support Alternative D4. The permit modification will allow for melter storage and treatment at the WTP pad. For planning purposes, a Class 3 permit modification is anticipated to take approximately 2 years to complete. In the schedule, RCRA permit activities begin in 2021, with the Class 3 permit approval in 2023. There is sufficient time to complete a RCRA permit modification to support this alternative prior to 2025. Figure 5-17 provides schedule details specific to this disposition alternative.

Air emissions activities are required to support this disposition alternative. A nonradioactive NSR will be required to determine the need to modify existing or establish a new source of toxic air emissions, including obtaining a toxic air permit. This disposition alternative will likely also require a revised radioactive air emissions permit for the LAW Vitrification Facility.

The air emissions permit modifications are expected to require 6-12 months to complete. For planning purposes, air emission permit modification activities are scheduled to begin in 2022, with DOH approval in 2023.
The construction of a treatment and storage pad at the WTP is required to support Alternative D4. There is sufficient time to complete the RCRA permit modification and construct a new treatment and storage pad at the WTP to support this alternative. For planning purposes, construction of a new pad will require 1 year to complete construction. The schedule identifies construction of the new WTP treatment and storage pad during 2023, and completing the pad in late FY 2024. This schedule provides approximately 1 year of float before the first LAW melter design life has been reached in 2025.

### Disposal Preparation at a New WTP Pad
Melter void filling and treatment at WTP pad allows melter removal as soon as possible (approximately 90 days from decision to perform changeout)
- New used melter preparation facility (pad) is needed
- Planning should begin early FY 2022

### Figure 5-17. Schedule for Alternative D4 – Disposal Preparation at a New Waste Treatment and Immobilization Plant Pad

#### 5.3 MELTER DISPOSITION ALTERNATIVES COMPARISON

#### 5.3.1 Safety Comparison

Each LAW melter disposition alternative was assessed for the following safety measures:

- Nuclear/radiological safety risk
- Chemical safety risk
- Industrial safety risk
- Safety documentation

Safety concerns with the disposition preparation activities and the impact from nearby activities and facilities were considered in this comparison. The results of the comparison for each safety measure are provided in Table 5-18.
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Nuclear/ radiological safety risk</td>
<td>Hazard: Low Risk: Low LAW Vitrification Facility has ventilation, controlled access, and other engineered or administrative control systems in place to mitigate exposures related to nuclear or radiological safety risk.</td>
<td>Hazard: Low Risk: Low LAW Vitrification Facility has ventilation, controlled access, and other engineered or administrative control systems in place to mitigate exposures related to nuclear or radiological safety risk.</td>
<td>Hazard: Moderate Risk: Moderate An outdoor pad is installed at the IDF, which does not have a controlled environment (i.e., building and ventilation system). The outdoor pad does not offer the same level of protection as other alternatives related to nuclear or radiological safety risk.</td>
<td>Hazard: Moderate Risk: Moderate An outdoor pad is installed at the WTP, which does not have a controlled environment (i.e., building and ventilation system). The outdoor pad does not offer the same level of protection as other alternatives related to nuclear or radiological safety risk.</td>
</tr>
<tr>
<td>Chemical safety risk</td>
<td>Hazard: Moderate Risk: Moderate Exposure to chemicals in the LAW Vitrification Facility is greater in this alternative (i.e., disposition activities occur in the facility).</td>
<td>Hazard: Moderate Risk: Moderate Exposure to chemicals in the LAW Vitrification Facility is greater in this alternative.</td>
<td>Hazard: Low Risk: Low Exposure to chemicals at the LAW Vitrification Facility is reduced in this alternative (i.e., IDF pad is physically located away from LAW Vitrification Facility).</td>
<td>Hazard: Low Risk: Low Exposure to chemicals at the LAW Vitrification Facility is reduced in this alternative (i.e., WTP pad is physically located away from LAW Vitrification Facility).</td>
</tr>
<tr>
<td>Industrial safety risk</td>
<td>Hazard: Moderate Risk: Moderate Exposure to industrial safety risks at the LAW Vitrification Facility is greater in this alternative.</td>
<td>Hazard: Moderate Risk: Moderate Exposure to industrial safety risks at the LAW Vitrification Facility is greater in this alternative.</td>
<td>Hazard: Low Risk: Low Exposure to industrial safety risks at the LAW Vitrification Facility is reduced in this alternative (i.e., IDF pad is physically located away from LAW Vitrification Facility).</td>
<td>Hazard: Low Risk: Low Exposure to industrial safety risks at the LAW Vitrification Facility is reduced in this alternative (i.e., WTP pad is physically located away from LAW Vitrification Facility).</td>
</tr>
</tbody>
</table>

IDF = Integrated Disposal Facility.  
LAW = low-activity waste.  
WTP = Waste Treatment and Immobilization Plant.
5.3.2 Mission Impact Comparison

Each LAW melter disposition alternative was assessed for the following mission impacts:

- Total availability
- Schedule risk/timing of assembly/storage availability
- Impacts to ongoing operations
- Resource requirements.

The results of the comparison for each mission impact are provided in Table 5-19.

Table 5-19. Comparison of Mission Impacts of Disposition Alternatives

|----------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------|------------------------------------------------------|------------------------------------------------------|
| Availability   | 70% availability  
| Risk: High  
Extends melter removal activities within the melter gallery by up to 2 months while performing void-fill and treatment. | 72% availability  
| Risk: Moderate  
Removes melter from gallery. However, disposition activities occur in adjacent LAW pad/gallery/airlock and could impact availability. | 72% availability  
| Risk: Low  
Removes melter from gallery as soon as possible. | 72% availability  
| Risk: Low  
Removes melter from gallery as soon as possible. |
| Schedule risk/timing of preparation capability availability | Risk: High  
Delays the installation of replacement melter. | Risk: Moderate  
Due to location of disposition activities, could impact installation of replacement melter. | Risk: Low  
IDF pad currently tracked on DFLAW Integrated Schedule. | Risk: Moderate  
New WTP pad not currently tracked on any schedule. |
| Impacts to ongoing operations | Risk: High  
Delays startup of replacement melter by 2 months. | Risk: Moderate  
Could impact operations if both melters go down simultaneously or close together in time due to use of other set of rails. | Risk: Low  
Used melter disposition activities are removed from LAW Vitrification Facility. | Risk: Low  
Used melter disposition activities are removed from LAW Vitrification Facility. |
| Resource requirements | Risk: Low  
No new acquisition to support this alternative. | Risk: Low  
No new acquisition to support this alternative. | Risk: Moderate  
Requires construction of a new pad at IDF completed circa 2025. | Risk: Moderate  
Requires construction of a new pad at WTP completed circa 2025. |

DFLAW = direct-feed low-activity waste.  
IDF = Integrated Disposal Facility.  
LAW = low-activity waste.  
WTP = Waste Treatment and Immobilization Plant.
5.3.3 Regulatory Comparison

Each LAW melter disposition alternative was assessed for the following regulatory aspects:

- NEPA
- RCRA
- Air emissions

The results of the comparison for each regulatory aspect are provided in Table 5-20.

**Table 5-20. Comparison of Regulatory Impacts of Disposition Alternatives**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>NEPA</td>
<td>Risk: Low No new analysis anticipated.</td>
<td>Risk: Low No new analysis anticipated.</td>
<td>Risk: Low May require additional analysis.</td>
<td>Risk: Low No new analysis anticipated.</td>
</tr>
<tr>
<td>RCRA</td>
<td>Risk: Low Planning case calls for Class 3 permit modification for LAW Vitrification Facility, with 2-year duration.</td>
<td>Risk: Low Planning case calls for Class 3 permit modification for LAW Vitrification Facility, with 2-year duration.</td>
<td>Risk: Low Planning case calls for Class 3 permit modification for IDF with 2.5-year duration.</td>
<td>Risk: Low Planning case calls for Class 3 permit modification for LAW Vitrification Facility, with 2-year duration.</td>
</tr>
</tbody>
</table>

IDF = Integrated Disposal Facility.  
LAW = low-activity waste.  
NEPA = National Environmental Policy Act.  
WTP = Waste Treatment and Immobilization Plant.

5.3.4 Cost Comparison

Each LAW melter disposition alternative was assessed for the following cost aspects:

- Acquisition costs
- Operating costs
- Life-cycle costs

The results of the cost comparison are provided in Table 5-21.
Table 5-21. Comparison of Cost of Disposition Alternatives

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Acquisition</td>
<td>$ 0</td>
<td>$ 0</td>
<td>$ 500,000</td>
<td>$ 600,000</td>
</tr>
<tr>
<td>Operating</td>
<td>$ 42,500,000</td>
<td>$ 42,500,000</td>
<td>$ 42,000,000</td>
<td>$ 42,500,000</td>
</tr>
<tr>
<td>Life-cycle</td>
<td>$ 42,500,000</td>
<td>$ 42,500,000</td>
<td>$ 43,000,000</td>
<td>$ 43,100,000</td>
</tr>
</tbody>
</table>

IDF = Integrated Disposal Facility.  
LAW = low-activity waste.  
WTP = Waste Treatment and Immobilization Plant.

5.3.5 Schedule Comparison

The only distinction between schedules for the disposition alternatives is that Alternatives D3 and D4 include activities to construct a new storage/treatment pad to prepare the used LAW melters for disposal. The new treatment/storage pad will need to be ready by FY 2025. There should be adequate time to provide a new treatment/storage pad at the IDF (Alternative D3) or WTP (Alternative D4) by the time the pad is needed. No alternative offers a schedule advantage in terms of being prepared to support melter disposition over any of the other alternatives.
6.0 RESULTS AND RECOMMENDATIONS

To evaluate the LAW melter replacement and disposition alternatives and provide a recommendation, ORP, BNI (WTP), CH2M HILL Plateau Remediation Company (IDF), WRPS (TOC), Waste Treatment Completion Contractor (WTCC), and Barnhart Crane & Rigging (melter transport) attended a workshop hosted by WRPS. The purposes of this workshop were to:

- Discuss LAW melter replacement and disposition options
- Achieve agreement on the down-selection of options to the presented alternatives
- Compare alternatives to evaluation criteria
- Select recommended alternatives for LAW melter replacement and disposition.

The evaluation criteria are based on safety measures, mission impacts, regulatory aspects, and cost. The replacement melter alternatives were also evaluated against transportation risk for the assembled melter. The evaluation criteria were made up of subcriteria that were the focus of the evaluations and discussions held during the workshop. The attendees reviewed and agreed with the following evaluation criteria and subcriteria:

- **Safety measures**
  - Nuclear/radiological safety risk
  - Chemical safety risk
  - Industrial safety risk
  - Safety documentation

- **Regulatory aspect**
  - NEPA
  - RCRA
  - Air emissions

- **Transportation**
  - Assembled melter only

- **Mission impact**
  - Availability
  - Schedule risk
  - Impacts to ongoing operations
  - Resource requirements

- **Cost**
  - Acquisition
  - Operating
  - Life-cycle

The evaluation process was completed under the oversight of WRPS Lean Management facilitators with no vested interest in the outcome of the process. Alternatives were evaluated against each subcriterion listed above using a numeric rating system (1, 3, or 5, with 1 considered the best). The meeting notes from this workshop are included in Appendix F.

6.1 LOW-ACTIVITY WASTE MELTER REPLACEMENT ALTERNATIVES EVALUATION RESULTS

Table 6-1 provides a summary of the rating consensus agreed to by the participants for each LAW melter replacement alternative during the workshop. Safety measures and mission impacts were key discriminators in the evaluations.
Table 6-1. Low-Activity Waste Melter Replacement Evaluation Summary

<table>
<thead>
<tr>
<th>Melter replacement comparative criteria</th>
<th>Alternative R1, Offsite assembly and storage</th>
<th>Alternative R2, Assembly and storage adjacent to LAW pad</th>
<th>Alternative R3, Assembly and storage in the 200 Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety measures</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>• Nuclear/radiological</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>• Chemical</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>• Industrial</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>• Safety documentation</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Subtotal</td>
<td>4</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>Mission impacts</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>• Availability</td>
<td>1</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>• Schedule/timing</td>
<td>1</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>• Ongoing operational impact</td>
<td>1</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>• Resource requirements</td>
<td>1</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Subtotal</td>
<td>4</td>
<td>16</td>
<td>8</td>
</tr>
<tr>
<td>Regulatory aspects</td>
<td>1</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>• NEPA</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>• RCRA</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>• Air emissions</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Subtotal</td>
<td>5</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Life-cycle cost</td>
<td>1</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Transport risk</td>
<td>5</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>TOTAL</td>
<td>19</td>
<td>35</td>
<td>25</td>
</tr>
</tbody>
</table>

LAW = low-activity waste.  
NEPA = National Environmental Policy Act.  

Safety Measures

During the safety discussions, the safety impacts from performing the assembly activities and those inherent from the assembly location were discussed. A location adjacent to an operating nuclear facility had more potential for safety impacts than a location in the 200 Area or an off-site location. Since the facilities in Alternatives R1 and R3 would be not located near or within a nuclear facility area, only industrial/chemical safety and hygiene standards apply. Activities performed at these facilities will not be subject to the requirements relative to nuclear safety as specified in the DSA of the impacted nuclear facility and DOE nuclear safety requirements.

Alternative R2 was differentiated from the other two alternatives based on safety measures related to location of the assembly activities within the area of an operating nuclear facility. In contrast to the other alternatives, Alternative R2 will need to invoke the USQ process to ensure that the safety basis remains intact and that new activities will not interfere with the controls in place to protect the public, workers, and environment. Additionally, Alternative R2 will likely require DOE approval of a revision to the LAW Vitrification Facility DSA.

Therefore, Alternative R2, adjacent to the LAW Vitrification Facility pad, ranked as the highest (least desirable) during the evaluation, as a result of having the most potential impact from the adjacent operating nuclear facility.

6-2
During the evaluation process, two potential safety concerns were identified that could impact melter replacement. The first concern was the possibility of an accident condition (e.g., nitrogen oxides [NO\textsubscript{x}] emissions) occurring with the operating melter during melter replacement. Such an event would interfere with workers replacing the used melter. However, for this evaluation, an accident condition with the operating melter will not be a discriminator between any of the melter replacement alternatives because the likelihood of occurrence will be the same for each alternative.

The second concern pertained to Alternative R2, which proposes constructing the melter assembly building near the LAW Vitrification Facility. When the LAW Vitrification Facility becomes operational, an “operating island” will be established such that construction activities within that island will need to be analyzed as part of the WTP USQ process. A map of the proposed melter assembly building relative to the operating island is shown in Figure 6-1.

![Figure 6-1. Waste Treatment and Immobilization Plant Operating Island](image-url)
Note that construction activities occur close to or at operating nuclear facilities on a regular basis at the Hanford Site, and the hazards related to that work are safely managed. However, construction within the defined boundary of a nuclear facility takes longer to perform due to additional controls and scrutiny and can also impact or delay ongoing commissioning or operations at the nuclear facility. This concern discriminates between Alternative R2, adjacent to the LAW Vitrification Facility pad, and the other melter replacement alternatives, as the concern will need to be addressed and factored into constructing a melter assembly building near an operating LAW facility.

**Mission Impacts**

Mission impacts also proved to be a key discriminator in the evaluation. Timing of assembly planning, impacting the ongoing activities at the LAW Vitrification Facility, and resource requirements had significant effect on the evaluation rating.

Alternative R1, off-site assembly, has the shortest assembly planning duration, does not impact ongoing operations, and can meet the project schedule needs without modifying the LAW melter replacement execution approach. Alternative R1 does have more risk from transporting the assembled melter a greater distance. Alternative R1 was rated as having the least mission impact of the three alternatives.

Alternative R2, adjacent to the LAW Vitrification Facility pad, was rated as having the highest impact on the mission. This rating is based on several impacts.

- Construction activities will be scheduled at the same period as cold commission activities, having a high potential for impacting facility commissioning and operations.
- Construction at this location is estimated to take longer due to interferences and limitations on the construction methods (e.g., boom cranes cannot be used adjacent to a nuclear facility).
- To meet project schedule needs, the assembly of Melters #3 and #4 will overlap, and Melter #2 will be required to operate 1½ years beyond design life.
- Design of the facility will require the earliest start of the alternatives (January 2018).
- With the operating island approach being implemented at WTP, additional requirements and difficulty constructing within this area increases the risk of meeting project needs.

Alternative R3, on-site assembly in the 200 Area, was ranked slightly higher than off-site assembly due to the need for a NEPA review, the need to overlap assembly for Melters #3 and #4, the duration of the design and construction requiring activities to start in January 2019, and the increase in life-cycle costs over off-site assembly.

**Regulatory Aspects**

An assessment of federal and state environmental requirements was performed against each of the melter replacement alternatives. Potential regulatory implications specific to each melter replacement alternative were identified regarding RCRA, toxic air permitting, and NEPA. Table 6-1 summarizes the regulatory aspects rating agreed to by the workshop participants.
Alternative R2 (adjacent to the LAW Vitrification Facility pad) received the most favorable rating from a regulatory perspective, as this alternative has adequate NEPA coverage and will be managed or have minimal impacts to existing waste management and air permitting systems at the WTP. Alternative R1 (offsite assembly) scored slightly higher, and the basis was uncertainty regarding RCRA programs and procedures that must be in place through an external subcontractor to manage dangerous waste that could be generated during melter assembly activities. Alternative R3 (on-site assembly in the 200 Area) resulted in the least favorable melter replacement alternative, due to uncertainty regarding NEPA coverage in the 200 Area. The NEPA uncertainty primarily pertains to impacts that could be triggered by the physical location of a new building to support Alternative R3. Potential impacts include additional NEPA documents or implementation of a mitigation action plan, as defined in the TC & WM EIS (DOE/EIS-0391).

**Cost**

Life-cycle cost considering combined operations and acquisition costs is not meaningfully different between the alternatives. The operations cost is nearly the same for all of the alternatives and accounts for greater than 90 percent of the life-cycle cost. The acquisition cost is different for the alternatives. Securing capital funding for an assembly and storage building (Alternatives R2 and R3) in the near-term was determined to be more difficult than expense funding (Alternative R1). The need for greater capital funding (Alternative R2) was determined to be more difficult than less capital funding (Alternative R3). From an acquisition cost perspective, the order of preference between the alternatives was Alternative R1 (first), Alternative R3, and Alternative R2 (last).

**Transport Risk**

Risk associated with the refractory shifting during transport can impact the mission. During all transportation activities, measures will be taken to ensure that the acceleration limit is not exceeded. Alternative R1 has the longest distance to transport the assembled melter, and therefore the most risk. Alternative R2 transports the assembled melter the shortest distance and has the lowest risk from transportation. Alternative R3 has moderate risk from transport of the assembled melter.

### 6.1.1 Low-Activity Waste Melter Replacement Alternative Recommendation

Based on the evaluation and rating by the workshop attendees, Alternative R1 (offsite assembly) was identified as the recommended replacement alternative. However, the risk associated with assembled melter transport will need to be accepted by DOE. This recommendation is based on the low level of safety concerns, ability to support the mission with the least impacts, and the elimination of capital acquisition cost to implement this alternative.

If DOE does not select to assemble the melter offsite, Alternative R3 (onsite assembly in the 200 Area) was rated as the next best alternative. This alternative rating was based on the need to perform a NEPA review, the need to overlap the assembly activities of the first two replacement melters to meet schedule needs, and the increase in cost over off-site assembly, including the need to pursue a capital project.
6.1.2 Melter Replacement Implementing Actions

To implement the recommended replacement alternative, DOE will need to take a number of actions. Table 6-2 provides the implementing action, a brief description of the action, and a need-by timeframe when the action should be completed. As shown in Table 6-2, several near-term actions are time critical as they are necessary to implement the recommended alternative without risking delay to providing replacement melters.

### Table 6-2. Low-Activity Waste Melter Replacement Alternatives Implementation Action Summary (2 pages)

<table>
<thead>
<tr>
<th>Implementing action</th>
<th>Description</th>
<th>Need-by timeframe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haul demonstration for possible routes</td>
<td>Tank Operations Contractor to perform similar transport mockup over possible routes from 300 Area to WTP site to confirm feasibility of meeting acceleration limit requirement of 0.075 g</td>
<td>As soon as practical, late FY 2017/early FY 2018, as results may impact assembly facility location requiring planning to being in early FY 2 018</td>
</tr>
<tr>
<td>Off-site assembly and storage capabilities determination</td>
<td>Tank Operations Contractor to prepare a request for information for potential subcontractors and facilities or sites available to perform off-site assembly and storage</td>
<td>Early FY 2018, to ensure that all replacement alternatives can meet schedule need</td>
</tr>
</tbody>
</table>
| DOE agrees to the recommended approach to provide assembled LAW melters and issues decision | DOE to select, identify responsibilities, and give direction on proceeding with LAW melter assembly alternative  
Decision may take into consideration results of haul demonstration, assembly capability path forward, and off-site capabilities determination | Mid-FY 2018, to ensure that all replacement alternatives can meet schedule need                          |
| Melter procurement, assembly, and storage responsibility  | DOE to identify responsibility and provide contract direction and authorization for procuring the next LAW melter (#4)                                                                                | Early FY 2019                                                                                         |
| Replacement melter acquisition strategy                 | Tank Operations Contractor to develop strategy document for procuring, assembling, and storing replacement melters                                                                                       | FY 2018, following replacement alternative direction from DOE                                          |
| LAW melter replacement execution alternative assessment   | Tank Operations Contractor to assess the impacts of consecutive changeouts versus staggered changeouts on LAW Vitrification Facility and overall mission | FY 2018                                                                                               |
| Assembly capability path forward                         | Tank Operations Contractor to develop backward pass schedule for assembly capabilities that meet schedule needs                                                                                         | Early FY 2018, to ensure that the alternatives schedule impacts are fully understood                   |
| Additional melter suppliers                             | Tank Operations Contractor to identify additional suppliers for LAW melter fabrication to eliminate single source and increase ability to expedite melter delivery | FY 2019, to allow for suppliers to be identified prior to next melter procurement                     |
Table 6-2. Low-Activity Waste Melter Replacement Alternatives
Implementation Action Summary (2 pages)

<table>
<thead>
<tr>
<th>Implementing action</th>
<th>Description</th>
<th>Need-by timeframe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative source for refractory</td>
<td>Tank Operations Contractor to identify additional sources of refractory or alternative acceptable refractory types</td>
<td>FY 2020, to allow for sources to be identified prior to next refractory procurement</td>
</tr>
<tr>
<td>Alternative R3 only – 200 Area assembly and storage location survey</td>
<td>Tank Operations Contractor to perform site survey assessing both existing facilities and new facility locations in the 200 Area, including WTP</td>
<td>Mid-FY 2018, to be used as input into planning for the design and NEPA review, if required</td>
</tr>
<tr>
<td>Alternative R3 only – NEPA review preparation</td>
<td>DOE, if alternative requires NEPA review, to plan for resources to support effort</td>
<td>Early FY 2018, for on-site assembly in 200 Area</td>
</tr>
</tbody>
</table>

DOE = U.S. Department of Energy.
FY = fiscal year.
LAW = low-activity waste.
NEPA = National Environmental Policy Act.
WTP = Waste Treatment and Immobilization Plant.

Action items that are specific to Alternative R3 are also included. For Alternative R3 to remain as a potential alternative for replacement, these actions will need to be completed in the timeframe identified.

6.2 LOW-ACTIVITY WASTE MELTER DISPOSITION ALTERNATIVES EVALUATION RESULTS

Table 6-3 provides a summary of the rating consensus agreed to by the workshop participants during the evaluation.
Table 6-3. Used Low-Activity Waste Melter Disposal Preparation Evaluation Summary

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<td>3</td>
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<td>• Nuclear/radiological</td>
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<td>3</td>
<td>1</td>
<td>1</td>
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<tr>
<td>• Chemical</td>
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<td>• Industrial</td>
<td>7</td>
<td>7</td>
<td>5</td>
<td>5</td>
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<tr>
<td>Subtotal</td>
<td>16</td>
<td>10</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>Mission impacts</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>• Availability</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>• Schedule/timing</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>• Ongoing operational impact</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>• Resource requirements</td>
<td>16</td>
<td>10</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>Subtotal</td>
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<td>10</td>
<td>6</td>
<td>8</td>
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<tr>
<td>Regulatory aspects</td>
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<td>• RCRA</td>
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<td>• Air emissions</td>
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<td>3</td>
<td>1</td>
<td>3</td>
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<tr>
<td>Subtotal</td>
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<td>3</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Life-cycle cost</td>
<td>1</td>
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<td>1</td>
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<tr>
<td>TOTAL</td>
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<td>13</td>
<td>17</td>
</tr>
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IDF = Integrated Disposal Facility.  
LAW = low-activity waste.  
NEPA = National Environmental Policy Act.  
WTP = Waste Treatment and Immobilization Plant.

Safety measures, regulatory aspects, and cost were rated and shown not to be significant discriminators during the evaluation. Mission impacts were identified as the key discriminator.

Alternative D1, Disposal Preparation at LAW Vitrification Facility Gallery/Airlock, was identified to have the greatest impact to the mission. This rating is based on installation of the replacement melter being delayed until the used melter can be removed from the LAW Vitrification Facility.

Alternative D2, Disposal Preparation at the Adjacent Pad/Gallery/Airlock (currently exists), was identified as having the next highest rating regarding mission impacts. This rating is based on the impacts that the preparation activities could have on LAW Vitrification Facility operations in this location.

Alternative D3, Disposal Preparation at a New IDF Pad, was rated as the lowest impact to the mission (the best disposal alternative). This rating is based on minimizing the work undertaken on the melter at the LAW Vitrification Facility and remainder of WTP, thereby allowing the next replacement melter to be installed as soon as possible and minimizing potential interactions between melter removal and ongoing facility operations. A pad is currently planned for the IDF, which could be permitted and designed for LAW melter disposal preparation.
Alternative D4, Disposal Preparation at a New WTP Pad (new facility requiring siting, design, and construction), was rated very closely to Alternative D3. This alternative is rated slightly higher primarily due to a WTP pad not currently being planned, compared with the IDF pad, and potential interactions between melter removal and ongoing WTP operations.

6.2.1 Low-Activity Waste Melter Disposition Alternative Recommendation

Based on the evaluation and rating by the workshop attendees, Alternative D3 (disposal preparation at a new IDF pad) was identified as the recommended used melter preparation for disposal alternative. In addition to the mission impacts discussed in Section 6.2, this alternative was rated the most favorable regarding mission impacts, as there is a pad currently planned at IDF and plans for a facility permit modification. The IDF pad design is yet to be decided, so could feasibly include the melter void-fill and treatment design requirements.

6.2.2 Melter Replacement Implementing Actions

To implement the recommended LAW melter disposition alternative, DOE will need to take several actions. The timing of these actions could impact the ability to implement the alternative. Table 6-4 provides the implementing actions, a brief description of each action, and a need-by timeframe when the action should be completed.

Table 6-4. Low-Activity Waste Melter Disposition Alternatives Implementation Action Summary

<table>
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<tr>
<th>Implementing action</th>
<th>Description</th>
<th>Need-by timeframe</th>
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<tr>
<td>Decision on LAW melter preparation location selection</td>
<td>DOE to document decision selecting location for melter preparation, identify contractor responsible, and authorize them to complete the workscope, including developing design requirements for preparation capability</td>
<td>Early FY 2018, to allow (if selected) for IDF pad permitting and design to accommodate LAW melter preparation activities</td>
</tr>
<tr>
<td>Void-fill criteria study</td>
<td>DOE to identify responsibility to perform a void-fill study that determines what is needed to comply with RCRA landfill requirements (discussed in Section 5.1.2)</td>
<td>Early FY 2018, to allow for study findings to be incorporated into the preparation design</td>
</tr>
<tr>
<td>Void-fill access ports approach</td>
<td>DOE to select contractor to evaluate and design access ports and melter technology for void filling LAW melter</td>
<td>Early FY 2019, to incorporate void-fill criteria study findings and allow for permit modifications prior to first melter changeout</td>
</tr>
<tr>
<td>Permit modifications to incorporate ability to use void-fill access ports</td>
<td>DOE to provide contract direction to modify WTP radioactive air emissions permit and RCRA permit to implement void-fill access port design change</td>
<td>Early FY 2020, to allow for design and testing prior to first planned melter changeout</td>
</tr>
<tr>
<td>Prepare package safety basis (PSSD) for LAW melter</td>
<td>DOE to identify responsibility to prepare LAW melter package safety basis to allow for transport from LAW Vitrification Facility to IDF</td>
<td>FY 2020, prior to LAW melter changeout</td>
</tr>
</tbody>
</table>

DOE = U.S. Department of Energy.  
FY = fiscal year.  
IDF = Integrated Disposal Facility.  
LAW = low-activity waste.  
PSSD = package-specific safety document.  
WTP = Waste Treatment and Immobilization Plant.
7.0 REFERENCES


RPP-RPT-60058, Rev. 0


Selkregg, K., 2017, “TCLP Chrome Leach Test” (email to A. G. Miskho, WRPS, April 4), Monofrax, LLC, Dewittville, New York.


Appendix A

LOW-ACTIVITY WASTE MELTER REPLACEMENT AND DISPOSITION CURRENT STATE MAPPING WORKSHOP RESULTS
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Current state mapping is a method used to document the sequence of activities by which a process is currently conducted. This is a helpful technique that facilitates improvement by making complex concepts understandable and by laying out the path to get from the present to the future.

In December 2016 and January 2017, workshops were held to outline the current state mapping process for low-activity waste (LAW) melter replacement and disposition. Participants of the workshop included subject matter experts from:

- Washington River Protection Solutions, LLC (WRPS) – One System, Engineering, Integration, ESH&Q
- Waste Treatment and Immobilization Plant (WTP) – Commissioning, Engineering, Plant Engineering, Environmental
- CH2M HILL Plateau Remediation Company (CHPRC) Integrated Disposal Facility (IDF)
- Pacific Northwest National Laboratory (PNNL)
- Barnhart Crane & Rigging.

The attendees participating in the workshop sessions are listed on the following pages. Two sessions were held during the workshop to focus on LAW melter replacement and LAW melter disposition. During each session, the functions for each LAW melter element were identified, activities for each function defined, and options for the activities documented. Potential risks and opportunities were also discussed and captured in the workshop results.

The scope of this evaluation is divided into the following activities:

- **LAW melter replacement**
  - Procure components, including the melter shell, melter lid, and refractory
  - Assemble components into a melter ready for installation
  - Transport the assembled melter to the LAW Vitrification Facility
  - Install assembled melter

- **LAW melter disposition**
  - Disconnect used melter
  - Prepare used melter for disposal
  - Transport used melter to disposal location
  - Dispose used melter.

During the current state mapping process, several major gaps were identified. This alternatives analysis focused on these gaps, including:

- Planning for procurement of additional replacement melters
- Assembly of replacement melters
- Transporting assembled melters
- How or where to prepare (void-fill and treat to meet land disposal restrictions) used melters for disposal at IDF.
# Meeting Sign-In Sheet

**Meeting Title:** LAW Melter Replacement and Disposition Alternative Analysis  
**Date/Time:** 12/14/16 8:00 a.m.-12:00 p.m.  
**Location:** POB 3110 / 2407

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Meeting Title: LAW Melter Replacement and Disposition Alternative Analysis

Date/Time: 12/14/16 12:30 p.m.-4:30 p.m.

Location: POB 3110 / 2407

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### Meeting Sign-In Sheet

**Meeting Title:** LAW Melter Replacement and Disposition Alternative Analysis

**Date/Time:** 1/11/2017 7-11 a.m.

**Location:** 1820 Terminal Drive

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<td><a href="mailto:Mikebeasley@bechtel.com">Mikebeasley@bechtel.com</a></td>
</tr>
</tbody>
</table>

A-4
Melter Procurement

- Space Refractory (8) - mtl/m
- Special building - c/w controls & pmts
- Env controls - survey & planning
- Refractory storage - current & future, & service

- Melt/assembly - forward
- Assemblies - materials/misc - common/small proc

- Expiry inspection & handling damage
- Spares (bubblers) - list components

- Logistics
  - Roberts, shipping
  - On-time, or not?

- Resources - in-house

Procurement

- Refractory - K2, E, H (Monofrax) (2 yrs)
- Zirnul backup brick
- Thermocouples - Peterson
  - Exotic metals (NiCr, Pt)
  - (Buddies, or not?)
  - Cooling panels (trailer)
- Electrical bus (are)
- Melt & Pellet (Limited area) material, etc.
  - Fabrication 2004-10, 2010
  - Straight time, 113 for output
  - Design changes - rework design package

FY2017 lessons learned
- Peterson

Procurement

- Assembling chute: 16 ft, 2 yrs to assemble
  - Refractory 1.5 yrs
  - 1 nd 1.5 st, 1.5 yrs
  - Skill training
Melter Assembly

Assembly - Process Flow

Stage Material
Prep Shell
Install Refractory
Install Lids
Install Gas Lid
Fit Check of Components
Install Shell
Discharge Chambers
As-built or Melter
Start for Transport

Assembly

Assembly Time
2-3 yrs

Coil
Crane

Building

Bld
NEW CTR
Melter Installation

Installation

Installation

When is Process Done

- Melter is in Place
- Seismic Pins & Clamps Installed, O&G Jumps & Seal Pieces Installed, Pipe Spouts Connected, Cooling Connections and Electrical Connections Done (Box to Electrodes), Instrumentation Installed, Process Connections Installed, Electrical Checks Completed

Duration

Roughly 2-3 months to 1 year from start to finish

- Winch Into Basin/Final Lift
- Install Electrode Grommets & Electrodes
- Install Session Clamps & Pins
- Install O&G Spout Pieces
- Install Video Spouts
- Install Pressure Connections
- Install Conductivity Reclaim Cables

- Poor Spout has been refurbished
Melter Removal

![Flowchart Image]

### Disconnect / Removal

- **Trigger**: Management decision to remove
- **Done**: Melter at end of rail/ready for transport (disposal)
  - Weld before removing plates/ Bonds
  - Covers
  - Hold seals

### Assumptions:
- Consumables remain in place
- 2 shifts (minimum)
- Vent remains on as long as possible
- 200 separate connections
- Plates to aid in sealing (using Pit, frame, springs)
- Contamination control needed
- Survey before prior to move
- Remove seismic restraints
- Pull out using (opportunity) Pin is available
Melter Transport

Melter Disposition
Appendix B

LOW-ACTIVITY WASTE MELTER REPLACEMENT AND DISPOSITION REQUIREMENTS ANALYSIS
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The requirements presented in this appendix are categorized according to the functional analysis in Section 2.1 of this report. Requirements specific to a function are identified under the section heading corresponding to that function. In addition, there are overarching requirements that apply to providing life-cycle management of low-activity waste (LAW) melters (see Figure 2-1) and therefore apply to all subfunctions, including Provide LAW Melters and Disposition Used LAW Melters and their subfunctions. These overarching requirements are identified below before listing the requirements applicable to the functions.

**Requirement:** The [Waste Treatment and Immobilization Plant] WTP shall be designed to...have a forty (40)-year operating life for the operating facilities (...LAW) exclusive of ancillary facilities (i.e., warehouses, construction support facilities, and administrative offices). [DE-AC27-01RV14136, Design, Construction, and Commissioning of the Hanford Tank Waste Treatment and Immobilization Plant, Modification No. 387, p. C-93]

**Requirement:** Comply with applicable Federal, state, and local requirements, including environmental permits and other regulatory approvals and authorizations. The WTP shall be designed and operated to ensure that exposure to the maximally exposed offsite individual (non-acute) is as low as reasonably achievable but not more than 1.5 mrem per year and hazardous organic emissions are as low as reasonably achievable but not more than 0.375 tons per year from components regulated under 40 CFR 265, “Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities,” Subpart AA, “Air Emission Standards for Process Vents.” [DE-AC27-01RV14136, Modification No. 387, p. C-94]

**Requirement:** Include process and facility design features that will efficiently minimize the use of services and utilities, and the generation of secondary wastes... [DE-AC27-01RV14136, Modification No. 387, p. C-94]

**Requirement:** The waste treatment capacity for each major facility is defined as a product of the facility design capacity (facility nameplate design capacity) multiplied by the integrated facility availability factor. The treatment capacity for LAW Vitrification Facility is 21 MTG per day. [DE-AC27-01RV14136, Modification No. 387, p. C-95 and Table C.7-1.1]

**Requirement:** The minimum integrated facility availability shall be equal to or greater than 70 percent. [DE-AC27-01RV14136, Modification No. 387, p. C-96]

**Requirement:** The minimum [direct-feed low-activity waste] DFLAW integrated facility availability shall be equal to or greater than 70 percent. [DE-AC27-01RV14136, Modification No. 387, p. C-96]

**Requirement:** The LAW Vitrification Facility design shall not preclude the installation of a third melter; melter power and control systems; melter feed; offgas treatment; container handling; heating, ventilation, and air-conditioning; and other system and components not initially installed. [DE-AC27-01RV14136, Modification No. 387, p. C-97]
Requirement: The design life of the melter shell is 5 years. [24590-LAW-3ZD-LMP-00001, Low-Activity Waste Melter Process System Design Description, Table 3-1, p. 18]

Requirement: The LAW melters have an operational lifespan estimated to be 5 years. [24590-LAW-3ZD-LMH-00001, LAW Melter Handling (LMH) System Design Description, p. 4]

Section 2.1.1 Requirements – Provide Replacement Low-Activity Waste Melters

There is one overarching requirement that applies to providing replacement LAW melters and therefore applies to all subfunctions under the function Provide LAW Melters. This overarching requirement is identified below before listing the requirements applicable to the subfunctions.

Requirement: [Bechtel National, Inc.] BNI is directed to proceed with implementation of the current contract baseline option…[U.S. Department of Energy (DOE), Office of River Protection] ORP accepts BNI’s approach [including]…procurement/storage of one unassembled spare melter each for…LAW utilizing existing appropriate storage facilities.” [Williams 2009]

Section 2.1.1.1 Requirements - Procure Replacement Low-Activity Waste Melters

The following are existing requirements considered pertinent to the Procure Replacement LAW Melters function for this alternative analysis.

Requirement: The [WTP] Contractor transitions spare parts to the [WTP] Operating Contractor, as instructed by DOE. [DE-AC27-01RV14136, Modification No. 387, p. C-97] This requirement is interpreted to include one unassembled spare melter.

Requirement: While in storage, melter components cannot be subjected to freezing temperatures. [24590-WTP-RPT-PM-09-001, Melter Assembly Building Alternatives, Rev. 0, p. 6]

Requirement: The melter base shall be placed on a mock-up of the LAW Vitrification Facility rails. [24590-QL-HC4-W000-00011-03-00504, LAW Melter Assembly Procedure, p. 6] It is important that the rail mock-up resembles the facility rails in style, strength, hardness, dimensions, tolerances, and foundation to provide the appropriate support for the assembly.

Requirement: To verify the final fabrications (subassemblies and components) are within the required size and tolerances to permit proper assembly of the LAW melter, the sub-assemblies and components shall be fit-up before shipping the equipment to the assembly site. [24590-QL-HC4-W000-00011-03-00504, p. 9] No melter refractory or gas barrier lid refractory will be in place during the fit-up. Fit-up, at a minimum, shall include the gas barrier lid, the shielded lid, and bubblers within specified fit-up tolerances.

Requirement: Melter storage area environmental requirements: [24590-LAW-3PS-LMP-T0002, Engineering Specification for Site Assembly of LAW Melters, pp 4-5]

- Minimum temperature – 50°F, 72 hours prior to assembly start.
- Maximum temperature – 90°F for preassembly storage.
- Capable of controlling environment to within +5°F of target temperature year-round.
Section 2.1.1.2 Requirements - Assemble Replacement Low-Activity Waste Melters

The following are existing requirements considered pertinent to the Assemble Replacement LAW Melters function for this alternative analysis.

Requirement: Components needed for the next assembly step must be available in laydown adjacent to the melter. [24590-WTP-RPT-PM-09-001, p. 6] There are approximately 47 pallets of fused cast refractory for one LAW melter with approximately 20 percent of the total needed in the assembly area at any time during assembly. The pallet storage area must allow space for handling the pallets. There will also be about 10 pallets for the castable and non-fused cast refractory in the assembly building at any time during assembly. During melter assembly, approximately 180 pallets of ancillary equipment and components for the LAW melter will be moving through the melter assembly area.

Requirement: During melter assembly, the humidity must be controlled at <50 percent. [24590-WTP-RPT-PM-09-001, p. 6]

Requirement: During the months of curing of the castable and fuse cast refractory, the temperature must be held between 70°F and 90°F. [24590-WTP-RPT-PM-09-001, p. 6]

Requirement: Mixing activities for castable and fuse cast items during assembly will require building heating, ventilation, and air-conditioning or respirators. [24590-WTP-RPT-PM-09-001, p. 7]

Requirement: Volatile organic compounds released during “baking” and any heavy metals runoff during assembly also must be controlled. [24590-WTP-RPT-PM-09-001, p. 7]

Requirement: If the assembled melter will be placed in storage, then lid component plugs shall be installed in the melter lid in lieu of lid components and then general configuration assembly shall be completed [24590-QL-HC4-W000-00011-03-00504, pp 25-27]

Requirement: If the assembled melter will be placed in start-up, then lid components (e.g., thermocouples, feed nozzles, bubblers, etc.) shall be installed in the melter lid rather than lid component plugs and then general configuration assembly shall be completed [24590-QL-HC4-W000-00011-03-00504, p. 25-27]

Requirement: Melter assembly and work area environmental requirements:
[24590-LAW-3PS-LMP-T0002, pp 4-5]

- Capable of controlling environment to within +5°F of target temperature year-round. Target temperatures will vary between 60°F and 90°F, depending on the assembly activity being performed. Target temperature tolerance establishes the maximum and minimum allowed temperatures during assembly.

- Maintain relative humidity below 50 percent during assembly and postassembly. Long-term storage (pre-heat-up) requires that the internal humidity not exceed 50 percent and a minimum hourly exchange in total air volume including flow through the discharge chambers. Note that when maintaining a long-term storage controlled environment within the melter plenum, all lid penetrations shall either have the start-up or operation components installed (i.e., bubblers) in the gas barrier lid ports or the storage plugs installed excluding the ports necessary to establish the air flow.
• Provide filtration with an efficiency designation equal to, or better than, Minimum Efficiency Reporting Value 9. Additional engineering controls (e.g., portable exhausters, work area separation, etc.) shall be implemented to control toxic and hazardous airborne particles and vapors associated with: welding Inconel; handling and mixing dry castable refractories; and cutting, shaping, and installing insulating boards, blankets, and cement.

Requirement: Prior to gas barrier lid installation, melter moves using melter wheels and melter rails shall not exceed a lateral acceleration of 0.10 g. [24590-LAW-3PS-LMP-T0002, p 5]

Requirement: After gas barrier lid installation, melter moves using melter wheels and melter rails shall not exceed a lateral acceleration of 0.075 g. [24590-LAW-3PS-LMP-T0002, p 5]

Section 2.1.1.3 Requirements - Store Assembled Replacement Low-Activity Waste Melters

The following are existing requirements considered pertinent to the Store Assembled Replacement LAW Melters function for this alternative analysis.

Requirement: To reduce the risk of refractory shifting/tilting, thermal cycling of the assembled melters needs to be limited, with no more than five total thermal cycles. The melter design requires refractory placement and gap spacing to be accurate, typically to within 1/16 in. Any shifting/tilting of the refractory could result in decreased performance, or even melter failure. [24590-WTP-RPT-PM-09-001, p. 6]

Requirement: If the melter is not in service within 1 year from assembly, it will need either a bake-out (200-400°F) or an inert gas purge to ensure there is not excess moisture build-up. Once the melter is assembled, the refractory will begin to lose strength unless the proper environment conditions are maintained. [24590-WTP-RPT-PM-09-001, p. 6]

Requirement: Temperature must be controlled at >50°F for storage. [24590-WTP-RPT-PM-09-001, p. 6]

Requirement: Volatile organic compounds released during “baking”…must be controlled. [24590-WTP-RPT-PM-09-001, p. 7]

Requirement: Melter storage and work area environmental requirements:
[24590-LAW-3PS-LMP-T0002, pp 4-5]

• Minimum temperature – 60°F post assembly.
• Maximum temperature – 90°F for post assembly.
• Capable of controlling environment to within +5°F of target temperature year-round.
• Maintain relative humidity below 50 percent postassembly. Long-term storage (pre-heat-up) requires that the internal humidity not exceed 50 percent and a minimum hourly exchange in total air volume including flow through the discharge chambers. Note that when maintaining a long-term storage controlled environment within the melter plenum, all lid penetrations shall either have the start-up or operation components installed (i.e., bubblers) in the gas barrier lid ports or the storage plugs installed excluding the ports necessary to establish the air flow.
• Provide filtration with an efficiency designation equal to, or better than, Minimum Efficiency Reporting Value 9.
Section 2.1.1.4 Requirements - Transport Assembled Replacement Low-Activity Waste Melters

The following are existing requirements considered pertinent to the Transport Assembled Replacement LAW Melters function for this alternative analysis.

**Requirement:** The melter design shall accommodate limited transport from an assembly area to its installed location without being damaged. [24590-LAW-3ZD-LMP-00001, p. 30]

The bricks in the melter refractory are very precisely placed. Too much deflection in the melter base or melter shell during transport could cause a shift/tilt in the bricks. In addition, deflections in the melter shell and melter base caused by thermal expansion/contraction or other reason could cause movement of the refractory bricks during normal operation.

Calculation LAW Melter Refractory Allowable Acceleration during Movement Operations (24590-LAW-M2C-LMP-00014, LAW Melter Refractory Allowable Acceleration During Movement Operations) recommends a maximum allowed lateral acceleration value of 0.075 g that the LAW melter main cavity refractory can withstand during melter movement operations without causing tipping or dislocation of the refractory inside the LAW melter. The drive systems of the melter must conform to the recommended maximum allowed acceleration for melter movement with refractory installation complete.

**Requirement:** To reduce the risk of refractory shifting/tilting, thermal cycling of the assembled melters needs to be limited, with no more than five total thermal cycles. The melter design requires refractory placement and gap spacing to be accurate, typically to within 1/16 in. Any shifting/tilting of the refractory could result in decreased performance, or even melter failure. Once the melter is assembled, the refractory will begin to lose strength unless the proper environment conditions are maintained. If the melter is not in service within 1 year from assembly, it will need either a bake-out (200° to 400°F) or an inert gas purge to ensure there is not excess moisture build-up. [24590-WTP-RPT-PM-09-001, p. 6]

**Requirement:** Axle loading of transport vehicle will not exceed American Association of State Highway and Transportation Officials (AASHTO) H-20 axle loading limits. [Derived from requirements developed for HNF-59379, Project L-859 Rebuild 1st Street, Canton Ave. to IDF Entrance]

**Requirement:** Any new roadways required for transport of assembled replacement LAW melters that need to be constructed shall not be less than required for AASHTO H-20 axle loading. [Derived from requirements developed for HNF-59379]

**Requirement:** Permits are required when: a) legal maximum width of a vehicle or load, 8 feet 6 inches, is exceeded; b) legal maximum height of a vehicle or load, 14 feet, is exceeded; c) legal length of a single unit, 40 feet, and overhang, 3 feet in front and 15 feet rear from the center of the last axle, is exceeded;... e) legal weights are exceeded. Legal weights are limited to the lesser of: gross vehicle weight of 105,500 pounds; single axle weight of 20,000 pounds; tandem axle weight of 34,000 pounds; two tire axle weight of 500 pounds per inch width; and, steer axle weight of 600 pounds per inch width. [MSC-PRO-52150, Oversize/Overweight Moves, p. 3]
Section 2.1.1.5 Requirements - Install Assembled Replacement Low-Activity Waste Melters

The following are existing requirements considered pertinent to the Install Assembled Replacement LAW Melters function for this alternative analysis. The LAW melter handling (LMH) system, part of the LAW Vitrification Facility system is being designed and installed to transfer new and failed or spent locally shielded melters and other equipment between the melter assembly pad and the melter gallery.

Requirement: The LMH system transfers new and failed (or spent) locally shielded melter and other equipment between the melter assembly pad and the melter gallery. [24590-LAW-3ZD-LMH-00001, p. 1]

Requirement: The WTP Contractor shall provide transport for new and spent or failed melters between the melter assembly pad and the melter gallery melter operating position. [24590-LAW-3ZD-LMH-00001, p. 18]

Requirement: The LMH system shall have the capability to pull the assembled melter during the import of a melter between the melter assembly pad and the melter gallery. [Paraphrased from 24590-LAW-3ZD-LMH-00001, p. 18]

Requirement: The assembled melter refractory bake-out/dry-out occurs after the LAW Vitrification Facility melter connections (e.g., water, air, instrumentation, jumper connections, and electrical power supply bus connections, offgas piping) and associated systems are installed and operable. [24590-LAW-3PS-LMP-T0002, p. 1]

Section 2.1.2 Requirements - Disposition Used Low-Activity Waste Melters

There are overarching requirements that apply to dispositioning used LAW melters (see Figure 2-1) and therefore apply to all subfunctions under Disposition LAW Melters. The following requirements apply to dispositioning LAW melters and all subfunctions.

Requirement: The LAW melter characteristics without consideration for disposal packaging (e.g., fabrication to seal weld, void fill, etc.) are: [24590-LAW-3ZD-LMP-00001, p. 94; 24590-WTP-ICD-MG-01-003, ICD 03 – Interface Control Document for Radioactive Solid Waste, p. 7; RPP-RPT-58204, Spent/Failed Low-Activity Melter Transport System Evaluation Report, p. 2]

- Height – 190 in.
- Length (long axis) – 367 in.
- Width (short axis) – 262 in. (including discharge chambers).
- Melter weight (empty) – 650,000 lb
- Melter weight (full of glass) – 700,000 lb
- Melter weight (seal welded, void filled and immobilized) – up to 1,000,000 lb
- Overpack – none.
Section 2.1.2.1 Requirements - Remove Used Low-Activity Waste Melters

The following are existing requirements considered pertinent to the Remove Used LAW Melters function for this alternative analysis.

Requirement: The LMH system shall have the capability to pull the spent or failed melter during the export of a melter between the melter gallery and the melter assembly pad. [24590-LAW-3ZD-LMH-00001, p. 18]

Requirement: The LAW melter shall be removable from the LAW Facility upon the end of life or failure. [24590-LAW-3ZD-LMP-00001, p. 75] Under normal operating conditions, the melters are anchored to rails in the LAW Vitrification Facility. When the melter needs to be replaced, the anchors will be removed and the melter will be rolled out of the facility along the rails. The LMH will perform removal and replacement.

Requirement: When the LAW melter has reached the end of its operating life, it is disconnected from all systems and all penetrations on the enclosure are seal welded before it is [to] be moved out of the LAW vitrification facility. Prior to deployment, the locally shielded melter is surveyed and decontaminated as required and is loaded on the [Tank Operations Contractor] TOC melter transport system. [WA 7890008967, “Hanford Facility Dangerous Waste Permit,” Rev. 8C, Waste Treatment & Immobilization Plant Operating Unit Group 10 (OUG-10), p. Appendix 4E.25]

Requirement: Spent [Used] LAW Melters will be disconnected from the offgas system, feed lines, electrical lines, and instrumentation. Open ports will be seal welded. The sealed exterior of the melter will be decontaminated, if needed, prior to removal from the containment building. [WA 7890008967, Rev. 8C, Waste Treatment & Immobilization Plant Operating Unit Group 10 (OUG-10), p. Appendix 4E.25] Containment buildings are units designed and operated in accordance with the requirements of WAC 173-303-695, “Containment Buildings,” which incorporates 40 CFR 264, Subpart DD, “Containment Buildings,” by reference. The LAW Vitrification Facility is described as having six containment buildings. One of these is the LAW locally shielded melter gallery containment building (L-0112). The LAW locally shielded melter gallery containment building does not include the airlock (L-0113) between the locally shielded melter gallery and the exterior melter assembly pad.

Section 2.1.2.2 Requirements - Prepare Used Low-Activity Waste Melters for Disposal

The following are existing requirements considered pertinent to the Prepare Used LAW Melters for Disposal function for this alternative analysis.

Requirement: WTP Contractor shall “package…low-activity waste (LAW) melters to meet specified conditions for receipt by TOC for transportation and disposal by [Plateau Remediation Contractor] PRC” [24590-WTP-ICD-MG-01-003, p. 2]

Requirement: Hazardous debris must be treated prior to land disposal… [40 CFR 268.45, “Treatment Standards for Hazardous Debris”]
**Requirement:** Hazardous debris must be treated for each “contaminant subject to treatment.” Hazardous debris must be treated by either the alternative treatment standards for hazardous debris in Table 1 of 40 CFR 268.45 or the waste-specific treatment standards for the waste contaminating the debris. [40 CFR 268.45] Table 1 in 40 CFR 268.45 identifies alternative treatment standards for hazardous debris categorized as extraction technologies, destruction technologies, and immobilization technologies. Immobilization technologies are identified as macroencapsulation, microencapsulation, and sealing.

**Requirement:** ...[C]ontainers must be either: (a) At least ninety percent full when placed in the land-fill; or (b) Crushed, shredded, or similarly reduced in volume to the maximum practical extent before burial in the landfill. [WAC 173-303-665(12), “Special Requirements for Containers”]

**Requirement:** The following are additional waste acceptance requirements that shall be specified in low-level waste disposal facility waste acceptance requirements: 1.) low-level waste must contribute to and not detract from achieving long-term stability of the facility, minimizing the need for long-term active maintenance, minimizing subsidence, and minimizing contact of water with waste. Void spaces within the waste and, if containers are used, between the waste and its container shall be reduced to the extent practical. 2.) Liquid low-level waste or low-level waste containing free liquid must be converted into a form that contains as little freestanding liquid as is reasonably achievable, but in no case shall the liquid exceed 1 percent of the waste volume when the low-level waste is in a disposal container, or 0.5 percent of the waste volume after it is processed to a stable form. 3.) Low-level waste must not be readily capable of detonation or of explosive decomposition or reaction at anticipated pressures and temperatures, or of explosive reaction with water. Pyrophoric materials contained in waste shall be treated, prepared, and packaged to be nonflammable. 4.) Low-level waste must not contain, or be capable of generating by radiolysis or biodegradation, quantities of toxic gases, vapors, or fumes harmful to the public or workers or disposal facility personnel, or harmful to the long-term structural stability of the disposal site. [DOE M 435.1-1, Radioactive Waste Management Manual, Change 2, Chapter IV, p. IV-3]

**Section 2.1.2.3 Requirements - Transport Used Low-Activity Waste Melters**

The following are existing requirements considered pertinent to the Transport Used LAW Melters function for this alternative analysis.

**Requirement:** Axle loading of transport vehicle will not exceed AASHTO H-20 axle loading limits. [HNF-59379]

**Requirement:** Tank Operations Contractor shall provide “…vehicles to move spent/failed melters on a basis to support WTP Contractor’s production schedule.” [24590-WTP-JCD-MG-01-003, Rev 6, p. 3] The exact location (physical interface) and method that interface owners will use for unloading/loading the LAW melters onto the TOC-provided transporters has not yet been finalized. As the project matures, the TOC, WTP Contractor and the PRC will need to coordinate and ensure that the equipment and procedures used for loading, transport, and unloading of LAW melters to be transferred at each physical interface is consistent and in accordance with the appropriate regulatory requirements.
Requirement: The physical interface point for the melter transport by the TOC will be at the LAW Building (Building 20) Vitrification facility. [24590-WTP-ICD-MG-01-003, p. 4]

Requirement: The transportation requirements for melters will be in accordance with the DOE/RL-2001-36, Hanford Sitewide Transportation Safety Document and its package specific requirements (as yet to be developed for melter transport), DOE O 460.1C, Packaging and Transportation Safety, and applicable requirements from 49 CFR 173, “Transportation – Shippers General Requirements for Shipments and Packagings.” [24590-WTP-ICD-MG-01-003, p. 6]

Requirement: Line Management will ensure a Hanford Oversize/Overweight Permit is obtained when moving oversize/overweight loads on Hanford roadways. [MSC-PRO-TRANS-52150, p. 3]

Requirement: Permits are required when: a) legal maximum width of a vehicle or load, 8 feet 6 inches, is exceeded; b) legal maximum height of a vehicle or load, 14 feet, is exceeded; c) legal length of a single unit, 40 feet, and overhang, 3 feet in front and 15 feet rear from the center of the last axle, is exceeded; d) legal weights are exceeded. Legal weights are limited to the lesser of: gross vehicle weight of 105,500 pounds; single axle weight of 20,000 pounds; tandem axle weight of 50,000 pounds per inch width; and, steer axle weight of 600 pounds per inch width. [MSC-PRO-TRANS-52150, Rev. 0, p. 3]

Section 2.1.2.4 Requirements - Dispose Used Low-Activity Waste Melters

The following are existing requirements considered pertinent to the Dispose Used LAW Melters function for this alternative analysis.

Requirement: Waste packages destined for IDF must meet waste acceptance criteria including specific radionuclide disposal limits, waste form restrictions, and descriptions of acceptable waste packages. [RPP-8402, Waste Acceptance Criteria for the Immobilized Low-Activity Waste Disposal Facility, p. 1-1] Note that used LAW melters currently are not authorized for disposal at IDF.

REFERENCES


HNF-59379, 2015, Project L-859 Rebuild 1st Street, Canton Ave. to IDF Entrance, Rev. 0, Mission Support Alliance, LLC, Richland, Washington.


Appendix C

LOW-ACTIVITY WASTE MELTER REPLACEMENT AND DISPOSITION ASSUMPTIONS
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The assumptions presented in this appendix are tabulated and enumerated according to the functional analysis in Section 2.1 of this report. Assumptions specific to a function are identified under the section heading corresponding to that function. In addition, there are overarching assumptions that apply to providing life-cycle management of low-activity waste (LAW) melters and therefore apply to all subfunctions. Overarching assumptions are presented in Table C-1. Assumptions germane to the function *Provide LAW Melters* and its subfunctions are presented in Table C-2 and categorized according to the function/subfunction to which they apply. Assumptions applicable to *Disposition Used LAW Melters* and their subfunctions are presented and categorized in Table C-3.

### Table C-1. Key Overarching Assumptions Associated with Low-Activity Waste Melter Logistics Alternative Analysis

<table>
<thead>
<tr>
<th>Item</th>
<th>Assumption</th>
<th>Basis description</th>
</tr>
</thead>
<tbody>
<tr>
<td>General 1</td>
<td>An operating contractor will be selected, within 90 days of completing hot commissioning of LAW Vitrification Facility, to operate the LAW Vitrification Facility, portions of the Analytical Laboratory, and balance of facilities necessary to support DFLAW operations. Transition to the operating contractor will not result in any schedule delays or changes to duration for implementing activities identified in this report.</td>
<td>ORP has not indicated how it intends to contract the operation of the LAW Vitrification Facility and associated BOF elements supporting the DFLAW program. Current versions of both the WTP Contract and Tank Operations Contract have language regarding operation of the LBL. Regardless of the decision made, it is expected that efforts will be made by all parties to provide for a smooth transition.</td>
</tr>
<tr>
<td>General 2</td>
<td>For purposes of assessing impacts to availability of the LAW Vitrification Facility, when one of the melters is going through removal and new melter installation, the other melter will continue to operate.</td>
<td>This assumption is consistent with current operations research modeling for calculating LAW Vitrification Facility availability. The operations research model design document (24590-WTP-MDD-PR-01-001,a Table 67) shows that downtime for melter replacement does not impact the other melter.</td>
</tr>
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BOF = balance of facilities.
DFLAW = direct feed low-activity waste.
LAW = low-activity waste.
LBL = Waste Treatment and Immobilization Plant Analytical Laboratory, Balance of Facilities, and LAW Vitrification Facility.

WTP = Waste Treatment and Immobilization Plant.
Table C-2. Key Assumptions Associated with the Function “Provide Low-Activity Waste Melters” (5 pages)

<table>
<thead>
<tr>
<th>Item</th>
<th>Assumption</th>
<th>Basis description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1.1.1 Procure Replacement Low-Activity Waste Melters</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1.1.1.a</td>
<td>The duration for LAW melter procurement is 4 years.</td>
<td>During the December 2016 current state mapping workshop, WTP subject matter experts stated that melter procurement will take 4 years, and no options were identified during the workshop that will shorten that duration. SRS stated that the procurement cycle for DWPF melters was 3-4 years.</td>
</tr>
<tr>
<td>2.1.1.1.b</td>
<td>The duration for refractory procurement is 2 years</td>
<td>During the December 2016 current state mapping workshop, WTP subject matter experts stated that refractory procurement will take 2 years, and no options were identified during the workshop that will shorten that duration. SRS stated that the refractory procurement cycle for the same refractory from the same vendor planned to be used was 2 years.</td>
</tr>
<tr>
<td>2.1.1.1.c</td>
<td>The same vendors (Petersen, Inc. for the melter fabrication, Special Metals Corporation for Inconel® products, and Monofrax LLC for the refractory) will be used in the future and will remain available for the duration of the project. If not, another vendor will be available to supply the melter components.</td>
<td>Enabling assumption allows for continuity of service and supplies.</td>
</tr>
<tr>
<td>2.1.1.2 Procure Replacement Low-Activity Waste Melters</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1.1.2.a</td>
<td>Approximately 5 years are needed to procure, design, build, and startup a new assembly/storage facility adjacent to the LAW Vitrification Facility pad. Approximately 4 years are needed to procure, design, build, and startup a new assembly/storage facility in the 200 Area of the Hanford Site.</td>
<td>The 4-year duration in 200 Area is based on a construction duration of 18 months for a 28,000 ft² storage building described in conceptual design report RPP-RPT-50967 (compared to 18,000 ft² three-bay melter assembly building) and allowing an additional 6 months for installation of cranes and rails. Design estimated at 24 months for a total of 4 years. Construction adjacent to the LAW Vitrification Facility is considered to take 1 year longer due to physical interferences and additional scrutiny.</td>
</tr>
<tr>
<td>2.1.1.2.b</td>
<td>Approximately 2 years are needed to subcontract assembly/storage capabilities offsite.</td>
<td>Engineering estimate based on similar subcontract experience.</td>
</tr>
</tbody>
</table>
### Table C-2. Key Assumptions Associated with the Function “Provide Low-Activity Waste Melters” (5 pages)

<table>
<thead>
<tr>
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</tr>
</thead>
</table>
| 2.1.1.2.c | Assembly duration is approximately 2½ years:  
- 1½ years for installation of refractory in melter body  
- 1 year for installation of refractory in melter lid, concurrently with melter body  
- 1 year to install components | During the December 2016 current state mapping workshop, WTP subject matter experts provided the melter assembly durations. SRS stated that the next replacement melter could be assembled in 18-24 months. |
| 2.1.1.2.d | The facility has sufficient equipment, spare parts, consumable materials, and other material to support melter assembly without requiring procurement of additional equipment, parts, or materials resulting in delays. | Enabling assumption to allow for schedule comparison. |
| 2.1.1.2.e | All facility systems (e.g., power, ventilation, communications, LAW melter handling system, and cranes) will be available on demand and will not shut down or delay the melter assembly. | Enabling assumption to allow for schedule comparison. |
| 2.1.1.2.f | For this evaluation, the melter assembly building adjacent to the LAW Vitrification Facility pad will not be considered a major modification per DOE-STD-1189.<sup>d</sup> | DOE-STD-1189,<sup>d</sup> Appendix F, Example 3, provides an example of a modification with common features to constructing the assembly building, and that example concluded the project did not involve a major modification. One significant uncertainty in this assumption is whether the melter assembly building will involve a hazard not previously evaluated in the documented safety analysis that will require more detailed analysis not available at this time. |

#### 2.1.3 Store Assembled Replacement Low-Activity Waste Melters

<table>
<thead>
<tr>
<th>Item</th>
<th>Assumption</th>
<th>Basis description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1.3.a</td>
<td>If a storage facility is not co-located with the assembly facility, approximately 5 years or 4 years are needed to procure, design, and build a new storage facility adjacent to the LAW Vitrification Facility or at the 200 Area of the Hanford Site, respectively.</td>
<td>Similar storage facility design as the assembly facilities in these locations, requiring similar durations to procure, design, and build.</td>
</tr>
</tbody>
</table>
### Table C-2. Key Assumptions Associated with the Function “Provide Low-Activity Waste Melters” (5 pages)

<table>
<thead>
<tr>
<th>Item</th>
<th>Assumption</th>
<th>Basis description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1.1.3.b</td>
<td>If a storage facility is not co-located with the assembly facility, approximately 2 years are needed to subcontract storage capabilities offsite.</td>
<td>Engineering estimate based on similar subcontract experience.</td>
</tr>
<tr>
<td>2.1.1.4 Transport Assembled Replacement Low-Activity Waste Melters</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1.1.4.a</td>
<td>The assembly location and storage location for replacement LAW melters will have dock access that allow the assembled LAW melter to be transferred to the transport system without having to lift or lower the assembled melter more than a few inches (i.e., can be accommodated with jack slides) without the need for temporary cribbing.</td>
<td>Enabling assumption to meet the acceleration limitation of assembled melter movement.</td>
</tr>
<tr>
<td>2.1.1.4.b</td>
<td>The assembled LAW melter will be moved from the transport system to the south end of the rail system on the LAW Vitrification Facility melter assembly pad.</td>
<td>Enabling assumption that allows for ease of resting the melter on the LAW melter rails.</td>
</tr>
<tr>
<td>2.1.1.4.c</td>
<td>The south end of the melter assembly pad at the LAW Vitrification Facility will have truck access allowing offload of the assembled LAW melter.</td>
<td>The final configuration of the end of the pad has not yet been constructed. This enabling assumption allows for transporter access at the south end of the melter assembly pad.</td>
</tr>
<tr>
<td>2.1.1.5 Install Assembled Replacement Low-Activity Waste Melters</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1.1.5.a</td>
<td>Melter install does not occur until the used melter is removed from the south end of the melter assembly pad and an assembled melter is staged at the south end of the melter assembly pad.</td>
<td>This assumption was established by WTP subject matter experts in support of evaluating the duration and resources required to install a replacement melter and shared at the December 2016 current state mapping workshops (see Appendix A).</td>
</tr>
<tr>
<td>2.1.1.5.b</td>
<td>Melter outage to install an assembled melter is a preplanned activity with preapproved work packages, available and qualified staff, and will have first priority to perform the necessary work. Only minor revisions will be needed in the preapproved work packages to account for unique situations surrounding the melter installation.</td>
<td>Same as above.</td>
</tr>
</tbody>
</table>
Table C-2. Key Assumptions Associated with the Function
“Provide Low-Activity Waste Melters” (5 pages)

<table>
<thead>
<tr>
<th>Item</th>
<th>Assumption</th>
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</tr>
</thead>
<tbody>
<tr>
<td>2.1.1.5.c</td>
<td>Melter outage to install an assembled melter is performed 24 hr/day, 7 days/week.</td>
<td>Same as above.</td>
</tr>
<tr>
<td>2.1.1.5.d</td>
<td>The facility has sufficient equipment, spare parts, consumable materials, and other material to support melter install without requiring procurement of additional equipment, parts, or materials resulting in delays.</td>
<td>Same as above.</td>
</tr>
<tr>
<td>2.1.1.5.e</td>
<td>All facility systems (e.g., power, ventilation, communications, LAW melter handling system, and cranes) will be available on demand and will not shut down or delay the melter installation.</td>
<td>Same as above.</td>
</tr>
<tr>
<td>2.1.1.5.f</td>
<td>A new melter is preassembled in the startup configuration and electrical checks have been performed. This includes installation of north melter pulley blocks and side pull hoist rings.</td>
<td>Same as above.</td>
</tr>
<tr>
<td>2.1.1.5.g</td>
<td>A new pour spout and seal head will be available and will be installed along with the new LAW melter.</td>
<td>Same as above.</td>
</tr>
<tr>
<td>2.1.1.5.h</td>
<td>An assembled replacement LAW melter will be available on demand and will be transported to and staged at the end of the melter assembly pad as needed without delay.</td>
<td>Same as above.</td>
</tr>
<tr>
<td>2.1.1.5.i</td>
<td>Work in the operating melter gallery to install the assembled replacement melter will be within a radiologically contaminated area and will require radiological controls.</td>
<td>Same as above.</td>
</tr>
<tr>
<td>2.1.1.5.j</td>
<td>Support services, including instrument calibrations and checks, waste services, waste packaging, radiological surveys, and radiological decontamination activities, will occur in parallel with removal activities and will not delay removal activities.</td>
<td>Same as above.</td>
</tr>
<tr>
<td>2.1.1.5.k</td>
<td>As-built melter dimensional interface points and tolerances do not impact installation.</td>
<td>Same as above.</td>
</tr>
</tbody>
</table>
Table C-2. Key Assumptions Associated with the Function “Provide Low-Activity Waste Melters” (5 pages)

<table>
<thead>
<tr>
<th>Item</th>
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</tr>
</thead>
<tbody>
<tr>
<td>2.1.1.5.1</td>
<td>Melter outage to install an assembled replacement LAW melter ends after the start of joule heating of the installed melter. Once joule heating of the melter is initiated, the melter is assumed to be turned over to Operations to bring the glass pool up to operating level, tune the melter operations, and start feeding waste to and pouring glass from the melter.</td>
<td>Same as above.</td>
</tr>
</tbody>
</table>

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Table C-3. Key Assumptions Associated with the Function “Disposition Used Low-Activity Waste Melters” (5 pages)

<table>
<thead>
<tr>
<th>Item</th>
<th>Assumption</th>
<th>Basis Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.2.1.1 Remove Used Low-Activity Waste Melters</td>
<td>Melter outage to remove the used melter begins after the feed lines to the melter are flushed and isolated, the offgas lines from the melter are flushed and isolated, and electrical power to the melter electrodes and heaters is shut down.</td>
<td>This assumption was established by WTP subject matter experts in support of evaluating the duration and resources required to install a replacement melter and shared at the December 2016 current state mapping workshops (see Appendix A).</td>
</tr>
<tr>
<td>2.2.1.1.a</td>
<td>Melter outage to remove an assembled melter is a preplanned activity with preapproved work packages, available and qualified staff, and will have first priority to perform the necessary work. Only minor revisions will be needed in the preapproved work packages to account for unique situations surrounding the melter removal.</td>
<td>Same as above.</td>
</tr>
<tr>
<td>2.2.1.1.b</td>
<td>Melter outage to remove a used melter is performed 24 hr/day, 7 days/week.</td>
<td>Same as above.</td>
</tr>
<tr>
<td>2.2.1.1.c</td>
<td>The facility has sufficient equipment, parts, and materials to support melter removal without requiring procurement of additional equipment, parts, or materials resulting in delays.</td>
<td>Same as above.</td>
</tr>
</tbody>
</table>
Table C-3. Key Assumptions Associated with the Function “Disposition Used Low-Activity Waste Melters” (5 pages)

<table>
<thead>
<tr>
<th>Item</th>
<th>Assumption</th>
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</tr>
</thead>
<tbody>
<tr>
<td>2.2.1.1.e</td>
<td>All facility systems (e.g., power, ventilation, communications, LAW melter handling system, and cranes) will be available on demand and will not shut down or delay the melter removal.</td>
<td>Same as above.</td>
</tr>
<tr>
<td>2.2.1.1.f</td>
<td>The transport system to remove the used LAW melter will be available on demand and will transport the used melter to its designated location as needed without delay.</td>
<td>Same as above.</td>
</tr>
<tr>
<td>2.2.1.1.g</td>
<td>Support services, including instrument calibrations and checks, waste services, waste packaging, radiological surveys, and radiological decontamination activities, will occur in parallel with removal activities and will not delay removal activities.</td>
<td>Same as above.</td>
</tr>
<tr>
<td>2.2.1.1.h</td>
<td>The used melter will retain the melt pool without any attempt to drain this material from the melter other than normal airlift capability.</td>
<td>Same as above.</td>
</tr>
<tr>
<td>2.2.1.1.i</td>
<td>Support organizations, including waste services, radiological engineering, health physics, industrial hygiene, industrial safety, and nuclear safety, will be present as necessary and will not delay removal activities.</td>
<td>Same as above.</td>
</tr>
<tr>
<td>2.2.1.1.j</td>
<td>Activities to determine the cause of failure of the melter will not be performed during the time that melter removal is occurring or in any way that interferes with melter removal.</td>
<td>Same as above.</td>
</tr>
<tr>
<td>2.2.1.1.k</td>
<td>Cooling water and offgas are not shut down until melter cooling results in [to be determined] temperatures within the melter.</td>
<td>Same as above.</td>
</tr>
<tr>
<td>2.2.1.1.l</td>
<td>Radiological engineering will need 24 hr to establish a melter baseline and radiological controls prior to beginning melter changeout work.</td>
<td>Same as above.</td>
</tr>
</tbody>
</table>
Table C-3.  Key Assumptions Associated with the Function “Disposition Used Low-Activity Waste Melters” (5 pages)

<table>
<thead>
<tr>
<th>Item</th>
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</tr>
</thead>
<tbody>
<tr>
<td>2.2.1.1.m</td>
<td>No downtime of LAW melter equipment support handling cranes.</td>
<td>Same as above.</td>
</tr>
<tr>
<td>2.2.1.1.n</td>
<td>A hoist and all below-the-hook devices are available to attach to the crane for use during melter changeout activities such as offgas removal. All necessary documentation has already been completed to proceed with installation of the hoist or other below-the-hook devices.</td>
<td>Same as above.</td>
</tr>
<tr>
<td>2.2.1.1.o</td>
<td>Feed and offgas lines (contaminated lines) will be worked on with a single crew in the area of the melter.</td>
<td>Same as above.</td>
</tr>
<tr>
<td>2.2.1.1.p</td>
<td>All consumables (e.g., bubblers) will remain in the melter upon melter failure.</td>
<td>Same as above.</td>
</tr>
<tr>
<td>2.2.1.1.q</td>
<td>The 10-in. primary and standby offgas lines do not require complete replacement. The 10-in. diameter removable spools next to the melter will be removed and replaced only. Replacement spools will be built to the dimensions of the previous spool and will be pressure tested by the vendor. Caps for offgas line stubs on the melter are available for installation.</td>
<td>Same as above.</td>
</tr>
<tr>
<td>2.2.1.1.r</td>
<td>The pour spout and seal head will be replaced.</td>
<td>Same as above.</td>
</tr>
<tr>
<td>2.2.1.1.s</td>
<td>The import/export winch will be assembled and checked for operation prior to use for LAW melter import/export activities.</td>
<td>Same as above.</td>
</tr>
<tr>
<td>2.2.1.1.t</td>
<td>Melter attachment point covers that are provided on the melter when new are available to be placed back on the spent melter after all hoses/spools/cables are disconnected.</td>
<td>Same as above.</td>
</tr>
<tr>
<td>2.2.1.1.u</td>
<td>The used melter will not be void-filled within the associated melter gallery or airlock.</td>
<td>Same as above.</td>
</tr>
<tr>
<td>2.2.1.1.v</td>
<td>The Radiological Control organization will need 48 hr to verify melter is within acceptable limits (including any additional cleanup) after it has been disconnected, but prior to removal from the melter gallery.</td>
<td>Same as above.</td>
</tr>
<tr>
<td>Item</td>
<td>Assumption</td>
<td>Basis Description</td>
</tr>
<tr>
<td>-------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>2.2.1.1.w</td>
<td>The transportation system to move the used melter is available on demand for used melter loading.</td>
<td>Same as above.</td>
</tr>
</tbody>
</table>
| 2.2.1.2.x   | Seal welding closure plates on the melter enclosure will allow management of the used LAW melter as a container. This allows for treatment (i.e., immobilization) of the used LAW melter at the container storage areas permitted for treatment. | Welding closure plates results in the melter being closed. Considering the melter as a container allows for treatment (immobilization technology) to be applied directly to the exterior of the used LAW melters to meet RCRA \[LDR requirements.  
Welding closed the melter is also an important element to the transportation function required to transfer used melters from WTP to the IDF for final disposal.  
Once a LAW melters is considered a container or containment system (i.e., “packaging intended to prevent the leakage of all radioactive material [including gases and liquids] during transport within the leakage rate limits specified in the TSD”), the melter can be transported to the treatment/storage pad or final disposal at IDF. |

**2.2.1.2 Prepare Used Low-Activity Waste Melters for Disposal**

<table>
<thead>
<tr>
<th>Item</th>
<th>Assumption</th>
<th>Basis Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.2.1.2.a</td>
<td>Void filling used melters will require 1 month to complete provided void fill ports are available on the melter.</td>
<td>This assumption is based on consultation with a vendor that has performed void filling at the Hanford Site (ERDF) on large oversized waste streams similar to used melters.</td>
</tr>
</tbody>
</table>
| 2.2.1.2.b   | Expanding foam will be used to meet void fill requirements identified in the IDF RCRA\(^a\) permit and as defined in WAC 173-303-665.\(^b\)                                                               | A variety of materials can be used to meet void fill requirements, and expanding foam was selected without evaluating all its benefits and risks. The void fill material is expected to be selected at some time in the future.  
The selection of polyurethane foam for this study was intended to limit increased weight of used melters after void fill.  
The density of expanding foam is approximately 6 lb/ft\(^3\), compared to cement-based products that are approximately 100-150 lb/ft\(^3\).  
Expanding foam has been used for void-fill of oversized items at ERDF.                                                                 |

\(^a\) RCRA = Resource Conservation and Recovery Act  
\(^b\) WAC = Washington Administrative Code
### Table C-3. Key Assumptions Associated with the Function “Disposition Used Low-Activity Waste Melters” (5 pages)

<table>
<thead>
<tr>
<th>Item</th>
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</tr>
</thead>
<tbody>
<tr>
<td>2.2.1.2.c</td>
<td>Treatment (immobilization technology) of used melters will require 1 month to complete with the use of a polymeric organic or urethane compounds.</td>
<td>This assumption is based on consultation with a vendor that has performed treatment (immobilization) at the Hanford site (ERDF) on large oversized waste streams similar to used melters.</td>
</tr>
</tbody>
</table>

#### 2.2.1.3 Transport Used Low-Activity Waste Melters

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>2.2.1.3.a</td>
<td>The assembled LAW melter will be moved from the transport system to the south end of the rail system on the LAW Vitrification Facility melter assembly pad.</td>
<td>24590-WTP-ICD-MG-01-003c (ICD-03) identifies the physical interface point for the melter transport will occur at the LAW Vitrification Facility. ICD-03 identifies that the WTP contractor: “will provide transport of the melters to the locations on the WTP site (physical interface) where the WTP contractor is required to load the melters onto the TOC provided transporter.”</td>
</tr>
<tr>
<td>2.2.1.3.b</td>
<td>The south end of the melter assembly pad at the LAW Vitrification Facility will have truck access allowing for offload of the assembled LAW melter.</td>
<td>The final configuration of the end of the pad has not yet been constructed. This enabling assumption allows for transporter access at the south end of the melter assembly pad.</td>
</tr>
</tbody>
</table>

#### 2.2.1.4 Dispose Used Low-Activity Waste Melters

<table>
<thead>
<tr>
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<th>Assumption</th>
<th>Basis Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.2.1.4.a</td>
<td>The IDF dangerous waste permit will be in place to allow used LAW melter disposal, and the melter, after being prepared for disposal, will meet the IDF waste acceptance criteria.</td>
<td>The IDF RCRA permit is currently tracked on the DFLAW Integrated Schedule, with Ecology approval in December 2020. This activity will support LAW melter disposal in the IDF. The permit is completed well in advance of expected melter replacement.</td>
</tr>
<tr>
<td>2.2.1.4.b</td>
<td>IDF will be ready to accommodate disposal activities.</td>
<td>The IDF RCRA permit is currently tracked on the DFLAW Integrated Schedule, with Ecology approval in December 2020. This activity will support LAW melter disposal in the IDF. The permit is completed well in advance of expected melter replacement.</td>
</tr>
</tbody>
</table>

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*a Resource Conservation and Recovery Act of 1976, as Amended, 42 USC 6901 et seq.*


*c 24590-WTP-ICD-MG-01-003, 2016, ICD 03 – Interface Control Document for Radioactive Solid Waste, Rev. 6, Bechtel National, Inc., Richland Washington*
Appendix D

LOW-ACTIVITY WASTE MELTER REPLACEMENT EXECUTION APPROACH DEVELOPMENT
The Low-Activity Waste (LAW) Melter Program replacement execution options address the management approach to executing the replacement functions (procure, assemble, store, transport, and install a LAW replacement melter); specifically, how each of the functions will be sequenced to deliver a replacement melter to support the project needs. Taking into consideration the long durations of the replacement functions, proper planning will be critical in delivering a replacement melter.

All execution options are based on the same assumed durations for each function:
- 4 years for melter component procurement
- 2½ years for melter assembly
- 5-year design life for LAW melter

Various approaches to sequencing the replacement functions were developed and evaluated.

1. **Comparison Case, LAW Melter Current Status**

   **Comparison Case, LAW Melter Current Status**: Melters #1 and #2 installed, Melter #3 components in storage. Melter assembly capability and Melter #4 procurement provided after Waste Treatment and Immobilization Plant (WTP) contract award (early fiscal year [FY] 2022). Melter #3 components stored until assembly capability available. Melter #4 assembly overlaps with Melter #3, when space becomes available following completion of refractory installation.

   **Risks:**
   - As shown in the yellow portion of the timeline of the above figure, the changeout of the initial melters #1 and #2 is scheduled beyond the melter design life at 9 years and 11 years of operations, respectively.
• The current contractual 70 percent availability requirement is supported by the WTP operational research model based on a changeout of the first melter 2½ years after hot commissioning, with the second after 5 years. At this point, the second melter will have been operating for 2 years beyond the design life when the cold commissioning period is included after melter heat up but before hot commissioning start. This scenario is not supportable based on the timeline for spare melter procurement and assembly.

• If melters do not operate beyond their design life of 5 years, the impact on melter availability could cause the facility to be unavailable for 5 out of the initial 10 years of operation. This will require a significant level of facility recommissioning under active conditions, followed by restart operational readiness reviews that could result in additional multiple-year delays.

• Melter failures earlier than the 5-year melter design life, as experienced with the first Defense Waste Processing Facility melter at the Savannah River Site, could significantly delay hot commissioning or cause more significant delays to the mission because no spare melter is available.

Benefits:
• Lessons learned from initial melter operations can be incorporated into the design of future melters.
• Costs for melters are deferred.
• Assembly activities are managed to require the need for one assembly facility at a time, and to also maintain a steady load and continuity of the assembly resources.

2. Staggered planned changeout, assembly just in time for changeout:

First changeout scheduled for 5 years, second for 7½ years. Procurement and assembly to be done in time for planned changeout.

• For the initial melter procurement, Melter #3 will be placed into storage until assembly is required for the first planned changeout.

• For each subsequent planned changeout, procurement and assembly will be managed to provide a fully assembled melter in time for installation needs. Assembly will immediately follow procurement.

• To allow for the 2½-year stagger, either Melter #2 changeout will be planned after 2½ years of operation (shortly after the start of hot commissioning), or 2½ years beyond the melter’s design life.
**Risks:**

- For initial operations, there is a risk of no assembled melter being available for 5 years.
- For subsequent melter replacements, there is a risk of no assembled melter available for 3 years.
- To stagger the changeouts, Melter #2 changeout extends 2½ years beyond melter design life.
- No replacement melter available in the event of premature failure during operations.
- Due to changeout durations and the delay in changeout, during direct feed low-activity waste (DFLAW) operations, Melter #1 has a risk of not being available 1 year, Melter #2 has a risk of 3 years.

**Benefits:**

- Allows for lessons learned from melter operations to potentially be incorporated into design sooner
- Reduced storage requirements after first melter
- Assembly requirement delayed
- Costs deferred for subsequent melters and assembly capabilities
- Allows for continuity of assembly requirements.
3. **Staggered planned changeout, initial replacement melter assembled early:**

First changeout scheduled for 5 years, second for 7½ years. Procurement and assembly to be done in time for planned changeout. Melter #3 assembled when received and placed into storage.

- For the initial melter procurement, Melter #3 will be assembled and then placed into storage until required for the first planned changeout. This allows for an assembled replacement melter to be available at the end of 3 years of melter operations.
- For each subsequent planned changeout, procurement and assembly will be managed to provide a fully assembled melter in time for installation needs. Assembly will immediately follow procurement.
- To allow for the 2½-year stagger, either Melter #2 changeout will be planned after 2½ years of operation (shortly after the start of hot commissioning), or 2½ years beyond the melter’s design life.

### Risks:

- For initial operations, there is a risk of no assembled melter being available for 3 years. This is two years earlier than Option #2.
- For subsequent melter replacements, there is a risk of no assembled melter available for 3 years.
- To stagger the changeouts, Melter #2 changeout extends 2½ years beyond melter design life. This increases the risk of not having a melter available for 2½ years during DFLAW operations.
- No replacement melter is available in the event of a premature failure during operations.
• Due to changeout durations and the delay in changeout, during DFLAW operations, Melter #1 has a risk of not being available 1 year, Melter #2 has a risk of 3 years.

Benefits:
• Provides an assembled melter for replacement if needed mid-way through Melter #1 operational life
• Allows for lessons learned from melter operations to potentially be incorporated into design sooner
• Reduced storage requirements after first melter
• Assembly requirement delayed
• Costs deferred for subsequent melters
• Allows for continuity of assembly requirements after initial melter assembly.

4. Staggered planned changeout, initial replacement procurement planned to eliminate storage

First changeout scheduled for 5 years, second for 7½ years. Procurement and assembly to be done in time for planned changeout. Melter #3 procured and delivered in time for the assembly to support schedule needs, eliminating the need for storage.

• For the initial melter procurement, Melter #3 procurement will be extended to the point assembly is required to deliver the assembled melter just in time for changeout. This eliminates the need for storage for Melter #3.
• For each subsequent planned changeout, procurement and assembly will be managed to provide a fully assembled melter in time for installation needs. Assembly will immediately follow procurement.
• To allow for the 2½-year stagger, either Melter #2 changeout will be planned after 2½ years of operation (shortly after the start of hot commissioning), or 2½ years beyond the melter’s design life.
Risks:

- For initial operations, there is a risk of no assembled melter being available for 5 years.
- For subsequent melter replacements, there is a risk of no assembled melter available for 3 years.
- To stagger the changeouts by 2½ years, either one melter’s operational life will be shortened or the other melter’s changeout delayed beyond the 5-year design life.
- Due to changeout durations and the delay in changeout, during DFLAW operations, Melter #1 has a risk of not being available 1 year, Melter #2 has a risk of 3 years.

Benefits:

- Eliminates storage requirements for initial replacement melter
- Allows for lessons learned from melter operations to potentially be incorporated into design sooner
- Assembly requirement delayed
- Costs deferred for subsequent melters
- Allows for continuity of assembly resources.
5. Consecutive changeout, assembly follows procurement just in time for changeout

Melter #1 changeout starting at 5 years, followed by Melter #2 changeout at 5½ years. Assembly immediately follows procurement, just in time for installation.

- For each planned changeout, procurement and assembly will be managed to provide a fully assembled melter ready for installation needs. Assembly will immediately follow procurement. Planned changeouts will be scheduled consecutively; once one melter changeout is complete, the next melter changeout will begin.

- For the initial melter procurement, Melter #3 procurement will be extended to the point assembly is required to deliver the assembled melter just in time for changeout. This eliminates the need for storage for Melter #3.

Risks:

- No replacement melter is available in the event of a premature failure during operations.
- For initial operations, there is a risk of no assembled melter being available for 5 years.
- For subsequent melter replacements, there is a risk of no assembled melter available for 5 years.
- Assembly resource needs are doubled as simultaneous melter assemblies are required.
- No continuity of assembly resources; up to three years between assembly needs.
- Early operational lessons learned cannot be easily incorporated into the design of Melters #3 and #4.
- During DFLAW operations, Melter #1 has a risk of not being available 1 year, Melter #2 has a risk of 1 year, due to changeouts.
Benefits:

- Does not require delaying melter changeout beyond the design life.
- Eliminates storage requirements for initial replacement melter.
- Assembly requirement delayed.

6. Consecutive changeout, assembly planned to allow resource continuity

Melter #1 changeout starting at 5 years, followed by Melter #2 changeout at 5½ years.

Alternating approach to replacement melter assembly to allow for assembly resources continuity. Melter #3 will be assembled and placed into storage until installation need. Melter #4 assembly immediately follows procurement, just in time for installation. Pattern continues for subsequent melters.

- For the initial melter procurement, Melter #3 procurement will be scheduled to allow for completion of assembly prior to Melter #4 assembly needs. Melter #4 is planned for just in time completion of assembly to meet the planned changeout schedule. This approach will continue for all subsequent melter procurement, assembly, and storage.
- For each planned changeout, procurement and assembly will be managed to provide a fully assembled melter ready for installation needs. Assembly will immediately follow procurement.
- To allow for continuity in assembly resources, storage of assembled melters is used to eliminate the assembly overlapping needs. This will require earlier procurement and assembly of every other melter, as shown below. Planned changeouts will be scheduled consecutively; once one melter changeout is complete, the next melter changeout will begin.

Legend
- Operating melter sequence
- Replacement melter preparation process sequence
- Commissioning
- Hot operations
- Changeout
- Replacement
Risks:

- For initial operations, there is a risk of no assembled melter being available for 3 years.
- For subsequent melter replacements, there is a risk of no assembled melter available for 3 years.
- Early operational lessons learned cannot be easily incorporated into the design of Melters #3 and #4.
- During DFLAW, Melter #1 has a risk of not being available 1 year, Melter #2 has a risk of 1 year, due to changeout.

Benefits:

- Provides an assembled melter for replacement if needed mid-way through Melter #1 operational life
- Allows for continuity in assembly resources for all replacement melters
- Does not require delaying melter changeout beyond the design life.

7. Staggered changeouts with replacement melter and components available at all times during operations starting with initial operations

Two melters installed, assembled melter and melter components available prior to melter operations, allows for backup melter at all times. At operations start and for each planned changeout, the next replacement melter (#3) has been assembled and placed into storage, the next melter (#4) components are in storage and will be assembled prior to Melter #3 changeout, and Melter #5 will be procured and components available onsite.

- This option provides for an assembled melter and procured melter components in storage, always available during LAW melter operations. Prior to LAW pre-cold commissioning start, the first replacement melter, Melter #3, will be procured and assembled, and the next melter, Melter #4, will be procured. Both Melter #3 (fully assembled) and Melter #4 (components) will be placed into storage until needed for installation. Prior to installing Melter #3, Melter #4 will be assembled, and Melter #5 will be procured. Both Melters #4 and #5 will be placed into storage. This approach will be taken for all subsequent melters.

- To implement this option, procurement for Melter #3 will be required 6½ years prior to LAW pre-cold commissioning; Melter #4 procurement 4 years prior. This option cannot be implemented due to the schedule needs. Transitioning to this approach may be considered for future melters.
Risks:

- Initial procurement and assembly of Melter #3 and procurement of Melter #4 cannot meet schedule needs.
- Increased cost from storage requirements.
- Cost incurred earlier.
- Early operational lessons learned cannot be easily incorporated into the design of Melters #3 and #4.
- To stagger the changeouts by 2½ years, either one melter’s operational life will be shortened or one melter’s changeout is delayed beyond the 5-year design life.
- During DFLAW operations, Melter #1 has a risk of not being available 1 year, Melter #2 has a risk of 3 years.

Benefits:

- Provides an assembled melter mid-way through Melter #1 operational life.
- Provides an assembled melter for replacement if premature failure occurs.
- Allows for continuity in assembly resources after Melter #3.

8. Staggered changeouts with replacement melter and components available at all times starting with initial changeouts

Two melters installed, assembled melter and melter components available prior to melter changeout, allows for backup melter at all times after initial changeout. At each planned changeout, the next replacement melter (#3) has been assembled and placed into storage; the next melter (#4) will be assembled prior to removal of Melter #3, and Melter #5 will be procured and components available onsite.
• This option provides for an assembled melter and procured melter components available in storage beginning with the first planned changeout. Melter #3 will be procured, assembled, and stored, and the next melter (#4) will be procured and assembled prior to the changeout.

• Both Melter #3 (fully assembled) and Melter #4 (components) will be placed into storage until needed for installation. Prior to installing Melter #3, Melter #4 will be assembled, and Melter #5 will be procured. Both Melters #4 and #5 will be placed into storage. This approach will be taken for all subsequent melters.

Risks:
• To stagger the changeouts, Melter #2 changeout extends 2½ years beyond the melter design life
• During DFLAW operations, Melter #1 has a risk of not being available 1 year, Melter #2 has a risk of 3 years.
• No replacement melter available for initial 3 years.
• Assembly of Melter #3 needs to begin in early FY 2021
• Procurement of Melter #4 needs to begin in early FY 2019
• Increase storage costs
• Costs incurred early
• Early operational lessons learned difficult to incorporate into Melters #3 and #4.
Benefits:

- Provides an assembled melter for replacement if needed mid-way through Melter #1 operational life
- Provides an assembled melter for replacement if a premature failure occurs for either operating melter, independently
- Allows for continuity in assembly resources after the first 5 years of operations.

9. Supporting melters separately, replacement melter and components available at changeouts

Each melter train’s replacement melters are managed separately, with no planned sharing of replacement melters. For each melter train, an assembled melter in storage and components for the next replacement melter will always be available starting with the first changeout.

- This option manages each operating melter separately, not taking into account sharing of replacement melters. An assembled melter and procured melter components are provided for each operating melter.

Risks:

- No replacement melter available for initial 3 years
- During DFLAW operations, Melter #1 has a risk of not being available 1 year, Melter #2 also has a risk of 1 year, due to changeout
- Increase costs from storage and melter procurement
- Melter procurement costs incurred early
• Early operational lessons learned difficult to incorporate.

Benefits:
• Provides an assembled melter for replacement if needed mid-way through Melter #1 operational life
• Provides an assembled melter for replacement if a premature failure occurs for either operating melter, independently
• Allows for continuity in assembly resources after the first 5 years of operations.

10. Operate melters until near failure, procurement initiated with changeout decision

Assembly immediately follows receipt of melter components, enabling an assembled melter to be available in 6½ years. Melter #3 procured and assembled upon receipt, and stored until changeout. Melter #4 procured upon initial operations. Subsequent melters are procured, followed by assembly, based on changeout decision.

• For this option, Melter #3 will be procured, assembled, and stored until the decision is made to replace an operating melter.
• At the start of LAW melter operations (pre-cold commissioning) or a changeout decision, the next replacement melter will be procured.
• Assembly will follow procurement and assembled melters will be placed into storage until needed.

Operate melters until near failure, procurement initiated with changeout decision: Assembly immediately follows receipt of melter components, allows for an assembled melter to be available in 6 ½ years. Approach: Melter #3 procured and assembled upon receipt and stored until changeout. Melter #4 procured upon initial operations. Subsequent melters are procured, followed by assembly, based on changeout decision.

* Dates identified on the EP-LAW Program integrated schedule, dated May 2017
Risks:
  - Risk of no assembled melter being available for 3 years for Melter #1
  - Melters required to extend operations beyond their design life at a minimum of 1 year
  - No continuity of assembly requirements
  - No replacement melter available for 6 years
  - Early operational lessons learned difficult to incorporate into Melters #3 and #4.

Benefits:
  - Costs may be deferred or avoided.
Appendix E

ASSEMBLED LOW-ACTIVITY WASTE MELTER TRANSPORTATION FEASIBILITY STUDY
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Barnhart Crane & Rigging studies the feasibility of hauling low activity waste melters from varying start points to WFP utilizing specialized transport and load handling equipment.

LAW Melter Transport Feasibility Study for New and Used Melters
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1.0 Introduction
Washington River Protection Solutions commissioned Barnhart Crane & Rigging conduct a feasibility study to determine how to transport an assembled Low Activity Waste (LAW) Melter to Hanford Waste Treatment Plant (WTP) LAW without exceeding a required acceleration limit, to transport a used melter from WTP (LAW) to the Integrated Disposal Facility (IDF), and to provide a description of transportation approach alternatives for the potential routes including loading, transport, and off-loading.

Section 2.0 of this document describes the load and transporter and refers to loading and unloading methods from a previous study.

Section 3.0 of this document outlines the physical characteristics of the roads in question and recommends route options given melter assembly locations. All route maps with mileage were drawn at a routing website, https://www.plotaroute.com/routeplanner. All Hanford area map references are from the Hanford Site Atlas (HNF-31002, Rev 2 – December 2011) as the guide for road and building identification. Roadway images are either from those taken during the haul route or screen captures from Google StreetView.

Section 4.0 describes by calculation the transporter’s ability to remain below a lateral acceleration limitation of 0.075g during melter transport.

Section 5.0 provides a conclusion to the study with recommendations.

2.0 Description of Load, Transporter, and Un/Loading Method
2.1 Low Activity Waste Melter Characteristics
Assembled and used melter information is provided below.

- The assembled melter dimensions are:
  - Height – 15.8-ft
  - Length – 21.8-ft
  - Width – 30.5-ft
- The assembled melter weighs approximately 656,700 pounds.
- The melter full of glass will be approximately 698,500 pounds.
- The melter full of glass and filled with a void fill material could be up to 1,100,500 pounds depending on the density of the fill material.

To prevent refractory brick from shifting or toppling inside the assembled melter during transport, a 0.075g acceleration limit has been established. The transporter’s ability to remain within this limitation is discussed in section 4.0. The transport of a used melter does not have the 0.075g acceleration limitation.

2.2 Transporter Characteristics
A previous study for Lucas Engineering identified a 12-axle doublewide Goldhofer PST-e/SL to transport a spent melter weighing an estimated 1,000,000-lbs with no acceleration limitations. While the 12-axle Goldhofer is a viable option for hauling all three melter stages listed above in
terms of capacity, for the purposes of this study Barnhart will use the dimensions and hauling characteristics of a 9-axle doublewide Goldhofer PST to transport an assembled melter. Because of the acceleration limitation placed on an assembled melter, a 9-axle Goldhofer has better leveling characteristics as compared to a 12-axle configuration because of a shorter wheelbase.

The 9-axle Goldhofer trailer has an overall length of 55-ft 10-in and width of 20-ft 8-in. When loaded, the Goldhofer's full width dimension would increase to 28-ft 4-in due to slide beams overhanging the trailer. Lastly, the Goldhofer and melter combined height would be 21-ft 10-in. This height is considered transport height on a flat road with available stroke to raise or lower by a few inches. Concept drawings for the Goldhofer trailer and melter dimensions are located in Appendix A.

A comparison of the 12- and 9-axle transporter configurations can be found in section 4.0.

2.3 Loading and Unloading Methods
Barnhart proposes two loading and unloading methods depending on loading dock elevation. Concept drawings for the two methods are located in Appendix B. When the transporter roadway is approximately 4-ft lower than the loading dock, Method 1 utilizes four 120-Ton (minimum) jacks to raise the melter and lower to slide track to move it laterally.

When the transporter roadway is flush with the loading dock, Method 2 utilizes Barnhart 1,000-Ton Pull-Up GANtries (PUGs) to achieve the necessary height required for the Goldhofer to position under the raised melter and slide track for horizontal movement.

Vertical lifting with jacks or Pull-Up Gantries Melter sliding involves a level track surface and smooth, controlled hydraulic operation. Lifting, lowering and sliding will be monitored with digital levels and accelerometers to insure movement remains within melter acceleration limitations.
3.0 Routes

The sections below describe the routes that WRPS tasked Barnhart to survey. Each route survey assess the conditions that may impact the transportation of a fully assembled melter. The route sections pertain to the physical dimensions of the melter and transporter relative to the obstacles found on the routes.

Throughout this section, obstacles are identified as hindrances to melter movement. Obstacles often include low hanging communication or data wires. Common practice to accommodate frequent movement of oversized loads is to bury these lines in conduit under the road. If less frequent movement is expected and there is enough slack in the lines, they can be raised temporarily. More rigid structures such as overhead pipes and traffic signal mast arms may require permanent modification to accommodate oversized loads.

3.1 North Richland to the LAW Facility

Route 4S (also known as Stevens Drive) provides access to the Hanford plateau from North Richland. At times, the roadway is comprised of three asphalt lanes per direction eventually reducing to two asphalt lanes up to the Wye Barricade – 40-ft and 30-ft of useable roadway, respectively. The road is regularly maintained with no potholes. Major intersections include Smartpark Street, University Drive, Battelle Boulevard, and Horn Rapids Road – all of which incorporate mast arm traffic signals. The mast arms vary in height, the lowest of which occurs at Smartpark street in the right hand lane at 20-ft 8-in. Signal light fixtures would likely need removed from mast arms to ensure their integrity during melter transport.

![](image)

*Image 1 – Smartpark and Route 4S (northward)*

Depending on land use designations, two locations in North Richland along Route 4S may have land available for a melter assembly facility. The first is located east of Route 4S and north of 300 Remediation Access Road; the second is located west of the intersection of Route 4S and Smartpark Street (blue striped areas on maps below).
With Smartpark Street as a starting point, there are two routes which make themselves evident after passing through the Wye Barricade.

Route 4S between North Richland and the Wye Barricade has no road slopes higher than 3% and no superelevations higher than 1%.

Travel through the Wye Barricade for oversize loads is facilitated with a bypass to the east of the security check point. From the Wye Barricade, Route 4S continues to the northwest while Route 2S begins to the north.

The significant terrain feature along Route 4S to the 200 East Area is a 5.7% slope approximately mile 19. The slope includes a 3.6% superelevation as the route turns to the west. The route utilizes the southern WTP entrance.
Route 2S is comprised of two lanes per direction with a gravel median at the elevation of the roadway along much of its length. The significant terrain feature along Route 2S is a 5.7% slope at approximately mile 25. All slopes along Route 2S incorporate superelevations that are less than 1%. Rail crossings occur along the length of the route but do not change the slope of the roadway in any significant way. The road’s edges are occasionally marked with potholes not more than 1.5-ft in diameter and 4-in in depth.

3.2 200 West Area to the LAW Facility

Hanford’s 200 West (200W) area is comprised of four major north-south running roads: Albany, Beloit, Camden, and Dayton; and six major east-west running roads: 10th, 13th, 16th, 19th, 23rd, and 27th. All roads are two lanes (one each direction), although there are sections of roadways that are un-improved gravel or unmaintained asphalt which are outlined below.
3.2.1 North-South Running Roads

Albany Avenue was at one time a maintained asphalt road, but does not appear to be maintained at this time. Its current width narrows to 20-ft at times with no road shoulders. Albany Avenue would require an increase to the travel width of at least 4-ft and confirmation of ground compaction requirements for the transporter. Albany has no significant overhead obstructions. Depending on land use designations, Albany may have land available for construction of a melter assembly facility.

Beloit Avenue is a two lane asphalt road with 24-ft of useable roadway along much of its length. Beloit has many congested intersections and at least 11 low hanging communication and data wires – the lowest of which is an 18-ft high data wire south of the 20th street intersection. The road has no slopes above 1% and no potholes – it appears to be a well maintained road. Depending on land use designations, Beloit may have land available for construction of a melter assembly facility.

Camden Avenue – like Beloit Avenue – is a two lane asphalt road with 24-ft of useable roadway along much of its length. In four separate locations, guy wires and communication lines are elevated to less than 19-ft, notably at the 19th street intersection. In our experience with previous hauls, wires are easier and cheaper to raise/relocate than guy wires. The road has no slopes above 1% and no potholes – it appears to be a well maintained road. Camden does not appear to have any land locations to construct a melter assembly facility.

Dayton Avenue is a two lane asphalt road with 24-ft of useable roadway along much of its length. While Dayton Avenue has no overhead obstructions lower than 22-ft 10-in, there do not appear to be suitable land locations along its length for new building construction. Also, the portion of Dayton Avenue south of 16th street is closed to unauthorized vehicles and appears less maintained than the rest of the roadway. The road has no slopes above 1% and no potholes.
3.2.2 East-West Running Roads

The east-west running roads have similar overhead obstructions as the abovementioned roads with the addition of overhead pipe obstructions. All pipe obstructions are above 22-ft, the lowest is located at Cooper Avenue and 16th street.

An overhead pipe structure on 19th street limits this as a feasible route because, while pipe structures elsewhere exceed 30-ft in width, the 19th street overhead pipe is only 25-ft wide.

A major slope exists along 19th street near the Camden Avenue intersection. The 6% slope is the highest non-superelevated slope measured during the study. The area is highly congested with no useful land available thus, while this slope is significant, the area is not feasible to haul from or through.

3.2.3 Melter Haul Options

Based on the height, width and congestion issues for the 200W area outlined above, possible locations for a melter assembly location from which to haul are the lots in the northeast corner of 200W (blue striped areas below) boxed in north and south by 27th and 23rd streets and east and
west by Albany and T-plant. These areas would facilitate traveling to the LAW facility from 200W via either Route 3 to the east of 200W or Dayton Avenue to the north.

One of three routes from the northeast corner of 200W are feasible: (1) exiting the area north via 27th street to Route 11A to WTP’s south entrance; (2) exiting the area north via 27th street to Route 11A to WTP’s northwest entrance; and (3) exiting the area east via 20th street/Route 3.
Option 1 is a 13 mile route which exits 200W via 27th street through a 29-ft 6-in wide gate then onto Route 11A. The route descends by a 4.9% slope at mile 5 to a four-way intersection and turns south onto Route 4S. A 4.4% uphill slope at mile 6 brings the route back onto the plateau with no other significant slopes or obstructions to the LAW facility.

Option 2 is a 10 mile route which exits 200W via 27th street through a 29-ft 6-in wide gate then onto Route 11A. The route descends by a 4.9% slope at mile 5 and ascends a 3.9% slope at mile 6. The route turns south at Canton Avenue into 200E, ascends a 5% slope at mile 9 and accesses the northwest corner of WTP via GPF Way.
Option 3 is a 7 mile route which exits 200W by Albany Avenue to 20th street/Route 3. The route has no significant slopes or obstructions to the LAW facility.

As a note, from a message dated March 23, 2017 from Todd Synoground’s (VP, Public Works, MSA) titled “Roads Selected for Restricted Access”, Beloit Avenue from T-plant to 27th street will be limited to authorized vehicles only.

From the 200W area, transporting an assembled melter using Option 3 would be the preferred route, given that Albany Avenue can be updated/upgraded.

### 3.3 200 East Area to the LAW Facility

Hanford’s 200 East (200E) area is comprised of three major north-south running roads: Akron, Baltimore, and Canton; and four major east-west running roads: 1st, 4th, 7th, and 12th. All roads are two lanes (one each direction), although there are sections of roadways that are un-improved gravel or unmaintained asphalt which are outlined below.

#### 3.3.1 North-South Running Roads

Akron Avenue has had many road revisions in the last 6 years. It begins in the northwest corner of 200E as a two lane asphalt road with 24-ft of useable roadway, but dissolves into the parking lot for 2704HV and 212H (the “Smurf Building”) just before 7th street. Akron Avenue is re-established at 4th street but just West of its last position from 2011 and is comprised of loose gravel until the road terminates at 1st street. Along Akron Avenue between 12th street and 7th street are two locations where tubing passes under the roadway with unknown ground compaction limitations. The road has no slopes above 1%. Depending on land use designations, Akron may have land available for construction of a melter assembly facility.

Baltimore Avenue is a two lane asphalt road with 24-ft of useable roadway along much of its length. South of 4th street, Baltimore Avenue widens to four lanes with no median for 48-ft of useable roadway width. Baltimore Avenue has six overhead obstructions, the lowest of which is a pipe at 18-ft 10-in located just south of the 7th street intersection. A culvert passes under
Baltimore Avenue between 7th and 4th streets with unknown ground compaction limitations. The road has no slopes above 1% and no potholes – it appears to be a well maintained road. Depending on land use designations, Baltimore Avenue does not appear to have land available for construction of a melter assembly facility.

Canton Avenue is a two lane asphalt road with 24-ft of useable roadway along most of its length. The road begins off of Route 11A, makes a detour around 241-AP tank farm at 4th street and terminates at Route 4S to the south. During the detour, Canton Avenue reduces to approximately 20-ft of useable roadway width and passes through a 22-ft wide gate. North of 4th street, Canton Avenue turns to the east to become GPF Way. A 5% slope occurs just north of Canton becoming GPF Way. The two entrances to WTP from GPF Way in the northwest and south occur off of Canton Avenue. Canton Avenue does not appear to have land available for construction of a melter assembly facility.

3.3.2 East-West Running Roads
200E is bounded to the north by 12th street, a two lane asphalt road with 24-ft of useable roadway along its entire length. The street has one overhead obstruction with a wire at 22-ft at the intersection with Baltimore Avenue. The road has no slopes above 1% and no potholes – it appears to be a well maintained road. Depending on land use designations, 12th street appears to have land available for construction of a melter assembly facility.

Beginning at Route 4S west of 200E, 7th street is a two lane asphalt road with 24-ft of useable roadway along most of its length. However, the road dead-ends into building 212H. It is re-established at Baltimore Avenue and continues east to Buffalo Avenue, a 15-ft wide gravel road. 7th street has three overhead wire obstructions between 20-ft and 24-ft and one guy wire overhead obstruction at 20-ft. The road has no slopes above 1% and no potholes – it appears to be a well maintained road. 7th street does not appear to have land available for construction of a melter assembly facility.

Route 3 – connecting 200W and 200E – becomes 4th street once inside the 200E area. 4th street is a two lane asphalt road with 24-ft of useable roadway along its entire length. Two congested intersections with Baltimore and Canton Avenues have numerous overhead wires at 19-ft and would take significant raising or burying to allow transporter passage.
An overhead pipe crosses 4th street adjacent to building 275EA at a height of 20-ft 5-in.

4th street has no slopes above 1% and no potholes – it appears to be well maintained. The road does not appear to have land available for construction of a melter assembly facility.

200E is bounded to the south by 1st street which extends from Akron to Canton Avenue. 1st street is a gravel road with approximately 20-ft of useable roadway width along much of its length. A short portion of 1st street is asphalt from the gate adjacent to building 2209E to Baltimore Avenue. The road is interrupted by a fence east of Baltimore Avenue which provides the perimeter for the IDF. 1st street provides access to the IDF via Canton Avenue. The road has no slopes above 1%. Depending on land use designations, 1st street appears to have land available for construction of a melter assembly facility.
3.3.3 Melter Haul Options
Based on the height, width and congestion issues for the 200E area outlined above, possible locations for a melter assembly location from which to haul are the lots outlined in the blue striped areas below. The two northern areas are boxed in by 12th street to the north and Akron and Baltimore Avenues to the west, each respectively. The southern area is boxed in north and south by Alameda Ave and 1st Street and east and west by Akron Avenue and Albion Avenue.

From the two northern areas, one route allows access to WTP’s northwest entrance. From the southern area, one option allows access to WTP’s southern entrance.
The 3.75 mile northern route follows 12th street, turns south onto Canton Avenue, ascends a 5% slope at mile 2, and accesses the northwest corner of WTP via GPF Way.

![Map 6 - 200E to LAW Facility, Northern Route](image)

The 2.75 miles southern route follows 1st street until Baltimore Avenue, turns south to access Route 4S, travels east to Canton Avenue, and accesses the southern entrance of WTP via GPF Way.

![Map 7 - 200E to LAW Facility, Southern Route](image)

From the 200E area, transporting an assembled melter using the southern route would be the preferred route.

3.4 Within the WTP
At this time – given the ever-changing facility and road locations at WTP – Barnhart can only give a general description of the WTP area. Melter assembly at WTP would be ideal as the number of obstructions reduces significantly compared to the other areas discussed and WTP’s
roads do not exceed 1% slope. Current roadways are two lanes of asphalt and gravel (in places) with 24-ft of useable roadway width and provide access directly to the LAW facility. Cursory evaluation indicates that existing buildings T-43 and T-47 appear to be suitable locations on the WTP site for melter assembly should they become available in the future. No other analysis can be pursued for WTP as a feasible site until construction activities are complete.

4.0 Transporter Acceleration
Barnhart Engineering was tasked to determine operational controls to keep melter acceleration under 0.075g and determine the maximum slope which the Goldhofer can correct in order to keep the melter level during transport. Barnhart’s detailed transporter slope calculation and operating description can be found in Appendix C.

The Goldhofer PST is a heavy haul self-propelled trailer with hydraulically driven axles powered by an attached motor and hydraulic reservoir – called a powerpack. The trailer can be leveled during travel and speed modulated as required during the haul. The axles are controlled via electronic remote control which allows for a very high degree of maneuverability in terms of turn radius and direction of travel. The PST trailer can – among other maneuvers – drive forward, in reverse, and turn in tight radii. The operator has complete control of the trailer’s every movement from driving to leveling. The operator can control how little or much time to achieve traveling speed, reducing the acceleration experienced by the trailer and its load.

The transport will conform to As Low As Reasonably Achievable (ALARA) practices by establishing and following a written procedure that will incorporate remote operation of the Goldhofer to allow for all personnel to be at a safe distance from the melter, and if adjustments are necessary at the transporter, the crew will limit their time in the transporter’s vicinity.

Barnhart selected a 9-axle doublewide Goldhofer primarily for its ability to adjust its deck for the most severe road grades found along the various routes. A secondary consideration involves axle load limitations for Washington State roadways. While this secondary consideration can be mitigated through superload permitting, Goldhofer axle loading is similar to tractor/trailer axle loads because of the numerous axles found on the Goldhofer to spread the load. The trailer configuration is limited to no fewer than 9-axles due to capacity limitations for fewer axles and deck strength.

To put the 0.075g limitation in perspective, consider a Goldhofer trailer traveling on a level asphalt surface at 3.1mph. Simply allowing the trailer to decelerate under its own rolling resistance induces only 0.02g on the trailer and its load. With this in mind we can better understand the capabilities of the Goldhofer trailer.

4.1 Transporter Operational Controls
The Goldhofer operator will adhere to following operational controls during melter transport:

- Maximum speed limit = 3.1mph
- Time to accelerate to achieve maximum speed ≥ 5 seconds
Time to decelerate to completely stop \( \geq 4 \text{ seconds} \)

It should be noted that transporter acceleration calculations include a safety factor of 2.

With the longest haul route from North Richland at just over 21 miles (via Route 4S) and given a transport speed of 3.1mph, the mathematical haul time calculates to about 7 hours. Considering operator fatigue, refueling stops, and transport slowing for adjustments, a haul would realistically take two 10-hour days with a natural stopping point after day one at the Wye Barricade. Haul duration from any location in the 200 areas to the LAW facility would account for no more than a single 10-hour day.

4.2 Transporter Leveling Capabilities

For both transporter configurations (12-axle and 9-axle), a double wide trailer arrangement can effectively level a load up to a 10\% slope across the width of the trailer.

A 12-axle double wide Goldhofer can provide a level hauling deck from front-to-back on road slopes up to 3.09\% grade. A 9-axle double wide Goldhofer can provide slightly better deck leveling on road slopes up to 4.24\% grade.

<table>
<thead>
<tr>
<th></th>
<th>Max Speed (mph)</th>
<th>Road Slope Limit Across Width</th>
<th>Road Slope Limit Down Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>12-Axle Double Wide Goldhofer</td>
<td>3.1</td>
<td>10%</td>
<td>3.09%</td>
</tr>
<tr>
<td>9-Axle Double Wide Goldhofer</td>
<td>3.1</td>
<td>10%</td>
<td>4.24%</td>
</tr>
</tbody>
</table>

Table 1 - Transporter Operational Capabilities

Barnhart has recently received additional information outlining allowable out-of-level tolerances for an assembled melter. The table below – provided by WRPS – shows allowable percent grades derived from acceleration.

<table>
<thead>
<tr>
<th>Acceleration</th>
<th>Degree</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.000</td>
<td>4.30</td>
<td>7.5%</td>
</tr>
<tr>
<td>0.010</td>
<td>3.73</td>
<td>6.5%</td>
</tr>
<tr>
<td>0.015</td>
<td>3.44</td>
<td>6.0%</td>
</tr>
<tr>
<td>0.020</td>
<td>3.15</td>
<td>5.5%</td>
</tr>
<tr>
<td>0.025</td>
<td>2.87</td>
<td>5.0%</td>
</tr>
<tr>
<td>0.030</td>
<td>2.58</td>
<td>4.5%</td>
</tr>
<tr>
<td>0.035</td>
<td>2.29</td>
<td>4.0%</td>
</tr>
<tr>
<td>0.040</td>
<td>2.01</td>
<td>3.5%</td>
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<tr>
<td>0.045</td>
<td>1.72</td>
<td>3.0%</td>
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<td>0.050</td>
<td>1.43</td>
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<tr>
<td>0.055</td>
<td>1.15</td>
<td>2.0%</td>
</tr>
<tr>
<td>0.060</td>
<td>0.86</td>
<td>1.5%</td>
</tr>
<tr>
<td>0.065</td>
<td>0.57</td>
<td>1.0%</td>
</tr>
<tr>
<td>0.070</td>
<td>0.29</td>
<td>0.5%</td>
</tr>
<tr>
<td>0.075</td>
<td>0.00</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

Table 2 - Grade Derived from Acceleration
From surveys taken during the route analysis, the steepest grade measured was 5.7% (5.5-in over 8-ft). A 9-axle double wide Goldhofer can remain level up to a 4.24% slope. The difference between the worst case grade and Goldhofer leveling capability is 1.46%. Rounding up and entering Table 2 above at 1.5% grade, we find that the allowable acceleration is reduced to 0.06g. This acceleration limitation has taken into account the Goldhofer’s ability to level and would then depend on the Goldhofer’s driving operation to remain under the acceleration limit which we discussed in section 4.1 as achievable.

Operationally, the Goldhofer will outfitted with digital levels to monitor both longitudinal and transverse slopes. Spotters will remain in radio contact with the operator to ensure effective communication concerning the melter’s disposition throughout the haul.

Should more stringent acceleration limitations be placed on the melter to the point that the melter’s loaded slope needed to be “pre-set” at a certain angle, Barnhart proposes shimming one end of the melter with steel plates. Shims would be placed under the slide beams to induce a melter slope angle and restrict the beam’s edge from loading the trailer at that angle. This option was briefly discussed but not investigated in depth.

4.3 Transportation Caveats
Barnhart provides the following list of caveats as unforeseen circumstances that may impact the ability of the Goldhofer configuration to remain within the melter’s acceleration limits. Circumstances include but are not limited to:

- Natural disaster (earthquake, high wind)
- Operator error
- Unintended vehicle impact
- Mechanical failure

5.0 Conclusion with Recommendations
5.1 Melter Internal Bracing Comments
An idea to brace the refractory bricks inside the assembled melter prior to transport has been discussed but was not investigated for this study. While an internally braced melter may be transported more quickly to its destination, the amount of time to brace, haul and remove bracing would be comparable to hauling an unbraced melter under conditions described in section 4.0.

5.2 Transporter Haul Demonstration
Barnhart recommends a haul demonstration along the possible routes outlined in this study. The demonstration should be as realistic as possible to include trailer configuration, travel speed and duration, load weight and dimensions, and means testing of operational limits with accelerometers affixed to the load for verification. Such an event would be instrumental in filling gaps in knowledge and save time and money through lessons learned by the time an actual haul takes place.
Appendix B

Load and Unload Method 1: Jack and Slide (Lucas Engineering Study)
Loading and Unloading Method 2: Pull Up Gantry's (Lucas Engineering Study)
Appendix C
Transporter Acceleration Calculation

Law Melter Transportation Limits Design

Task:
Analyze the accelerations during transport. Determine the required starting/stopping time for the goldhofer such that the overall acceleration/deceleration felt by the melter is 0.075g.

Parameters:
1. Transport speed will be limited to walking speed (approximately 3.1 mph).
2. A safety factor of 2 will be applied to the acceleration/deceleration time.
3. Only 20" of the goldhofer's 23.6" stroke will be considered useable.

Constants:
\[ k := 1000 \text{ lb} \quad \psi := \frac{1}{2} \text{ lb in}^2 \quad \psi_1 := \frac{1}{2} \text{ ksi in}^2 \quad g := \frac{32.2}{3} \text{ ft sec}^2 \quad TN := 2000 \text{ lb} \]
\[ E := 29000 \text{ ksi} \quad N := 2 \]

Determine Allowable Out of Levelness of Haul Path:

\[ \tan \left( \frac{\theta}{d} \right) = \frac{5.68 \text{ deg}}{10 \% \text{ Grade}} \]

Fig. 1 Goldhofer End View

\[ \text{Goldhofer Useable Stroke} \]
\[ \text{Distance Between Outmost Cylinders Across Width of Trailer} \]
\[ \frac{\pi}{d} = 5.68 \text{ deg} \]

12-Line Goldhofer

\[ \tan \left( \frac{\theta}{d_2} \right) = \frac{1.77 \text{ deg}}{3.09\% \text{ Grade}} \]

Fig. 2 Goldhofer Side View

\[ \text{Distance from Axle to Axle Down Length of Goldhofer} \]
\[ \frac{\pi}{d_2} = 1.77 \text{ deg} \]
During Barnhart's route study, the worst longitudinal percent grade observed was 5.7% and the worst transverse percent grade observed was 3.6%. From the findings above, based on using a 8-Line Double Wide Goldhofer, the worst out of level that the Melter would experience is 4.6% in the longitudinal direction and 0% in the transverse direction.

<table>
<thead>
<tr>
<th>Acceleration</th>
<th>Degree</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.000</td>
<td>4.30</td>
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</tr>
<tr>
<td>0.075</td>
<td>0.00</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

Referencing the table above, this out of levelness of the melter will reduce the allowable acceleration/deceleration from the trailer to 0.06g. Below we will determine required start/stop times to achieve this acceleration/deceleration for walking speed.
Determining Time Required During Acceleration/Deceleration:

\[ a := 0.06g = \frac{1.93}{s^2} \text{ Acceptable acceleration/deceleration} \]

\[ v := 3.1 \text{ mph} \text{ Travel Speed} \]

\[ v = 4.55 \frac{m}{s} \]

\[ t := \frac{v}{a} \text{ Required amount of time for acceleration/deceleration} \]

\[ t = 4.71 s \]

For acceleration/deceleration operations, the maximum speed will be limited to 3.1 mph. Operators must accelerate/decelerate such that the time it takes to achieve max speed/complete stop is a minimum of 5 seconds.

***END OF CALCULATION***
Appendix D

Route Maps, Enlarged

North Richland to LAW Facility

Map 8 - Smartpark to LAW Facility, Route 45
200W to LAW Facility

Map 10 - 200W to LAW Facility, Option 1
200E to LAW Facility

Map 13 - 200E to LAW Facility, Northern Route
Appendix F

LOW-ACTIVITY WASTE MELTER REPLACEMENT AND DISPOSITION
LOGISTICS EVALUATION WORKSHOP NOTES
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One System is assisting the U.S. Department of Energy (DOE) in evaluating gaps in low-activity waste (LAW) melter replacement and disposition planning. The scope of this evaluation is divided into the following activities:

- **Replacement**
  - Procure components including the melter shell, melter lid, refractory
  - Assemble components into a melter ready for installation
  - Transport the assembled melter to the LAW Vitrification Facility
  - Install assembled melter

- **Disposition**
  - Disconnect used melter
  - Prepare used melter for disposal
  - Transport used melter to disposal location
  - Dispose used melter.

During the current state mapping process for LAW melter replacement, transport, and disposition, held in December and January 2017, several major gaps were identified. This alternatives analysis focused on these gaps:

- Planning for procurement of additional replacement melters
- Assembly of replacement melters
- Transporting assembled melters
- How or where to prepare (void-fill and treat to meet land disposal restrictions) used melters for disposal at the Integrated Disposal Facility (IDF).

During this workshop, the LAW Melter Logistics Alternatives Analysis team presented the options that have been identified for melter replacement (morning session) and melter disposition (afternoon session). The down-selection process to a set of alternatives was presented to the workshop attendees. During the workshop, each of the alternatives was assessed against the following criteria categories to determine a preferred alternative:

- Safety measures
- Mission impacts
- Regulatory aspects
- Cost
- Transportation risks (replacement melter).

Attendees for each session are listed in Attachment F-1.

**Low-Activity Waste Melter Replacement Session**

During the previous current state mapping process workshops, estimated durations for key activities were identified.

- 5-year LAW melter design lift
- 3-6 years for LAW melter procurement (using 4 years for alternatives analysis)
- 2 years for refractory procurement
- 1½ years to install melter body refractory
- 1 year to install lid refractory
- 1 year to install melter components after refractory installation
• 2½ years for melter assembly if refractory installation can occur simultaneously
• 3 months for melter disconnect and 3 months for melter installation (6 months for melter changeout).

Note that melter assembly capabilities are not currently planned. 24590-WTP-RPT-PM-09-001, Melter Assembly Building Alternatives, assessed specific assembly options focusing on the current contract period and recommended that the operating contractor reevaluate the melter assembly provisions during the operating period.

Low-Activity Waste Melter Replacement Execution Approach

Taking into consideration the durations, options of how to best approach execution of the melter replacement were identified. The approach used was presented during the workshop, starting with the option to take no additional action until the situation requires action, and how this option was improved on.

Ten melter replacement execution approach options were identified and had been evaluated against the following initial criteria.

• Meets facility target availability of 70 percent
• Meets schedule needs/durations
• Availability of replacement melters
• Melter changeout delayed beyond design life
• Melter procurements before operations/early operations
• Ease of implementing lessons learned
• When assembly and storage capabilities are needed.

Two melter replacement execution approach options were previously down-selected: just-in-case with planned changeouts staggered every 2½ years, and just-in-time with planned consecutive changeouts and managed assembly activities to allow for continuity. The second approach, consecutive changeouts, was selected to continue with the alternatives analysis as it provides an approach that does not require delaying melter changeout 2½ years beyond design life.

Low-Activity Waste Melter Replacement Execution Options

Each of the LAW melter replacement activities were then assessed for potential approach options.

Procurement – No options were identified (several potential enhancements may be considered to reduce risk, such as multiple providers for melter body and refractory, long-lead item pre-ordering)

Assembly – Options identified in assembly locations:

• Offsite
• Onsite located near LAW Vitrification Facility
• Onsite located in the WTP or 200 Area

Storage – For the analysis, storage is assumed to be co-located with assembly; no additional options identified.
Replacement melter transportation – Additional consideration for transportation required to meet the 0.075 g acceleration limit.

Washington River Protection Solutions, LLC (WRPS) contracted Barnhart Crane & Rigging, specialists in heavy and complex transport, to evaluate the routes to determine feasibility of transporting a melter to WTP from North Richland and within the 200 Area. The results of this feasibility study are included in Appendix E.

Melter Replacement Alternative Development

Each of the approach options were incorporated into the execution approach, along with estimated planning duration needs. To meet the melter assembly need timeframe, on-site assembly near the LAW Vitrification Facility and in the WTP or 200 Area would need to have begun already.

The execution approach was evaluated for potential changes that enable on-site assembly to be feasible. The assembly of Melter #3 could potentially be delayed to overlap with Melter #4 assembly by approximately 1 year, without requiring the assembly capability to be increased. This approach to assembling the melters will need to be thoroughly planned and managed.

Additional changes to the execution approach are needed to provide planning for assembly onsite. Melter #3 assembly could be planned using a just-in-time approach for the first changeout, which will require Melter #2 to be operated 1½ years beyond the melter design life. The subsequent changeouts will be scheduled 1 year apart instead of consecutively, which provides some flexibility in changeout planning.
Melter Replacement Alternative Evaluation

Each alternative with evaluated and ranked against the criteria as shown in Attachment F-2 and listed below.

- Safety measures
  - Nuclear/radiological safety risk
  - Chemical safety risk
  - Industrial safety risk
  - Safety documentation

- Mission impact
  - Availability
  - Schedule risk/timing of assembly/storage availability
  - Impacts to ongoing operations
  - Resource requirements

- Regulatory aspect
  - NEPA
  - RCRA
  - Air emissions

- Cost
  - Acquisition
  - Operating
  - Life-cycle

- Transportation risk.

The results of the workshop evaluation are provided in Table F-1 and Table F-2.
### Table F-1. Low-Activity Waste Melter Replacement Evaluation Summary

<table>
<thead>
<tr>
<th>Melter replacement comparative criteria</th>
<th>Alternative R1 – Offsite assembly and storage</th>
<th>Alternative R2 – Assembly and storage adjacent to LAW pad</th>
<th>Alternative R3 – Assembly and storage in the 200 Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety measures</td>
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<td>Mission impacts</td>
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<td>• Availability</td>
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</tr>
<tr>
<td>• Schedule/timing</td>
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<td>5</td>
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<tr>
<td>• Ongoing operational impact</td>
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<td>• Resource requirements</td>
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<td>• RCRA</td>
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<td>Life-cycle cost</td>
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<td>TOTAL</td>
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LAW = low-activity waste.  
NEPA = National Environmental Policy Act.  

Offsite assembly was selected as the recommended alternative assuming that transportation is feasible.
**Table F-2. Low-Activity Waste Melter Disposition Evaluation Summary**

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**IDF** = Integrated Disposal Facility.  
**LAW** = low-activity waste.  
**NEPA** = National Environmental Policy Act.  
**WTP** = Waste Treatment and Immobilization Plant.

Alternative D3, Disposal Preparation at new IDF Pad, was selected as the recommended alternative.

**Actions**

Several of the evaluation tables included in the report will be updated to reflect the discussions from the workshop, including risks from being co-located with the LAW Vitrification Facility; discussion in availability moved to timing criteria; and resource requirements to reflect the changes needed to ensure an alternative is feasible (e.g., overlap assembly, delay melter changeout). Other actions include:

- Reconfirm evaluation results when the cost estimates are complete, as the cost estimates were based on preliminary numbers.
- Develop recommended actions and decisions for DOE to implement recommendation, including:
  - Assembly capability approach decision
  - Melter #4 procurement
  - NEPA review if required
  - Siting study for assembly location.
• Incorporate information from transportation feasibility study when available and reconfirm results. If the results indicate that transport is feasible, consider a demonstration with a heavy load and accelerometers to evaluate routes.

• Define and fully understand the implications of having potential shift in refractory during transport. Corrective actions and impacts to the melter operations should be considered.

• Consider the potential for thermocycling during transport of a replacement melter and the measures needed to eliminate risk.

• Consider adding a quantifiable measure to risk, with a suggestion to use glass production cost. There are also impacts to the overall process from waste feed delivery to the LAW pretreatment system (LAWPS) or Pretreatment (PT) Facility to the HLW Vitrification Facility and the LAW Vitrification Facility that could be defined.

• Track the risk of operating a melter longer than design life or having a premature failure, if not currently being tracked.

Ensuring melter operations is key to minimizing the risk to the program. Two key methods to reduce this risk is ensuring that a replacement melter is always available in the event of a premature failure, and extending the life of the melter with confidence in operations.

References

**Attachment F-1: LAW Melter Logistics Alternative Workshop Attendance**

**Meeting Sign-In Sheet**

**Meeting Title:** LAW Melter Replacement and Disposition Alternative Analysis

**Date/Time:** 5/3/2017 8-11a.m.

**Location:** 3110 POB - CR 2407

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<th>Name</th>
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# Meeting Sign-In Sheet

**Meeting Title:** LAW Melter Replacement and Disposition Alternative Analysis

**Date/Time:** 5/3/2017 12:30-3:30 p.m.

**Location:** 3110 POB - CR 2407

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Attachment F-2: LAW Melter Logistics Alternative Workshop Results

Melter Replacement and Transportation Evaluation Results
LAW Melter Disposition Evaluation Results

Regulatory Aspects
- Alternative D1: Evaluation of LAW in existing DAF
  - Cost: $0
  - Acq. Cost: $0
  - Operating Cost: $42,000,000
  - Lifecycle Cost: $42,000,000

- Alternative D2: Evaluation of LAW in new DAF
  - Cost: $3,000,000
  - Acq. Cost: $1,000,000
  - Operating Cost: $42,000,000
  - Lifecycle Cost: $43,000,000

- Alternative D3: Evaluation of LAW in existing DAF
  - Cost: $3,000,000
  - Acq. Cost: $1,000,000
  - Operating Cost: $42,000,000
  - Lifecycle Cost: $43,000,000

- Alternative D4: Evaluation of LAW in new DAF
  - Cost: $3,000,000
  - Acq. Cost: $1,000,000
  - Operating Cost: $42,000,000
  - Lifecycle Cost: $43,000,000