# AR TARGET SHEET

The following document was too large to scan as one unit, therefore, it has been broken down into sections.

EDMC#: 0068138
SECTION: 1 of 2

DOCUMENT #:

TITLE: Ecology review of DBVS

0068138

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
3100 Port of Benton Blvd • Richland, WA 99352 • (509) 372-7950

October 31, 2005

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Mr. Roy J. Schepens, Manager
Office of River Protection
United States Department of Energy
P.O. Box 450, MSIN: H6-60
Richland, Washington 99354-1670

Mr. Edward S. Aromi
President and General Manager
CH2M Hill Hanford Group, Inc.
P.O. Box 1500, MSIN: H6-08
Richland, Washington 99354-1670

Dear Mr. Schepens and Mr. Aromi:

Re: Letter from R. Schepens, Office of River Protection, to M. Wilson, Ecology

- "Final Dangerous and Mixed Waste Research and Development and Demonstration Permit for Demonstration Bulk Vitrification Facility Required Submittal – Review of Secondary Waste System, 05-TPD-050", dated May 13, 2005
- "Review of the Secondary Waste System, 05-ED-057", dated July 20, 2005
- "Agreed to Revisions for Secondary Waste and Waste Dryer System Designs, 05-ED-085," dated October 27, 2005

Ecology has completed review of the Demonstration Bulk Vitrification System (DBVS) engineering design and supporting information for the Secondary Waste System and the accompanying Independent Qualified Registered Professional Engineer certified report. These materials were submitted by the United States Department of Energy, Office of River Protection in accordance with its Dangerous Waste Research, Development, and Demonstration Facility Permit (RD&D) for the DBVS Permit WA 7890008967. Based on the information submitted pursuant to Permit Conditions IV.A.8.b.i. through IV.A.8.b.viii., IV.A.8.c., IV.A.8.e., and IV.A.8.f., Ecology approves construction of the Secondary Waste System. This includes six secondary waste tanks and the associated ancillary equipment subject to the implementation of Enclosure 1 to this letter, Record of Comment Resolution.

This approval does not constitute Ecology approval of information unrelated to the Secondary Waste System.

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A copy of the pages to be inserted into the DBVS Facility Permit, WA 7890008967, including a revised List of Attachments to the Permit and instructions for posting these pages to the permit, are included as Enclosure 2 to this letter. These enclosed pages hereby become official parts of the RD&D Permit for the DBVS Facility and are to be inserted into the Permit.

If you have any questions regarding this action, please call Kathy Conaway at (509) 372-7890 or Suzanne Dahl at (509) 372-7892.

Sincerely,

Michael A. Wilson
Program Manager
Nuclear Waste Program

KAC:pll
Enclosures

cc w/enc: Gil Ramin, USDOE
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Environmental Portal

# POSTING INSTRUCTIONS FOR THE SECONDARY WASTE SYSTEM DESIGN SUBMITTAL

## PERMIT PAGES:

List of Attachments:

Remove pages 9 through 11, LIST OF ATTACHMENTS (revision 0b) and replace with new pages 9 through 11 (revision 0c).

Remove page 22 and replace with new page 22 (revision 0a).

Remove pages 65 through 67a; Revised Tables IV.1., IV.2., and IV.3 (revision 0a), and replace with new pages 65 through 67b (revision 0b).

## PERMIT ATTACHMENTS:

For Permit Attachment AA, Remove the entire Section 2.0, "Facility Description", and replace with new Section 2.0. This revision has "Permit Revision 1" in the top right hand corner.

For Permit Attachment FF, remove entire Section 2.0 and replace with single page that states that the current version of Section 2.0 is located in Permit Attachment AA.

For Permit Attachment JJ, remove Sections 2.3.2, 2.4 and Figure 2-2 and replace with single page that states that the current version of these sections/figure are located in Permit Attachment AA.

For Permit Attachment KK, remove Sections 2.2.1, 2.3.2, 2.3.3, 2.6, Figures 2-2 and 2.6 and replace with single page that states that the current version of these sections/figures are located in Permit Attachment AA

For Permit Attachment FF, remove the entire Section 4.0, "Bulk Vitrification Test and Demonstration Facility" and replace with new Section 4.0. This revision has "Permit Revision 2" in the top right hand corner.

For Permit Attachment JJ, remove Sections 4.2.9, 4.2.10 and 4.2.11 and replace with single page that states that the current version of these sections is located in Permit Attachment FF.

For Permit Attachment KK, remove the entire Section 4.0 and replace with a single page that states the current version of Section 4.0 is located in Permit Attachment FF.

For Permit Attachment LL, remove the entire Section 4.0 and replace with a single page that states the current version of Section 4.0 is located in Permit Attachment FF.

For Permit Attachment FF, remove the entire Appendix B and replace with new Appendix B.

For Permit Attachment JJ, remove Figures B-1 and B-4 and replace with a single page that states the current version of Figures B-1 and B-4 is located in Permit Attachment FF

For Permit Attachment KK, remove Appendix B and replace with a single page that states the current version of Appendix B is located in Permit Attachment FF

For Permit Attachment LL, remove Appendix B and replace with a single page that states the current version of Appendix B is located in Permit Attachment FF

Add the following to the end of Attachment KK:

Document entitled: Appendix 4 Secondary Waste System

**Permit Attachment FF**

**Section 2.0**

The current version of Section 2.0 is located in Permit Attachment AA

## LIST OF ATTACHMENTS

The following listed documents are hereby incorporated, in their entirety, by reference into this Permit. Some of the documents are excerpts from the Permittees' DBVS Facility Research, Development, and Demonstration Dangerous Waste Permit Application dated May 10, 2004 (document #04-TED-036); hereafter called the Permit Application. Ecology has, as deemed necessary, modified specific language in the attachments. These modifications are described in the permit conditions (Parts I through V), and thereby supersede the language of the attachment. These incorporated attachments are enforceable conditions of this Permit, as modified by the specific permit conditions, except for Attachment 1 which is included in this Permit for information purpose only;

| | |
|---|---|
| Attachment AA | Facility Description - Section 2 of the Permit Application |
| Attachment BB | Waste Analysis Plan - Section 6 of the Permit Application; and |
| | Analytical Methods - Appendix D of the Permit Application |
| Attachment CC | Personnel Training - Section 8 of the Permit Application |
| Attachment DD | Contingency Plan - Section 10 of the Permit Application; and |
| | Hanford Test and Demonstration Facility Contingency Plan - Appendix C of the Permit Application |
| Attachment EE | Closure Plan - Section 11 of the Permit Application |
| Attachment FF | Emergency Preparedness and Prevention – Following Sections of the Permit Application: |

| | |
|---|---|
| Section 2 | Facility Description |
| Section 4 | Bulk Vitrification Test and Demonstration Facility |
| Section 5 | Operations Plan |
| Appendix B | Process Flow Diagrams |
| Appendix F | ICV® Container Refractory Information |

| | |
|---|---|
| Attachment GG | Recordkeeping and Reporting - Section 9 of the Permit Application |
| Attachment HH | RESERVED |
| Attachment II | Inspection Plan - Section 7 of the Permit Application |
| Attachment JJ | Container Management – Following Sections and Figures of the Permit Application: |

| | |
|---|---|
| Section 2.3.2 | Waste Retrieval and Storage |
| Section 2.4 | Treated Waste Packaging |
| Section 4.2.9 | Vitrification Container Preparation |
| Section 4.2.10 | In-Container Vitrification |
| Section 4.2.11 | Post-Vitrification Activities |
| Section 7.2.4 | Weekly Inspections |
| Section 7.4 | Corrective Action |
| Figure 2-2 | Test and Demonstration Facility Site and Equipment Layout – Page 1 |
| Figure 7-1 | Typical Inspection Checklist for Waste Storage Area |
| Figure B-1 | Phase 1 Process Flow Diagram – Page 1 |
| Figure B-4 | Phase 2 Process Flow Diagram – Page 1 |
| Appendix F | ICV® Container Refractory Information |
| Appendix 1 | Container Foundations |
| Appendix 2 | Waste Receipt System – Reserved |
| Appendix 3 | Waste Dryer System – Reserved |
| Appendix 4 | Secondary Waste System - Reserved |

Attachment KK Tank Management – Following Sections, Figures, and Appendices of the Permit Application:

| | |
|---|---|
| Section 2.2.1 | Bulk Vitrification System Components |
| Section 2.3.2 | Waste Retrieval and Storage |
| Section 2.3.3 | Waste Transfer |
| Section 2.6 | Secondary Wastes |
| Section 4 | Bulk Vitrification Test and Demonstration Facility |
| Section 7.2.3 | Daily Inspections |
| Section 7.4 | Corrective Action |
| Section 7.5 | Recordkeeping |
| Figure 2-2 | Test and Demonstration Facility Site and Equipment Layout – Page 1 |
| Figure 2-4 | Waste Retrieval System for Phase 1 and Phase 2 |
| Figure 7-2 | Typical Inspection Checklist for Waste Tank Storage Area |
| Appendix B | Process Flow Diagrams |
| Appendix F | ICV® Container Refractory Information |
| Appendix 1 | Tank Foundations |
| Appendix 2 | Waste Receipt System |
| Appendix 3 | Waste Dryer System – Reserved |
| Appendix 4 | Secondary Waste System |

Attachment LL Demonstration Bulk Vitrification System - Following Sections and Appendices of the Permit Application:

| | |
|---|---|
| Section 4 | Bulk Vitrification Test and Demonstration Facility |

| | | |
|---|---|---|
| | Section 5 | Operations Plan |
| | Appendix A | Draft Test Matrix and Objectives |
| | Appendix B | Process Flow Diagrams |
| | Appendix E | Emergency Condition Parameter Limit Values |
| | Appendix F | ICV® Container Refractory Information |
| | Appendix 1 | DBVS Foundations |
| | Appendix 2 | Waste Receipt System- Reserved |
| | Appendix 3 | Waste Dryer System - Reserved |
| | Appendix 4 | Secondary Waste System - Reserved |
| Attachment 1 | Section 1.0 | Introduction |
| | Section 1.1 | Regulatory Basis |
| | Section 1.2 | Facility Owner and Operator Information |
| | Section 1.3 | Background Information |
| | Section 1.4 | Purpose of Test and Demonstration Project |
| | Section 1.5 | Project Objectives |
| | Section 1.6 | Justification for Project |
| | Section 1.7 | Planned Scale of Operation |
| | Section 1.8 | Other Facility Permits |

**TABLE IV.1.**

**DEMONSTRATION BULK VITRIFICATION SYSTEM (DBVS) FACILITY TANK SYSTEMS DESCRIPTION**

| Dangerous and/or Mixed Waste Tank Systems Name | System Designation and Equipment Number | Engineering Description (Drawing No., Specification No., etc.)[b] | Narrative Description, Table & Figures | Maximum Capacity (gallons) |
|---|---|---|---|---|
| Waste and Simulant Staging Tank | WRS-Tanks RESERVED | RESERVED | Sections 2.3.2 and 4.2.3; Table 2-1; Figures 2-3, 2-4, and Figure B-7 | 1,000 |
| Waste and Simulant Staging Tanks | DBVS-Tanks | Permit Attachment KK, Appendix 2, Section 2, Drawing #s: DBVS-SK-M105 and F-145579-00-P-0005, Section 5, Specification #: F-145579-D-SP-028. | Sections 2.3.2 and 4.2.2.2; Table 2-1; Figures 2-2 and B-1 | |
| #1 | 32-D74-002 | | | 18,000 |
| #2 | 32-D74-003 | | | 18,000 |
| #3 | 32-D74-016 | | | 18,000 |
| #4 | RESERVED | | | 18,000 |
| Receiver Tank From Bottom of Dryer | DBVS-Tanks | RESERVED | RESERVED | RESERVED |
| Dry Waste Silos (Hoppers) | DBVS-Tanks | RESERVED | Sections 2.3.3 and 4.2.8 and Figure B-1 | |
| #1 | 34-D002-007 | | | 140 cubic feet |
| #2 | 34-D002-008 | | | 140 cubic feet |

| Dangerous and/or Mixed Waste Tank Systems Name | System Designation and Equipment Number | Engineering Description (Drawing No., Specification No., etc.)[b] | Narrative Description, Table & Figures | Maximum Capacity (gallons) |
|---|---|---|---|---|
| Dryer Condensate Tanks | DBVS-Tanks<br>37-D74-009<br>37-D74-010 | ~~RESERVED~~<br>Permit Attachment KK, Appendix 4, Section 3, Drawing F-145579-37-A-0101; Section 5, Specification 145570-D-SP-031 | Sections 2.6 and 4.3.2; Table 4-5; Figures 2-2, B-1, and B-4 | Dryer Condensate:<br>18,000<br>18,000 |
| Dryer Offgas Condensate Tank | DBVS-Tanks<br>33-D74-015 | RESERVED | Figure B-1 and B-4 | 500 |
| Venturi Scrubber System (VSS)<br>#1<br>#2 | DBVS Tank<br>36-D74-052<br>36-D74-054 | RESERVED | Sections 2 and 4; Figures B-2 and B-5 | <br>690<br>690 |
| Venturi Scrubber System (VSS) Bleed Tanks<br>#1<br>#2 | DBVS -Tanks<br>37-D74-011<br>37-D74-012 | ~~RESERVED~~<br>Permit Attachment KK, Appendix 4, Section 3, Drawing F-145579-37-A-0101; Section 5, Specification 145570-D-SP-031 | Section 4.2.15; Figures 2-2, B-2, and B-5 | <br>18,000<br>18,000 |

| | | | | |
|---|---|---|---|---|
| Tri-Mer Effluent<br>#1<br><br>#2<br><br>#3<br><br>#4<br><br>#5<br><br>#6 | DBVS –Tanks<br>37-D74-013<br><br>37-D74-014<br><br>RESERVED<br><br>RESERVED<br><br>RESERVED<br><br>RESERVED | ~~RESERVED~~<br>Permit Attachment KK, Appendix 4, Section 3, Drawing F-145579-37-A-0101; Section 5, Specification 145570-D-SP-031 | Sections 2.6 and 4.2.15; Figures 2-2, B-3, and B-6 | 18,000<br><br>18,000<br><br>18,000<br><br>18,000<br><br>18,000<br><br>18,000 |
| NH3 Scrubber Effluent/Bleed Tank | DBVS-Tank RESERVED | RESERVED | Figure B-3 | 2,000 |
| Tri-Mer Bleed Sump Tank | RESERVED | RESERVED | RESERVED | RESERVED |

**TABLE IV.2.**

**DEMONSTRATION BULK VITRIFICATION SYSTEM (DBVS) FACILITY TANK SYSTEMS SECONDARY CONTAINMENT SYSTEMS INCLUDING SUMPS AND FLOOR DRAINS**

| Sump/Floor Drain I.D. No. & Room Location | Maximum Sump Capacity (gallons) | Sump Dimensions (feet) & Materials of Construction | Engineering Description (Drawing No., Specification No., etc.) |
|---|---|---|---|
| WRS Pump Skid, Sample Room | RESERVED | RESERVED | Permit Attachment KK, Appendix 2, Section 2, Drawing # DBVS-SK-M101. Section 5, Specification 145579-D-SP-027 |
| Pump Skid, Equipment Room | RESERVED | RESERVED | Permit Attachment KK, Appendix 2, Section 2, Drawing # DBVS-SK-M101, Section 5, Specification 145579-D-SP-027 |
| Waste Receipt Tanks: 32-D74-002 32-D74-003 32-D740016 | RESERVED | RESERVED | Permit Attachment KK, Appendix 2, Section 2, Drawing # DVBS-SK-M105, Section 5, Specification: 145579-D-SP- |

| | | | |
|---|---|---|---|
| | | | 028 |
| Secondary Waste System Pump Skid | RESERVED | RESERVED | Permit Attachment KK, Appendix 4, Section 3, Drawing F-145579-37-A-0100, Section 5, Specification 145579-D-SP-011 |
| Secondary Waste Tanks Dryer Condensate 37-D74-009 37-D74-010 Venturi Scrubber Bleed 37-D74-011 37-D74-012 Tri-Mer 37-D74-013 37-D74-014 | RESERVED<br>RESERVED<br>RESERVED<br>RESERVED | RESERVED<br>RESERVED<br>RESERVED<br>RESERVED | Permit Attachment KK, Appendix 4, Section 3, Drawing F-145579-37-A-0101; Section 5, Specification 145570-D-SP-031 |

## TABLE IV.3.

## DEMONSTRATION BULK VITRIFICATION SYSTEM (DBVS) FACILITY TANK SYSTEMS PROCESS AND LEAK DETECTION SYSTEM INSTRUMENTS AND PARAMETERS

| Sub-system Locator and Name (including P&ID) | Control Parameter | Type of Measuring or Leak Detection Instrument | Location of Measuring Instrument (Tag No.) | Instrument Range | Failure State | Expected Range | Instrument Accuracy | Instrument Calibration Method No. and Range |
|---|---|---|---|---|---|---|---|---|
| Pump Skid Equipment Room Sump Level Indication F-145579-32-A-0100 | Level | TT-Mini-Probe | 32-LSH-011 | RESERVED | RESERVED | RESERVED | RESERVED | RESERVED |
| Pump Skid Sample Room Sump Level Indication F-145579-32-A-0100 | Level | TT-Mini-Probe | 32-LSH-032 | RESERVED | RESERVED | RESERVED | RESERVED | RESERVED |
| Waste Receipt Tanks: 32-D74-002 32-D74-003 32-D74-016 F-145579-32-A-0101 | Level | TT-Mini-Probe | 32-LSH-103<br>32-LSH-203<br>32-LSH-303 | RESERVED<br>RESERVED<br>RESERVED | RESERVED<br>RESERVED<br>RESERVED | RESERVED<br>RESERVED<br>RESERVED | RESERVED<br>RESERVED<br>RESERVED | RESERVED<br>RESERVED<br>RESERVED |
| Secondary Waste Pump Skid | Level | TT-Mini-Probe | 37-LSH-007 | RESERVED | RESERVED | RESERVED | RESERVED | RESERVED |
| Secondary Waste Tanks Dryer Condensate 37-D740009 37-D74-010 Venturi Scrubber Bleed 37-D74-011 37-D74-012 Tri-Mer 37-D74-013 37-D74-014 | Level | TT-Mini-Probe | 37-LSH-103<br>37-LSH-203 | RESERVED<br>RESERVED | RESERVED<br>RESERVED | RESERVED<br>RESERVED | RESERVED<br>RESERVED | RESERVED<br>RESERVED |
| | Level | TT-Mini-Probe | 37-LSH-303<br>37-LSH-403 | RESERVED<br>RESERVED | RESERVED<br>RESERVED | RESERVED<br>RESERVED | RESERVED<br>RESERVED | RESERVED<br>RESERVED |
| | Level | TT-Mini-Probe | 37-LSH-503<br>37-LSH-603 | RESERVED<br>RESERVED | RESERVED<br>RESERVED | RESERVED<br>RESERVED | RESERVED<br>RESERVED | RESERVED<br>RESERVED |

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# 2.0 FACILITY DESCRIPTION

## 2.1 FACILITY SITING

The planned site location for the Test and Demonstration Facility is shown in Figure 2-1. The site is located immediately west of the 241-S Tank Farm in the 200 West Area of the Hanford Site. The wastes planned for treatment are currently stored in Tank 241-S-109; a 2,839,050-L (750,000-gal) SST located in the 200 West Area. The waste from Tank 241-S-109 will be transferred to a waste staging tank and/or waste receipt tank(s) at the planned Test and Demonstration Facility location after pretreatment.

The site is west of the existing 241-S Tank Farm fence in an already disturbed area and will support process and ancillary equipment for the DBVS. The proposed location allows close access to existing electrical and raw water utilities, telephone, and Hanford local area network services. Surface materials consist of soft sand and soil that are free from surface contamination. The site is sufficiently level to provide for equipment placement with minimum grading or excavation. Cooper Avenue, running north-south on the west side of the 241-S Tank Farm, provides ingress and egress to the area.

## 2.2 PHYSICAL PLANT

The Test and Demonstration Facility (Figures 2-2 and 2-3) will make use of existing infrastructure to the maximum extent possible. Because of the unit-specific installation, operational, and closure needs of the DBVS, some infrastructure elements may be modified, augmented, or added. Potential infrastructure elements include:

- Utilities (water, electric power, sewer, steam)
- Communications (telephone and computer)
- Roadways
- Radioactive material containment
- Hazardous material containment
- Secondary waste storage/transfer systems
- Treated waste storage/transfer systems.

Facility security provisions and signage will comply with applicable portions of WAC 173-303-310.

### 2.2.1 Bulk Vitrification System Components

The DBVS consists of trailer-mounted and skid-mounted equipment suitable for field installation, operation, and removal at the completion of the project. The system includes the major components, systems, and areas listed below, which are described in detail in Section 4.0.

The general arrangement of the following components for Phase 1 and for Phase 2 (Figures 2-2 and 2-3) includes:

- Waste retrieval system
- Waste staging tank and pumps
- Waste receipt tanks and pumps
- Process additive storage/handling
- Waste feed preparation (mixer/dryer)
- Vitrification container preparation system
- In-container vitrification (ICV®) system
- Electrical equipment
- Offgas treatment system
- Control and data acquisition system
- ILAW storage
- Secondary waste storage and handling (containers or tanks).

### 2.2.2 Support Systems

Support systems are systems that are required to operate the DBVS, but are not directly involved with the process. The support systems consist of:

- Control station
- Personnel contamination control and survey station
- Personnel rest areas (e.g., lunch room and restrooms)
- Change room
- Safety showers and eye wash stations
- Backup generator.

## 2.3 WASTE CHARACTERISTICS, RETRIEVAL/STORAGE, AND TRANSFER

### 2.3.1 Waste Characteristics

The waste in Tank 241-S-109 is stratified. In the bottom of the tank is a layer of sludge. On top of the sludge is a mixed saltcake solid and liquid layer and the top layer is drained saltcake. The salt cake waste is the source waste material for the Test and Demonstration Facility. Some characterization of the waste in Tank 241-S-109 was previously conducted. Characterization results represent the Best Basis Inventory (BBI) for the liquid and saltcake fraction of the tank waste. A detailed discussion of the waste characteristics is located in Section 6.2.

### 2.3.2 Waste Retrieval and Storage

The retrieval detail for Tank 241-S-109 is presented in RPP-18812, *Tank S-109 Partial Retrieval Functions and Requirements*, and has been submitted to Ecology for approval of the retrieval process.

There will be a difference in the retrieval of waste from Tank 241-S-109 and its transfer to the DBVS between Phases 1 and 2 of the program. During Phase 1, waste from Tank S-109 will be routed through a solids/liquid hydroclone separator and sensing instruments to a staging tank that will hold 3,780 L (1,000 gal) of material (Figure 2-4). The sensing instruments will provide process control or waste characterization information. Staging tank discharge will be pumped to either a DBVS waste receipt tank or, if not suitable for processing in the DBVS, to the DST system.

During Phase 2 the waste will be transferred directly to the waste receipt tanks. The transfer route will go through the solids/liquid hydroclone separator and sensing instrumentation, but bypass the 3,780 L (1,000 gal) waste staging tank (Figure 2-4).

The Test and Demonstration Facility will accept tank waste into waste receipt tanks with capacities shown in Table 2-1.

**Table 2-1. Waste Receipt Tank Capacity**

| Phase | Number of Tanks | Capacity | Total Capacity |
|---|---|---|---|
| 1 | 1 | 3,780 L (1,000 gal) | 3,780 L (1,000 gal) |
| 2 | 4 | 68,140 L (18,000 gal) | 272,160 L (72,000 gal) |

All waste storage tanks and containers including the waste staging tank and waste receipt tanks will be properly and legibly marked in accordance with the requirements of WAC 173-303-395(6). Containers will be managed in accordance with the requirements of WAC 173-303-630. All waste tank systems will comply with the design, installation, and operating requirements of WAC 173-303-640, as applicable. Tank system materials of construction will be selected with appropriate consideration for the corrosion potential of the materials stored and process conditions.

Secondary containment will be provided for all tanks in the form of double-walled tankage or containment structures with sumps. Containment provisions will be designed and constructed for compliance with WAC 173-303-640(4).

During Phase 1, the waste staging tank and waste receipt tank will be double shell tanks or placed in containment structures with sumps (Figures 2-2 and 2-3). For Phase 2, the waste staging tank will be bypassed but will either remain in its structure or be removed and decontaminated in compliance with the Test and Demonstration Facility closure plan (Section 11.0).

### 2.3.3 Waste Transfer

Waste transfer will be in the form of waterborne salt solution. Waste left in a waste receipt tank at the end of a campaign may be transferred to another tank and mixed with incoming waste for processing. A waste transfer line water flush may be made after each batch transfer of waste feed, as needed. Waste transfer will occur only after verification that all systems are ready for the transfer/receipt of waste. The vitrification station will be located beneath the dried waste hoppers for gravity feed of waste to the container. The mixer/dryer, vitrification, cooldown, and topoff/survey stations will be provided with radiation shielding and spill containment curbs.

Secondary containment will be provided for liquid waste transfer operations in the form of hose-in-hose or pipe-in-pipe transfer lines. Dried waste transfer from the mixer/dryer to the hopper will have secondary containment. Dried waste transfer from the hopper to the container will be conducted inside a removable hood sealed to the container top. Cleanup of spills within the hood will be performed using a containment system.

## 2.4 TREATED WASTE PACKAGING

Containers of treated waste resulting from the bulk vitrification process will be placed in a dedicated temporary storage area at the Test and Demonstration Facility site (Figure 2-2) during the RD&D permit duration. By generating immobilized treated waste directly in the container, the treatment container also serves as the final disposal container. The storage area will be designed to hold all containers of treated waste generated during the project. The storage area will meet the provisions of WAC 173-303-630(7)(c)(i) and (ii) which are applicable for storage areas that store containers holding only wastes that do not contain free liquids (i.e., the bulk vitrification waste containers):

*(i) The storage area is sloped or otherwise designed and operated to drain and remove liquid resulting from precipitation; or*

*(ii) The containers are elevated or are otherwise protected from contact with accumulated liquids.*

All containers, handling procedures, and handling equipment will meet the waste acceptance criteria of the accepting disposal facility. Final disposal of treated waste will be at a permitted Hanford Site facility.

## 2.5 NON-REGULATED MATERIALS/SYSTEMS

Information provided in the following sections is general in nature and represents the minimum considerations for handling of non-regulated materials. Management of specific materials related to DBVS operation is discussed in Section 4.0.

### 2.5.1 Potable Water

Water for process use will be transported by tanker truck to the Test and Demonstration Facility. The water source will provide settled river water or potable water. Backflow prevention will be provided to prevent the backflow of potable water to the tanker truck by utilizing an air gap as

the backflow mechanism, or other approved backflow prevention device, as applicable. Backflow prevention devices will be Washington State-certified models accessible for inspection by a water purveyor in a non-radiological zone.

Administrative and engineering controls (e.g., scheduled inspections, containment pads and curbs) will be in place to avoid spillage of water (which could potentially result in the mobilization of contaminants in the vadose zone).

### 2.5.2 Raw Materials, Process Additives, and Consumables

Raw materials, process additives, and other consumable materials will be stored in tanks, containers, or bulk storage in the Test and Demonstration Facility (Figure 2-2). Storage and delivery systems will be designed to accommodate the ingress and egress of trucks delivering raw materials and consumables. This accommodation may be composed of docks or stockpiles that allow for ease of loading/off-loading of the materials and consumables. Soil storage may be provided by a hopper truck with pneumatic conveying of soil to the DBVS during both phases. For Phase 2, a soil stockpile may be used in lieu of the hopper truck due to the higher usage rate of soil. Refractory sand will be stored in a stockpile for both phases. Other process additives will be stored in containers. The design and location of the loading/off-loading areas will be compatible with existing Hanford Site roadways and/or other roadways added for the planned Test and Demonstration Facility.

### 2.5.3 Electric Power System

Under normal operating conditions, all electric power for the Test and Demonstration Facility will be obtained from the Hanford Site grid through a local transformer. A backup generator will be located at the site to provide power in the event grid power is lost. The backup generator will have about a 1,200-kilowatt total load rating. The generator will be diesel-powered. A 37,850-L (10,000-gal) diesel fuel storage tank will be provided for the generator drive motor.

The backup generator is capable of powering the Test and Demonstration Facility systems with 480 volt loads on a continuous basis. However, it will be intended only for use in continuous operation of the offgas treatment system, system pumps, the control system, and other electrically-operated equipment needed for a controlled system shutdown in the event of a power outage and achieving full system shutdown until power from the Hanford Site grid can be restored.

## 2.6 SECONDARY WASTES

A variety of secondary wastes may be generated during the planned project. This section covers general requirements for management of expected secondary wastes. Details are provided in Section 4.0.

Secondary waste streams such as liquid effluent will be disposed of in the Liquid Effluent Retention Facility, the Effluent Treatment Facility (ETF), or the 200 Area Treated Effluent Disposal Facility, as appropriate. Disposition of solid waste streams will be managed in accordance with HNF-EP-0063, *Hanford Site Solid Waste Acceptance Criteria*, and the waste acceptance criteria of the receiving facility, as necessary. Disposition of secondary liquid

effluent waste streams will be managed in accordance with HNF-3172, *Liquid Waste Processing Facilities Waste Acceptance Criteria*, and the acceptance criteria of the receiving facility, as necessary.

Dedicated tanks will be provided for onsite liquid waste storage pending sampling and transfer to a treatment facility. It is anticipated that up to ten 68,140L (18,000 gal) tanks may be used. Six tanks are planned for the initial phase for the liquid secondary waste with 2 tanks dedicated to the three waste stream listed below. If necessary, additional tanks may be added. Tank systems will comply with the applicable portions of WAC 173-303-640.

Storage tank capacity requirements are based on the following assumptions:

- Dryer condensate = 3.40 gpm x 60 min/hr x 7.9 hr/dryer batch x 8 dryer batches ≈ 12,900 gal
- Quench blowdown = 2.39 gpm x 60 min/hr x 168 hr/ICV batch ≈ 24,100 gal
- Tri-Mer Scrubber blowdown[1] = 4.29 gpm x 60 min/hr x 200 hr/ICV batch ≈ 51,500 gal
- Total flow to ETF per ICV container ≈ 88,500 gal per container.

Offgas treatment system equipment designs will comply with the applicable requirements of WAC 173-400, 173-401, 173-460, WAC 246-247, and ASME AG-1, *Code on Nuclear Air and Gas Treatment*. The design of the gaseous and particulate effluent monitoring system will comply with ANSI/HPS N13.1, *Sampling and Monitoring Releases of Airborne Radioactive Substances from the Stacks and Ducts of Nuclear Facilities*. The process equipment will interface with systems that transport secondary waste to appropriate locations.

## 2.7 IGNITABLE, REACTIVE, AND/OR INCOMPATIBLE MATERIALS

In the course of the RD&D project, it is unlikely that tank waste batches will be received that are incompatible with other materials present in the facility, especially process additives. DOE has identified flammable/toxic gases as a potential waste incompatibility. Incompatibilities will be addressed in DOE safety documentation to comply with WAC 173-303-395. Process knowledge, process history, pertinent literature on waste chemistry and tank history and waste analysis will be used to address the Dangerous Waste Codes D001 (Ignitability), D002 (Corrosivity), and D003 (Reactivity) for the waste before transfer to the Test and Demonstration Facility. Verification sampling to document the absence of characteristic codes will be performed on the first batch of retrieved waste as part of the WRS prior to transfer to the DBVS waste receipt tank.

## 2.8 OCCUPATIONAL SAFETY AND HEALTH

All buildings, structures, and equipment utilized in the planned project will incorporate design features that comply with applicable subparts of Occupational Safety and Health Administration (OSHA) Regulation 29 CFR 1910, "Occupational Safety and Health Standards."

[1] Only if used as a backup to the SCR.

**Figure 2-1. Planned Site Location of the Test and Demonstration Facility**

OFFICIAL USE ONLY

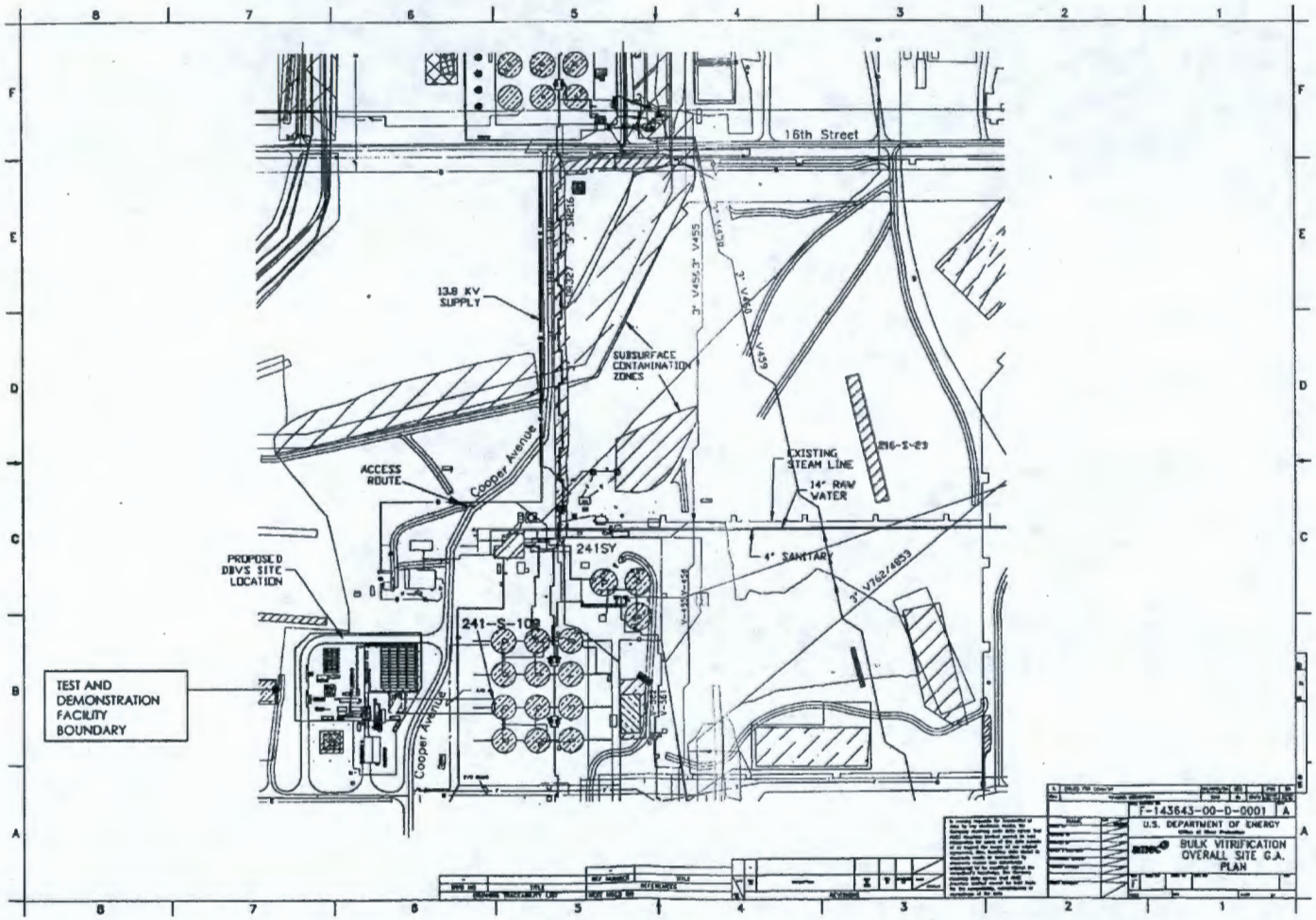

**Figure 2-2. Test and Demonstration Facility Site and Equipment Layout - Page 1**

OFFICIAL USE ONLY

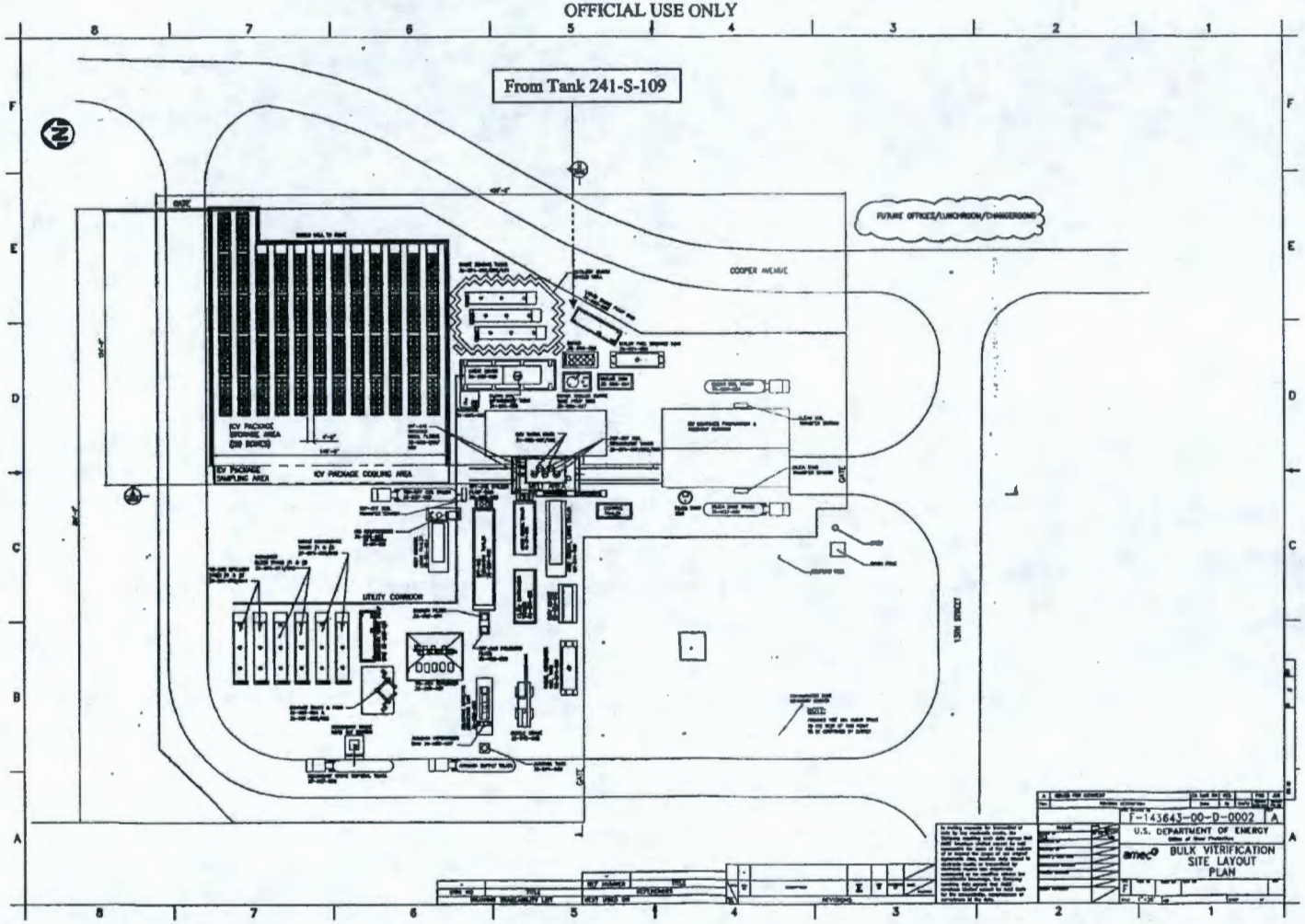




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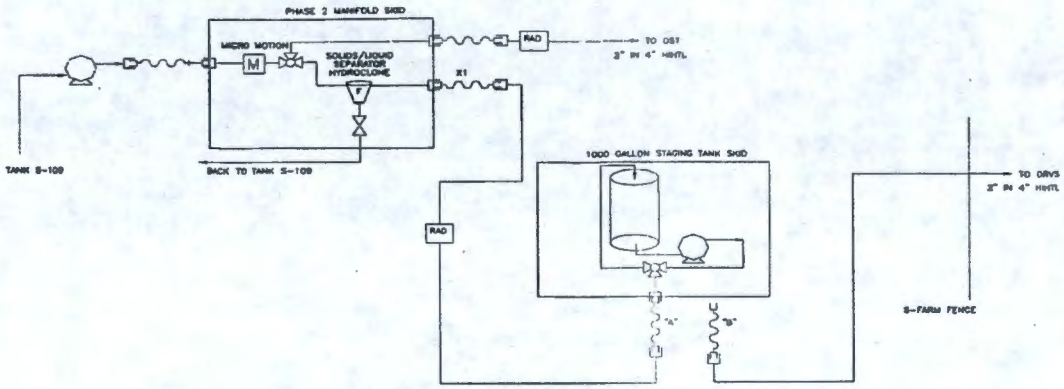
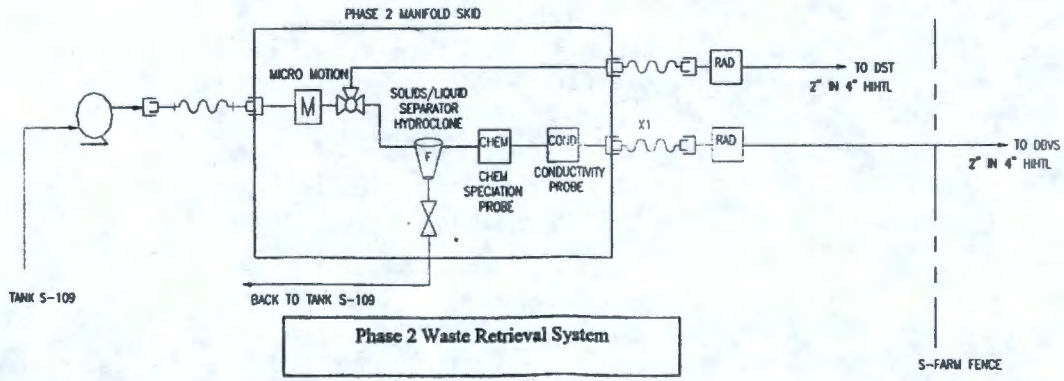
**Figure 2-4. Waste Retrieval System for Phase 1 and Phase 2**




**Phase 1 Waste Retrieval System**




**Phase 2 Waste Retrieval System**



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# Permit Attachment FF

## Section 2.0

The current version of Section 2.0 is located in Permit Attachment AA

**Permit Attachment JJ**

**Section 2.3.2**
**Section 2.4**
**Figure 2-2**

The current version of these sections and figure is located in Permit Attachment AA

**Permit Attachment KK**

**Section 2.2.1**
**Section 2.3.2**
**Section 2.3.3**
**Section 2.6**
**Figure 2-2**
**Figure 2-4**

The current version of these sections and figures is located in Permit Attachment AA

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# 4.0 BULK VITRIFICATION TEST AND DEMONSTRATION FACILITY

The DBVS treatment equipment will be installed and operated under two phases as described in Section 1.7.1. The scope and conduct of the phased operation is described in detail in Section 5.0. Unless otherwise stated, the configuration and operation described are consistent with Phase 2 activities.

## 4.1 TECHNOLOGY-SPECIFIC GOALS AND OBJECTIVES

The primary purpose of testing the DBVS is to fully demonstrate the bulk vitrification process on Hanford tank waste while meeting the project objectives listed in Section 1.5 and assuring protection of human health and the environment. In terms of technology-specific assessment goals and objectives, the DBVS must also demonstrate its ability to perform effectively while:

- Preventing the release of contaminants into the environment during processing
- Preventing exposure of plant operating personnel to hazardous process streams
- Minimizing the production of secondary waste streams.

## 4.2 PROCESS AND EQUIPMENT DESCRIPTION

The primary technology to be used for the DBVS is an ICV® process. Process flow diagrams for both phases of the RD&D project are provided in Appendix B. Process operation is essentially the same for both phases.

The salt solution is retrieved from Tank 241-S-109, subjected to pretreatment as required (Section 1.7.3), and transferred to the waste receipt tank(s). The waste is mixed with glass formers in a mixer/dryer unit and dried prior to being transferred to the ICV® containers (Section 4.2.8). Transfer of the dried waste mixture is accomplished through ports in the container lid.

The ICV® container is prepared before the waste mixture is transferred to the container. Preparation of the ICV® container includes lining the container with refractory materials that will be selected based on successful testing/operation at the range of process temperatures expected. Refractory material will include cast material and sand as noted in Appendix F. The electrodes are then mounted on the container lid. The lid is lowered onto the container with a refractory gasket sealing the lid to the container, bolted in place, and the offgas ductwork is connected. Once the ICV® container is prepared, the waste mixture is added from the mixer/dryer in batches.

The waste mixture is vitrified by resistive heating caused by electrical resistance of soil and waste. The heating cycle lasts for approximately 130 hours.[1] Vitrification emissions are routed to an offgas treatment system (Section 4.2.12).

After completion of the vitrification process (Section 4.2.11), fill material (e.g., sand) will be added to fill the void container volume and provide a sufficient fill fraction (>90% by volume)

[1] Total container processing time, including waste mixing/drying, container fill, connection hookup, etc., is approximately 168 hours or one operating week.

for container landfill disposal. The vitrified waste will undergo cooling, sampling, and external decontamination as required. Final cooling may occur at designated cooling stations along the process line or at an interim storage location on the Test and Demonstration Facility site. Core samples may be removed through ports in the container for analysis and testing. Test results will be used to support waste form qualification, risk assessment, and performance assessment. A composite core sample (e.g., vitrified material, sand, and refractory material) will be evaluated for compliance with LDR, as noted in Section 6.0.

### 4.2.1 System Capacity

The feed rate to the mixer/dryer may be varied as one of the parameters being evaluated through this demonstration project. During Phase 1, up to three test runs will be performed to conduct systems verification and initial waste treatment using approximately 1,135 L (300 gal) of tank waste per container. The amount of waste introduced into each container will be varied during Phase 2 in order to investigate the effect of waste loading on processing time, electric power usage, etc. Over the entire series of test campaigns in Phase 2, the average waste material volume used per test will be approximately 58,080 L (15,345 gal) of a 5 M salt solution. However, individual campaigns may be conducted using up to 76,540 L (20,220 gal) of a 5 M salt solution in a container load.

### 4.2.2 Waste Retrieval System

As noted in Section 2.3.2, the WRS will provide waste feed from Tank 241-S-109 to the DBVS in two distinct phases. During Phase 1, a limited quantity of waste is planned to be provided to the DBVS. During this phase, the quantity of waste will be limited within the facility such that the facility will be classified as below a Hazard Category-3 radiological facility as defined in DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*. During Phase 2, the quantity of waste to the facility will be increased such that the facility will be classified as a Hazard Category-2 facility. The qualitative definition of a Hazard Category-2 facility is that the hazard analysis shows the potential for only significant localized consequences.

During Phase 1, waste transfer will occur through a Waste Staging Tank Skid, which will include the following safety features:

- Leak detection - The skid will perform a secondary containment role. If there are any leaks in the staging tank, piping, fittings, etc, within this skid, the skid will contain the leak. A leak detection sensor located on the floor of the skid will detect the leak and activate an alarm system. Any material leaked into the skid will be routed back to either Tank 241-S-109 or to the DST system.
- Waste staging tank ventilation - The waste staging tank and the containment structure will be "passively vented" to atmosphere through high-efficiency particulate air (HEPA) filter(s).
- Tank overflow protection - A tank overflow detector will be provided, with remote indication that the tank level has been exceeded. An overflow line will also be provided to direct the overflowing waste to the floor of the skid. As mentioned above, if this

"faulted condition" occurs, the leak detection system will identify the situation and waste transfer operations can be stopped.

- Sampling port - A sampling port will be provided on the top of the waste staging tank to allow waste samples to be withdrawn from the tank for analysis.
- "Bad batch disposal"- If the waste staging tank's contents are found not to be within the acceptable specification for acceptance to the DBVS, the waste batch will be sent to the DST system. The waste retrieval pump can be valved to send out-of-specification waste back into the transfer line to Tank 241-S-109, and via the 3-way valve in the pump pit, to the SY Farm Waste Retrieval Receiver Tank.

**4.2.2.1 Phase 1 Activities.** During Phase 1, waste from Tank 241-S-109 will be sent to a double-wall staging tank that will hold 3,780 L (1,000 gal) of waste. A retrieval pump will be used to remove waste from Tank 241-S-109 and transfer it to the staging tank. It is anticipated that the waste transfer pump will be a jet pumping system similar to the ones used for saltwell pumping on the Hanford Site and that the transfer rate will be between 19 L/min and 28 L/min (5 - 10 gpm). The pump, solids/liquid separator, and the sensing systems noted in the following paragraphs will be located in a pump pit containment structure adjacent to Tank 241-S-109.

The pump suction will be screened to prevent entrainment of solid particles in the pump inlet stream. The pump discharge will be routed through a solids/liquid hydroclone separator capable of reducing the waste stream solids content to 3% or less. Hydroclone separator devices use a tangential inflow to a vertical cylindrical vessel creating a spiral flow path for the liquid, using centrifugal forces to remove solid particles from the flow stream and move them outwards to the vessel walls. The dispersed particles move downward under gravity into a cone-shaped collection chamber, while the purified liquid moves upward to the center of the unit to a top mounted outlet. The unit is usually equipped with an airlock on the collection chamber to maintain pressure drop across the unit without drawing in ambient air. This filtration system will have the capability to be flushed back to Tank 241-S-109 and/or be replaced, if the differential pressure across it exceeds the allowable value.

From the solids/liquid hydroclone separator, the filtered waste will be monitored by sensing instruments to provide process control over waste transfer or waste characteristic information. Waste transfer process control will be based on the results of waste sampling and analysis. The proposed instruments to be included in this system are:

- A flow meter capable of indicating the specific gravity and flow rate of the waste.
- A chemical speciation probe.[1] This is an experimental device being developed by Pacific Northwest National Laboratory that will utilize Raman technology to provide scientific information on the chemical speciation of the waste.
- A conductivity probe. This device will provide information on the waste conductivity. The conductivity probe is planned to be a process control device.
- An optional gamma radiation monitor.

[1] Due to the experimental nature of this probe, it will not be used for regulatory compliance purposes.

A three-way valve will direct waste to either the waste staging tank or, if the waste does not meet the waste acceptance criteria noted in Section 6.0, to the DST system for storage and eventual disposal. The waste transfer piping from pump pit to either of these locations will be through a hose-in-hose-transfer line (HIHTL) and will be equipped with an optional on-line radiation monitoring system which will continuously measure the quantity of Cs-137 being transferred through the HIHTL.

Initial waste retrieval during Phase 1 will direct waste to the DST system. CH2M HILL Process Engineering personnel will monitor the transfer data, while waste is being sent to the SY tank farm and determine when to route the waste stream to the waste staging tank. When the waste characteristics are deemed acceptable for processing, the three-way valve in the pump pit will be positioned to send waste to the waste staging tank.

The waste staging tank will have only one inlet/outlet combination. While transferring waste from Tank 241-S-109 to the waste staging tank, the tank will be connected to Tank 241-S-109 via a HIHTL. With this design, the system is physically disconnected from the DBVS facility when the waste staging tank is being filled with waste. Once the waste staging tank is filled the waste batch is characterized. When it has been verified that the waste meets the DBVS waste acceptance criteria the HIHTL connecting the waste staging tank and Tank 241-S-109 will be disconnected. The HIHTL from the DBVS facility will then be connected to the same connector on the waste staging tank. The contents of the waste staging tank will then be pumped to the DBVS receiver tank, via this HIHTL that will exit the farm, go under Cooper Avenue, and mate up with a receiver skid at the DBVS facility.

If analysis of tank contents determines that the waste batch is not acceptable for processing, it will be routed to the DST system.

**4.2.2.2 Phase 2 Activities.** During Phase 2, the "segmentation" concept from Phase 1 will no longer be required since the DBVS Facility will be a Hazard Category-2 facility. Waste transfer rates will be increased to an anticipated 76 L/min (20 gpm). The waste tank can, and will be, directly connected to the DBVS facility. The transfer route from Tank 241-S-109 to DBVS will bypass the waste staging tank skid. The solids/liquid separator and the sensing instrumentation will be retained but the solids/liquid separator capacity will be increased to accommodate the increased waste flow rate.

### 4.2.3 Waste Receipt and Storage

The WRS transfers waste into waste receipt tank(s) for process feed, storage, and sampling. The waste received will be stored in tanks as noted in Table 2-1. Tank capacities are based on anticipated waste processing rates described in Sections 1.7.5 and 4.2.1. All waste storage tanks will be double-wall construction with HIHTL and leak detection provisions. Waste tanks will be vented through the offgas treatment system (Sections 4.2.15 and 4.2.16).

A single 3,780-L (1,000-gal) waste receipt tank will be used during Phase 1 because the total amount of waste treated in the initial campaigns will be minimal. The use of a small tank will limit the amount of waste stored during Phase 1 to an amount below Hazard Category-3 requirements.

At the completion of Phase 1, the 3,780-L (1,000-gal) storage tank may be retained and used for storage of process additives such as simulated waste materials (simulants) or spiking agents during Phase 2 if allowed after flushing and inspection to clean debris standards. .

Three Waste Receipt Tanks will be installed during Phase 1 for Phase 2 operationsso that one or more tanks can be used to provide waste feed for treatment while the other tanks are being filled and sampled as described in Section 6.0. The waste receipt tanks have a maximum capacity of 68,137 liters (18,000 gallons) each and are constructed of carbon steel. Secondary containment is provided by a secondary tank that encloses the inner tank and will hold the entire contents of the primary tank. Leak detection is provided by a high level alarm located in the sump for each tank and will detect a leak at 65 gallons. The Waste Receipt System is represented on Process Flow Diagram B-4 located in Appendix B of Permit Attachment KK. P&IDs for the Waste Receipt System and the detailed designs are also located in Permit Attachment KK. The detailed design for the Waste Receipt Tanks is provided on drawings DBVS-SK-M105, sheets 1 and 2, F-145579-00-P-005, and Specification F-145579-D-SP-028.

### 4.2.4 Process Additives

The DBVS will use soil, waste simulants, glass additives, offgas treatment chemicals, and other materials as process additives. Table 4-1 contains a summary of these materials, their storage methods, and uses. Soil will be used to form the matrix for the vitrification process and to add an additional layer of clean material on the vitrified mass in the container. Waste simulants will be used for running system verification tests prior to treatment of actual SST waste during Phase 1 and as "filler" to attain the required process material volume (waste plus simulant) for a given test campaign during testing in both phases. Waste simulants could include spiking agents for specific process performance testing purposes. The majority, estimated at seventy-five percent (75%) of simulants will be used in Phase 1. A 68,140-L (18,000-gal) double-wall tank will be used for simulant storage during this phase. This tank may be retained onsite for use as one of the waste storage tanks for Phase 2 operations or may be removed from the site at the completion of Phase 1. Process additives will be kept in dedicated storage areas segregated from regulated waste storage to minimize the possibility of contamination. Residual simulant material not used in Phase 2 will be analyzed for dangerous waste characteristics and, if designated as dangerous waste, will be managed in accordance with standard Hanford Site procedures.

Graphite will be placed in the vitrification container to help initiate the soil/waste melting process. Boron and zirconium will be used in small quantities (approximately 2,100 kg (4,630 lbs) and 3,000 kg (6,615 lbs) per container load, respectively) to optimize glass performance. Sand will be used as an insulator.

### 4.2.5 Dry Material Handling

Dry materials will be stored and either conveyed or transferred in bulk from various process staging areas to equipment within the DBVS. Depending on the material characteristics and the amounts used, the additives may be stored in tanks, containers, or in bulk (stockpiles) compliant with applicable regulatory requirements.

During Phase 1, the amount of soil required for the vitrification matrix will be limited. The soil will be stored in an onsite hopper for pneumatic conveying to the treatment system. A similar arrangement may be provided for Phase 2, or, depending on the soil usage rate, a stockpile may be maintained. The loading point for soil into the treatment system will be equipped with parallel storage silos and a baghouse air pollution control system. For stockpiles, engineering controls for dust suppression will be implemented.

**Table 4-1. Process Additives Information**

| Additive | Form | Storage Method | Use | Point of Introduction |
|---|---|---|---|---|
| Soil | Solid | Hopper (Phase 1) Hopper stockpile (Phase 2) | Vitrification matrix, container topoff | Dryer |
| Sand | Solid | Stockpile | Insulating material | ICV container |
| Waste simulants | Solid/slurry | Tank | Waste material substitute; "spiking agents" | Waste receipt tank, dryer |
| Graphite | Solid | Containers | Vitrification aid | ICV container |
| Boron | Solid | Containers | Glass performance aid | Dryer |
| Zirconium | Solid | Containers | Glass performance aid | Dryer |
| Water | Liquid | Tank | Air pollution control | Quench unit, venturi scrubber, Tri-Mer scrubber |
| Ammonia | Gas | Pressurized tanker | Air pollution control | Selective catalytic reduction |
| Sulfuric acid | Liquid | Containers | Air pollution control | Tri-Mer scrubber |
| Sodium chlorate | Liquid | Containers | Air pollution control | Tri-Mer scrubber |
| Sodium sulfide | Liquid | Containers | Air pollution control | Tri-Mer scrubber |
| Sodium hydroxide | Liquid | Containers | Air pollution control | Tri-Mer scrubber |

### 4.2.6 Liquid Material Handling

Liquid materials other than waste feed will be used during DBVS operations. These include water and scrubbing chemicals. Water will be provided directly from tanker trucks. Other liquid material used will either be stored in portable tanks or in containers (e.g., carboys, drums) depending on the material handling requirements and/or the quantity used. Materials stored in portable tanks will be replenished either by removal and replacement of the tank or refilling from

a tanker. Liquid chemical storage areas will be provided with suitable spill containment provisions.

### 4.2.7 Gaseous Material Handling

As an integral part of a best available control technology program, ammonia will be used as an air pollution control aid for removal of oxides of nitrogen ($NO_x$). The gas will be supplied from a pressurized liquid ammonia tanker truck. Ammonia will be vaporized and injected into the offgas stream to ensure proper mixing and efficient $NO_x$ scrubbing.

### 4.2.8 Waste Feed Preparation

Before the vitrification process begins, the waste material will be mixed with additives and dried to remove moisture in a batch-mode rotary mixer/dryer. The unit will be indirect-heated by steam from a diesel-fired onsite boiler. The boiler is a closed-loop system. Waste material will be pumped from waste receipt storage tanks. Appropriate additives will be conveyed or transferred to the unit. The dry material transfer systems will be equipped with weigh stations to control the amount of material being added to the dryer.

The mixer/dryer fill capacity for waste salt solution and process additives is 10,000 L (2,645 gal) at a nominal fill fraction of 45 to 50% (48.4% is the measured fraction from testing). The nominal drying cycle time is eight hours but may be as short as six hours for relatively dry incoming waste. During the mixing/drying cycle, the unit will be maintained under vacuum to promote the release of moisture from the material being processed at a reduced temperature. The moisture content of the material will be monitored by a load cell on the unit (noting the weight of moisture removed) and a moisture sensor in the exhaust duct. Discharge of dried material to the waste container will be vacuum transferred to feed hoppers and then gravity fed through an enclosed chute with shutoff valves. The amount of waste transferred will be determined from mixer/dryer load cell readings.

Mixer/dryer offgases will be treated to remove moisture before being routed to the main offgas treatment system for additional emission control.

### 4.2.9 Vitrification Container Preparation

The typical waste container for the vitrification process is expected to be a steel box approximately 3.0 m (10 ft) high, 2.4 m (8 ft) wide, and 7.3 m (24 ft) long. Containers will comply with the waste acceptance criteria for the receiving TSD unit (a permitted Hanford Site facility). Prior to waste distribution, the container will be lined with insulating board, sand, and a layer of castable refractory. The castable refractory (Appendix F) will face the waste material. A layer of melt-initiating graphite and soil will be placed over the castable refractory in the bottom of the container. The container will contain a port(s) for sampling the vitrified waste to obtain samples for analyses listed in Section 6.0.

A steel lid with attached electrodes will be sealed onto the container prior to waste deposition using bolted flanges and a refractory gasket. The lid contains several ports for waste material addition, electrode connections, venting, sampling, and introduction of post-vitrification materials. All connections will be mechanically sealed to the container lid. In addition, waste

transfer connections will be equipped with shutoff valves to prevent spillage of material as the chute is attached to and removed from the port. To minimize potential contamination to workers and the environment, the connection points will be equipped with secondary containment and spilled material recovery equipment during material transfer, melting, and cooldown. Containment will consist of a ancillary waste transfer enclosure (AWTE) that seals to the container lid before waste is added to the container. The AWTE provides containment while the waste and soil addition connections are made and during the melt process. The operator is able to access the waste and soil addition connections through glove ports in the AWTE. Once the melt is complete and the container is cool enough to add clean soil on the top, the AWTE will be removed to allow the container to move to the temporary storage area. The waste container filling/vitrification station will be equipped with shielding, as required.

### 4.2.10 In-Container Vitrification

The waste mixture, including simulants and glass formers, from the mixer/dryer will be placed into the vitrification container through ports in the sealed container lid. Electric power will be applied to the electrodes, vitrifying the container contents via resistive heating to produce ILAW. The ILAW is the final RCRA waste form for disposal. Ambient air, filtered through a HEPA filter, is injected to assist in establishing and maintaining airflow through the container to the offgas treatment system, cool the vitrification offgases, and provide thermal protection for HEPA filters in the offgas treatment system. Vitrification offgases are vented under induced draft to the offgas treatment system. During the vitrification process, the depth of material will typically decrease due to consolidation in melting.

Both "bottom-up" and "top-down" melting may be conducted during testing to determine the most effective method of waste treatment. The current plans focus on the bottom-up melt procedure; however, there may be a need to perform top-down melting at some time during the testing process. Top-down melting is conducted by applying power to the electrodes only after all waste materials and process additives have been placed in the container. Bottom-up melting begins melting with a shallow layer of material in the container and continues as more material is added until the desired depth of melt is obtained.

### 4.2.11 Post-Vitrification Activities

After vitrification has been completed, the container connection to the offgas treatment system will be maintained. Clean fill materials will be added to fill cavities around the electrodes and cover the top of the vitrified mass to minimize headspace in the container, creating a container that is at least 90% full.

Sampling of the vitrified waste, radiation surveying, and external decontamination (container wipedown, vacuuming of dust, etc.), as necessary, can be conducted any time after initial cooling has been completed. Sampling of the melt will be conducted by a coring process through a port in the side of the container. The method of sealing the sampling port during and after sampling has not been finalized. However, the port will be sealed in such a manner that the container remains in compliance with the RD&D Permit and the permitted storage/disposal facility waste acceptance criteria. Sampling protocol and methodology is addressed in Section 6.0. The data obtained will be used for waste form qualification, risk assessment, and performance assessment.

Temporary storage for up to 50 treated waste containers will be located at the north end of the Test and Demonstration Facility (Figure 2-2). At the completion of RD&D activities, the containers will be transported to the IDF or to another permitted Hanford Site storage/disposal facility.

### 4.2.12 Offgas Treatment Requirements

Emissions may consist of either fugitive (i.e., bulk process additive loading and transfer) or point (i.e., stack) sources. Hazardous or radioactive emissions will not be released through fugitive sources, as those sources will be limited to nonhazardous and nonradioactive materials. Emission calculations for all sources will utilize appropriate emission factors, source classification codes, or other information. Fugitive emissions, which will consist only of nonhazardous materials such as dust from process additive transfers, will be addressed in the *New Source Review Notification of Construction for the Supplemental Treatment Test and Demonstration Facility* (Schepens 2004).

Point sources may emit both nonradioactive and radioactive emissions. These sources will be equipped with a continuous emissions monitoring system (CEMS) that will monitor and record emissions of radionuclides (beta and gamma detectors) and those criteria pollutants (e.g., particulate matter, carbon monoxide [CO], $NO_x$, and oxides of sulfur [$SO_x$]) for which regulatory monitoring requirements exist and are included in the final emission source permit(s)). The CEMS will be designed, installed, and operated in compliance with applicable portions of 40 CFR 60, Appendix B. The design of the gaseous and particulate effluent monitoring system will comply with ANSI/HPS N13.1, *Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities.* The CEMS data will be acquired in real time, but will be available for review in the form of periodically generated reports. Offgas treatment for DBVS operations will address the following issues:

- Particulate and gaseous emissions from waste receipt and storage
- Particulate emissions from process additive receipt, storage, and transfer (not including fugitive emissions from stockpiles)
- Particulate and gaseous emissions from mixer/dryer (dedicated partial system)
- Particulate and gaseous emissions from waste container filling and vitrification
- Particulate emissions from waste container topoff after vitrification.

All offgas treatment system connections to treatment equipment and the waste container tops will be sealed and the offgas ducting maintained under induced draft to prevent escape of pollutants.

With the exception of process additive management emissions, all emissions will be routed to an offgas treatment system prior to discharge to the atmosphere. Nominal efficiencies and the major pollutant controlled by the various offgas treatment system components used are provided in Table 4-2. Table 4-3 contains calculated removal efficiencies for major pollutants. Removal efficiencies were calculated using the Table 4-2 component efficiencies and the offgas treatment system arrangement in Appendix B. Appendix B contains additional information on the offgas treatment system components and efficiencies.

**Table 4-2. Offgas Treatment Component Efficiencies**

| Component | Nominal Control Efficiency | | | | | |
|---|---|---|---|---|---|---|
| | Water/ Water Vapor | Organic Compounds | HCl | $NO_x$ | $SO_x$ | Particulate[1] |
| Baghouse | — | — | — | — | — | 99% |
| Condenser | 95 – 98% | 50% | <10% | <10% | <10% | — |
| Mist Eliminator | 10 – 25% | — | — | — | — | — |
| Sintered Metal Filter | — | — | — | — | — | 99.5% |
| HEPA Filter | — | — | — | — | — | 99.95% |
| Quench System | 10 – 25% | 10% | 10% | 10% | 10% | 10% |
| Packed Tower Scrubber (optional)[2] | — | 90% | 93% | 93% | 93% | <50% |
| Venturi Scrubber | — | 25% | 25% | 25% | 25% | 95% |
| Selective Catalytic Reduction Unit(s) | — | — | — | 99%[3] | — | — |
| Carbon Filter | — | 95 – 99% | 25% | 25% | 25% | — |

[1] Particulate removal efficiencies are for ten-micron (10 μ) particle diameters and up. Removal efficiencies are based on AP-42 (EPA 1995), Appendix B.1, reference texts and process knowledge

[2] Efficiency range varies with pollutant adsorbed

[3] The selective catalytic reduction design goal is 99% efficiency

### 4.2.13 Process Additive Emissions Control

Particulate emissions from offloading and transfer of process additives will be controlled by dedicated baghouse and vent systems. A covered hopper with a sealed pneumatic conveying system will be used to transfer soil to the mixer/dryer soil holding tank or silos. Particulate matter collected at the baghouses is returned to the appropriate additive storage area for reuse.

### 4.2.14 Mixer/Dryer Offgas Emissions Control

The mixer/dryer emissions will be partially treated for moisture removal using a glycol-cooled condenser prior to being routed to the main offgas treatment system. The partially treated offgases from this system will then be routed to the main offgas treatment system downstream of the chemical/venturi scrubber. Water condensed in the condenser and removed in the mist eliminator will be routed to a storage tank for sampling and subsequent treatment or disposal. Estimated rates and volumes of liquid secondary wastes generated from offgas emissions control system operations are provided in Section 2.6.

**Table 4-3. Pollutant Removal Efficiencies[1]**

| Pollutant | Nominal Control Efficiency |
|---|---|
| Moisture | 96% |
| Organic Compounds | 98% |
| HCl | 55% |
| $NO_x$ | 99.95% |
| $SO_x$ | <50% |
| Particulate Matter | >99.9999% |

[1] Based on arrangement of offgas treatment system components in Appendix B process flow diagrams

### 4.2.15 Phase 1 Main Offgas Treatment System

The Phase 1 offgas treatment system will consist of two stages of sintered metal particulate filters, a glycol-cooled condenser, a quench section, one of two redundant atomizing chemical scrubber/venturi scrubber, mist eliminator system, additional stages of HEPA filtration and up to two independent $NO_x$ treatment devises.

Offgas from the melting process first passes through two stages of sintered metal particulate filtration. The purpose of the filters is to minimize radioactive contamination of downstream components to facilitate maintenance and operations. Dust collected from the sintered metal filters is recycled to the mixer/dryer. Dust from the final batch will be incorporated into the mixer/dryer where a final container using clean fill material will be processed to flush the system, and sent to the IDF or another permitted disposal facility. HEPA filters later in the system backup the sintered metal filters ensuring the particulate emissions are minimized.

After the sintered melt filters, the offgas passes through one of two redundant quenchers that cools the gas prior to introduction into the atomizing chemical scrubber/venturi scrubber. Either quencher can quench 100% of the offgas stream. In addition to quenching the offgas, the quencher augments the ability of the system to remove particulate matter and gaseous pollutants. Although this augmentation is not credited, it provides additional redundancy or capability to the offgas system.

Following the quencher, offgas is introduced into one of two redundant atomizing chemical venturi scrubbers. The atomizing chemical venturi scrubbers will be installed in parallel, with one in service and the other on standby. Either of the two atomizing chemical venturi scrubbers can scrub 100% of the offgas stream. Dilute sodium hydroxide will be injected in the atomizing scrubber section to reduce hydrogen chloride and other acid gas emissions. In addition to scrubbing hydrogen chloride and other acid gas emissions from the offgas, the scrubber augments the ability of the system to remove particles and $NO_x$. This augmentation is not credited but occurs nonetheless and provides additional redundancy or capability to the offgas system.

Following the atomizing chemical venturi scrubber, offgases will pass through an additional condenser and one of two redundant mist eliminators, with drainage from those units routed to the scrubber recycle tanks. Condensed liquids are drained into the scrubber recycle tank. An offgas heater, parallel HEPA filters, and a carbon filter for radioactive iodine removal will follow the mist eliminator.

$NO_x$ treatment will be accomplished by a selective catalytic reduction (SCR) unit with a Tri-Mer packed tower scrubber as a back-up system. The packed tower unit consists of a quench unit and five towers in series that sequentially convert oxides of nitrogen to molecular nitrogen ($N_2$) by reduction reactions with chemical reagents ($H_2SO_4$, $NaClO_2$, NaS, and NaOH). Offgases will be discharged through a HEPA polishing filter, redundant exhaust blowers in parallel, and the system stack.

Reagents for the packed tower scrubber will be selected based on chemical species anticipated to be present in the offgases. Blowdown from the scrubber recycle tank will be sampled and routed to the ETF or other permitted Hanford Site facility for treatment and disposal.

Venturi scrubber blowdown contaminant types and their weight fractions/concentrations are provided in Table 4-4. If in service, the Tri-Mer packed tower will be used for only a portion of the vitrification cycle. Packed tower scrubber blowdown, also in the form of a continuous bleed stream, will be 16 L/min (4.29 gpm) and will produce approximately 194,950 L (51,500 gal) over the processing of a single waste container. Packed tower scrubber blowdown will consist of a sodium salt solution containing sulfates, sulfuric acid, sodium chlorite, sodium sulfide, sodium sulfite, sodium hydroxide, nitrates, and nitric acid. Carbon filters will be modular units rather than refillable contactors. Upon reaching saturation, the units will be removed, sampled, and disposed.

**Table 4-4. Scrubber Blowdown Contaminants**

| Contaminant | Concentration |
|---|---|
| Sodium Hydroxide (NaOH) | 2 % by weight |
| Sodium Nitrate ($NaNO_3$) | 13 % by weight |
| Sodium Carbonate ($Na_2CO_3$) | 2.5 % by weight |
| Sodium Sulfite ($Na_2SO_3$) | 0.5 % by weight |
| Sodium Chloride (NaCl) | 0.02% by weight |
| Sodium Fluoride (NaF) | 4 ppm by volume |
| Cs-137 | Trace |

### 4.2.16 Phase 2 Main Offgas Treatment System

It is not expected that any enhancements of the offgas treatment system will be required between the end of Phase 1 and the beginning of Phase 2. However, if the Phase 1 offgas treatment system performance does not meet expectations, changes to the system will be made with prior Ecology approval. The packed tower scrubber may be used to allow the option of routing of

exhaust gases either through the SCR(s) or the tower scrubber to determine the effect on both scrubbing efficiency and scrubber blowdown rates.

### 4.2.17 Control and Data Acquisition System

The DBVS control system and the associated data acquisition systems will be located in a trailer as shown in Figure 2-2. Some operating parameters may be monitored and operating steps may be performed manually as opposed to remotely. Personnel safety and ALARA considerations will require that many of the operations directly related to the process (mixer-dryer, melt station) be monitored and performed remotely. Other operations such as operation of the utilities, secondary waste, SCR, etc, will have key parameters monitored remotely while other monitoring and operating steps are manual. Both RD&D experiment data (process operating conditions) and offgas emissions data will be acquired.

## 4.3 SECONDARY WASTE STREAMS

### 4.3.1 General

All Test and Demonstration Facility secondary waste streams (i.e., any output stream other than the treated DBVS waste) will be managed in accordance with the *Hanford Site Liquid Waste Acceptance Criteria* (HNF-3172) or *Hanford Site Solid Waste Acceptance Criteria* (HNF-EP-0063) and the receiving TSD unit waste acceptance criteria for the treatment and/or disposal path for each stream. A waste minimization program for secondary wastes will be implemented. Shipments of waste to offsite treatment or disposal facilities are not anticipated. However, should they occur, these shipments will be conducted in compliance with WAC 173-303-280(1).

Nonradioactive nonhazardous waste streams include air pollution control equipment dusts from process additive transfer, used baghouse filters, empty process additive containers, and damaged/failed equipment. These waste materials will be managed as general solid waste per *Hanford Environmental Protection Requirements* (HNF-RD-15332).

### 4.3.2 Liquid Effluent Secondary Waste Streams

The Test and Demonstration Facility will produce the liquid secondary wastes noted in Table 4-5. The secondary waste stream will be sampled and analyzed prior to being routed to the ETF or other facility for treatment. Sampling and analysis will be performed in accordance with the waste acceptance criteria of the receiving disposal facility. Secondary wastes will be collected either continuously or at scheduled intervals and stored at the Test and Demonstration Facility in 68,140-L (18,000-gal) double-wall tanks. Up to 10 liquid effluent storage tanks may be onsite at the Test and Demonstration Facility at a given time, depending on the rate of waste generation and the duration of sampling and analysis. Sampling and analysis procedures are noted in Section 6.0. When a tank is filled, its contents will be sampled and the waste will be transported to the ETF. If required, wastes will be filtered prior to shipment to ETF. If the waste does not meet ETF waste acceptance criteria, it will be sent to a DST or other approved Hanford Site storage facilities.

The Secondary Waste System is located on the northwest corner of the DBVS site (See drawings F-145579-00-D-0002, F-145579-00-P-0008 and F-145579-00-P-0013 in Attachment KK, Appendix 4, Section 3). The secondary waste storage tanks and ETF tanker loadout station are located north of the OGTS fan/Stack assembly. Tank construction will meet the requirements of WAC 173-303-640 and will be equipped with freeze protection consistent with Performance Category-2 (ambient temperature of 34°C [30°F]). The secondary waste pump skid is located just south of the secondary waste storage tanks and east of the OGTS Stack and fan assembly. The loadout station is depicted on P&ID F-145579-37-A-0100 located in Attachment KK, Appendix 4, Section 3. The spill confinement berm for the tanker truck is designed specifically for the purpose of confining spills that might occur during tanker loading operation. The loadout station is depicted on P&ID F-145579-37-A-0100 located in Attachment KK, Appendix 4, Section 3.

**Table 4-5. Liquid Secondary Wastes**

| Waste | Source | Frequency of Generation | Pollutants |
|---|---|---|---|
| Washdown Water | Equipment Cleaning, Spill Remediation | Recurring (Equipment Cleaning)<br>Infrequent (Spill Remediation) | Particulate Matter, Radionuclides, Caustic (high pH) Solution |
| Boiler Blowdown | Boiler Maintenance | Infrequent | Particulate Matter, Boiler Antifouling Agents, Surfactants |
| Mixer/Dryer Condenser, Mist Eliminator Drainage | Mixer/Dryer Offgas Condenser, Mist Eliminator Operation | Recurring (Scheduled Holding Tank Discharge) | Particulate Matter, Radionuclides |
| Scrubber System Blowdown or Bleed | Main Offgas Treatment System Operation | Recurring (Scheduled Scrubber Holding Tank Blowdown)<br>Continuous (Scrubber Holding Tank Bleed) | Particulate Matter, Radionuclides, Caustic (high pH) Solution, Dissolved Inorganic Gases, Dissolved Acid Gases, Organic Compounds |

### 4.3.3 Solid/Semisolid Secondary Waste Streams

The Test and Demonstration Facility will produce the solid, semisolid, or sludge secondary wastes noted in Table 4-6. Unless otherwise stated, these wastes will be collected on a scheduled basis and disposed in permitted facilities. Wastes that will routinely be returned to process use, such as spilled nonhazardous process additives, are not included in this list.

**Table 4-6. Solid/Semisolid Secondary Wastes**

| Waste | Source | Frequency of Generation | Pollutants |
|---|---|---|---|
| Spent Carbon Filters | Main Offgas Treatment System | Scheduled or Upon Detection of Pollutant Breakthrough | Particulate Matter, Radionuclides, Organic Compounds |
| Spent HEPA Filters | Mixer/Dryer Offgas Treatment System, Main Offgas Treatment System, ICV® Purge Air Inlet | Scheduled | Particulate Matter, Radionuclides, Organic Compounds |
| Spent SCR Catalyst | Main Offgas Treatment System | Scheduled or Upon Detection of Catalyst Fouling/Poisoning | Particulate Matter, Radionuclides, Organic Compounds |
| Scrubber Tank Sludge | Main Offgas Treatment System | Scheduled or Upon Detection of Excessive Buildup | Inorganic Solids, Water Containing High or Low pH Inorganic Compounds, Radionuclides, Caustic (high pH) Solution, Organic Compounds |
| Used Personal Protective Equipment | Equipment Cleanup, Maintenance, and Operation | Recurring | Particulate Matter, Radionuclides |
| Failed/Damaged Equipment | Equipment Cleanup, Maintenance, and Operation | Recurring | Particulate Matter, Radionuclides |

**Permit Attachment JJ**

**Section 4.2.9**
**Section 4.2.10**
**Section 4.2.11**

The current version of these sections is located in Permit Attachment FF

# Permit Attachment KK

## Section 4.0

The current version of these sections is located in Permit Attachment FF

# Permit Attachment LL

## Section 4.0

The current version of these sections is located in Permit Attachment FF

# APPENDIX B

# PROCESS FLOW DIAGRAMS

# FIGURES

Figure B-1. Phase 1 Process Flow Diagram - Page 1 ..... B-1
Figure B-2. Phase 1 Process Flow Diagram - Page 2 ..... B-2
Figure B-3. Phase 1 Process Flow Diagram - Page 3 ..... B-3
Figure B-4. Phase 2 Process Flow Diagram - Page 1 ..... B-4
Figure B-5. Phase 2 Process Flow Diagram - Page 2 ..... B-5
Figure B-6. Phase 2 Process Flow Diagram - Page 3 ..... B-6
Figure B-7. Phase 1 WRS Flow Diagram ..... B-7
Figure B-8. Phase 2 WRS Flow Diagram ..... B-8

**Figure B-1. Phase 1 Process Flow Diagram - Page 1**

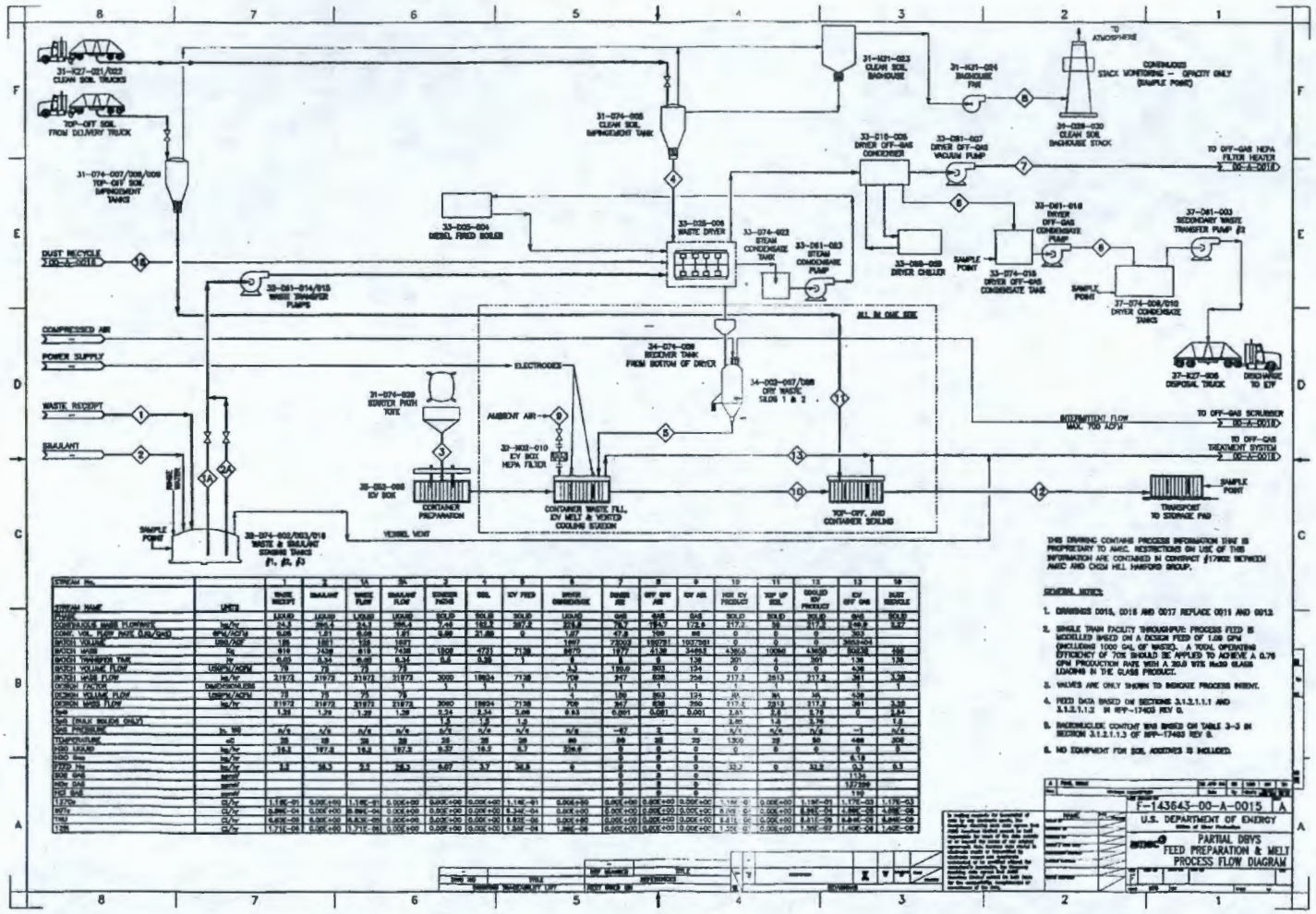

**Figure B-2. Phase 1 Process Flow Diagram - Page 2**

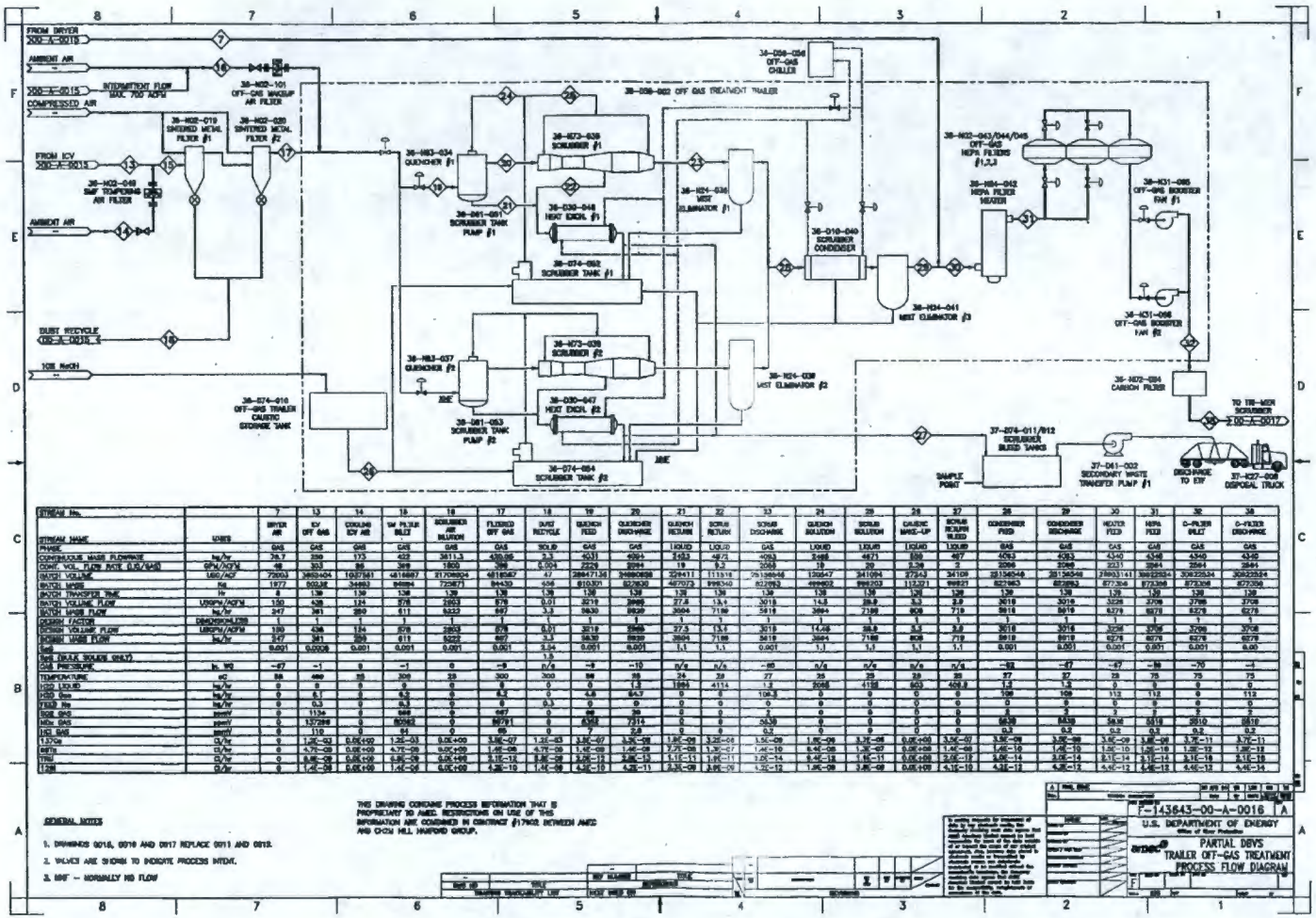

**Figure B-1. Phase 1 Process Flow Diagram - Page 1**

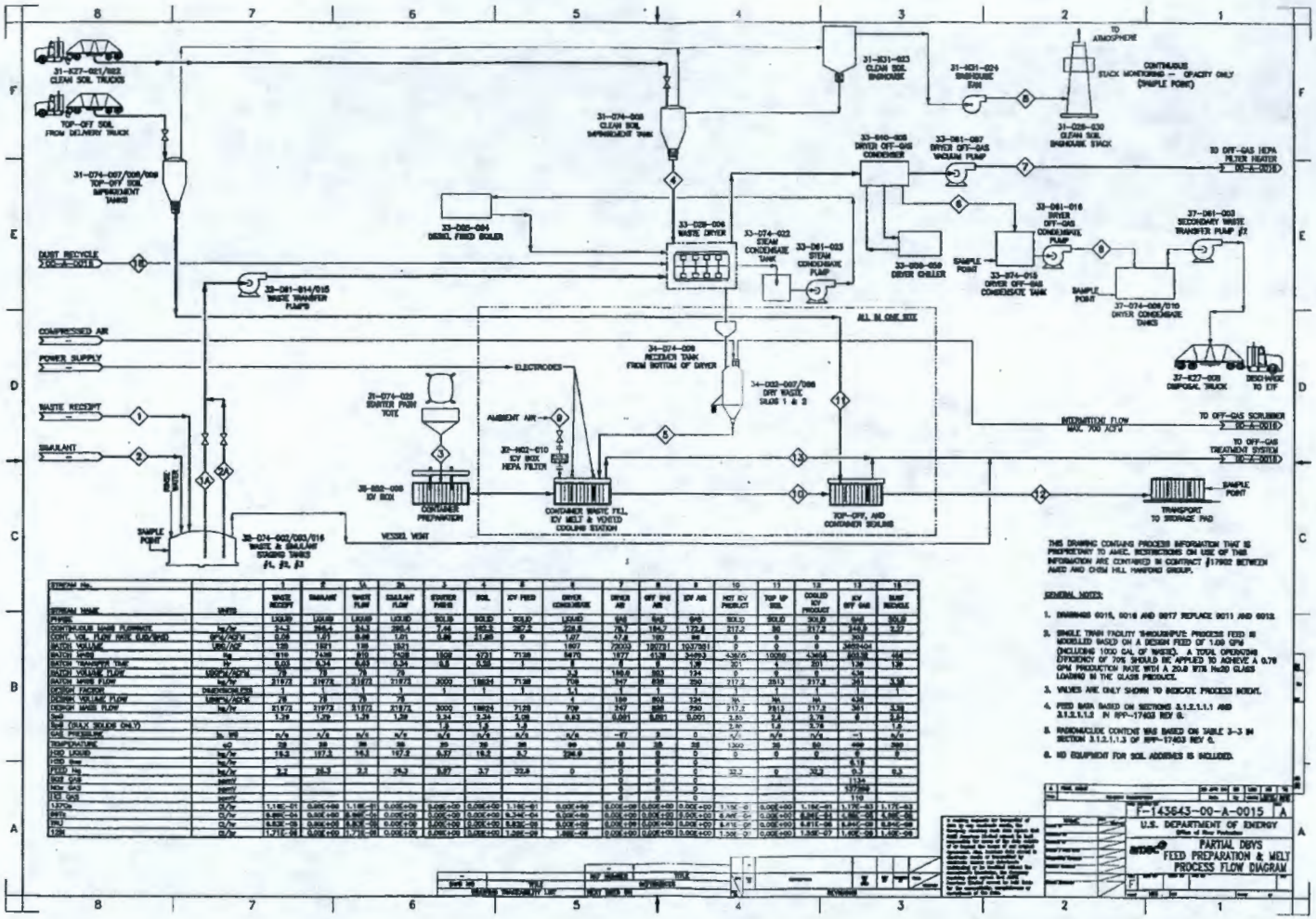




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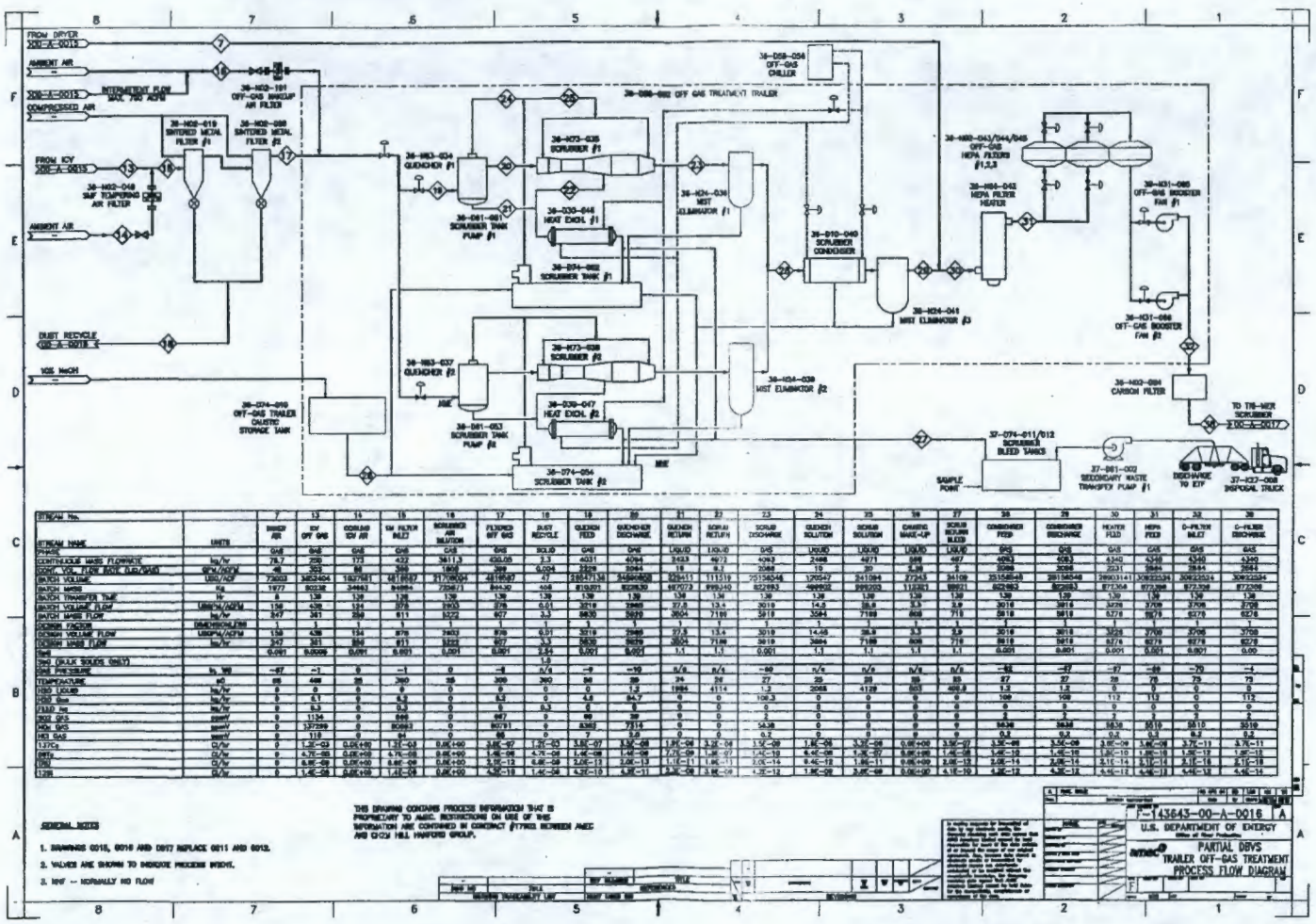
**Figure B-2. Phase 1 Process Flow Diagram - Page 2**




| STREAM No. | | 7 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 23 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STREAM NAME | UNITS | INBED AIR | EV OFF GAS | COOLED EV AIR | EM FILTER INLET | SCRUBBER OFF SOLUTION | FILTERED OFF GAS | DUST RECYCLE | QUENCH FEED | QUENCHER DISCHARGE | QUENCH RETURN | SCRUB RETURN |
| PHASE | | GAS | GAS | GAS | GAS | GAS | GAS | SOLID | GAS | GAS | LIQUID | LIQUID |
| CONTINUOUS MASS FLOWRATE | lbs/hr | 78.7 | 250 | 173 | 432 | 3611.3 | 430.05 | 1.3 | 4031 | 4094 | 3433 | 4073 |
| CONT. VOL. FLOW RATE (LIQ/GAS) | SCFM/GPM | 45 | 352 | 84 | 396 | 1808 | 396 | 0.004 | 2328 | 3044 | 18 | 9.2 |
| BATCH VOLUME | USG/ACF | 73003 | 3453404 | 1827681 | 4818487 | 3170004 | 4818487 | 47 | 2384713.8 | 3484408 | 328411 | 111319 |
| BATCH MASS | Kg | 1977 | 82232 | 34463 | 84884 | 73367.1 | 84430 | 406 | 810201 | 822830 | 667073 | 895340 |
| BATCH TRANSFER TIME | Hr | 6 | 139 | 139 | 139 | 139 | 139 | 139 | 139 | 139 | 134 | 134 |
| BATCH VOLUME FLOW | USGPM/ACFM | 156 | 428 | 124 | 578 | 3403 | 578 | 0.01 | 3016 | 3486 | 37.8 | 13.4 |
| BATCH MASS FLOW | lbs/hr | 247 | 361 | 250 | 611 | 5322 | 607 | 3.3 | 5830 | 5920 | 3904 | 7199 |
| DENSITY FACTOR | DIMENSIONLESS | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| DESIGN VOLUME FLOW | USGPM/ACFM | 156 | 428 | 124 | 578 | 3403 | 578 | 0.01 | 3016 | 3486 | 37.8 | 13.4 |
| DESIGN MASS FLOW | lbs/hr | 247 | 361 | 250 | 611 | 5322 | 607 | 3.3 | 5830 | 5920 | 3904 | 7199 |
| TIME | | 0.001 | 0.0009 | 0.001 | 0.001 | 0.001 | 0.001 | 0.01 | 0.001 | 0.001 | 1.1 | 1.1 |
| TN2 (BULK SOLIDS ONLY) | | | | | | | | 1.0 | | | | |
| GAS PRESSURE | in. WG | -47 | -1 | 0 | -1 | 0 | -4 | n/a | -9 | -10 | n/a | n/a |
| TEMPERATURE | oC | 68 | 488 | 38 | 260 | 35 | 300 | 260 | 50 | 39 | 34 | 34 |
| H2O LIQUID | lbs/hr | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1.2 | 1884 | 4114 |
| H2O Gas | lbs/hr | 0 | 6.1 | 0 | 6.2 | 0 | 6.2 | 0 | 4.8 | 84.7 | 0 | 0 |
| H2O Hg | lbs/hr | 0 | 0.3 | 0 | 0.3 | 0 | 0 | 0.3 | 0 | 0 | 0 | 0 |
| NO2 GAS | scfm/hr | 0 | 1134 | 0 | 946 | 0 | 667 | 0 | 99 | 39 | 0 | 0 |
| NOx GAS | scfm/hr | 0 | 137399 | 0 | 80993 | 0 | 80791 | 0 | 8383 | 7314 | 0 | 0 |
| HCl GAS | scfm/hr | 0 | 118 | 0 | 84 | 0 | 68 | 0 | 7 | 3.6 | 0 | 0 |
| 137Cs | Ci/hr | 0 | 1.3E-03 | 0.0E+00 | 1.3E-03 | 0.0E+00 | 3.8E-07 | 1.2E-03 | 3.8E-07 | 1.3E-08 | 1.9E-08 | 3.3E-08 |
| 90Sr | Ci/hr | 0 | 4.7E-05 | 0.0E+00 | 4.7E-05 | 0.0E+00 | 1.4E-08 | 4.7E-08 | 1.4E-08 | 1.4E-08 | 7.0E-09 | 1.8E-07 |
| 129I | Ci/hr | 0 | 6.8E-09 | 0.0E+00 | 6.8E-09 | 0.0E+00 | 3.1E-12 | 6.8E-09 | 2.0E-13 | 3.0E-13 | 1.1E-11 | 1.8E-11 |
| 129I | Ci/hr | 0 | 1.4E-08 | 0.0E+00 | 1.4E-08 | 0.0E+00 | 4.3E-12 | 1.4E-08 | 4.3E-13 | 4.3E-11 | 2.3E-08 | 3.8E-08 |

| STREAM No. | | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| STREAM NAME | UNITS | QUENCH SOLUTION | SCRUB SOLUTION | CHEMICAL MAKE-UP | SCRUB SOLUTION BLEED | CONDENSER FEED | CONDENSER DISCHARGE | HEATER FEED | HEPA FEED | D-FILTER INLET | D-FILTER DISCHARGE |
| PHASE | | LIQUID | LIQUID | LIQUID | LIQUID | GAS | GAS | GAS | GAS | GAS | GAS |
| CONTINUOUS MASS FLOWRATE | lbs/hr | 2466 | 4071 | 599 | 497 | 4063 | 4063 | 4340 | 4340 | 4340 | 4340 |
| CONT. VOL. FLOW RATE (LIQ/GAS) | SCFM/GPM | 10 | 30 | 5.38 | 3 | 3086 | 3086 | 2331 | 3844 | 3844 | 3844 |
| BATCH VOLUME | USG/ACF | 120547 | 341084 | 27243 | 34109 | 3515548 | 2815548 | 2803141 | 3092234 | 3092234 | 3092234 |
| BATCH MASS | Kg | 499902 | 995203 | 112383 | 99921 | 822983 | 822983 | 873308 | 873308 | 873308 | 873308 |
| BATCH TRANSFER TIME | Hr | 139 | 139 | 139 | 139 | 139 | 139 | 139 | 139 | 139 | 139 |
| BATCH VOLUME FLOW | USGPM/ACFM | 14.5 | 38.8 | 3.3 | 3.9 | 3016 | 3016 | 3226 | 3706 | 3706 | 3706 |
| BATCH MASS FLOW | lbs/hr | 3584 | 7199 | 806 | 716 | 5818 | 5818 | 6276 | 6276 | 6276 | 6276 |
| DENSITY FACTOR | DIMENSIONLESS | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| DESIGN VOLUME FLOW | USGPM/ACFM | 14.45 | 38.8 | 3.3 | 3.9 | 3016 | 3016 | 3226 | 3706 | 3706 | 3706 |
| DESIGN MASS FLOW | lbs/hr | 3584 | 7199 | 806 | 716 | 5818 | 5818 | 6276 | 6276 | 6276 | 6276 |
| TIME | | 1.1 | 1.1 | 1.1 | 1.1 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| TN2 (BULK SOLIDS ONLY) | | | | | | | | | | | |
| GAS PRESSURE | in. WG | n/a | n/a | n/a | n/a | -48 | -47 | -47 | -49 | -70 | -4 |
| TEMPERATURE | oC | 27 | 35 | 35 | 35 | 27 | 27 | 28 | 75 | 75 | 75 |
| H2O LIQUID | lbs/hr | 28 | 4128 | 603 | 498.8 | 1.2 | 1.2 | 0 | 0 | 0 | 0 |
| H2O Gas | lbs/hr | 0 | 0 | 0 | 0 | 109 | 109 | 112 | 113 | 0 | 113 |
| H2O Hg | lbs/hr | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NO2 GAS | scfm/hr | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 2 | 2 | 2 |
| NOx GAS | scfm/hr | 0 | 0 | 0 | 0 | 5438 | 5438 | 5636 | 5510 | 5510 | 5510 |
| HCl GAS | scfm/hr | 0 | 0 | 0 | 0 | 0.2 | 0.2 | 0.2 | 0.3 | 0.2 | 0.2 |
| 137Cs | Ci/hr | 1.8E-08 | 3.3E-08 | 0.0E+00 | 3.9E-07 | 3.9E-09 | 3.5E-09 | 3.8E-09 | 3.8E-08 | 3.7E-11 | 3.7E-11 |
| 90Sr | Ci/hr | 6.4E-08 | 1.8E-07 | 0.0E+00 | 1.4E-08 | 1.8E-10 | 1.8E-10 | 1.8E-10 | 1.8E-10 | 1.8E-13 | 1.8E-13 |
| 129I | Ci/hr | 1.1E-12 | 3.0E-11 | 0.0E+00 | 2.0E-12 | 2.0E-14 | 2.0E-14 | 2.1E-14 | 2.1E-14 | 2.1E-18 | 2.1E-18 |
| 129I | Ci/hr | 1.9E-12 | 3.8E-08 | 0.0E+00 | 4.1E-10 | 4.2E-12 | 4.2E-12 | 4.4E-12 | 4.4E-12 | 4.4E-15 | 4.4E-15 |

GENERAL NOTES

1. DRAWINGS 0015, 0016 AND 0017 REPLACE 0011 AND 0012.
2. VALVES ARE SHOWN TO INDICATE PROCESS INTENT.
3. NNF -- NORMALLY NO FLOW

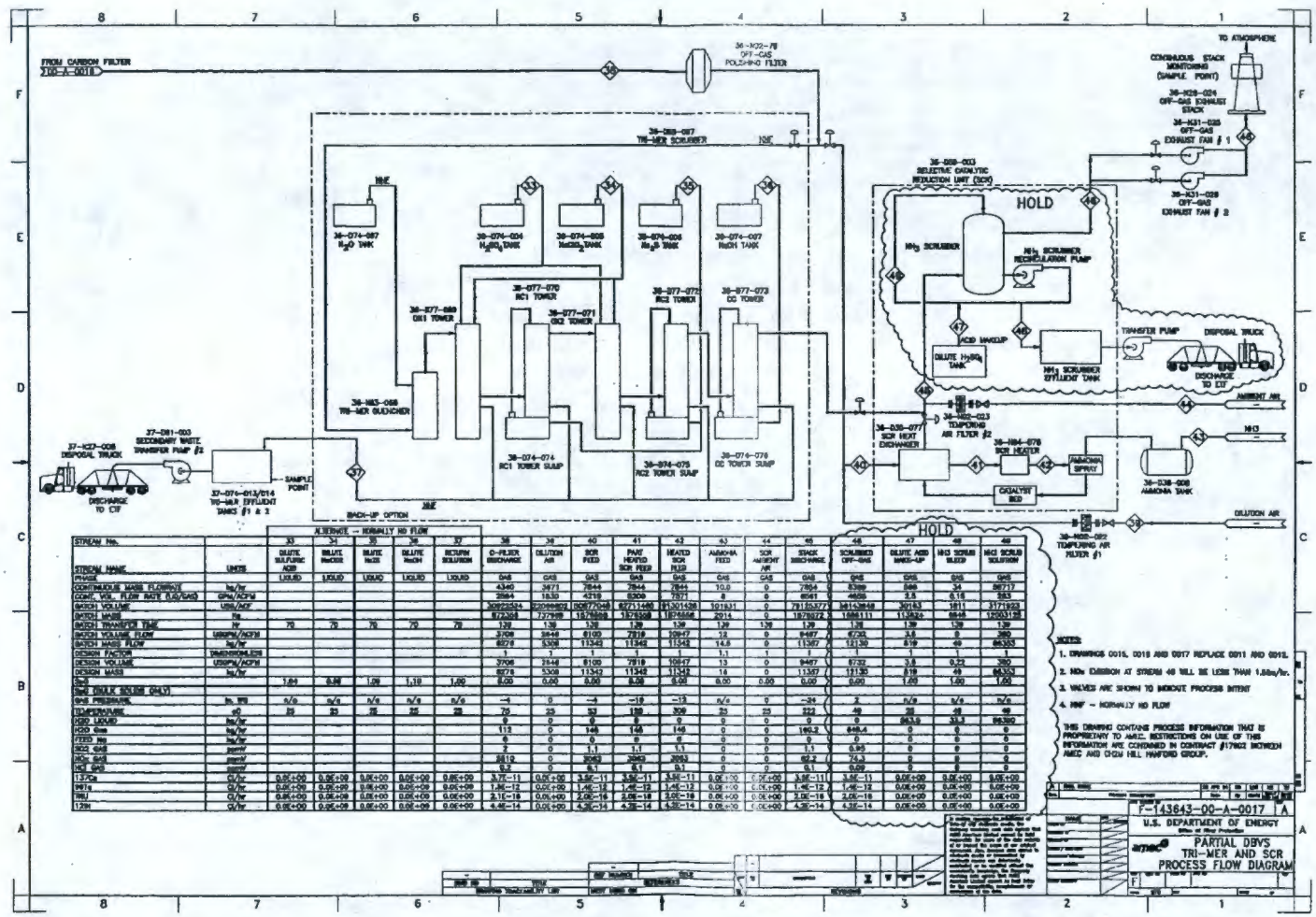
THIS DRAWING CONTAINS PROCESS INFORMATION THAT IS PROPRIETARY TO AMEC. RESTRICTIONS ON USE OF THIS INFORMATION ARE CONTAINED IN CONTRACT #17903 BETWEEN AMEC AND CH2M HILL HANFORD GROUP.

F-143643-00-A-0016 A

U.S. DEPARTMENT OF ENERGY
Office of River Protection

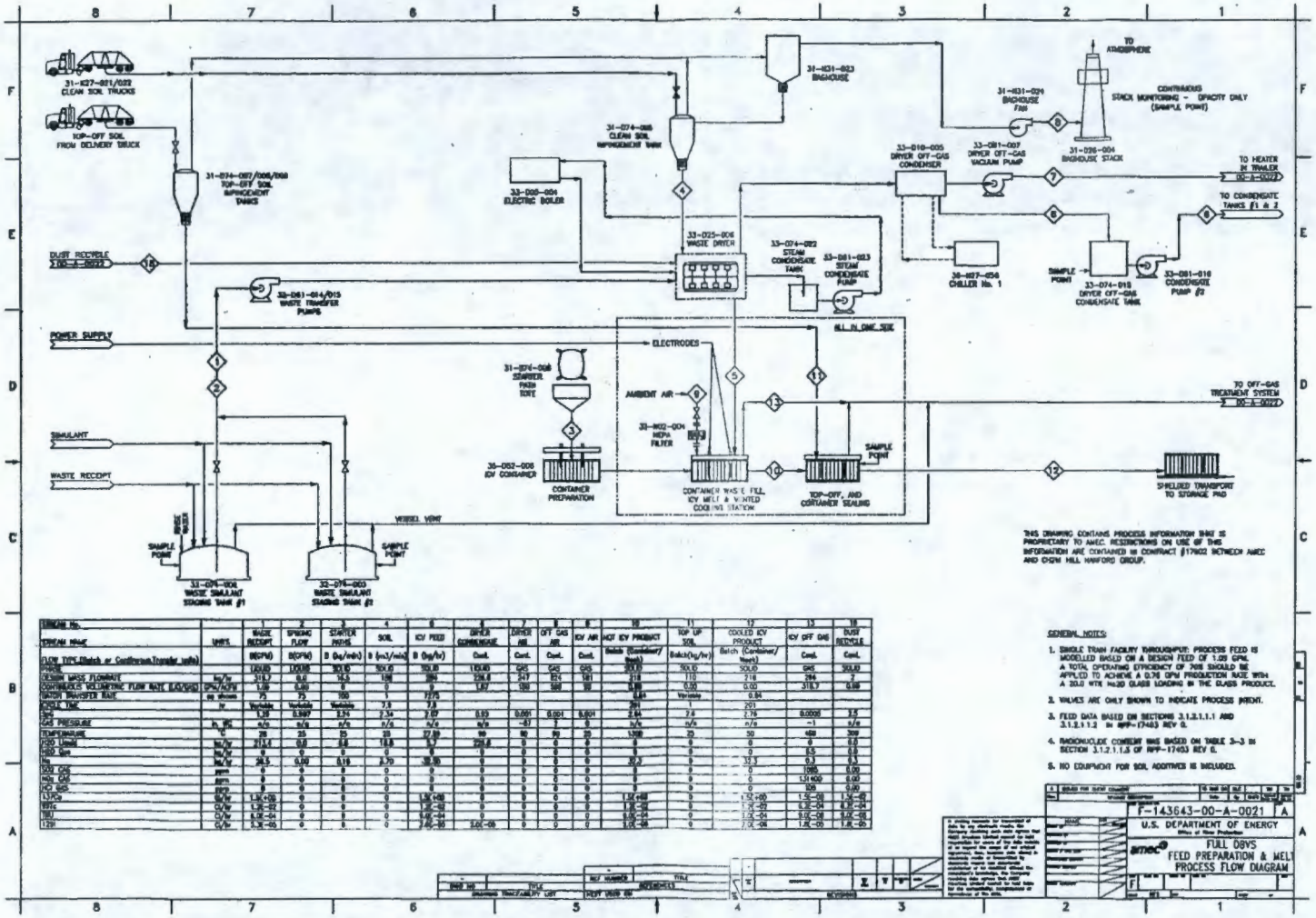
PARTIAL DBVS
TRAILER OFF-GAS TREATMENT
PROCESS FLOW DIAGRAM

**Figure B-3. Phase 1 Process Flow Diagram - Page 3**




| STREAM No. | | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ALTERNATE → NORMALLY NO FLOW | | | | | | | | | | | | | | | | |
| STREAM NAME | UNITS | DILUTE SULFURIC ACID | DILUTE NaOCl | DILUTE NaOH | DILUTE NaOH | RECYCLE SOLUTION | C-FILTER DISCHARGE | DILUTION AIR | SCR FEED | PART HEATED SCR FEED | HEATED SCR FEED | AMMONIA FEED | SCR AMBIENT AIR | STACK DISCHARGE | SCRUBBED OFF-GAS | DILUTE ACID MAKE-UP | NH3 SCRUB BLEED | NH3 SCRUB SOLUTION |
| PHASE | | LIQUID | LIQUID | LIQUID | LIQUID | LIQUID | GAS | GAS | GAS | GAS | GAS | GAS | GAS | GAS | GAS | GAS | GAS | GAS |
| CONTINUOUS MASS FLOWRATE | kg/hr | | | | | | 4340 | 3471 | 7844 | 7844 | 7844 | 10.0 | 0 | 7804 | 8389 | 588 | 34 | 88717 |
| CONT. VOL. FLOW RATE (LQ/GAS) | GPM/ACFM | | | | | | 2984 | 1830 | 4210 | 5300 | 7571 | 8 | 0 | 6561 | 4655 | 2.5 | 0.16 | 583 |
| BATCH VOLUME | USG/ACF | | | | | | 30922534 | 22099802 | 50677048 | 67211480 | 912001428 | 101831 | 0 | 7915537.2 | 14613648 | 30183 | 1811 | 3171973 |
| BATCH MASS | lb | | | | | | 573268 | 727498 | 1676268 | 1572308 | 1824468 | 2014 | 0 | 1975972.2 | 1486111 | 113532 | 8646 | 1203128 |
| BATCH TRANSFER TIME | hr | 70 | 70 | 70 | 70 | 70 | 139 | 139 | 139 | 139 | 139 | 139 | 139 | 139 | 139 | 139 | 139 | 139 |
| BATCH VOLUME FLOW | USGPM/ACFM | | | | | | 3708 | 3848 | 6100 | 7818 | 10917 | 13 | 0 | 9477 | 6732 | 3.6 | 0 | 380 |
| BATCH MASS FLOW | lb/hr | | | | | | 8278 | 5308 | 11342 | 11342 | 11342 | 14.5 | 0 | 11357 | 12130 | 819 | 49 | 86353 |
| DESIGN FACTOR | DIMENSIONLESS | | | | | | 1 | 1 | 1 | 1 | 1 | 1.1 | 1 | 1 | 1 | 1 | 1 | 1 |
| DESIGN VOLUME | USGPM/ACFM | | | | | | 3708 | 3848 | 6100 | 7818 | 10917 | 13 | 0 | 9477 | 6732 | 3.6 | 0.22 | 380 |
| DESIGN MASS | lb/hr | | | | | | 8278 | 5308 | 11342 | 11342 | 11342 | 16 | 0 | 11357 | 12130 | 819 | 49 | 86353 |
| pH | | 1.84 | 8.98 | 1.09 | 1.10 | 1.00 | 8.00 | 8.00 | 8.00 | 8.00 | 8.00 | 8.00 | 0.00 | 8.00 | 8.00 | 1.00 | 1.00 | 1.00 |
| pH (BULK SOLUTION ONLY) | | | | | | | | | | | | | | | | | | |
| GAS PRESSURE | in. WG | n/a | n/a | n/a | n/a | n/a | -4 | 0 | -4 | -19 | -13 | n/a | 0 | -24 | 2 | n/a | n/a | n/a |
| TEMPERATURE | oC | 25 | 25 | 25 | 25 | 25 | 70 | 25 | 53 | 150 | 300 | 25 | 25 | 222 | 49 | 25 | 49 | 49 |
| H2O LIQUID | kg/hr | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.1 | 33.1 | 86302 |
| H2O Gas | kg/hr | | | | | | 112 | 0 | 146 | 146 | 146 | 0 | 0 | 140.2 | 848.4 | 0 | 0 | 0 |
| FIXED NO | kg/hr | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SO2 GAS | ppmV | | | | | | 7 | 0 | 1.1 | 1.1 | 1.1 | 0 | 0 | 1.1 | 0.95 | 0 | 0 | 0 |
| NOx GAS | ppmV | | | | | | 5810 | 0 | 3062 | 3062 | 3062 | 0 | 0 | 62.2 | 74.3 | 0 | 0 | 0 |
| HCl GAS | ppmV | | | | | | 0.2 | 0 | 0.1 | 0.1 | 0.1 | 0 | 0 | 0.1 | 0.09 | 0 | 0 | 0 |
| 137Cs | Ci/hr | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 3.7E-11 | 0.0E+00 | 3.5E-11 | 3.5E-11 | 3.5E-11 | 0.0E+00 | 0.0E+00 | 3.5E-11 | 3.5E-11 | 0.0E+00 | 0.0E+00 | 0.0E+00 |
| 14C | Ci/hr | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 1.9E-12 | 0.0E+00 | 1.4E-12 | 1.4E-12 | 1.4E-12 | 0.0E+00 | 0.0E+00 | 1.4E-12 | 1.4E-12 | 0.0E+00 | 0.0E+00 | 0.0E+00 |
| 129I | Ci/hr | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 2.1E-16 | 0.0E+00 | 2.0E-16 | 2.0E-16 | 2.0E-16 | 0.0E+00 | 0.0E+00 | 2.0E-16 | 2.0E-16 | 0.0E+00 | 0.0E+00 | 0.0E+00 |
| 129I | Ci/hr | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 4.4E-14 | 0.0E+00 | 4.3E-14 | 4.3E-14 | 4.3E-14 | 0.0E+00 | 0.0E+00 | 4.3E-14 | 4.3E-14 | 0.0E+00 | 0.0E+00 | 0.0E+00 |

**Figure B-4. Phase 2 Process Flow Diagram - Page 1**




| STREAM No. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STREAM NAME | UNITS | WASTE RECEIPT | SPIKING FLOW | STARTER PAPER | SOIL | ICV FEED | DRYER CONDENSATE | DRYER AIR | OFF GAS AIR | ICV AIR | HOT ICV PRODUCT | TOP UP SOIL | COOLED ICV PRODUCT | ICV OFF GAS | DUST RECYCLE |
| FLOW TYPE (Batch or Continuous, Transfer, solid) | | B(GPM) | B(GPM) | B (kg/min) | B (m3/min) | B (kg/hr) | Cont. | Cont. | Cont. | Cont. | Batch (Container/Melt) | Batch(kg/hr) | Batch (Container/Melt) | Cont. | Cont. |
| PHASE | | LIQUID | LIQUID | SOLID | SOLID | SOLID | LIQUID | GAS | GAS | GAS | SOLID | SOLID | SOLID | GAS | SOLID |
| VOLUME MASS FLOWRATE | kg/hr | 318.7 | 0.0 | 14.5 | 108 | 384 | 238.8 | 247 | 274 | 181 | 218 | 110 | 218 | 284 | 2 |
| CONTINUOUS VOLUMETRIC FLOW RATE (L/S/GPS) | GPM/SCFM | 1.00 | 0.00 | 0 | 0 | 0 | 1.07 | 180 | 160 | 80 | 0.00 | 0.00 | 0.00 | 318.7 | 0.00 |
| BATCH TRANSFER RATE | kg/batch | 75 | 75 | 700 | 1 | 1775 | | | | | 0.84 | Variable | 0.84 | | |
| CYCLE TIME | hr | Variable | Variable | Variable | 7.5 | 7.5 | | | | | 201 | 1 | 201 | | |
| [illegible] | | 1.20 | 0.997 | 2.34 | 2.34 | 2.07 | 0.93 | 0.001 | 0.001 | 0.001 | 2.64 | 2.6 | 2.75 | 0.0000 | 2.6 |
| GAS PRESSURE | in. WG | n/a | n/a | n/a | n/a | n/a | n/a | -87 | 2 | 0 | n/a | n/a | n/a | -1 | n/a |
| TEMPERATURE | C | 20 | 25 | 35 | 20 | 27.50 | 90 | 90 | 90 | 20 | 1300 | 20 | 50 | 450 | 300 |
| H2O Liquid | kg/hr | 313.4 | 0.0 | 0.0 | 10.8 | 0.7 | 238.8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 |
| H2O Gas | kg/hr | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.5 | 0.0 |
| $N_2$ | kg/hr | 24.5 | 0.00 | 0.19 | 0.70 | 38.30 | 0 | 0 | 0 | 0 | 37.3 | 0 | 37.3 | 0.3 | 0.1 |
| SO2 GAS | ppm | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1085 | 0.00 |
| HCl GAS | ppm | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,31400 | 0.00 |
| HCN GAS | ppm | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 309 | 0.00 |
| $I_2$/Kr | Ci/hr | 1.3E+06 | 0 | 0 | 0 | 0 | 1.3E+06 | 0 | 0 | 0 | 0 | 1.3E+06 | 0 | 1.52+00 | 1.3E-02 | 1.3E-02 |
| $^{90}Sr$ | Ci/hr | 1.3E-02 | 0 | 0 | 0 | 0 | 1.3E-02 | 0 | 0 | 0 | 0 | 1.3E-02 | 0 | 1.2E-03 | 6.3E-04 | 6.3E-04 |
| $^{137}Cs$ | Ci/hr | 6.3E-04 | 0 | 0 | 0 | 0 | 6.3E-04 | 0 | 0 | 0 | 0 | 6.3E-04 | 0 | 1.3E-04 | 8.0E-08 | 8.2E-08 |
| $^{129}I$ | Ci/hr | 5.3E-05 | 0 | 0 | 0 | 0 | 7.4E-05 | 3.0E-09 | 0 | 0 | 0 | 3.0E-09 | 0 | 7.2E-08 | 1.8E-05 | 1.8E-05 |



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**Figure B-5. Phase 2 Process Flow Diagram - Page 2**

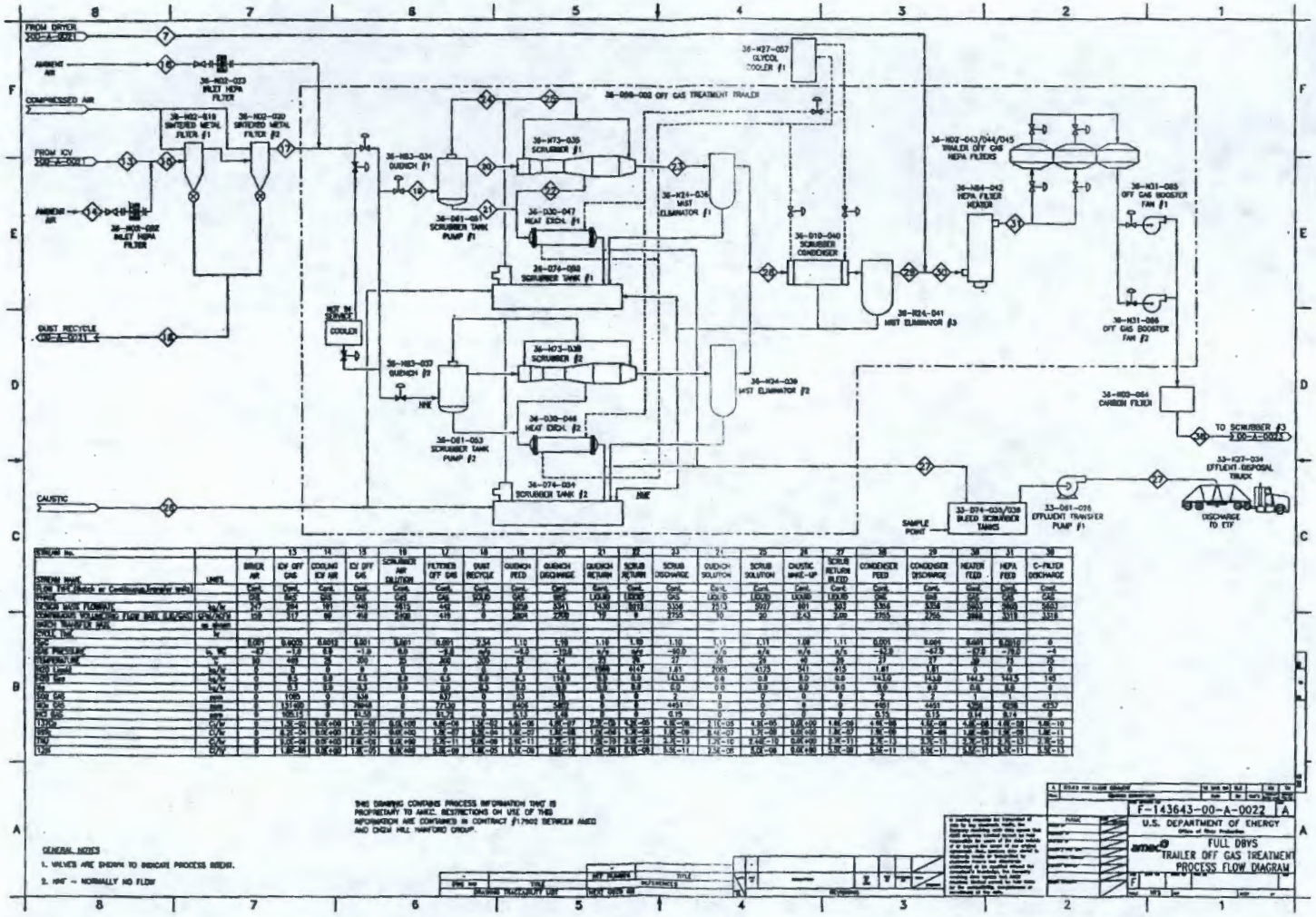




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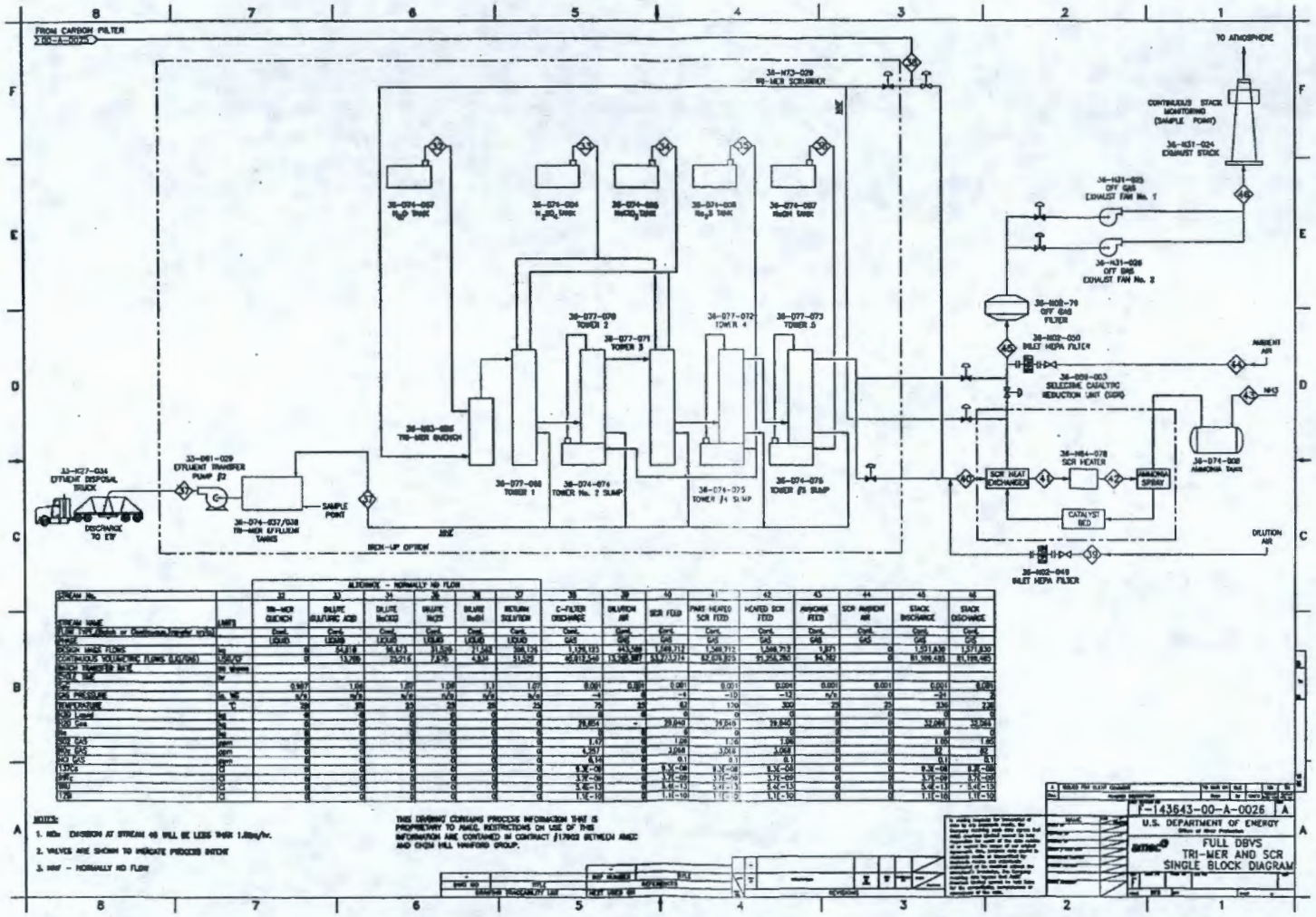
**Figure B-6. Phase 2 Process Flow Diagram - Page 3**




| STREAM No. | | 32 | 33 | 34 | 36 | 38 | 37 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ALTERNATE - NORMALLY NO FLOW | | | | | | | | | | | | | |
| STREAM NAME | | TRI-MER SUCTION | DILUTE SULFURIC ACID | DILUTE NaOH | DILUTE NaOH | DILUTE NaOH | RETURN SOLUTION | C-FILTER DISCHARGE | DILUTION AIR | SCR FEED | PART HEATED SCR FEED | HEATED SCR FEED | AMMONIA FEED | SCR AMBIENT AIR | STACK DISCHARGE | STACK DISCHARGE |
| FLOW TYPE (Batch or Continuous/Impulse cycle) | | Cont. | Cont. | Cont. | Cont. | Cont. | Cont. | Cont. | Cont. | Cont. | Cont. | Cont. | Cont. | Cont. | Cont. | Cont. |
| PHASE | | LIQUID | LIQUID | LIQUID | LIQUID | LIQUID | LIQUID | GAS | GAS | GAS | GAS | GAS | GAS | GAS | GAS | GAS |
| DESIGN MASS FLOWS | lb | 0 | 54,018 | 90,121 | 31,509 | 27,008 | 308,126 | 1,126,133 | 243,368 | 1,369,312 | 1,369,312 | 1,369,313 | 1,871 | 0 | 1,351,830 | 1,377,830 |
| CONTINUOUS VOLUMETRIC FLOWS (Liq/Gas) | GPM/CFM | 0 | 13,298 | 22,216 | 7,878 | 4,824 | 51,425 | 40,612,549 | 13,528,897 | 53,713,174 | 82,615,925 | 91,256,780 | 84,162 | 0 | 81,399,485 | 81,784,485 |
| BATCH TRANSFER RATE | lb/batch | | | | | | | | | | | | | | | |
| CYCLE TIME | hr | | | | | | | | | | | | | | | |
| pH | | 0.987 | 1.06 | 1.07 | 1.08 | 1.1 | 1.07 | 8.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| GAS PRESSURE | in. WC | N/A | N/A | N/A | N/A | N/A | N/A | -4 | 0 | -4 | -10 | -13 | N/A | 0 | -24 | 0 |
| TEMPERATURE | °F | 28 | 28 | 25 | 28 | 28 | 25 | 75 | 25 | 62 | 170 | 300 | 25 | 25 | 230 | 228 |
| H2O Liquid | lb | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| H2O Gas | lb | 0 | 0 | 0 | 0 | 0 | 0 | 29,854 | - | 29,849 | 29,849 | 29,849 | 0 | 0 | 32,044 | 32,044 |
| N2 | lb | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NOx GAS | ppm | 0 | 0 | 0 | 0 | 0 | 0 | 1.07 | 0 | 1.06 | 1.06 | 1.06 | 0 | 0 | 1.85 | 1.85 |
| SOx GAS | ppm | 0 | 0 | 0 | 0 | 0 | 0 | 4,357 | 0 | 3,048 | 3,048 | 3,048 | 0 | 0 | 82 | 82 |
| CO GAS | ppm | 0 | 0 | 0 | 0 | 0 | 0 | 8.14 | 0 | 0.1 | 0.1 | 0.1 | 0 | 0 | 0.1 | 0.1 |
| 13DCB | lb | 0 | 0 | 0 | 0 | 0 | 0 | 9.3E-08 | 0 | 9.3E-08 | 9.3E-08 | 9.3E-08 | 0 | 0 | 9.3E-08 | 9.3E-08 |
| DBFC | lb | 0 | 0 | 0 | 0 | 0 | 0 | 3.7E-09 | 0 | 3.7E-09 | 3.7E-09 | 3.7E-09 | 0 | 0 | 3.7E-09 | 3.7E-09 |
| TMB | lb | 0 | 0 | 0 | 0 | 0 | 0 | 5.4E-13 | 0 | 5.4E-13 | 5.4E-13 | 5.4E-13 | 0 | 0 | 5.4E-13 | 5.4E-13 |
| TCB | lb | 0 | 0 | 0 | 0 | 0 | 0 | 1.1E-10 | 0 | 1.1E-10 | 1.1E-10 | 1.1E-10 | 0 | 0 | 1.1E-10 | 1.1E-10 |



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**Figure B-7. Phase 1 WRS Flow Diagram**

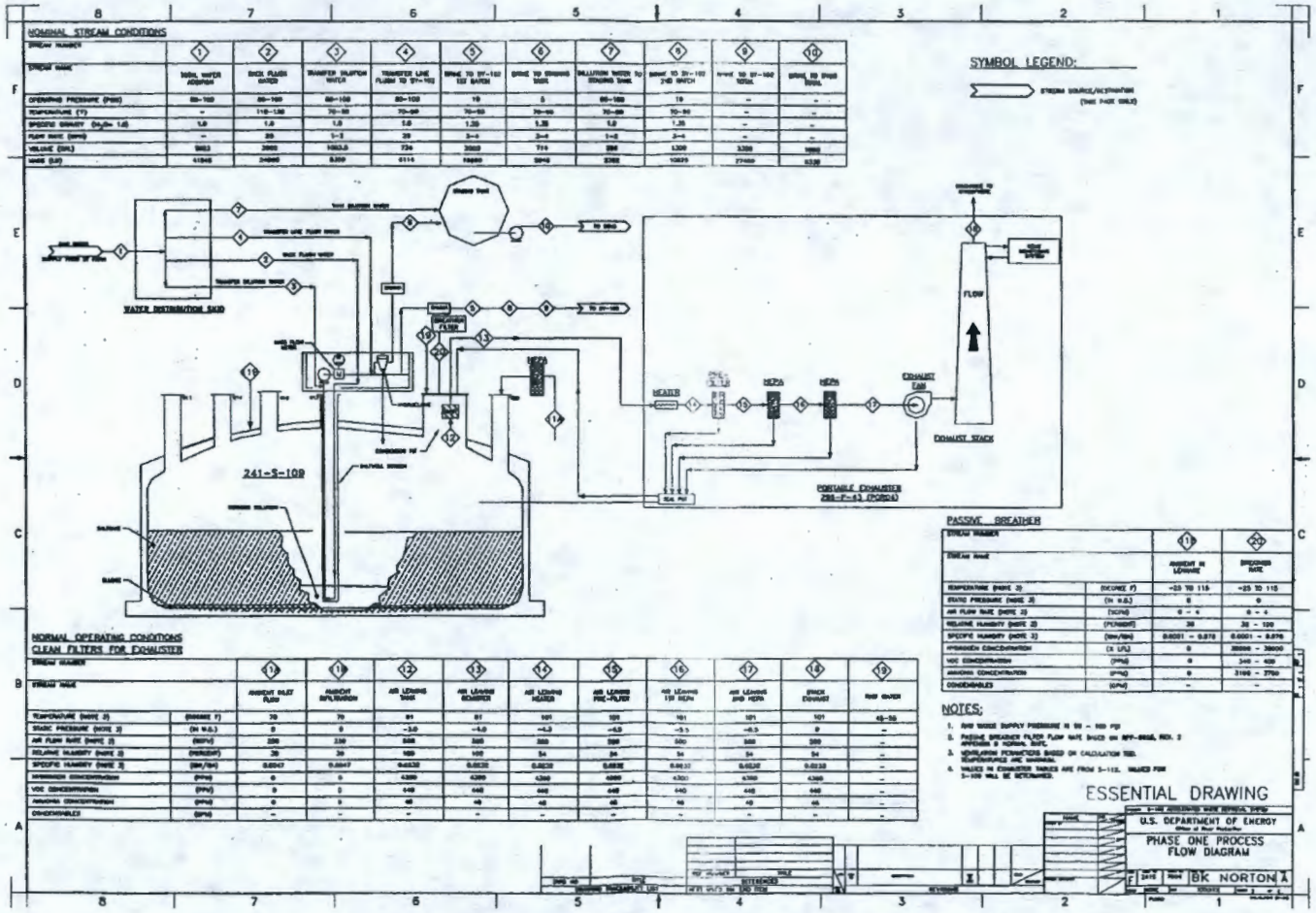




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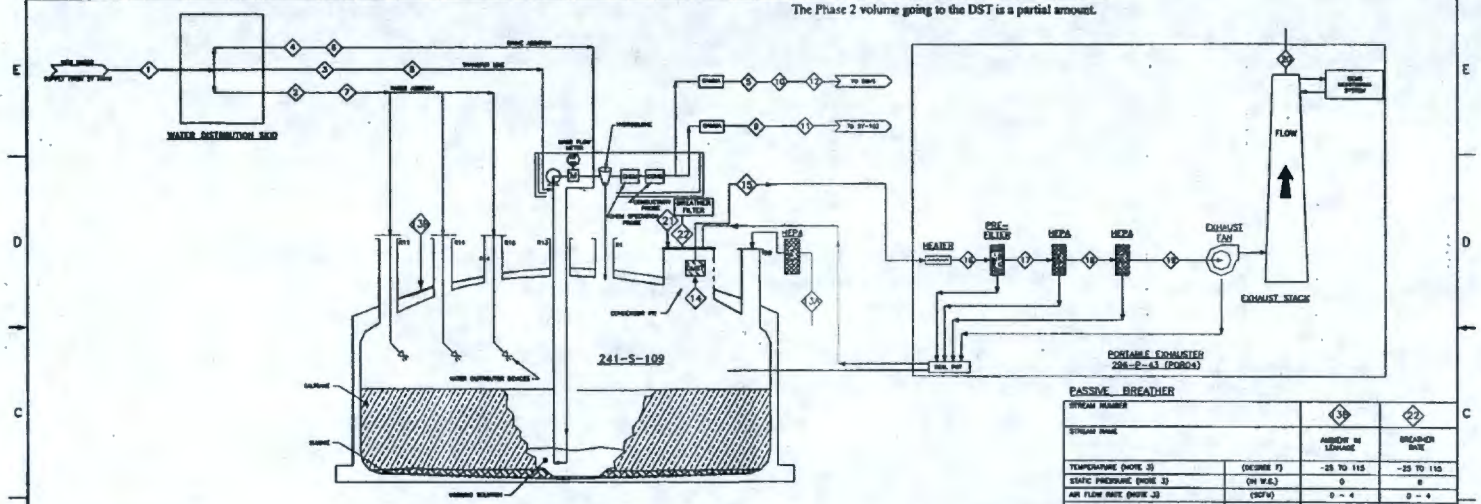
**Figure B-8. Phase 2 WRS Flow Diagram**

NOMINAL STREAM CONDITIONS

| STREAM NUMBER | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STREAM NAME | TOTAL WATER ADDITION AS SATURES | WATER ADDITION TO S-109 1ST BATCH | TRANSFER DILUTION WATER 1ST BATCH TO SY-102 | BRINE ADDITION TO SY-102 1ST BATCH | TRANSFER DILUTION WATER 1ST BATCH TO DSHS | BRINE ADDITION TO DSHS 1ST BATCH | WATER ADDITION TO S-109 TOTAL | TRANSFER DILUTION WATER TOTAL | TRANSFER LINE FLUSH TO SY-102 | TRANSFER LINE FLUSH TO DSHS | ADDITION TO SY-102 TOTAL | TOTAL TRANSFER TO DSHS |
| OPERATING PRESSURE (PSIG) | - | 80-100 | 80-100 | 10 | 80-100 | 10 | 80-100 | 80-100 | 80-100 | 80-100 | 10 | 10 |
| TEMPERATURE (°F) | - | 110-120 | 70-90 | 70-90 | 70-90 | 70-90 | 110-120 | 70-90 | 70-90 | 70-90 | 70-90 | 70-90 |
| SPECIFIC GRAVITY ($H_2O$= 1.0) | 1.0 | 1.0 | 1.0 | 1.35 | 1.0 | 1.25 | 1.0 | 1.0 | 1.0 | 1.0 | 1.35 | 1.25 |
| FLOW RATE (GPM) | - | 20 | 2-3 | 8-10 | 2-3 | 8-10 | - | - | 20 | 20 | - | - |
| VOLUME (GAL) | 67744 | 7000 | 187.5 | 750 | 7031 | 14063 | 243000 | 339062.5 | 134 | 147 | 30334 | 647022 |
| MASS (LB) | 5647267 | 62475 | 1562 | 6240 | 58570 | 117141 | 2673890 | 2750881 | 1114 | 1223 | 293490 | 3380882 |

The Phase 2 volume going to the DST is a partial amount.




SYMBOL LEGEND: (THIS PAGE ONLY)

STREAM SOURCE/DESTINATION

PASSIVE BREATHER

| STREAM NUMBER | | 38 | 22 |
|---|---|---|---|
| STREAM NAME | | AMBIENT IN LEAKAGE | BREATHER RATE |
| TEMPERATURE (NOTE 3) | (DEGREE F) | -25 TO 115 | -25 TO 115 |
| STATIC PRESSURE (NOTE 3) | (IN W.G.) | 0 | 0 |
| AIR FLOW RATE (NOTE 3) | (SCFM) | 0 - 4 | 0 - 4 |
| RELATIVE HUMIDITY (NOTE 3) | (PERCENT) | 30 | 30 - 100 |
| SPECIFIC HUMIDITY (NOTE 3) | (LBM/LBA) | 0.0001 - 0.078 | 0.0001 - 0.078 |
| HYDROGEN CONCENTRATION | (% LFL) | 0 | 30000 - 38000 |
| VOC CONCENTRATION | (PPM) | 0 | 340 - 400 |
| AMMONIA CONCENTRATION | (PPM) | 0 | 3100 - 3700 |
| CONDENSABLES | (GPM) | - | - |

NOTES:

1. RAW WATER SUPPLY PRESSURE IS 80 - 100 PSI
2. PASSIVE BREATHER FILTER FLOW RATE BASED ON SPP-SEDS, REV. 2 APPENDIX G NORMAL RATE.
3. VENTILATION PARAMETERS BASED ON CALCULATION 100. TEMPERATURES ARE MANUAL.
4. VALUES IN EXHAUSTER TABLES ARE FROM S-112. VALUES FOR S-109 WILL BE DETERMINED.

NORMAL OPERATING CONDITIONS
CLEAN FILTERS FOR EXHAUSTER

| STREAM NUMBER | | 39 | 38 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| STREAM NAME | | AMBIENT INLET FLOW | AMBIENT INFILTRATION | AIR LEAKING TANK | AIR LEAKING DEMISTER | AIR LEAKING HEATER | AIR LEAKING PRE-FILTER | AIR LEAKING 1ST HEPA | AIR LEAKING 2ND HEPA | STACK EXHAUST | RAW WATER |
| TEMPERATURE (NOTE 3) | (DEGREE F) | 70 | 70 | 81 | 91 | 101 | 101 | 101 | 101 | 101 | 40-55 |
| STATIC PRESSURE (NOTE 3) | (IN W.G.) | 0 | 0 | -3.0 | -4.0 | -4.3 | -4.5 | -5.5 | -6.5 | 0 | - |
| AIR FLOW RATE (NOTE 3) | (SCFM) | 250 | 250 | 500 | 500 | 500 | 500 | 500 | 500 | 500 | - |
| RELATIVE HUMIDITY (NOTE 3) | (PERCENT) | 30 | 30 | 100 | 100 | 34 | 34 | 34 | 34 | 34 | - |
| SPECIFIC HUMIDITY (NOTE 3) | (LBM/LBA) | 0.0047 | 0.0047 | 0.0232 | 0.0232 | 0.0232 | 0.0232 | 0.0232 | 0.0232 | 0.0232 | - |
| HYDROGEN CONCENTRATION | (PPM) | 0 | 0 | 4300 | 4300 | 4300 | 4300 | 4300 | 4300 | 4300 | - |
| VOC CONCENTRATION | (PPM) | 0 | 0 | 440 | 440 | 440 | 440 | 440 | 440 | 440 | - |
| AMMONIA CONCENTRATION | (PPM) | 0 | 0 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | - |
| CONDENSABLES | (GPM) | - | - | - | - | - | - | - | - | - | - |

ESSENTIAL DRAWING

U.S. DEPARTMENT OF ENERGY
Office of River Protection

PHASE TWO PROCESS FLOW DIAGRAM

BK NORTON



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**Permit Attachment JJ**

**Figures B-1 and B-4**

The current version of these figures is located in Permit Attachment FF

# Permit Attachment KK

## Appendix B

The current version of this appendix is located in Permit Attachment FF

# Permit Attachment LL

## Appendix B

The current version of this appendix is located in Permit Attachment FF

Rev. 0, October 31, 2005

# Permit Attachment KK Tank Management

# Appendix 4 Secondary Waste System

# Attachment KK Tank Management

## Appendix 4 Secondary Waste System

CONTENTS

Section 1 Supporting Calculations with Drawings

Section 2 Independent Qualified Registered professional Engineer Design Assessment Reports

Section 3 Drawings

Section 4 Engineering Change Notices

Section 5 Specifications

Section 6 Corrosion Review

# Permit Attachment KK Tank Management

## Appendix 4 Secondary Waste System

### Section 1 Supporting Calculations with Drawings

145579-C-CA-009, Rev 1, PC-1 Basic Foundations[a]
145579-D-CA-019, Rev A, DBVS Hose-in-Hose Transfer Line Heat Trace Calculation[b]
145579-D-CA-031, Rev B, DBVS Detectable Leak Volume for the Secondary Waste System
145579-A-CA-005, Rev. A, Full DBVS Process Mass Balance Conversion (Tri-Mer Scrubber Operations)
145579-D-CA-049, Rev. 0, DBVS Secondary Waste Storage Tank Heater Sizing.

[a] Calculation 145579-C-CA-009 is located in Permit Attachment KK, Appendix 1, Section 1.

[b] Calculation 145579-D-CA-019 is located in Permit Attachment KK, Appendix 2, Section 1.

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**CALCULATION COVER SHEET** **Date: 03/08/05**

**Calculation No:** 145579-D-CA-031
**Calculation Title:** DBVS Detectable Leak Volume for the Secondary Waste System
**Project No. & Title:** 145579 DBVS, Demonstration Bulk Vitrification System
**Design Verification Required:** ☐ Yes ☒ No
**Calculation Type:** ☐ Scoping ☒ Preliminary ☐ Final
☐ Superseded by Calculation No: _____ ☐ Voided

***ORIGINAL AND REVISED CALCULATION/ANALYSIS APPROVAL***

| | Rev. A Printed Name/Signature/Initials/D | Rev. B Printed Name/Signature/Initials/D | Rev. __ Printed Name/Signature/Initials/ |
|---|---|---|---|
| Originator: | John J Irwin | John J Irwin JJI 3/8/05 | |
| Checked By: | Charles E. Grenard | Charles E. Grenard CEG 3/8/05 | |
| Approved By: | | | |
| Other: | | | |

***AFFECTED DOCUMENTS***

| Document Number | Document Title | Rev. Number | Responsible Discipline Lead Initials |
|---|---|---|---|
| | | | |
| | | | |
| | | | |

***RECORD OF REVISION***

| Rev. | Reason for Revision |
|---|---|
| A | Initial review |
| B | Incorporated Reviewer comments |
| | |

***ATTACHMENTS***

| Attachments | Title | Total Pages |
|---|---|---|
| A | DBVS P&IDs | 2 |
| B | DBVS Piping Layouts | 1 |
| C | DBVS Mechanical Layouts (M101, etc, ) | 3 |
| D | 145579-D-SP-010, Appendix C | 2 |
| | | |

***TOTAL CALCULATION PAGE COUNT 16***

Form EP 3.3-2F, Sept 2002

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CALCULATION SHEET

Date: 03/08/05

| | |
|---|---|
| Calculation No. 145579-D-CA-031 | |
| Rev. No. B | ORIGINATOR: J. J. Irwin |
| Calculation Title: DBVS Detectable Leak Volume for the Secondary Waste System | CHECKER: C. E. Grenard |

## 1.0 Introduction

### 1.1 Purpose

The purpose of this calculation is to determine the maximum credible fluid volumes for leaks in the primary piping or secondary waste storage tanks in the DBVS Secondary Waste System (SWS). The SWS is comprised of six tank skids a pump/process piping skid and interconnecting transfer lines between the skids and the DBVS dryer, OGTS scrubber and OGTS Tri-Mer skid. Each tank skid, pump skid and interfacing system contains interface piping connection points. Connection between skids and tanks is made by hose-in-hose transfer lines (HIHTLs).

### 1.2 Scope

The scope of this calculation is to determine the maximum credible fluid volumes resulting from a leak in the primary piping or secondary waste storage tank prior to a leak detection alarm. A potential leak into the SWS loadout station berm is not covered in this calculation as there is no leak detection instrument in the berm and this off-normal event requires an operator response.

For the purpose of this report, leaks are assumed to occur at the following locations:

1. At one of the secondary waste storage tanks,
2. At the DBVS dryer to secondary waste storage tank HIHTL at the dryer connection point,
3. At the DBVS OGTS scrubber to secondary waste storage tank HIHTL at the scrubber connection point,
4. At the DBVS PGTS Tri-Mer to secondary waste storage tank HIHTL at the scrubber connection point,
5. At the DBVS secondary waste storage tank recycle line to secondary waste pump skid HIHTL at the storage connection point (flow is back to the pump skid),
6. At the DBVS secondary waste storage tank outlet to secondary waste pump skid HIHTL at the pump skid connection point (flow is back to the storage tank),

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CALCULATION SHEET

Date: 03/08/05

| | |
|---|---|
| Calculation No. 145579-D-CA-031 | |
| Rev. No. B | ORIGINATOR: J. J. Irwin |
| Calculation Title: DBVS Detectable Leak Volume for the Secondary Waste System | CHECKER: C. E. Grenard |

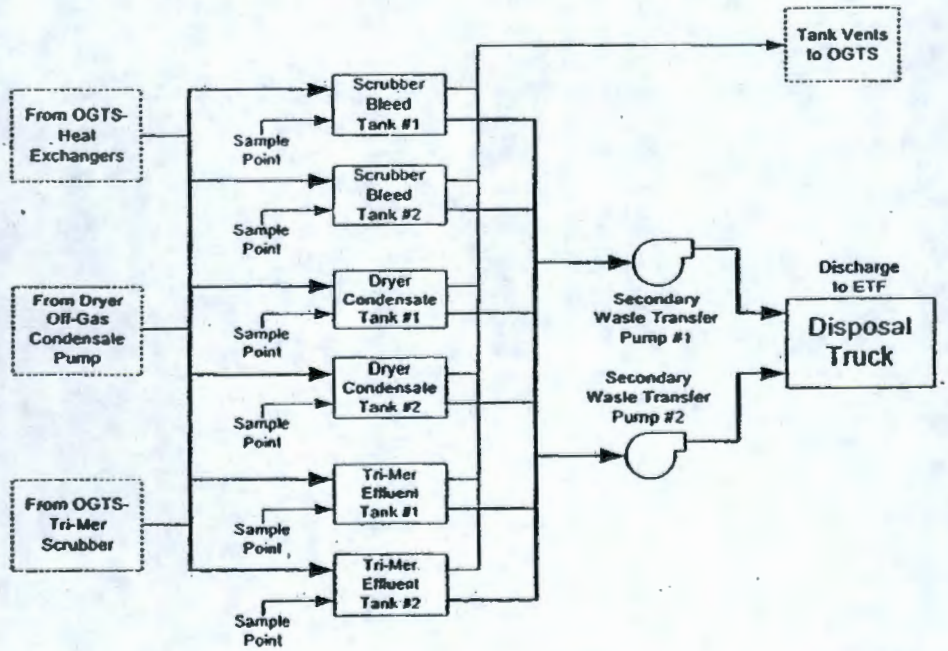
7. At the DBVS secondary waste load-out line to secondary waste pump skid HIHTL at the load-out station connection point (flow is back to the pump skid).

## 2.0 Basis

### 2.1 Design Inputs

The fluid flow network for the SWS system is depicted in Figure 1. A discrete depiction of the fluid leak paths are listed in Table 1.

Figure 1. SWS Conceptual Flow Schematic



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CALCULATION SHEET

Date: 03/08/05

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|---|---|
| Calculation No. 145579-D-CA-031 | |
| Rev. No. B | ORIGINATOR: J. J. Irwin |
| Calculation Title: DBVS Detectable Leak Volume for the Secondary Waste System | CHECKER: C. E. Grenard |

**Table 1. SWS Fluid Leak Configurations**

| Input Description | Reference Dimensions | Reference Location |
|---|---|---|
| SWS secondary waste storage tank, front valve secondary containment housing | 9.25 inch wide by 36 inch long | F-145579-37-D-0006 |
| SWS waste transfer pump skid, equipment room | 7.65 ft wide by 19.66 ft long | DBVS-SK-M001 |
| 2 inch HIHTL, 2-PDC-33-0154, dryer condensate feed to secondary waste storage tank | 333 ft Long(1) | 145579-D-SP-010, Appendix C |
| 2 inch HIHTL, 2-PSS-36-0311,OGTS Scrubber tank to secondary waste storage tank | 130 ft Long(1) | 145579-D-SP-010, Appendix C |
| 2 inch HIHTL, 2-PTS-36-0320, OGTS Tri-Mer skid to secondary waste storage tank | 134 ft Long(1) | 145579-D-SP-010, Appendix C |
| 2 inch HIHTL, 2-PSW-37-0351, secondary waste storage tank to secondary waste pump skid recycle line | 19 ft Long(1) | 145579-D-SP-010, Appendix C |
| 2 inch HIHTL, 2-PSW-37-0355, secondary waste pump skid inlet from secondary waste storage tank | 57.5 ft Long(1) | 145579-D-SP-010, Appendix C |
| 2 inch HIHTL, 2-PSW-37-0354, secondary waste pump skid outlet to load-out station | 73.5 ft Long(1) | 145579-D-SP-010, Appendix C |
| Height of liquid in secondary waste storage tank front valve secondary containment housing to cause leak alarm | 1 inch | F-145579-37-D-0006 |

Notes:
1) The 2 inch HIHTL contains a 2.0 inch OD primary and a 4 inch ID Secondary.

## 2.2 Criteria

There are no pre-determined acceptance criteria.

## 2.3 Assumptions

The assumptions used in the calculation are as stated below and within the body of the calculation and/or attachments.

1. The piping flow arrangements are determined form the system P&IDs (Attachment A and the piping layout drawings (Attachment B).

2. Main process piping external to the waste transfer pump skid or secondary waste storage tanks are Hose-in Hose Transfer Lines (HIHTLs). Hose lengths are

determined from the DBVS site layout drawings, HIHTL technical specification and are assumed to be bounding (Attachment B). Drain slopes in the HIHTLs are as specified on the P&IDs (Attachment A).

3. The secondary waste storage tank and outlet valve housing dimensions are determined from drawing F-145579-37-D-0003 and F-145579-37-D-0006 (Attachment C). The storage tank secondary was assumed to have inside dimensions of 10 ft wide by 40 ft long. The secondary tank is conservatively assumed to be a flat rectangular structure.

4. The SWS waste transfer pump skid enclosure outer dimensions are determined from drawing DBVS-SK-M001 (Attachment C). The container inside dimensions are based upon an assumption of 2 inches of insulation on the inside walls of the container.

5. A leak originating in the primary of the storage tank covers the bottom of annular region between the inner and outer tank before draining through a penetration to the tank outlet secondary housing..

6. Fluid leaks into the annulus of the secondary waste storage tank fills the secondary tank bottom to a depth of ¼ inch before draining to the tank outlet secondary enclosure. The fluid then fills the secondary enclosure to a depth of 1 inch.

7. A leak originating in the primary of a HIHTL fills the annular region between the inner and outer hose before draining through a connection point penetration assembly to either to the tank secondary or the waste transfer pump skid. The HIHTL leak is assumed to result from a complete rupture of the primary.

8. Fluid leaking into the waste transfer pump skid covers the catch basin to a depth of ¼ inch before draining to the skid's leak detector sump. Note that the secondary waste pump skid is required to be designed to drain any freestanding liquids in the container to a floor sump (see 145579-D-SP-011, Section 3.1.2.3). The floor sump will be designed to collect liquids drained to it such that 1.5 gallons of liquid in the sump will activate the leak detector.

## 3.0 References

145579-D-SP-010, Hose-In-Hose Transfer Line Assemblies, Rev. 0, DMJM, December, 2004.

145579-D-SP-011, Secondary Waste Pump Skid, Rev. 0, DMJM, November, 2004.

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Date: 03/08/05

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|---|---|
| Calculation No. 145579-D-CA-031 | |
| Rev. No. B | ORIGINATOR: J. J. Irwin |
| Calculation Title: DBVS Detectable Leak Volume for the Secondary Waste System | CHECKER: C. E. Grenard |

145579-D-SP-031, Secondary Waste Storage Tanks, Rev. 0, AMEC, November, 2004.

F-145579-00-P-0008, Revision C, Sheet 1, "Bulk Vitrification Secondary Piping Layout" (Attachment B)

F-145579-37-0100, Revision 0A, Sheet 1, "Bulk Vitrification Secondary Waste Pump Skid/ Loadout P&ID" (Attachment A).

F-145579-37-0101, Revision 0A, Sheet 1, "Bulk Vitrification Secondary Waste Storage P&ID" (Attachment A).

F-145579-37-D-0003, Revision C, Sheet 1, "Bulk Vitrification Secondary Waste Tank Assembly and Nozzle Arrangement" (Attachment C)

F-145579-37-D-0006, Revision B, Sheet 1, "Bulk Vitrification Secondary Containment Details" (Attachment C)

DBVS-SK-M001, Revision G, Sheet 1, "Bulk Vitrification Secondary Waste Pump Skid Container Interfaces." (Attachment C)

## 4.0 Methods

Standard mathematical expressions are utilize to calculate the volumes in the annulus of the HIHTLs, the secondary tank bottom, the tank outlet housing or the secondary waste pump skid catch pan.

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|---|---|
| Calculation No. 145579-D-CA-031 | |
| Rev. No. B | ORIGINATOR: J. J. Irwin |
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## 5.0 Results and Conclusions

The results of the calculation are presented in Table 2.

**Table 2. Calculated Fluid Volume to Leak Detection for Postulated SWS Leaks**

| Scenario | Fluid volume, gallons |
|---|---|
| 1) Leak from secondary waste storage tank, fluid in secondary tank and outlet housing | 63.8 |
| 2) Leak from dryer to secondary waste storage tank HIHTL, fluid in HIHTL secondary, secondary tank and outlet housing | 226.8 |
| 3) Leak from OGTS scrubber to secondary waste storage tank HIHTL, fluid in HIHTL secondary, secondary tank and outlet housing | 127.4 |
| 4) Leak from OGTS Tri-Mer to secondary waste storage tank HIHTL, fluid in HIHTL secondary, secondary tank and outlet housing | 129.4 |
| 5) Leak from secondary waste recycle line to waste transfer pump skid HIHTL, fluid in HIHTL secondary and waste transfer pump skid catch pan and sump | 34.2 |
| 6) Leak from secondary waste pump skid to secondary waste storage tank HIHTL, fluid in HIHTL secondary and secondary tank outlet housing | 29.6 |
| 7) Leak from secondary waste load-out line to waste transfer pump skid HIHTL, fluid in HIHTL secondary and waste transfer pump skid catch pan and sump | 60.9 |

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|---|---|
| Calculation No. 145579-D-CA-031 | |
| Rev. No. B | ORIGINATOR: J. J. Irwin |
| Calculation Title: DBVS Detectable Leak Volume for the Secondary Waste System | CHECKER: C. E. Grenard |

## 6.0 Calculations and Analysis

Using standard mathematical techniques the volumes of simple geometries can be calculate for the various elements of the SWS components. Table 3 lists the results of the fluid volume calculations.

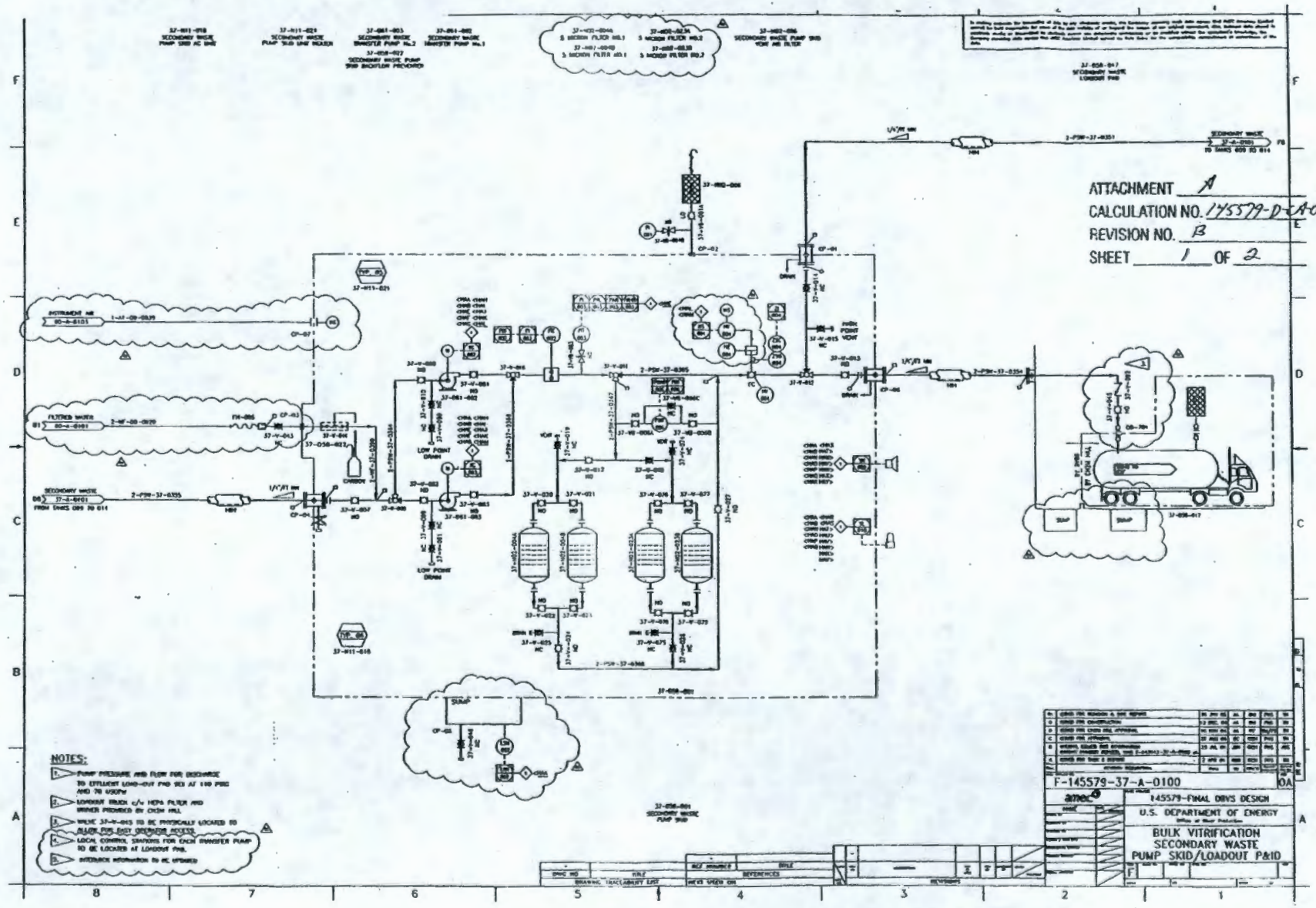
**Table 3. Calculated Fluid Volumes for SWS Components**

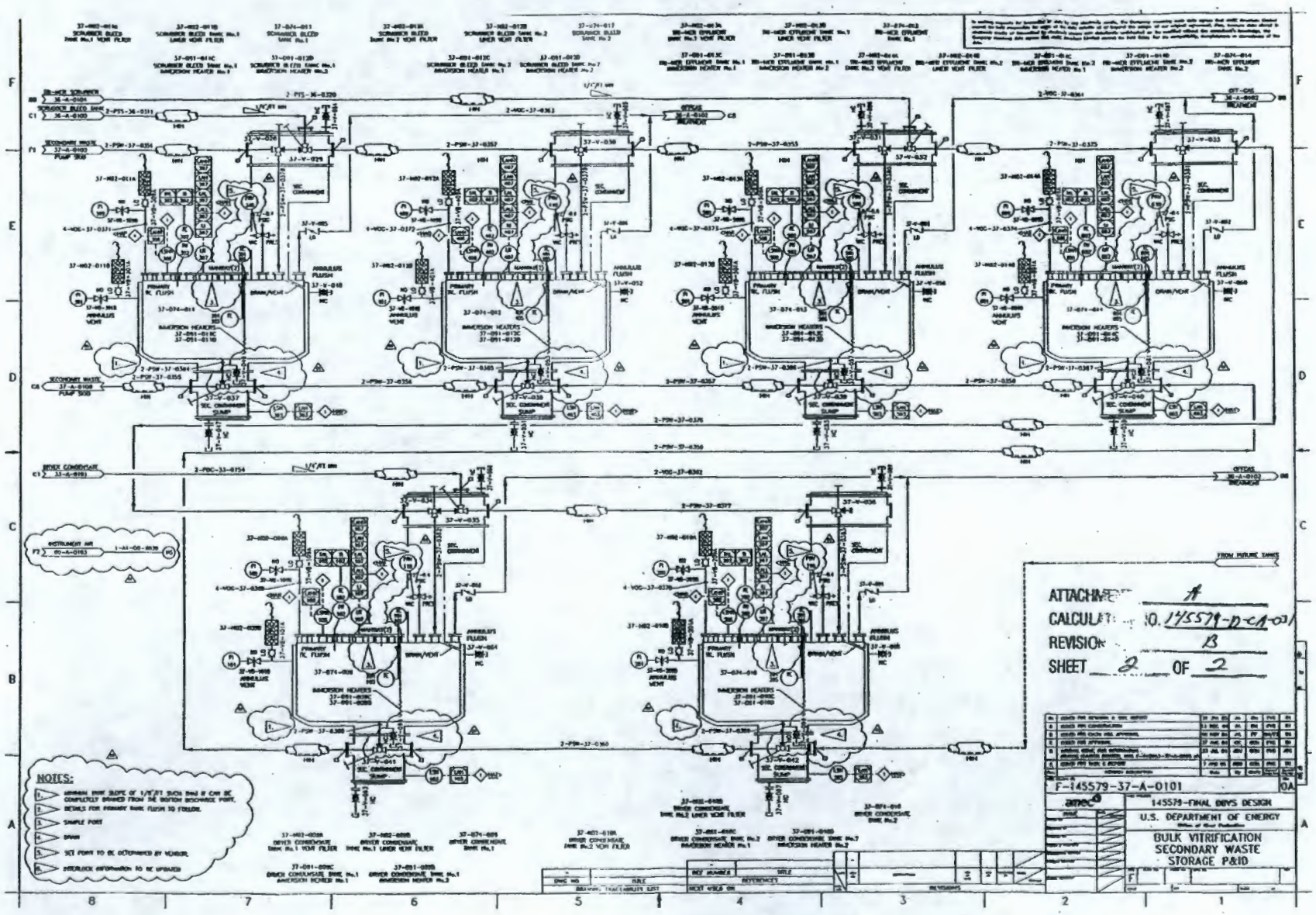
| SWS component | Volume, cu.ft. | Volume, gallons |
|---|---|---|
| SWS Secondary waste storage tank, secondary tank bottom at ¼ inch depth | 8.33 | 62.34 |
| SWS Secondary waste storage tank, Tank Outlet Secondary Enclosure Assembly at 1 inch depth | 0.19 | 1.44 |
| SWS Waste transfer pump skid, Equipment Room catch pan at ¼ inch depth | 3.05 | 23.45 |
| SWS Waste transfer pump skid leak detector sump | NA | 1.5 |
| 2 inch HIHTL, 2-PDC-33-0154, dryer condensate feed to secondary waste storage tank | 21.79 | 163.04 |
| 2 inch HIHTL, 2-PSS-36-0311,OGTS Scrubber tank to secondary waste storage tank | 8.51 | 63.65 |
| 2 inch HIHTL, 2-PTS-36-0320, OGTS Tri-Mer skid to secondary waste storage tank | 8.77 | 65.61 |
| 2 inch HIHTL, 2-PSW-37-0351, secondary waste storage tank to secondary waste pump skid recycle line | 1.24 | 9.30 |
| 2 inch HIHTL, 2-PSW-37-0355, secondary waste pump skid outlet to secondary waste storage tank | 3.76 | 28.15 |
| 2 inch HIHTL, 2-PSW-37-0354, secondary waste pump skid load-out line to load-out station | 4.81 | 36.0 |

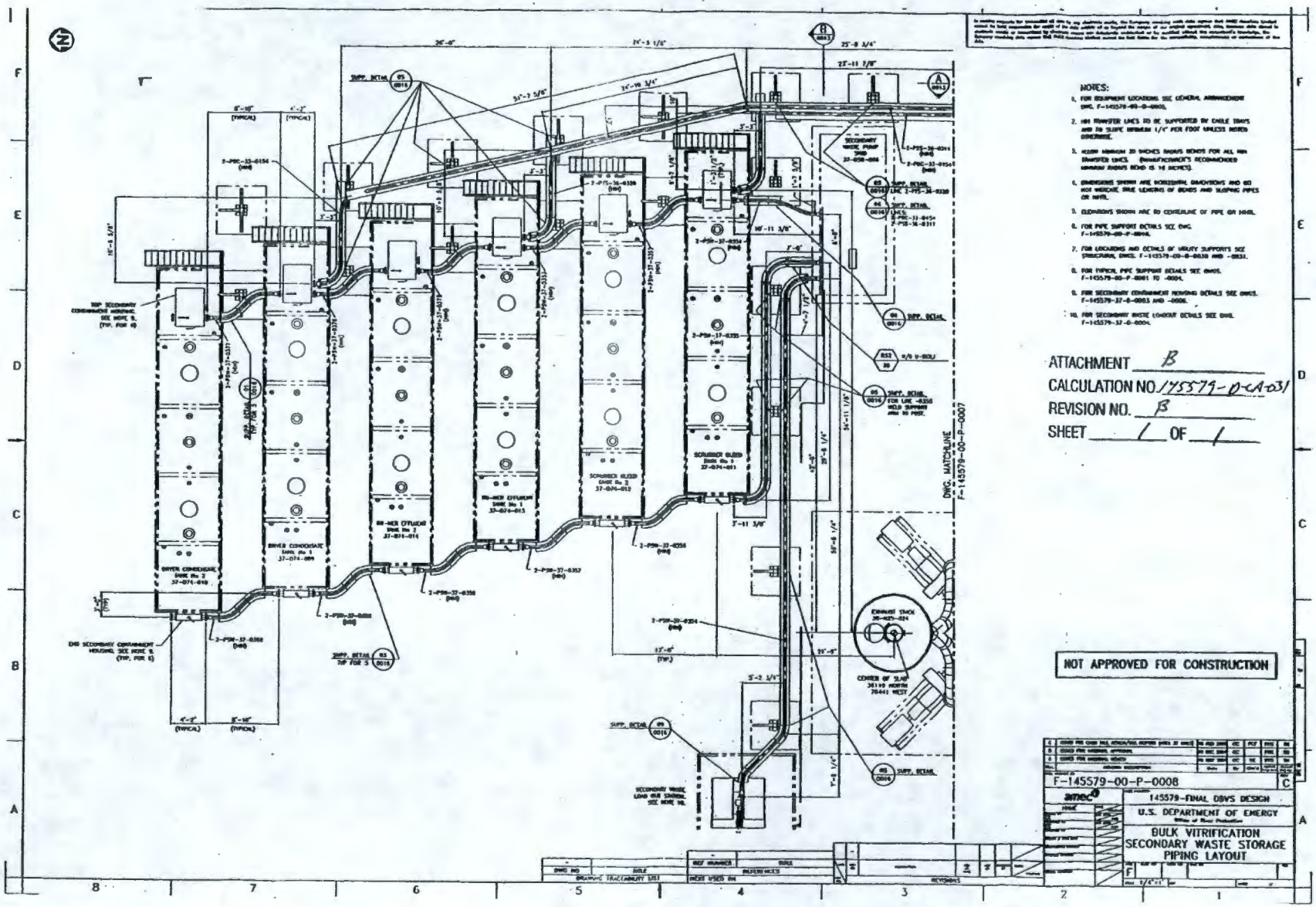
Notes:
1) Volume of a rectangular enclosure is width x length x height of fluid
2) Volume of a cylindrical annulus is Pi x (D2^2 – D1^2)/4 * length of fluid
3) Volume of a cylinder is Pi x D1^2/4 * length of fluid

Where:
D2 = ID of HIHTL outer hose, 2.0 inches
D1 = OD of HIHTL inner hose or ID of Flex Line, 4.0 inches
Pi = Approx. 3.14

ATTACHMENT A
CALCULATION NO. 145579-D-A02
REVISION NO. B
SHEET 1 OF 2




ATTACHMENT A
CALCULATION NO. 145579-D-CA-031
REVISION B
SHEET 2 OF 2
F-145579-37-A-0101
145579-FINAL DBVS DESIGN
U.S. DEPARTMENT OF ENERGY
BULK VITRIFICATION
SECONDARY WASTE
STORAGE P&ID
NOTES:


NOTES:
1. FOR EQUIPMENT LOCATIONS SEE GENERAL ARRANGEMENT DWG. F-145579-00-G-0005.
2. NON TRANSFER LINES TO BE SUPPORTED BY CABLE TRAYS AND TO SLOPE MINIMUM 1/4" PER FOOT UNLESS NOTED OTHERWISE.
3. MINIMUM 30 INCHES BRANCH BENDS FOR ALL NON TRANSFER LINES. (MANUFACTURER'S RECOMMENDED MINIMUM BRANCH BEND IS 14 INCHES).
4. DIMENSIONS SHOWN ARE HORIZONTAL DIMENSIONS AND DO NOT INCLUDE RISE LENGTHS OF BENDS AND SLOPING PIPES OR NOTE.
5. ELEVATIONS SHOWN ARE TO CENTERLINE OF PIPE OR HOSE.
6. FOR PIPE SUPPORT DETAILS SEE DWG. F-145579-00-P-0004.
7. FOR LOCATIONS AND DETAILS OF UTILITY SUPPORTS SEE STRUCTURAL DWGS. F-145579-00-S-0030 AND -0031.
8. FOR TYPICAL PIPE SUPPORT DETAILS SEE DWGS. F-145579-00-P-0001 TO -0004.
9. FOR SECONDARY CONTAINMENT REMOVAL DETAILS SEE DWGS. F-145579-37-0-0003 AND -0006.
10. FOR SECONDARY WASTE LOADOUT DETAILS SEE DWG. F-145579-37-0-0004.
ATTACHMENT B
CALCULATION NO. 145579-0-CA-031
REVISION NO. B
SHEET 1 OF 1
NOT APPROVED FOR CONSTRUCTION
DWG. MATCHLINE F-145579-00-P-0007
F-145579-00-P-0008
C
145579-FINAL DBVS DESIGN
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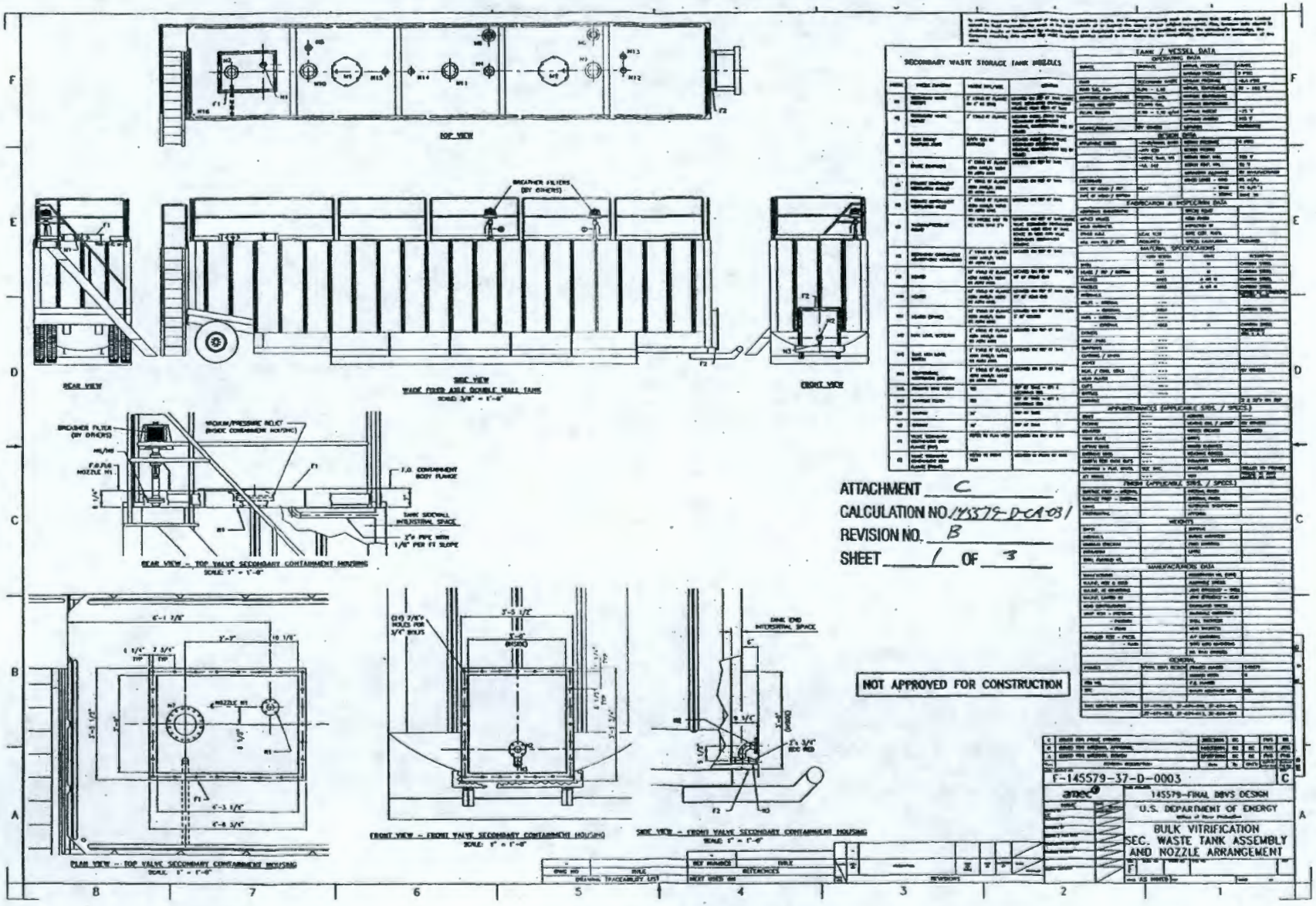
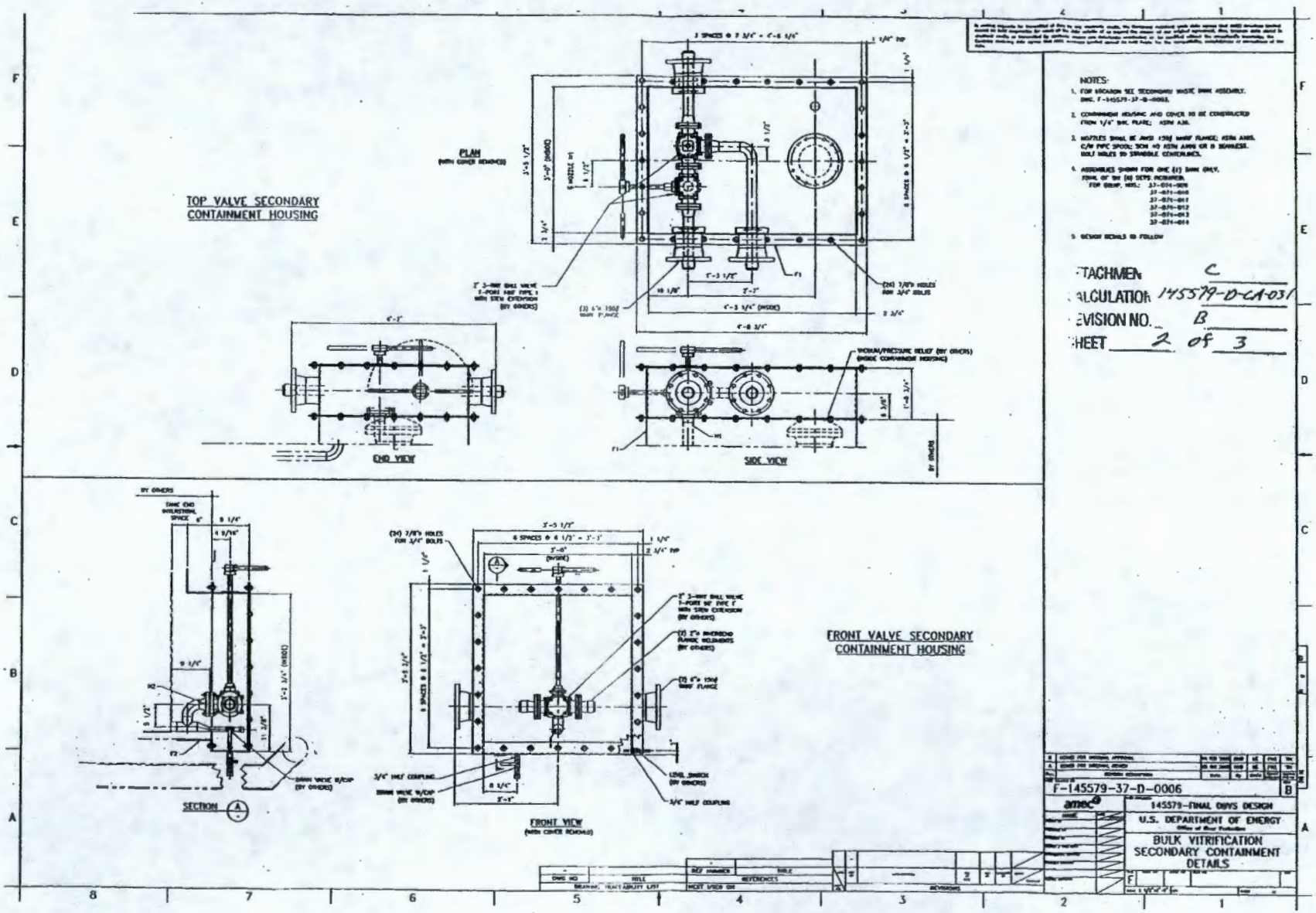
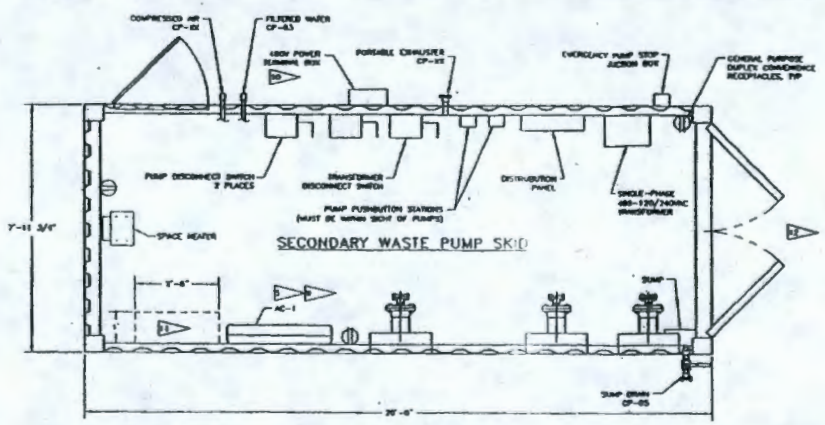
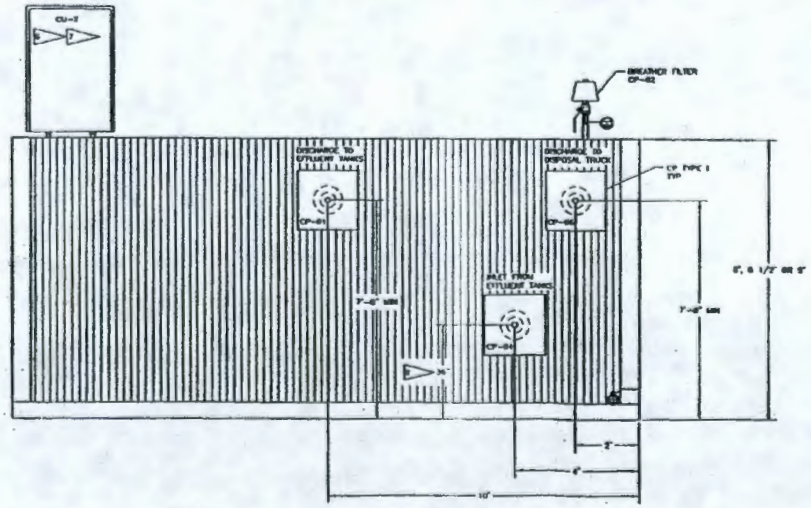
BULK VITRIFICATION
SECONDARY WASTE STORAGE
PIPING LAYOUT


TOP VIEW
REAR VIEW
SIDE VIEW
WIDE FIXED AISLE DOUBLE WALL TANK
FRONT VIEW
REAR VIEW – TOP VALVE SECONDARY CONTAINMENT HOUSING
PLAN VIEW – TOP VALVE SECONDARY CONTAINMENT HOUSING
FRONT VIEW – FRONT VALVE SECONDARY CONTAINMENT HOUSING
SIDE VIEW – FRONT VALVE SECONDARY CONTAINMENT HOUSING
SECONDARY WASTE STORAGE TANK NOZZLES
TANK / VESSEL DATA
DESIGN DATA
FABRICATION & INSPECTION DATA
MATERIAL SPECIFICATIONS
APPURTENANCES (APPLICABLE SHEL / SPECS)
FINISH (APPLICABLE SHEL / SPECS)
WEIGHTS
MANUFACTURING DATA
GENERAL
ATTACHMENT C
CALCULATION NO. 145579-D-CA-031
REVISION NO. B
SHEET 1 OF 3
NOT APPROVED FOR CONSTRUCTION
F-145579-37-D-0003
145579-FINAL DBVS DESIGN
U.S. DEPARTMENT OF ENERGY
BULK VITRIFICATION
SEC. WASTE TANK ASSEMBLY
AND NOZZLE ARRANGEMENT


TOP VALVE SECONDARY CONTAINMENT HOUSING
PLAN
END VIEW
SIDE VIEW
SECTION
FRONT VIEW
FRONT VALVE SECONDARY CONTAINMENT HOUSING
NOTES:
ATTACHMENT C
CALCULATION 145579-D-CA-031
REVISION NO. B
SHEET 2 of 3
F-145579-37-D-0006
145579-FINAL DBVS DESIGN
U.S. DEPARTMENT OF ENERGY
BULK VITRIFICATION SECONDARY CONTAINMENT DETAILS




PLAN VIEW (ROOF REMOVED)




SECONDARY WASTE PUMP SKID INTERFACES

SITE VIEW

GENERAL NOTES:

1. REFERENCE SPECIFICATION 145579-0-SP-001 FOR DESIGN, FABRICATION, DESIGNS AND INSPECTION REQUIREMENTS.
2. DO NOT SCALE. ALL DIMENSIONS ARE IN INCHES AND ARE REFERENCE ONLY UNLESS OTHERWISE SPECIFIED.
3. THIS ARRANGEMENT DRAWING IS FOR ILLUSTRATIVE PURPOSES ONLY. WITH THE EXCEPTION OF THE DISCONNECT SWITCHES AND PUSH BUTTONS, THE LOCATION OF ELECTRICAL EQUIPMENT IS FLEXIBLE, AND SHALL BE DEPENDENT ON MAINTENANCE REQUIREMENTS AND ACTUAL TRAILER CONFIGURATION (SEE SPECIFICATION FOR ELECTRICAL EQUIPMENT MAINTENABILITY REQUIREMENTS).
4. FOR SIMPLICITY AND CLARITY, HEATING AND EXTERNAL LIGHTING AND ASSOCIATED EQUIPMENT ARE NOT SHOWN (SEE SPECIFICATION FOR LIGHTING REQUIREMENTS).
5. MOUNT UNIT PER MANUFACTURERS RECOMMENDATIONS.
6. SEAL REFRIGERANT PIPING AND CONDUIT PENETRATIONS THROUGH CONTAINER WALL WITH RTV. MINIMUM SUCTION LINE WITH 3/4" THICK CLOSED CELL FOAM PIPE INSULATION.
7. MOUNT CONDENSING UNIT ON UNISTRUT CHANNEL WELDED TO ROOF OF CONTAINER.
8. WALL MOUNT AC-1 MINIMUM 6'-0" ABOVE FLOOR.
9. CRITICAL DIMENSION
10. LABEL OUTSIDE OF TRAILER, BOX COVER AS FOLLOWS "CAUTION: THREE 480VAC SOURCES PRESENT."
11. AREA BENEATH THE FIRST HOSE AIR SAMPLER TO BE INSTALLED BY BUYER. AREA SHALL SPAN FROM FLOOR TO 7'-0" ABOVE FLOOR MINIMUM.
12. DOUBLE DOORS MUST BE LOCATED ON OTHER END OF PUMP SKID. FILTERS SHALL BE LOCATED AVOID INSIDE THE DOUBLE DOORS.
13. SEE DRAWING DBVS-SK-W003 FOR CP PENETRATION DETAILS.

ATTACHMENT C
CALCULATION NO. 145579-D-CA-031
REVISION NO. B
SHEET 3 OF 3

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|---|---|
| 145579-FINAL DBVS DESIGN | |
| U.S. DEPARTMENT OF ENERGY | |
| SECONDARY WASTE PUMP SKID CONTAINER INTERFACES | |
| F | DBVS-SK-W001 B |

A ISSUED FOR COMMENT

CH2M Technology

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TECHNICAL SPECIFICATION

| | | | |
|---|---|---|---|
| PROJECT: | Final DBVS Design | 145579-D-SP-010 | REV. 0 |
| PROJECT NO.: | 145579 | HOSE-IN-HOSE TRANSFER LINE ASSEMBLIES | |
| CLIENT: | AMEC E&E - Richland, Washington | | |

Appendix C

Hose Assembly List

(2 pages including cover)

ATTACHMENT D

CALCULATION NO. 145579-D-CA-031

REVISION NO. B

SHEET 1 OF 2





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## TECHNICAL SPECIFICATION

| | | | |
|---|---|---|---|
| PROJECT: | Final DBVS Design | 145579-D-SP-010 | ATTACHMENT 13 REV. 0 |
| PROJECT NO.: | 145579 | HOSE-IN-HOSE TRANSFER LINE ASSEMBLIES | CALCULATION NO. 145579-0-CA-031 REVISION NO. B |
| CLIENT: | AMEC E&E - Richland, Washington | | SHEET 2 OF 2 |

| Item No. | Hose No. (Line No.) | Start Connection Type | Start Connection Size | Start Connection Rating | End Connection Type | End Connection Size | End Connection Rating | Hose Length | Hose Orientation | Hose Location |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2-PLW-32-0101 | CP-11 | Sliding | 2 | Top Sec. Contain. Housing | Rigid | 16 | 35'-0" | A to B | Note 3 |
| | 2-PLW-32-0102 | CP-08 | Sliding | 2 | CP-301 | Sliding | 2 | 37'-0" | A to B | Note 3 |
| | 2-PLW-32-0103 | End Sec. Contain. Housing | Sliding | 16 | CP-09 | Sliding | 2 | 74'-0" | A to B | Note 3 |
| | 2-PLW-32-0108 | CP-302 | Sliding | 2 | Top Sec. Contain. Housing | Rigid | 16 | 74'-0" | A to B | Note 3 |
| | 2-PLW-32-0119 | Top Sec. Contain. Housing | Rigid | 16 | Top Sec. Contain. Housing | Rigid | 16 | 8'-6" | A to B | Note 3 |
| | 2-PLW-32-0120 | Top Sec. Contain. Housing | Rigid | 16 | Top Sec. Contain. Housing | Rigid | 16 | 8'-6" | A to B | Note 3 |
| | 2-PLW-32-0121 | Top Sec. Contain. Housing | Rigid | 16 | Top Sec. Contain. Housing | Rigid | 16 | 8'-6" | A to B | Note 3 |
| | 2-PLW-32-0122 | Top Sec. Contain. Housing | Rigid | 16 | Top Sec. Contain. Housing | Rigid | 16 | 8'-6" | A to B | Note 3 |
| | 2-PLW-32-0123 | End Sec. Contain. Housing | Rigid | 16 | End Sec. Contain. Housing | Rigid | 16 | 8'-6" | A to B | Note 3 |
| | 2-PLW-32-0124 | End Sec. Contain. Housing | Rigid | 16 | End Sec. Contain. Housing | Rigid | 16 | 8'-6" | A to B | Note 3 |
| | 2-PDC-33-0154 | CP-303 | Sliding | 2 | Top Sec. Contain. Housing | Sliding | 2 | 333'-0" | A to B | Note 3 |
| | 2-PSS-36-0311 | | Sliding | 2 | Top Sec. Contain. Housing | Sliding | 2 | 130'-0" | A to B | Note 3 |
| | 2-PTS-36-0328 | Pump Disch. Nozzle | Sliding | 2 | Top Sec. Contain. Housing | Sliding | 2 | 134'-0" | A to B | Note 3 |
| | 2-PSW-37-0354 | CP-01 | Sliding | 2 | Top Sec. Contain. Housing | Sliding | 2 | 19'-0" | A to B | Note 3 |
| | 2-PSW-37-0362 | Top Sec. Contain. Housing | Rigid | 5 | Top Sec. Contain. Housing | Sliding | 2 | 10'-6" | A to B | Note 3 |
| | 2-PSW-37-0363 | Top Sec. Contain. Housing | Rigid | 5 | Top Sec. Contain. Housing | Sliding | 2 | 10'-6" | A to B | Note 3 |
| | 2-PSW-37-0364 | CP-06 | Sliding | 2 | Conn. At Loadout Area | Sliding | 2 | 73'-6" | A to B | Note 3 |
| | 2-PSW-37-0365 | End Sec. Contain. Housing | Sliding | 2 | CP-04 | Sliding | 2 | 57'-6" | A to B | Note 3 |
| | 2-PSW-37-0366 | End Sec. Contain. Housing | Rigid | 5 | End Sec. Contain. Housing | Sliding | 2 | 10'-6" | A to B | Note 3 |
| | 2-PSW-37-0367 | End Sec. Contain. Housing | Rigid | 5 | End Sec. Contain. Housing | Sliding | 2 | 10'-6" | A to B | Note 3 |
| | 2-PSW-37-0368 | End Sec. Contain. Housing | Rigid | 5 | End Sec. Contain. Housing | Sliding | 2 | 10'-6" | A to B | Note 3 |
| | 2-PSW-37-0369 | End Sec. Contain. Housing | Rigid | 5 | End Sec. Contain. Housing | Sliding | 2 | 10'-6" | A to B | Note 3 |
| | 2-PSW-37-0370 | End Sec. Contain. Housing | Rigid | 5 | End Sec. Contain. Housing | Sliding | 2 | 10'-6" | A to B | Note 3 |
| | 2-PSW-37-0375 | Top Sec. Contain. Housing | Rigid | 5 | Top Sec. Contain. Housing | Sliding | 2 | 10'-6" | A to B | Note 3 |
| | 2-PSW-37-0376 | Top Sec. Contain. Housing | Rigid | 5 | Top Sec. Contain. Housing | Sliding | 2 | 10'-6" | A to B | Note 3 |
| | 2-PSW-37-0377 | Top Sec. Contain. Housing | Rigid | 5 | Top Sec. Contain. Housing | Sliding | 2 | 10'-6" | A to B | Note 3 |

NOTES
1. See DBVS-SK-M106 for specifics on end connector type.
2. For dimensions of 16", Seller shall lengthen primary hose as needed to meet requirement.
3. Seller shall identify on fabrication schedule when location information is needed.





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**Figure 1. Subcontractor Calculation Review Checklist.**

Page 1 of 1

Subject: DBVS Detectable Leak Volume for the Secondary Waste System

**The subject document has been reviewed by the undersigned.**
**The checker reviewed and verified the following items as applicable.**

Documents Reviewed: 145570-D-CA-031 Rev. B

Analysis Performed By: Thomas H May

- Design Input
- Basic Assumptions
- Approach/Design Methodology
- Consistency with item or document supported by the calculation
- Conclusion/Results Interpretation
- Impact on existing requirements
- _____

Checker (printed name, signature, and date) Thomas H May 4/21/05
Thomas H May

Organizational Manager (printed name, signature and date)
David H Shuford David H Shuford 4/21/05

The following correction need to be made to the text:

1. Calculation needs to be signed by organizational manager

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# CALCULATION SHEET

CALC. NO.: 145579-A-CA-005 REV: A DATE: April 12, 2005

CALC. TITLE: Full DBVS Process Mass Balance Conversion (Tri-Mer Scrubber Operating)

PROJECT NO.: 145579 PROJECT TITLE: Final DBVS Design

Design Verification Required: ☐ Yes ☐ No

Calculation Type: ☐ Scoping ☐ Preliminary ☒ Final

Superseded by Calculation No.: ☐ Voided

## ORIGINAL AND REVISED CALCULATIONS/ANALYSIS APPROVAL

| REV. | ORIGINATOR: | DATE: | CHECKED: | DATE: | APPROVED | DATE |
|---|---|---|---|---|---|---|
| A | Khosrow Nikkhah | 12-Apr-05 | Rusty Craft | 12-Apr-05 | J. Heim | 14 Apr 05 |
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## AFFECTED DOCUMENTS

| DOCUMENT NUMBER: | TITLE: | REV. NO.: | DISC. LEAD INITIALS |
|---|---|---|---|
| F-145579-00-A-0030 | Full DBVS Feed Preparation and Melt (Tri-Mer Operating) | F | KN |
| F-145579-00-A-0031 | Full DBVS Trailer Off-Gas Treatment (Tri-Mer Operating) | F | KN |
| F-145579-00-A-0032 | Full DBVS Tri-Mer Scrubber (Tri-Mer Operating) | F | KN |
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## RECORD OF REVISION

| REV. NO. | REASON FOR REVISION: |
|---|---|
| A | Issued for CH2 Review / 90% Report |
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## ATTACHMENTS

| DOCUMENT NUMBER/ID: | TITLE: | TOTAL PAGES |
|---|---|---|
| Attachment 1 | Demonstration Bulk Vitrification System (DBVS) Mass Balance (Tri-mer Operationg) | 46 |
| Attachment 2 | IDEAS Stream Data | 8 |
| | | |
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## LIST OF TERMS

| | |
|---|---|
| _aq | aqueous phase |
| ACF | absolute cubic feet |
| ACFM | absolute cubic feet per minute |
| °C | degrees Celsius |
| Ci | Curie |
| DBVS | Demonstration Bulk Vitrification System |
| °F | degrees Fahrenheit |
| $ft^3$ | cubic feet |
| _g | gaseous phase |
| g/mL | grams per milliliter |
| gal | gallons |
| h | hour |
| in | inch |
| ICV | In-Container Vitrification |
| kg | kilogram |
| kPa | kilopascals |
| _l | liquid phase |
| lbs | pounds |
| lbs/hr | pounds per hour |
| lbs/yr | pounds per year |
| M | Molar |
| $m^3$ | cubic meters |
| $mg/m^3$ | milligram per cubic meter |
| N | Normal |
| OGTS | Off-Gas Treatment System |
| PCB | Poly Chlorinated Biphenyls |
| ppb | parts per billion |
| ppm | parts per million |
| ppmV | parts per million volume |
| _s | solid phase |
| SpG | Specific Gravity |
| TOC | Total Organic Carbon |
| USGPM | US gallons per minute |
| WG | Water Gauge |

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## 1.0 EXECUTIVE SUMMARY

This Mass Balance Document is for a demonstration plant that is to be operated under a Research, Development and Demonstration (RDD) permit. The Demonstration Bulk Vitrification System (DBVS) processes a liquid salt solution originating from Tank S-109. It converts this low-activity mixed waste into solid glass form by mixing the waste with soil and glass Former additives and melting it with an electric current. The target is to treat 0.76 USGPM of 5 molar sodium (M Na) Hanford low-activity waste. About 13,170 gallons waste solution will be processed in one melt box. The DBVS is comprised of the following process systems:

- Clean Soil and Glass Formers
- Liquid Waste
- Dryer
- Dryer-to-Box
- ICV™ Box
- Off-Gas Treatment

An Excel®[1] spreadsheet (Attachment #1) has been developed to convert the IDEAS™ software continuous and steady state mass balance outputs for the DBVS, when the back-up Tri-Mer scrubber is operating. The goal is to generate both batch and design flow rates and concentrations that describe the DBVS process and can be used in a satisfactory fashion for DBVS process design. It is intended that the modified spreadsheet outputs will be used in conjunction with the process flow diagrams (PFDs) to provide the basis of the DBVS process design information for the alternate operation of the DBVS when the SCR is not operating and the Tri-Mer scrubber is on-line in its place.

[1] Excel® is a registered trademark of Microsoft Corporation, Redmond, Washington.

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## 2.0 INTRODUCTION

An Excel® spreadsheet has been developed to take in the IDEAS™ Software outputs and where necessary modify them to present an accurate mass and heat balance for the DBVS process in which some unit operations work on a batch basis while others (such as the off-gas treatment system) work continuously.

This document provides a detailed cell-by-cell description of the aforementioned spreadsheet so that it can be understood and verified by others.

## 3.0 SCOPE

The scope of this simple spreadsheet includes the converting of mass balance software outputs to provide stream characteristics as well as continuous and design flow rates. This information t is used for inclusion on the DBVS PFDs.

## 4.0 BACKGROUND

The Process Design Criteria items that are not themselves calculated, serve as the input source of the IDEAS™ heat and mass balance software model. This computer model generates a continuous steady state mass balance. The aforementioned Excel® spreadsheet takes these outputs and generates the information that is necessary for process design in various areas of the DBVS. This information is described in detail in the following sections.

## 5.0 METHODOLOGY

This Excel® spreadsheet consists of several input and calculation worksheets. The input worksheets gather all the process input data that are to be used in calculation worksheets. The calculation worksheets in turn present the process stream characteristics and flows for inclusion in the PFDs. The calculations involved are comprised of simple conversions of mass balance software outputs to different units or using the software outputs to calculate component and elemental concentrations and flow rates.

A more extensive mass balance worksheet is used to display the detailed process heat and mass balance, while information is also calculated and gathered in more summarized form to accompany each of the PFDs.

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## 5.1 SPREADSHEET

The Excel® spreadsheet described above consists of 13 different worksheet pages and are listed as follows:

- Notes
- IDEAS Stream Data
- Stream Analyzer Data
- Rad Conc ppb
- Stream Pressures
- Inputs
- Mass Balance
- PFD 30
- PFD 31
- PFD 32

The first spreadsheet page titled "Notes" contains helpful and informative notes by the author and does not in any way interact with other worksheets in the Excel® file.

The next three spreadsheet pages ("IDEAS Stream Data", "Stream Analyzer Data" and "Rad Conc ppb") contain information, which is directly imported from the IDEAS™ software modules that track the stream flow rates and component concentrations and record them.

These spreadsheet pages only contain data and therefore no calculations or formulae can be found in them. In fact, in the earlier phases of this project, these spreadsheets were intended to be used directly as the mass balance tables that would accompany the PFDs. Because the project requirements continued to change and develop over the course of time, it was decided to use simple calculations to represent this data in the project specific forms and units.

The worksheet page "Stream Pressures" is where the stream pressure values in inches of WG are recorded. These pressures are based on pressure calculations performed in calculation document 145579-V-CA-002 (Reference #1). In this spreadsheet, stream pressures are converted to kPa units for inclusion in the IDEAS™ software, where stream pressure impacts the gaseous volumetric flow rates.

The worksheet page "Inputs" has in it all the input process design criteria and unit conversions used in all of the worksheets with calculations.

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Spreadsheet calculations are mainly limited to the "Mass Balance" calculation worksheet and the six PFD worksheet pages that are used in the PFDs.

### 5.1.1 IDEAS Stream Data

This page in the spreadsheet carries the following information based on the corresponding IDEAS™ software output:

- Row 2 = Stream No.
- Row 3 = Stream Name
- Row 4 = Solids, kg/h
- Row 5 = Solution, kg/h
- Row 6 = Stream, kg/h
- Row 7 = Solution, $m^3/h$
- Row 8 = Vapor, $Nm^3/h$
- Row 9 = Stream, $m^3/h$
- Row 10 = Solids SpG
- Row 11 = Solution SpG
- Row 12 = Stream SpG
- Row 13 = Solids content, Mass %
- Row 14 = Temperature, °C
- Row 15 = Pressure, kPa
- Row 17 = Solid phase Na, kg/h
- Row 18 = Liquid phase water, kg/h
- Row 19 = Liquid phase Na, kg/h
- Row 20 = Water vapor, kg/h
- Row 21 = Solid phase Na, Mass %

### 5.1.2 Stream Analyzer Data

This page in the spreadsheet carries the analysis of each stream for all possible components in the list below in rows 5 to 114. The values for radionuclides (shown in bold font here) are included in ppb by linking them to the corresponding column in the worksheet "Rad Conc ppb". Values for other components are given in Mass %.

Some radionuclides such as C-14 and H-3 are included in the component list but are currently not part of the project scope and do not show up in the vitrification system.

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- Row 5 = Water_aq
- Row 6 = Steam_g
- Row 7 = N2_g
- Row 8 = O2_g
- Row 9 = Al3+_aq
- Row 10 = Ca2+_aq
- Row 11 = Cl-_aq
- Row 12 = CO3-2-_aq
- Row 13 = Cr2+_aq
- Row 14 = F-_aq
- Row 15 = Fe3+_aq
- Row 16 = K+_aq
- Row 17 = Li+_aq
- Row 18 = Mg2+_aq
- Row 19 = Mn4+_aq
- Row 20 = NH3_aq
- Row 21 = Ni2+_aq
- Row 22 = NO2-_aq
- Row 23 = NO3-_aq
- Row 24 = OH_aq
- Row 25 = Pb2+_aq
- Row 26 = PO4-3-_aq
- Row 27 = Sb5+_aq
- Row 28 = Se6+_aq
- Row 29 = Si4+_aq
- Row 30 = SO4-2+_aq
- Row 31 = Sr2+_s
- Row 32 = C_s
- Row 33 = Na+_aq
- Row 34 = Pu-258_s
- Row 35 = Cs-137_s
- Row 36 = Sr-90_s
- Row 37 = Tc-99_s
- Row 38 = Co-60_s
- Row 39 = Eu-154_s
- Row 40 = Hanford Soil_s
- Row 41 = NO_g

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- Row 42 = NO2_g
- Row 43 = CO2_g
- Row 44 = HCl_g
- Row 45 = SO2_g
- Row 46 = Na2O_s
- Row 47 = CH4_g
- Row 48 = H2SO4_aq
- Row 49 = HNO3_aq
- Row 50 = Al3+_s
- Row 51 = Ca2+_s
- Row 52 = Cl-_s
- Row 53 = CO3-2-_s
- Row 54 = Cr2+_s
- Row 55 = F-_s
- Row 56 = Fe3+_s
- Row 57 = K+_s
- Row 58 = Li+_s
- Row 59 = Mg2+_s
- Row 60 = Mn4+_s
- Row 61 = Na+_s
- Row 62 = NH3_s
- Row 63 = Ni2+_s
- Row 64 = NO2-_s
- Row 65 = NO3-_s
- Row 66 = OH_s
- Row 67 = Pb2+_s
- Row 68 = PO4-3-_s
- Row 69 = Sb5+_s
- Row 70 = Se6+_s
- Row 71 = Si4+_s
- Row 72 = SO4-2+_s
- Row 73 = Sr2+_s
- Row 74 = HCl_aq
- Row 75 = CaOH2_s
- Row 76 = CaSO4.2H2O_s
- Row 77 = CaCl2_aq
- Row 78 = CaSO4_aq

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- Row 79 = Glass_s
- Row 80 = CO_g
- Row 81 = CaCO3_s
- Row 82 = CaCO3_aq
- Row 83 = H2CO3_aq
- Row 84 = NH3_g
- Row 85 = HF_aq
- Row 86 = HF_g
- Row 87 = CaF2_aq
- Row 88 = Al2O3_s
- Row 89 = CrO2_s
- Row 90 = K2O_s
- Row 91 = Fe2O3_s
- Row 92 = PbO2_s
- Row 93 = PCB_s
- Row 94 = I-129_aq
- Row 95 = I-129_s
- Row 96 = C-14_s
- Row 97 = Hg_aq
- Row 98 = H_3_g
- Row 99 = CaO_s
- Row 100 = NaOH_aq
- Row 101 = Na2SO3_aq
- Row 102 = NaCl_aq
- Row 103 = NaF_aq
- Row 104 = NaNO3_aq
- Row 105 = Na2CO3_aq
- Row 106 = NaClO2_aq
- Row 107 = Na2S_aq
- Row 108 = ClO2_g
- Row 109 = NaNO2_aq
- Row 110 = Na2SO4_aq
- Row 111 = B2O3_s
- Row 112 = ZrO2_s
- Row 113 = Air_g
- Row 114 = N2H8SO4_aq

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The reason for referencing the radionuclide values to another worksheet is that in this way transferring the Mass % of each component from the mass balance software would be easier, if radionuclides were transferred to a worksheet of their own, where units could be kept at ppb.

For example in cell C34 of worksheet page "Stream Analyzer Data", the TRU[2] (Pu-239) content of the feed (Stream 1) is given as 4.5 E+01 ppb and the formula used for that cell is:

C34 ='Rad Conc ppb'! C5

- Similarly for other radionuclide content of the feed which is comprised of $^{137}$Cs, $^{90}$Sr, $^{99}$Tc, $^{60}$Co, $^{154}$Eu and $^{129}$I are given in the following cells with the ppb values and formulae shown below:
- $^{137}$Cs: C35='Rad Conc ppb'! C6 = 5.50E+01
- $^{90}$Sr: C36='Rad Conc ppb'! C7 = 1.27E+01
- $^{99}$Tc: C37='Rad Conc ppb'! C8 = 2.14E+03
- $^{60}$Co: C38='Rad Conc ppb'! C9 = 3.77E-03
- $^{154}$Eu: C39='Rad Conc ppb'! C10 = 7.24E-02
- $^{129}$Iaq: C94='Rad Conc ppb'! C11 = 397.84

Similarly for the subsequent streams in columns D to AV, values of radionuclides concentration were recorded by linking the radionuclides rows 34-39 and 94-98 to the corresponding radionuclide concentration values in worksheet page "Rad Conc ppb".

### 5.1.3 Worksheet "Rad Conc ppb"

In this worksheet page, the values of the radionuclide concentrations are recorded for each stream in rows 6 to11, by reading them in the IDEAS™ software stream analyzer modules and typing them in each cell. There are no calculations or cells with equations linked to other cell sources in other worksheet pages. An example is given in section 5.1.2 for the radionuclides concentration in the feed stream. These values are then used as input sources for calculation of activity rates for each radionuclide.

[2] TRU (TRANSURANIC Elements) is defined as: Alpha-emitting radionuclides with anatomic number greater than 92 and with half-life greater than 10 years. In this calculation it is modeled as Pu-239

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### 5.1.4 Worksheet "Inputs"

This worksheet contains both the constants, which are defined set points used in the Process Design Criteria 145579-A-DC-002 (PDC) and unit conversion data (Reference #2). The data "Inputs" that can be found either directly or indirectly in the PDC are listed in column B, whilst column I contains conversion inputs that are used to convert the mass balance software outputs in the three worksheet pages to units used in the process heat and mass balances.

### 5.1.5 Worksheet "Mass Balance"

The Mass Balance worksheet page is where the detailed DBVS continuous mass balance is calculated and displayed using outputs described in sections 5.1.1 to 5.1.4.

Cells in Rows 2 and 3 are linked to corresponding cells in "IDEAS Stream Data" and list the mass balance stream numbers and names.

Row 4 shows the solids flow rate in kg/h for each stream.

Cell C4 with formula C4 ='IDEAS Stream Data'! C4 records the continuous solids feed rate from the "IDEAS Stream Data" worksheet page as 0.08 kg/h.

Row 5 shows the solution flow rate in kg/h for each stream.

Cell C5 with formula C5 ='IDEAS Stream Data'! C5 records the continuous solution feed rate from the "IDEAS Stream Data" worksheet page as 319.62 kg/h.

Row 6 shows the total flow rate in kg/h for each stream.

Cell C6 with formula C6 ='IDEAS Stream Data'! C6 records the continuous solution feed rate from the "IDEAS Stream Data" worksheet page as 319.70 kg/h.

Row 7 shows the solution flow rate in $m^3/h$ for each stream.

Cell C7 with formula C7 ='IDEAS Stream Data'! C7 records the continuous volumetric solution feed rate from the "IDEAS Stream Data" worksheet page as 0.25 $m^3/h$.

Row 8 shows the total vapor flow rate in $m^3/h$ for each stream.

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Cell C8 with formula C8 ='IDEAS Stream Data'! C8 records the continuous volumetric vapor feed rate from the "IDEAS Stream Data" worksheet page as 0.0 $Nm^3/h$.

Row 9 shows the total volumetric flow rate in $m^3/h$ for each stream.

Cell C9 with formula C9 ='IDEAS Stream Data'! C9 records the continuous volumetric feed rate from the "IDEAS Stream Data" worksheet page as 0.25 $Nm^3/h$.

Row 10 shows the solids SpG for each stream.

Cell C10 with formula C10 ='IDEAS Stream Data'! C10 records the solids SpG from the "IDEAS Stream Data" worksheet page as 2.28.

Row 11 shows the solution SpG for each stream.

Cell C11 with formula C11 ='IDEAS Stream Data'! C11 records the solution SpG from the "IDEAS Stream Data" worksheet page as 1.29.

Row 12 shows the stream SpG for each stream.

Cell C12 with formula C12 ='IDEAS Stream Data'! C12 records the stream SpG from the "IDEAS Stream Data" worksheet page as 1.29.

Row 13 shows the solids weight % for each stream.

Cell C13 with formula C13 ='IDEAS Stream Data'! C13 records the solids weight % from the "IDEAS Stream Data" worksheet page as 0.02.

Row 14 shows the temperature for each stream.

Cell C14 with formula C14 ='IDEAS Stream Data'! C14 records the stream temperature from the "IDEAS Stream Data" worksheet page as 28 °C.

Row 15 shows the pressure for each stream.

Cell C15 with formula C15 ='IDEAS Stream Data'! C15 records the stream pressure from the "IDEAS Stream Data" worksheet page as 0 inches WG.

Row 16 is blank

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Row 17 with formula C17 = C6*'Stream Analyzer Data'! C5 / 100 calculates the mass flow rate of water to be 213.4 kg/h. C6 as described above is the total flow rate in kg/h for each stream. Cell C5 in the "Stream Analyzer Data" worksheet page shows the water content of the LAW feed stream to be 66.75 weight %.

Row 18 with formula C18 = C6*'Stream Analyzer Data'! C6 / 100 calculates the mass flow rate of water vapor to be 0.0 kg/h. C6 as described above is the total flow rate in kg/h for each stream. Cell C6 in the "Stream Analyzer Data" worksheet page shows the water content of the LAW feed stream to 0.0 weight %.

Row 19 with formula C19 = [C6*('Stream Analyzer Data'! C33+'Stream Analyzer Data'! C61)/100] calculates the mass flow rate of sodium to be 28.45 kg/h. C6 as described above is the total flow rate in kg/h for each stream. Cell C33 shows the $Na^+$ aqueous content to be 8.9 weight % and Cell C61 in the "Stream Analyzer Data" worksheet page shows the $Na^+$ solids content of the LAW feed stream to 0.0 weight %.

The formula used above adequately describes the Na content of the feed stream, where the sodium content is limited to $Na^+$ in solid and aqueous forms. However in cases where sodium content is represented in the form of $Na_2O$, this species' value (Row 46) in the "Stream Analyzer Data" worksheet page has to be included as well. For example Cell I19 with formula:

I19 = I6*('Stream Analyzer Data'! G33 + 'Stream Analyzer Data'! G61 + ('Stream Analyzer Data'! G46)*(46/62))/100 includes component $Na_2O$_s in the ICV feed, which is mainly because sodium content of the soil part of the ICV feed is represented as $Na_2O$.

Rows 20, 21 and 22 show the concentration of $SO_x$, $NO_x$ and HCl gases in ppm by volume. These values involve no calculations or formulae and the corresponding values are read from the IDEAS Stream Analyzer modules and recorded in the corresponding rows for each of the gas streams. There is no calculation or formulae in these rows.

Row 23 records the concentration of $^{137}Cs$ in various streams by linking worksheet "Mass Balance" to the "Stream Analyzer Data" worksheet page. For example, Cell C23 with formula C23 = 'Stream Analyzer Data'! C35/1000 records the $^{137}Cs$ concentration in ppm Mass in the feed. Row 25 calculates the mass flow rate of the radionuclide component $^{137}Cs$. For example for the waste feed stream the formula C25 = (C23/1000)*C6, gives the mass flow rate $^{137}Cs$ in g/h. Knowing the g/h rate of this component, cell C24 calculates the activity rate for $^{137}Cs$ by the formula C24 = Inputs!

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$B$30*C25, where Inputs! $B$30 is the specific activity of $^{137}$Cs as given in the "Inputs" worksheet and referenced in the PDC document.

Row 26 records the concentration of $^{90}$Sr in various streams by linking worksheet "Mass Balance" to the "Stream Analyzer Data" worksheet. For example, Cell C26 with formula.

C26 = 'Stream Analyzer Data'! C36/1000 records the $^{90}$Sr concentration in ppm Mass in the feed. Row 28 calculates the mass flow rate of the radionuclide component $^{90}$Sr. For example for the waste feed stream the formula C28 = (C26/1000)*C6, gives the mass flow rate $^{90}$Sr in g/h. Knowing the g/hr rate of this component, cell C27 calculates the activity rate for $^{90}$Sr by the formula C27 = Inputs! $B$31*C28, where Inputs! $B$31 is the specific activity of $^{90}$Sr as given in the "Inputs" worksheet and referenced in the PDC document.

Row 29 records the concentration of $^{99}$Tc in various streams by linking worksheet "Mass Balance" to the "Stream Analyzer Data" worksheet. For example, Cell C29 with formula.

C29 = 'Stream Analyzer Data'! C37/1000 records the $^{99}$Tc concentration in ppm Mass in the feed. Row 31 calculates the mass flow rate of the radionuclide component $^{99}$Tc. For example for the waste feed stream the formula C31 = (C29/1000)*C6, gives the mass flow rate $^{99}$Tc in g/h. Knowing the g/h rate of this component, Cell C30 calculates the activity rate for $^{99}$Tc by the formula:

C30 = Inputs! $B$32*C31, where Inputs! $B$32 is the specific activity of $^{99}$Tc as given in the" Inputs" worksheet and referenced in the PDC document.

Row 32 records the concentration of $^{60}$Co in various streams by linking worksheet page "Mass Balance" to the "Stream Analyzer Data" worksheet page. For example, Cell C32 with formula.

C32 = 'Stream Analyzer Data'! C38/1000 records the $^{60}$Co concentration in ppm Mass in the feed. Row 34 calculates the mass flow rate of the radionuclide component $^{60}$Co. For example for the waste feed stream the formula C34 = (C32/1000)*C6, gives the mass flow rate $^{60}$Co in g/h. Knowing the g/h rate of this component, Cell C33 calculates the activity rate for $^{60}$Co by the formula.

C33= Inputs! $B$34*C34, where Inputs! $B$34 is the specific activity of $^{60}$Co as given in the" Inputs" worksheet and referenced in the PDC document.

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## CALCULATION SHEET

| | | | | | |
|---|---|---|---|---|---|
| CALC. NO.: | 145579-A-CA-005 | REV: | A | DATE: | April 12, 2005 |
| CALC. TITLE: | Full DBVS Process Mass Balance Conversion (Tri-Mer Scrubber Operating) | | | | |
| PROJECT NO.: | 145579 | PROJECT TITLE: | Final DBVS Design | | |

Row 35 records the concentration of $^{154}$Eu in various streams by linking worksheet "Mass Balance" to the "Stream Analyzer Data" worksheet page. For example, Cell C35 with formula.

C35 = 'Stream Analyzer Data'! C39/1000 records the $^{154}$Eu concentration in ppm Mass in the feed. Row 37 calculates the mass flow rate of the radionuclide component $^{154}$Eu. For example for the waste feed stream the formula C37 = (C35/1000)*C6, gives the mass flow rate$^{154}$Eu in g/h. Knowing the g/h rate of this component, Cell C36 calculates the activity rate for $^{154}$Eu by the formula

C36= Inputs! $B$33*C37, where Inputs! $B$33 is the specific activity of $^{154}$Eu as given in the "Inputs" worksheet and referenced in the PDC document.

Row 38 records the concentration of $^{239}$Pu in various streams by linking worksheet page "Mass Balance" to the "Stream Analyzer Data" worksheet page. For example, Cell C38 with formula.

C38 = 'Stream Analyzer Data'! C34/1000 records the $^{239}$Pu concentration in ppm Mass in the feed. Row 40 calculates the mass flow rate of the radionuclide component $^{239}$Pu. For example for the waste feed stream the formula C40 = (C38/1000)*C6, gives the mass flow rate $^{239}$Pu in g/h. Knowing the g/h rate of this component, Cell C39 calculates the activity rate for $^{239}$Pu by the formula C39= Inputs! $B$29*C40, where Inputs! $B$29 is the specific activity of $^{239}$Pu as given in the "Inputs" worksheet page and referenced in the PDC document.

Rows 41, 42 and 43 were dedicated to similar calculations for tritium ($^{3}$H). In this version, this component is not followed and the aforementioned rows are therefore hidden and not used in the mass balance.

Row 44 records the concentration of $^{129}$I in various streams by linking worksheet page "Mass Balance" to the "Stream Analyzer Data" worksheet page. For example, Cell C44 with formula.

C44 = 'Stream Analyzer Data'! C94/1000 records the $^{129}$I concentration in ppm Mass in the feed. Row 46 calculates the mass flow rate of the radionuclide component $^{129}$I. For example for the waste feed stream the formula C46 = (C44/1000)*C6, gives the mass flow rate $^{129}$I in g/h. Knowing the g/h rate of this component, Cell C45 calculates the activity rate for $^{129}$I by the formula.

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# CALCULATION SHEET

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|---|---|---|---|---|---|
| CALC. NO.: | 145579-A-CA-005 | REV: | A | DATE: | April 12, 2005 |
| CALC. TITLE: | Full DBVS Process Mass Balance Conversion (Tri-Mer Scrubber Operating) | | | | |
| PROJECT NO.: | 145579 | PROJECT TITLE: | Final DBVS Design | | |

C45= Inputs! $B$35*C46, where Inputs! $B$35 is the specific activity of $^{129}I$ as given in the "Inputs" worksheet and referenced in the PDC document.

The above mentioned formulae and values entered for column C of the "Mass Balance" worksheet page are repeated again where applicable for other streams in columns D to AV to represent the corresponding values for Streams 2 to 46.

### 5.1.6 Worksheet PFD 030

In this worksheet page a mass and heat balance table is created for inclusion with the PFD F-145579-00-0030 Rev F, the Full DBVS Feed Preparation and Melt (Tri-Mer Operating) Process Flow Diagram.

The rows in this table correspond to the following stream characteristics that were required for adequate design of the process system with the units mentioned below:

- Stream Number
- Stream Name
- Phase
- Continuous Mass Flow rate, lb/h
- Cont. Volumetric Flow Rate (for liquid and gas only) USGPM/ACFM
- Batch Volume, USG/ACF
- Batch Mass, lb
- Batch Transfer Time, h
- Batch Volumetric Flow Rate, (for liquid and gas only) USGPM/ACFM
- Batch Mass Flow Rate, lb/h
- Design Factor, Dimensionless
- Design Volumetric Flow Rate, (for liquid and gas only) USGPM/ACFM
- Design Mass Flow Rate, lb/h
- SpG, Dimensionless
- SpG (Bulk solids only), Dimensionless
- Gas Pressure, inches WG
- Temperature, °F
- H2O, Liquid (continuous), lb/h
- H2O, Gas (continuous), lb/h
- Feed Na (continuous), lb/ h
- SO2 Gas Concentration, ppmV
- NOx Gases Concentration, ppmV

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# CALCULATION SHEET

| | | | | | |
|---|---|---|---|---|---|
| CALC. NO.: | 145579-A-CA-005 | REV: | A | DATE: | April 12, 2005 |
| CALC. TITLE: | Full DBVS Process Mass Balance Conversion (Tri-Mer Scrubber Operating) | | | | |
| PROJECT NO.: | 145579 | PROJECT TITLE: | Final DBVS Design | | |

- HCl Gas Concentration, ppmV
- $^{137}$Cs, Ci/h
- $^{99}$Tc, Ci/h
- TRU, Ci/h
- $^{129}$I, Ci/h

All these values are directly calculated or recorded from the worksheets that represent IDEAS™ outputs or from the "Mass Balance" worksheet where some calculations are performed as described in the previous section. The only exceptions are streams that represent alternative options to the normal process flow. Also because this is a combination of batch and continuous operations, for certain flows batch flow rates are calculated using input assumptions in the "Inputs" worksheet as well as outputs from the IDEAS™ software that are recorded in other worksheets of this spreadsheet. These calculations are described below in more detail.

Rows 2 and 3 show the Stream numbers and names by linking the cells in those rows to the corresponding cells in worksheet page "IDEAS Stream Data".

Row 4 contains the phase (solid, aqueous, gaseous) of the contents of each stream.

Row 5 shows the continuous mass flow rate in lbs/h and for Stream 1, the waste receipt it is given by the formula C5 = 'IDEAS Stream Data'! C6*Inputs! I2, where Cell C6 in the "IDEAS Stream Data" worksheet page is the continuous flow in kg/h and Cell I2 in worksheet page "Inputs" has the conversion constant for converting kg to lbs., i.e. 2.2.

Row 6 shows the continuous volumetric flow rate and in the case of stream, this done by the formula:

C6 = ('IDEAS Stream Data'! C7*Inputs! I8)/Inputs! I4/Inputs! I6, where Cell C7 in "IDEAS Stream Data" worksheet page has the solution volumetric flow rate in $m^3$/h and the cells I4 and I6 in the "Inputs" worksheet represent conversion factors for USGPM to liters and hours to minutes respectively, i.e. 3.785 and 60.

Row 7 takes the value in Row 6 and converts to a batch volume of solution or gas. In the case of Stream 1, because one batch is meant to be a batch corresponding to one batch of the waste solution fed to the dryer and there are eight batches per DBVS box the batch volume is calculated by the formula:

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## CALCULATION SHEET

| | | | | | |
|---|---|---|---|---|---|
| CALC. NO.: | 145579-A-CA-005 | REV: | A | DATE: | April 12, 2005 |
| CALC. TITLE: | Full DBVS Process Mass Balance Conversion (Tri-Mer Scrubber Operating) | | | | |
| PROJECT NO.: | 145579 | PROJECT TITLE: | Final DBVS Design | | |

C7 = (C6*Inputs! B3*Inputs! I6)/Inputs! B2, where B3 is the total batch time for one melt (201 hrs), I6 is the conversion factor for hours to minutes (60) and B2 is number of solution batches used for one melt (8).

Similarly, Row 8 calculates the mass the batch mass by the formula.

C8 =C5*Inputs! B3/Inputs! B2, for one batch of the waste feed used in one dryer feed batch.

Assuming a batch transfer rate of 24 USGPM (shown in Cell C13), Cell C9 calculates the batch transfer time for one batch of waste feed using the formula C9 = C7/C13/Inputs! I6 =1.14 h.

Cell C10 records the batch volumetric flow by linking that cell to the value of that flow in the "Inputs" worksheet page.

Cell C11 calculates the batch mass transfer rate by dividing the batch mass by the batch transfer time of 1.14 hrs. Therefore C11= C8/C9 = 15,428 lb/h.

Cell C12 is the design factor relating Feed Design Rate to the Feed Batch Flow Rate. In this case the design factor is 1.0.

Cell C13 is the design volumetric flow rate with the formula C13 = C12*C10.

Cell C14 shows the design mass flow rate by the formula C14 = C12*C11.

Cell C15 records the SpG of Stream 1 by the formula C15 = 'IDEAS Stream Data'! C12.

Row 16 records the streams' bulk density for solids only.

Row 17 records the gaseous pressure in inches of WG.

Row 18 records the temperature in °F. For example, cell C18 records the temperature of the waste feed stream by the formula.

C18 = 'IDEAS Stream Data'! C14*(9/5)+32, where C14 in the "IDEAS Stream Data" worksheet page is the same temperature in °C.

Row 19 records the continuous water flow rate in lb/h. For Stream 1, this is shown by the formula:

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## CALCULATION SHEET

| | | | | | |
|---|---|---|---|---|---|
| CALC. NO.: | 145579-A-CA-005 | REV: | A | DATE: | April 12, 2005 |
| CALC. TITLE: | Full DBVS Process Mass Balance Conversion (Tri-Mer Scrubber Operating) | | | | |
| PROJECT NO.: | 145579 | PROJECT TITLE: | Final DBVS Design | | |

C19 = 'IDEAS Stream Data'! C18*Inputs! I2, where I2 in worksheet page "Inputs" is the conversion factor of 2.2 used for converting kg to lb.

Row 20 in a similar fashion calculates the continuous water vapor flow rate in lb/h.

Row 21 calculates and represents the Feed Sodium flow rate in lb/h. In case of the feed this is shown in Cell C21 by the formula C21 = 'IDEAS Stream Data'! C19*Inputs! I2, which converts the Feed Na flow rate in kg/h to lb/h.

Rows 22, 23 and 24 record the concentration of SO2, NOx and HCl in off-gas streams directly from the "Mass Balance" worksheet page.

Rows 25 to 28 record the activity rates of $^{137}Cs$, $^{99}Tc$, TRU and $^{129}I$ by directly linking the cells to the corresponding cells in the worksheet "Mass Balance" page. For example in the feed stream the following formulae are used:

- C25 = 'Mass Balance'! C24
- C26 = 'Mass Balance'! C30
- C27 = 'Mass Balance'! C39
- C28 = 'Mass Balance'! C45

Throughout the "PFD 30" worksheet page, the same formulae as described above are used to record the mass balance values for subsequent streams. In cases where the process stream requires additional information to be shown, the formulae used may be different. These cases are outlined below:

In Row 6 for streams where continuous volumetric flow rate is calculated, the units read from the "IDEAS Stream Data" are in $m^3$/hr and have to be converted to ACFM. For example in Cell L6, the dryer air continuous volumetric flow rate is given as

L6 = ('IDEAS Stream Data'! I9/Inputs! I6)*Inputs! I10, where I10 in the "Inputs" worksheet page is the factor for converting $m^3$ to $ft^3$ (35.315).

In the case of Stream 7A, (Column M), the dryer ventilation air is designated as an alternate air supply to the DBVS process. For this reason and the fact that it is not part of the process mass balance in the IDEAS software, its continuous and design flows are calculated in this worksheet.

The design value of this stream is 600 ACFM. When the off-gas treatment is operating, this quantity of dilution air required down stream of the melt (Stream 16) is

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## CALCULATION SHEET

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|---|---|---|---|---|---|
| CALC. NO.: | 145579-A-CA-005 | REV: | A | DATE: | April 12, 2005 |
| CALC. TITLE: | Full DBVS Process Mass Balance Conversion (Tri-Mer Scrubber Operating) | | | | |
| PROJECT NO.: | 145579 | PROJECT TITLE: | Final DBVS Design | | |

supplied by this stream. In the worksheet "Mass Balance" page Cell M10 is set at 600 ACFM and because the dryer enclosure has to be vented at all times, Cell M6 representing the continuous flow is also set at 600 ACFM. The corresponding mass flow rate at Cell M5 is given by the equation:

M5 =('PFD 31'!J5/'PFD 31'!J6)*'PFD 30'!M6, where Cells J5 and J6 represent mass and volumetric flows of another ambient air stream and Cell M6 is the volumetric flow rate of Stream 7A.

Stream 8 represents the off-gas stream for the clean soil baghouse and does not connect to the rest of the DBVS process and the Off-Gas Treatment System (OGTS). The continuous flow of this stream is calculated from this assumed batch and design flow rate of 1,000 ACFM using the equation: N6 = (N10*Inputs! B20*Inputs! B2*Inputs! I6)/Inputs! B3/Inputs! I6

Cell N5 calculates the mass flow rate of Stream 8 using the mass to volumetric ratios of Stream 7A, which is also an ambient air stream and at the same pressure and temperature. The equation used for the mass flow rate here is N5 = (M5/M6)*N6

### 5.1.7 Worksheet PFD 031

In this worksheet page a mass and heat balance table is created for inclusion with the PFD F-145579-00-0031 Rev F, the Full DBVS Trailer Off-Gas Treatment (Tri-Mer Operating) Process Flow Diagram.

The rows in this table correspond to the following stream characteristics that were required for adequate design of the process system with the units mentioned below:

- Stream Number
- Stream Name
- Phase
- Continuous Mass Flow rate, lb/h
- Cont. Volumetric Flow Rate (for liquid and gas only) USGPM/ACFM
- Batch Volume, USG/ACF
- Batch Mass, lb
- Batch Transfer Time, h
- Batch Volumetric Flow Rate, (for liquid and gas only) USGPM/ACFM
- Batch Mass Flow Rate, lb/h

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# CALCULATION SHEET

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|---|---|---|---|---|---|
| CALC. NO.: | 145579-A-CA-005 | REV: | A | DATE: | April 12, 2005 |
| CALC. TITLE: | Full DBVS Process Mass Balance Conversion (Tri-Mer Scrubber Operating) | | | | |
| PROJECT NO.: | 145579 | PROJECT TITLE: | Final DBVS Design | | |

- Design Factor, Dimensionless
- Design Volumetric Flow Rate, (for liquid and gas only) USGPM/ACFM
- Design Mass Flow Rate, lb/h
- SpG, Dimensionless
- SpG (Bulk solids only), Dimensionless
- Gas Pressure, inches WG
- Temperature, °F
- H2O, Liquid (continuous), lb/h
- H2O, Gas (continuous), lb/h
- Feed Na (continuous), lb/h
- SO2 Gas Concentration, ppmV
- NOx Gases Concentration, ppmV
- HCl Gas Concentration, ppmV
- $^{137}$Cs, Ci/h
- $^{99}$Tc, Ci/h
- TRU, Ci/h
- $^{129}$I, Ci/h

The aforementioned values are directly calculated or recorded from the worksheets that represent IDEAS™ outputs or form the "Mass Balance" worksheet where some calculations are performed as described in the previous section. The only exceptions are streams that represent alternative options to the normal process operation. Also because this is a combination of batch and continuous operations for certain flows batch flow rates are calculated using input assumptions in the "Inputs" worksheet as well as outputs from the IDEAS™ software that are recorded in other worksheets of this spreadsheet. These calculations are the same as those described in the section pertaining to page "PFD 030" and for details of each row please refer to the section for "PFD 030".

Again, where there is an alternative option and a stream is not normally part of the normal operating process, its design and continuous flows are calculated independently. These exceptions are described below in more detail.

Stream 7 in "PFD 031" is the same as Stream 7 in "PFD 030" and represents the dryer air that is sent to the OGTS for treatment. Stream 7C is the alternate ambient air that would be used in full instead of dryer air, when the dryer is not operating. Stream 7B is the total air stream that is sent to the OGTS. Stream 7B would be supplied either by both stream 7 and 7C. Stream 7C would have a flow all the time with Stream 7

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## CALCULATION SHEET

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|---|---|---|---|---|---|
| CALC. NO.: | 145579-A-CA-005 | REV: | A | DATE: | April 12, 2005 |
| CALC. TITLE: | Full DBVS Process Mass Balance Conversion (Tri-Mer Scrubber Operating) | | | | |
| PROJECT NO.: | 145579 | PROJECT TITLE: | Final DBVS Design | | |

representing additional flow during normal operation at times when the dryer is operating. When the dryer is not operating the flow for Stream 7 would be adjusted to compensate for flow in Stream 7.

In column C in "PFD 031", all Stream 7 values are set to be equal to Stream 7 in "PFD 030". The batch time for Stream 7 is set at 8 hours, which is the dryer batch time. The batch time for Stream 7B and 7C is 139 hrs, which is equal to the duration of the melt period. Calculation of batch mass and volumes are performed on these bases. Cell D7 uses the batch times to calculate the batch volume of air for Stream 7B:

D7 = D6*Inputs! $B$3*Inputs!$I$6, where D6 is the continuous flow rate in ACFM and Cells B3 and I6 in the "Inputs" worksheet page represent ICV batch duration of 201 hours and factor for converting hours to minutes.

The volumetric design flow for Stream 7 in Cells D13 and L13 in worksheet page "PFD 030" is set equal to 11.2 ACFM at 212 °F, based on the following calculation:

- At upstream of the vacuum pump the pressure is assumed to be 121 torr
- Pressure downstream is atmospheric or whatever vacuum there is in the OGTS before the mist eliminator (in this case –20.1 inches WG)
- Air flow for the vacuum pump is 55 ACFM to keep up with the condenser load
- 1 torr =133.322 Pascals
- 121 torr = 16.31 kPa
- Going from 16.31 kPa to 81.39 kPa (this is the point in the OGTS that the vacuum pump discharge joins and temperature changes from 100°F (37.8°C; 310.8 K) to 212°F (100°C or 373 K)
- Since based on Ideal Gas law P1V1/T1 =P2 V2/T2, knowing P1 =16.31 kPa, V1 =55 CFM, T1 =310.8 K, P2 = 96.2 kPa and T2 =373 K then:
- [(16.31 x 55)/310.8] = [96.2 x V2]/373
- And therefore V2 = (16.31 x 55 x 373)/(310x 96.2) = 11.2 ACFM at 212°C

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## CALCULATION SHEET

| | | | | | |
|---|---|---|---|---|---|
| CALC. NO.: | 145579-A-CA-005 | REV: | A | DATE: | April 12, 2005 |
| CALC. TITLE: | Full DBVS Process Mass Balance Conversion (Tri-Mer Scrubber Operating) | | | | |
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The continuous stream flows is then calculated based on the ratio of the dry operation time and the ICV melt cycle of 201 hours. This is given in Cell L6 by:

L6 = ((Inputs! B2*Inputs! B27)/Inputs! B3)*L13; where as mentioned above L13 is the calculated design flow and Cells B2, B3 and B27 are batch times for dryer operation, ICV batch time of 201 hours and the number of dryer batch operations per ICV batch time.

The other exception to the rules described in detail for various rows in section PFD 030 is Stream 14. This stream is comprised of ambient air only and it is used only if the melt is off and the melt off-gas Stream 13 has no flow.

In the worksheet PFD 031 page, Stream 14 is set to be at the same batch and design volumetric rate as Stream 15. This is shown in cell H10: H10 = I10. When the melt is off, Stream 14 will provide an equivalent stream of ambient air in order have a constant flow to the OGTS. In Cell H10 the batch flow rate is given by H10 = I10, where I10 is the calculated batch flow of Stream 15.

All other stream values in the subsequent columns are calculated as described in the section PFD 030.

### 5.1.8 Worksheet PFD 032

In this worksheet page a mass and heat balance table is created for inclusion with the PFD F-145579-00-0032 Rev F, the Full DBVS TRI-MER and SCR (Tri-Mer Operating) Process Flow Diagram.

The rows in this table correspond to the following stream characteristics that were required for adequate design of the process system with the units mentioned below:

- Stream Number
- Stream Name
- Phase
- Continuous Mass Flow rate, lb/h
- Cont. Volumetric Flow Rate (for liquid and gas only) USGPM/ACFM
- Batch Volume, USG/ACF
- Batch Mass, lb
- Batch Transfer Time, h
- Batch Volumetric Flow Rate, (for liquid and gas only) USGPM/ACFM

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# CALCULATION SHEET

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|---|---|---|---|---|---|
| CALC. NO.: | 145579-A-CA-005 | REV: | A | DATE: | April 12, 2005 |
| CALC. TITLE: | Full DBVS Process Mass Balance Conversion (Tri-Mer Scrubber Operating) | | | | |
| PROJECT NO.: | 145579 | PROJECT TITLE: | Final DBVS Design | | |

- Batch Mass Flow Rate, lb/h
- Design Factor, Dimensionless
- Design Volumetric Flow Rate, (for liquid and gas only) USGPM/ACFM
- Design Mass Flow Rate, lb/h
- SpG, Dimensionless
- SpG (Bulk solids only), Dimensionless
- Gas Pressure, inches WG
- Temperature, °F
- H2O, Liquid (continuous), lb/h
- H2O, Gas (continuous), lb/h
- Feed Na (continuous), lb/ h
- SO2 Gas Concentration, ppmV
- NOx Gases Concentration, ppmV
- HCl Gas Concentration, ppmV
- $^{137}$Cs, Ci/h
- $^{99}$Tc, Ci/h
- TRU, Ci/h
- $^{129}$I, Ci/h

All the aforementioned values are directly calculated or recorded from the worksheets that represent IDEAS™ outputs or form the "Mass Balance" worksheet where some calculations are performed as described in the previous section. Also because this is a combination of batch and continuous operations for certain flows batch flow rates are calculated using input assumptions in the "Inputs" worksheet page as well as outputs from the IDEAS™ software that are recorded in other worksheet pages of this spreadsheet. These calculations are the same as those described in the section pertaining to PFDs 030 and 031. For details of each row, please refer to the section for PFD 030. Values are given for Streams 33 to 37 in the TRI-MER scrubber, as this is the alternate case where the SCR is not operating. PFD 032 is only designated for off-gas polishing and $NO_x$ reduction by Tri-Mer Scrubber.

The radionuclides in stream 37 (cells H25-H28) should in effect be equal to all of their input to the Tri-Mer scrubber in stream 40, however due to rounding off errors in the mass balance software a slight increase is shown. Since the radionuclides concentrations and flow rate values are very small, this should be regarded as a conversion problem.

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# CALCULATION SHEET

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|---|---|---|---|---|---|
| CALC. NO.: | 145579-A-CA-005 | REV: | A | DATE: | April 12, 2005 |
| CALC. TITLE: | Full DBVS Process Mass Balance Conversion (Tri-Mer Scrubber Operating) | | | | |
| PROJECT NO.: | 145579 | PROJECT TITLE: | Final DBVS Design | | |

## 6.0 ASSUMPTIONS

The Excel® spreadsheet is based on input worksheets containing continuous mass balance software data. A list of assumptions and design criteria used in the calculation worksheets can be found in worksheet page "Inputs". These assumptions are based on various sources that are listed in the PDC Document 145579-A-DC-002 (Reference #2).

## 7.0 REFERENCES

1. Pressure Calculation Document 145579-V-CA-002 Rev C and Excel Spreadsheet *145579-A-CA-002 (Ductwork Pressures) In Progress1.xls*, March 7, 2005

2. Process Design Criteria 145579-A-DC-002, Rev 0F, April 8, 2005.

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# 145579-A-CA-005

## Attachment 1

## Demonstration Bulk Vitrification System (DBVS) Mass Balance (Tri-Mer Operating)

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DEMONSTRATION BULK VITRIFICATION SYSTEM (DBVS) MASS BALANCE

FEBRUARY 7, 2005

## NOTES

[redacted]

ATTACHMENT 1
145579-A-CA-004-REV A

DEMONSTRATION BULK VITRIFICATION SYSTEM (DBVS) MASS BALANCE

FEBRUARY 7, 2005

IDEAS STREAM DATA

| Stream No. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Stream Name | | WASTE RECEIPT | SPIKING FLOW | STRIPPER PATHS | SOIL | ICV FEED | DRYER CONDENSATE | DRYER AIR | OFF GAS AIR | ICV AIR | HOT ICV PRODUCT | TOP UP SOIL | COOLED ICV PRODUCT |
| Solids | kg/hr | 0.0715 | | 7.38 | 142.21 | 276.53 | 0.000116 | | | | 212.1 | [redacted] | 212.1 |
| Solution | kg/hr | 919.63 | | 6.167 | 7.46 | 2.79 | 216.1 | | | | | | |
| Stream | kg/hr | 315.57 | | 7.38 | 149.7 | 279.08 | 216.1 | 50.8 | 1009.28 | [redacted] | 212.1 | 36.11 | 212.1 |
| Solution | m3/hr | 0.344 | | 0.006167 | 0.0075 | 0.0028 | 0.221 | | | | | [redacted] | |
| Vapor | Nm3/hr | | | | | | | 30.41 | 1358.34 | [redacted] | | | |
| Stream | m3/hr | 0.246 | | 0.00531 | 0.0064 | 0.133 | 0.223 | 33.12 | 1009.01 | 135.71 | 0.0001 | [redacted] | 0.0001 |
| Solids SG | | 2.39 | | 2.4 | 2.34 | 2.13 | 0.00253 | | | | 2.65 | | 2.65 |
| Solution SG | | 1.29 | | 0.967 | 0.947 | 0.946 | 0.966 | | | | | [redacted] | |
| Stream SG | | 1.29 | 0.997 | 0.93 | 0.9 | 2.08 | 0.996 | 0.000922 | 0.00116 | 0.00117 | 2.65 | | 2.65 |
| Solids Concent | % | 0.0249 | | 97.5 | 95 | 99 | 0.3E-05 | | | | 100 | [redacted] | 100 |
| Temperature | °C | 30 | 25 | 25 | 25 | 28.1 | 50 | 50 | 25 | 25 | 1300 | 25 | 50 |
| Pressure | kPa | 101.33 | 101.33 | 101.33 | 101.33 | 101.33 | 101.33 | 96.87 | 101.33 | 100.87 | 101.33 | 101.33 | 101.33 |
| ---------- | ---------- | ---------- | ---------- | ---------- | ---------- | ---------- | ---------- | ---------- | ---------- | ---------- | ---------- | ---------- | ---------- |
| S: Na | kg/hr | | | 0.0735 | 2.04 | 31.75 | | | | | 31.47 | | 31.47 |
| L: Water | kg/hr | 213.4 | | 6.167 | 7.46 | 2.79 | 216.1 | | | | | [redacted] | |
| L: Na | kg/hr | 86.45 | | | | | | | | | | | |
| V: Steam | kg/hr | | | | | | | | | | | | |
| S: Na | % | | | 1.01 | 2.07 | 11.49 | | | | | 14.84 | | 14.84 |

CHECKER NOTES:

1. Cells highlighted in Yellow have correct input values that match the IDEAS print-out.
2. Cells highlighted in Red do not match the IDEAS print-out. Generally the differences are minor and should not affect the indicated results.
3. Checked by William B. (Rusty) Crest. Dated April 12, 2005.



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DEMONSTRATION BULK VITRIFICATION SYSTEM (DBVS) MASS BALANCE

FEBRUARY 7, 2005

IDEAS STREAM DATA

| Stream No. | | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Stream Name | | ICV OFF GAS | COOLING ICV AIR | ICV OFF GAS | SCRUBBER AIR DILUTION | FILTERED OFF GAS | DUST RECYCLE | QUENCH FEED | QUENCHER DISCHARGE | QUENCH RETURN | SCRUB RETURN | SCRUB DISCHARGE | QUENCH SOLUTION |
| Solids | kg/hr | 2.27 | | 2.27 | | 0.00068 | 2.27 | 0.00068 | 0.00E-00 | 0.225 | | 0.00E-00 | |
| Solution | kg/hr | | | | | | | | 0.216 | 2308.99 | | 0.2623 | 2401.33 |
| Stream | kg/hr | 234.69 | | | 872.84 | | 2.27 | | | 2372.02 | | | |
| Solution | m3/hr | | | | | | | | 10.000015 | 2.24 | 4.55 | 0.268-05 | 2.27 |
| Vapor | km3/hr | | | | 754.6 | | | | | | | | |
| Steam | m3/hr | 474.65 | 135.71 | | 848.31 | | 0.00091 | | | 2.24 | 4.55 | | 2.27 |
| Solids SG | | 2.54 | | 2.54 | | 2.54 | 2.54 | 2.54 | 2.54 | | | 2.54 | |
| Solution SG | | 6.153 | | | | | | 0.903 | 0.996 | 1.06 | 1.06 | 0.967 | 1.06 |
| Stream SG | | 0.00049 | 0.00117 | 0.000429 | 0.00114 | 0.000496 | 2.54 | 0.000682 | 0.00112 | 1.06 | 1.06 | 0.00112 | 1.06 |
| Solids Content | % | 0.071 | | 0.577 | | 0.000174 | 100 | 4.94E-05 | 4.88E-04 | | | 4.98E-07 | |
| Temperature | °C | | 25 | 299.99 | 25 | | 299.99 | 110.81 | 28.58 | 36.13 | 36.16 | 26.53 | 28.2 |
| Pressure | kPa | 100.73 | 100.7 | 100.7 | 98.34 | 98.34 | 101.33 | 98.19 | 98.18 | 101.33 | 98 | 98.39 | 95 |
| S: Na | kg/hr | 0.336 | | 0.336 | | 0.000161 | 0.336 | 0.000101 | 1.81E-05 | 0.0037 | 0.00722 | 1.81E-05 | 0.00341 |
| L: Water | kg/hr | | | | | | | | 0.216 | 2131.57 | 4337.64 | 0.0945 | 2166.51 |
| L: Na | kg/hr | | | | | | | | | | | | |
| V: Steam | kg/hr | 2.57 | | 2.57 | | 2.57 | | 2.57 | 25.05 | | | 31.15 | |
| S: Na | % | 14.83 | | 14.83 | | 14.83 | 14.83 | 14.83 | 14.83 | | | 14.83 | |

CHECKER NOTES:
1. Cells highlighted in Yellow have correct input values that
2. Cells highlighted in Red do not match the IDEAS print-out
3. Checked by William E. (Rusty) Croft. Dated April 12, 200



ATTACHMENT 1
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DEMONSTRATION BULK VITRIFICATION SYSTEM (DBVS) MASS BALANCE

FEBRUARY 7, 2005

## IDEAS STREAM DATA

| Stream No. | | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Stream Name | | SCRUB SOLUTION | CAUSTIC MAKE-UP | SCRUB RETURN BLEED | CONDENSER FEED | CONDENSER DISCHARGE | HEATER FEED | HEPA FEED | C-FILTER INLET | 34% SULFURIC ACID | NaCl02 | NaBS |
| Solids | kg/hr | [redacted] | | [redacted] | 0.80E-06 | 0.80E-06 | 0.80E-06 | 0.80E-06 | 0.81E-06 | | | |
| Solution | kg/hr | [redacted] | 91.00 | 90.81 | 0.0922 | [redacted] | [redacted] | [redacted] | [redacted] | 33.47 | 459 | 367.65 |
| Stream | kg/hr | 4802.31 | 91.00 | 16.31 | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | 33.47 | 459 | 367.66 |
| Solution | m3/hr | 4.54 | 0.086 | 0.062 | 0.26E-05 | [redacted] | [redacted] | [redacted] | [redacted] | 0.0782 | 0.453 | 0.345 |
| Vapor | Nm3/hr | | | | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | | | |
| Stream | m3/hr | 4.54 | 0.086 | 0.062 | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | 0.0782 | 0.453 | 0.345 |
| Solids SG | | [redacted] | | [redacted] | 2.54 | 2.54 | 2.54 | 2.54 | 2.54 | | | |
| Solution SG | | 1.06 | 1.03 | 1.09 | 0.997 | | | | | 1.18 | 0.994 | 1.06 |
| Stream SG | | 1.06 | 1.03 | 1.06 | 0.00111 | 0.0011 | 0.0011 | 0.000991 | 0.000949 | 1.18 | 0.994 | 1.06 |
| Solids Content | % | [redacted] | | 0.00102 | 4.90E-07 | 4.73E-07 | 4.73E-07 | 4.73E-07 | 4.73E-07 | | | |
| Temperature | °C | 25.2 | 25 | 25 | 38.36 | 38.46 | 38.49 | 38.79 | 38.98 | 25 | 25 | 25 |
| Pressure | kPa | 101.33 | 101.33 | 101.33 | 98.39 | 98.32 | 98.29 | 98.26 | 98.13 | 101.33 | 101.33 | 101.33 |
| G: Na | kg/hr | 0.00732 | | 0.00E-05 | 1.01E-06 | 1.01E-06 | 1.01E-06 | 1.01E-06 | 1.01E-06 | | | |
| L: Water | kg/hr | 4333.69 | [redacted] | 86.16 | 0.0922 | | | | | 59.82 | 1312.75 | 240.89 |
| L: Na | kg/hr | | | | | | | | | | | |
| V: Steam | kg/hr | | | | 31.18 | 31.25 | 31.25 | 31.25 | 31.25 | | | |
| S: Na | % | [redacted] | [redacted] | [redacted] | 14.83 | 14.83 | 14.83 | 14.83 | 14.78 | | | |

CHECKER NOTES:

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2. Cells highlighted in Red do not match the IDEAS print-ou
3. Checked by William B. (Rusty) Clark. Dated April 12, 200



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DEMONSTRATION BULK VITRIFICATION SYSTEM (DBVS) MASS BALANCE

FEBRUARY 7, 2005

IDEAS STREAM DATA

| Stream No. | | | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Stream name | | 50% NaOH | RETURN SOLUTION | C-FILTER DISCHARGE | DILUTION AIR | TRIMMER FEED | PART HEATED SCR FEED | HEATED SCR FEED | AMMONIA FEED | AMBIENT AIR | ELUTED TRIMER OFF GA | FAN EXHAUST | DILUTE ACID MAKE-UP | |
| Solids | kg/hr | | [redacted] | [redacted] | | [redacted] | | | | | | | | |
| Solution | kg/hr | 64.27 | [redacted] | | | | | | | | | | | |
| Steam | kg/hr | 64.27 | | [redacted] | | [redacted] | | | | | | | | |
| Solution | m3/hr | 0.0889 | 0.879 | | | | | | | | | | | |
| Vapor | lbm3/hr | | | [redacted] | | [redacted] | | | | | 6212.75 | [redacted] | | 9964.02 |
| Steam | m3/hr | 0.0889 | 0.879 | | | | | | | | 7417.44 | | | 9934.13 |
| Solids SG | | | 2.55 | 2.55 | | 2.55 | | | | | | | | |
| Solution SG | | 1.51 | 1.51 | | | | | | | | | | | |
| Steam SG | | 1.51 | 1.51 | 4.5E-04 | 0.00118 | 0.00043 | 0.000433 | 0.00043 | 0.000588 | 0.00109 | 0.00147 | 0.000953 | | 0.00117 |
| Solids Content | % | | 0.72E-06 | 4.73E-06 | | 4.73E-06 | | | | | | | | |
| Temperature | °C | 25 | 25 | 74.44 | 25 | 74.44 | 115 | 115 | 25 | 25 | 37.44 | 35.56 | | 26.7 |
| Pressure | kPa | 101.33 | 101.33 | 97.90 | 101.33 | 96.07 | 75.3 | 75.3 | 101.33 | 92.33 | 92.43 | [redacted] | | 101.33 |
| S: Na | kg/hr | | 0.99E-06 | 0.26E-09 | | 1.81E-06 | | | | | | | | |
| L: Water | kg/hr | [redacted] | 649.36 | | | | | | | | | | | |
| L: Na | kg/hr | | 16 | | | | | | | | | | | |
| V: Steam | kg/hr | | | 31.25 | | 31.25 | | | | | [redacted] | | | 64.27 |
| S: Na | % | | 14.82 | 14.82 | | 14.82 | | | | | | | | |

CHECKER NOTES:
1. Cells highlighted in Yellow have correct input values that
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3. Checked by William S. (Rusty) Gist. Dated April 12, 200

RPP-24544 REV 1

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DEMONSTRATION BULK VITRIFICATION SYSTEM (DBVS) MASS BALANCE

FEBRUARY 7, 2005

IDEAS STREAM DATA

| Stream No. | | 48 | 49 | 50 | 51 | 52 |
|---|---|---|---|---|---|---|
| Stream Name | | HNO SCRUB BLEED | HNO SCRUB SOLUTION | [illegible] ADD | 2-OE ADD | TREAMER WATER ADDITION |
| Solids | kg/hr | | | [illegible] | [illegible] | [redacted] |
| Solution | kg/hr | 33.57 | | [illegible] | [illegible] | [redacted] |
| Stream | kg/hr | 33.57 | | [illegible] | [illegible] | [redacted] |
| Solution | m3/hr | 0.0341 | | | | |
| Vapor | km3/hr | | | | | |
| Stream | m3/hr | 0.0341 | | [illegible] | [illegible] | [redacted] |
| Solid SG | | | | [illegible] | [illegible] | |
| Solution SG | | 0.996 | | | | 0.997 |
| Stream SG | | 0.997 | 0.996 | [redacted] | | 0.997 |
| Solids Content | % | | | [illegible] | [illegible] | |
| Temperature | °C | 27.00 | 25 | [illegible] | [illegible] | 25 |
| Pressure | kPa | 101.33 | 101.33 | [illegible] | [illegible] | 101.33 |
| S: Na | kg/hr | | | | | |
| L: Water | kg/hr | 33.57 | | | | [redacted] |
| L: Na | kg/hr | | | | | |
| V: Steam | kg/hr | | | | | |
| S: Na | % | | | | | |

CHECKER NOTES:

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2. Cells highlighted in Red do not match the IDEAS print-out
3. Checked by William S. (Rusty) Cole. Dated April 13, 200

ATTACHMENT 1
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## Stream Analyzer Data

| | 1 WASTE RECEIPT | 2 SPIKING FLOW | 3 STARTER PATHS | 4 SOIL | 5 ICV FEED | 6 DRYER CONDENSATE | 7 DRYER AIR | 8 OFF GAS AIR | 9 ICV AIR | 10 HOT ICV PRODUCT | 11 TOP UP SOIL | 12 COOLED ICV PRODUCT | 13 ICV OFF GAS | 14 COOLING ICV AIR | 15 ICV OFF GAS | 16 SCRUBBER AIR DILUTION | 17 FILTERED OFF GAS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Not Used | | | | | | | | | | | | | | | | | |
| Water | 66.76 | 66.75 | 0.0 | 0 | 1 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1.27 | 0 | 0.76 | 0 | 0.76 |
| $N_2$ | 0 | 0 | 0 | 0 | 0 | 0 | 76.71 | 76.71 | 76.71 | 0 | 0 | 0 | 53.69 | 76.71 | 53.69 | 76.71 | 53.69 |
| $O_2$ | 0 | 0 | 0 | 0 | 0 | 0 | 23.29 | 23.29 | 23.29 | 0 | 0 | 0 | 36.3 | 23.29 | 34.48 | 23.29 | 34.64 |
| $Al^{3+}$ | 0.1 | 0.1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $Ca^{2+}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $Cl^-$ | 0.02 | 0.02 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $CO_3^{2-}$ | 0.03 | 0.03 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $Cr^{2+}$ | 0.05 | 0.05 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $F^-$ | 0.01 | 0.01 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $Fe^{3+}$ | 0.02 | 0.02 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $K^+$ | 0.01 | 0.01 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $Li^+$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $Mg^{2+}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $Mn^{2+}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $NO_3^-$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $NO_2^-$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $NO^-$ | 0.33 | 0.33 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $NO_3^-$ | 22.3 | 22.3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $OH^-$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $Pb^{2+}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $PO_4^{3-}$ | 0.43 | 0.43 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $Na^+$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $Sr^{2+}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $Zn^{2+}$ | 0.01 | 0.01 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $SO_4^{2-}$ | 0.28 | 0.28 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $Sr^+$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C | 0.02 | 0.02 | 50 | 0 | 0.02 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $Na_2O$ | 0.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pu | 4.5E-01 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 4.2E-01 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 4.1E-01 | 0.0E+00 | 0.0E+01 | 6.3E-03 | 0.0E+00 | 3.7E-03 | 0.0E+00 | 1.1E-06 |
| Cs | 5.5E-01 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 4.4E-01 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 4.2E-01 | 0.0E+00 | 0.2E-01 | 7.6E-01 | 0.0E+00 | 9.5E-01 | 0.0E+00 | 1.4E-04 |
| Sr-90 | 1.8E-01 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 1.5E-01 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 1.3E-01 | 0.0E+00 | 1.8E-01 | 1.7E-03 | 0.0E+00 | 1.0E-03 | 0.0E+00 | 3.1E-07 |
| Tc | 3.1E-00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 2.4E-03 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 2.7E-03 | 0.0E+00 | 3.3E-03 | 1.5E-02 | 0.0E+00 | 0.0E+01 | 0.0E+00 | 3.0E-02 |
| Cs | 3.0E-03 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 1.3E-03 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 5.7E-03 | 0.0E+00 | 0.7E-03 | 8.3E-07 | 0.0E+00 | 2.1E-07 | 0.0E+00 | 9.3E-11 |
| Sr | 7.2E-02 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 1.3E-02 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 1.1E-01 | 0.0E+00 | 1.1E-01 | 1.8E-03 | 0.0E+00 | 5.0E-00 | 0.0E+00 | 1.3E-00 |
| Hanford Soil_1 | 0 | 0 | 46.2 | 92.35 | 38.02 | 0 | 0.000 | 0 | 0 | 44.90 | 92.35 | 66.0 | 0.50E-01 | 0.00 | 0.90E-01 | 0.00E+00 | 0 |
| $NO_2$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00E+00 | 11.17 | 0 | 0.04 | 0.00E+00 | 0.00E-00 |
| $NOx_2$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00E+00 | 0 | 0 | 1.24 | 0 | 0.74 | 0.00E+00 | 7.40E-01 |
| $CO_2$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4.77 | 0 | 2.83 | 0 | 2.85 |
| $HCl_2$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.01 | 0 | 0.01 | 0.00E+00 | 1.00E-02 |
| $SO_2$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.36 | 0 | 0.16 | 0 | 1.00E-01 |
| $NaNO_3$ | 0 | 0 | 1.32 | 2.86 | 1.38 | 0 | 0 | 0 | 0 | 20 | 2.65 | 20 | 0.19 | 0 | 0.138 | 0 | 0 |
| $OH_2$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $H_2SO_4$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00E+00 | 0.00E+00 |
| $HNO3_{(l)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00E+00 | 0 | 0 | 0 | 0 |
| $Al^{3+}$ | 0 | 0 | 0 | 0 | 0.11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $Ca^{2+}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $Cl^-$ | 0 | 0 | 0 | 0 | 0.02 | 0 | 0 | 0 | 0 | 0.02 | 0 | 0.02 | 0 | 0 | 0 | 0 | 0 |
| $CO_3^{2-}$ | 0 | 0 | 0 | 0 | 0.06 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $CrO_4^-$ | 0 | 0 | 0 | 0 | 0.07 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $F^-$ | 0 | 0 | 0 | 0 | 0.01 | 0 | 0 | 0 | 0 | 0.01 | 0 | 0.01 | 0 | 0 | 0 | 0 | 0 |
| $Fe^{3+}$ | 0 | 0 | 0 | 0 | 0.02 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $K^+$ | 0 | 0 | 0 | 0 | 0.02 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $Li^+$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $Mg^{2+}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $Mn^{2+}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $Na^+$ | 0 | 0 | 0 | 0 | 16.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $NH_3$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $NO_2^-$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $NO_3^-$ | 0 | 0 | 0 | 0 | 0.07 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $NO^-$ | 0 | 0 | 0 | 0 | 22.94 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $OH^-$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $Pb^{2+}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $PO_4^{3-}$ | 0 | 0 | 0 | 0 | 3.40 | 0 | 0 | 0 | 0 | 0.04 | 0 | 0.04 | 0.01 | 0 | 0 | 0 | 0 |
| $Na^+$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $Sr^{2+}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $Zn^{2+}$ | 0 | 0 | 0 | 0 | 0.01 | 0 | 0 | 0 | 0 | 0.02 | 0 | 0.02 | 0 | 0 | 0 | 0 | 0 |
| $SO_4^{2-}$ | 0 | 0 | 0 | 0 | 0.33 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $Sr^+$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| HCl_g | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $CaCl_2$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $CaSO_4 \cdot 2H_2O_{(s)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

DEMONSTRATION BULK VITRIFICATION SYSTEM (DBVS) MASS BALANCE

FEBRUARY 7, 2005

| | 1 WASTE RECEIPT | 2 SPRING FLOW STRIKER PATHS | 3 SOIL | 4 ICV FEED | 5 DRYER CONDENSATE | 6 DRYER AIR | 7 OFF GAS AIR | 8 ICV AIR | 9 HOT ICV PRODUCT | 10 TOP UP SOIL | 11 COOLED ICV PRODUCT | 12 ICV OFF GAS | 13 COOLING ICV AIR | 14 ICV OFF GAS | 15 SCRUBBER AIR DILUTION | 16 FILTERED OFF GAS | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CaCO2_kg | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CaSO4_kg | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Glass | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CO2_g | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1.3 | 0 | 4.37 | 0 | 5.74 |
| CaCO3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CaCO3_kg | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MgCO3_kg | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NH3_g | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| HF_kg | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| HF_g | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CaFe2_kg | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Al2O3_l | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.28 | 0 | 0.28 | 0 | 0 | 0 | 0 | 0 | 0 |
| CaO_l | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.15 | 0 | 0.15 | 0 | 0 | 0 | 0 | 0 | 0 |
| K2O_l | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.02 | 0 | 0.02 | 0 | 0 | 0 | 0 | 0 | 0 |
| FeO0_l | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.04 | 0 | 0.04 | 0 | 0 | 0 | 0 | 0 | 0 |
| FeO_l | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PCB | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Liq | 3.38E-02 | 0.00E+00 | 3.80E+00 | 6.09E+00 | 4.14E+02 | 3.38E-02 | 3.38E-02 | 3.38E-02 | 3.38E-02 | 4.41E+01 | 0.00E+00 | 2.45E+01 | 4.41E+02 | 0.00E+00 | 2.45E+02 | 0.00E+00 | 0.00E+00 |
| U_l | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| O_l1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Fe_l | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| S_l | 0 | 0 | 0.00E+00 | 0 | 0.00E+00 | 0 | 0 | 0 | 0 | 0 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| CaO | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.21 | 0 | 0.21 | 0 | 0 | 0 | 0 | 0 | 0 |
| NaOH_kg | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NaAlSiO4_kg | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NaCl | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NaF | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NaNO3_kg | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Na2CO3_kg | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Na2SO4_kg | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NaBr_kg | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CsNO3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NaNO2_kg | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Na2SiO4_kg | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SO2_g | 0 | 0 | 0 | 3.84 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.26 | 0 | 0.85 | 0 | 0 |
| O2_g | 0 | 0 | 0 | 2.35 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.07 | 0 | 0.24 | 0 | 0 |
| Ar | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Na2SiO4_kg | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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DEMONSTRATION BULK VITRIFICATION SYSTEM (DBVS) MASS BALANCE

FEBRUARY 7, 2005

**Stream**

| | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | DUST RECYCLE | QUENCH FEED | QUENCHER DISCHARGE | QUENCH RETURN | SCRUB RETURN | SCRUB DISCHARGE | QUENCH SOLUTION | SCRUB SOLUTION | CAUSTIC MAKE-UP | SCRUB RETURN BLEED | CONDENSER FEED | CONDENSER DISCHARGE | HEATER FEED | HEPA FEED |
| Hot Liquid | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Water | 0 | 0 | 0.02 | 94.97 | 90.32 | 0.01 | 99.53 | 99.53 | 99 | 99.17 | 0.01 | 0.0 | 0 | 0 |
| Steam | 0 | 0.02 | 2.51 | 0 | 0 | 2.51 | 0 | 0 | 0 | 0 | 0.02 | 0.17 | 0.17 | 0.17 |
| $N_2$ | 0 | 71.99 | 71.34 | 0 | 0 | 71.33 | 0 | 0 | 0 | 0 | 71.33 | 71.34 | 71.34 | 71.34 |
| $O_2$ | 0 | 23.63 | 23.14 | 0 | 0 | 23.14 | 0 | 0 | 0 | 0 | 23.34 | 23.34 | 23.34 | 23.34 |
| $Al_2O_3$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $CaO_{(s)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $Ca_{(s)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $CO_{2(s)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $Cr_{(s)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $F_{(s)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $Fe_{(s)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $K_{(s)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $Li_{(s)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $Mg_{(s)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $Mn_{(s)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $Na_{(s)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $NiO_{(s)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $NiS_{(s)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $NiSO_{(s)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $NiO_{(s)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $Ni_{(s)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $Pb_{(s)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $PO_4_{(s)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $S_{(s)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $SiO_{2(s)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $Na_{(s)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $SO_4_{(s)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $Sb_{(s)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $Sn_{(s)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $SO_4_{(s)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $Sb_{(s)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $O_{(s)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $Al_{(s)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $Ca_{(s)}$ | 6.1E-01 | 3.3E-07 | 3.3E-06 | 7.4E-01 | 7.3E-06 | 3.1E-01 | 3.3E-06 | 7.3E-06 | 0.0E+00 | 7.3E-06 | 3.1E-01 | 3.3E-06 | 3.3E-06 | 3.3E-06 |
| $Cr_{(s)}$ | 7.3E-01 | 3.3E-06 | 3.3E-06 | 3.1E-01 | 3.3E-04 | 3.3E-07 | 3.3E-04 | 3.3E-04 | 0.0E+00 | 3.3E-04 | 3.3E-07 | 3.7E-07 | 3.7E-07 | 3.7E-07 |
| $Fe_{(s)}$ | 1.3E-01 | 3.3E-06 | 3.3E-06 | 3.1E-01 | 3.3E-06 | 3.3E-10 | 3.3E-06 | 3.3E-06 | 0.0E+00 | 3.3E-06 | 3.3E-10 | 3.3E-10 | 3.3E-10 | 3.3E-10 |
| $K_{(s)}$ | 1.3E-01 | 7.3E-01 | 7.7E-04 | 1.3E-01 | 1.3E-01 | 7.3E-06 | 1.3E-01 | 1.3E-01 | 0.0E+00 | 1.3E-01 | 7.3E-06 | 7.3E-06 | 7.3E-06 | 7.3E-06 |
| $Li_{(s)}$ | 4.3E-01 | 2.7E-11 | 3.3E-13 | 4.3E-11 | 3.3E-13 | 2.7E-13 | 3.3E-13 | 3.3E-13 | 0.0E+00 | 3.3E-13 | 3.3E-13 | 3.3E-13 | 3.3E-13 | 3.3E-13 |
| $Mg_{(s)}$ | 1.3E-01 | 2.1E-10 | 3.3E-11 | 1.3E-09 | 1.3E-09 | 3.3E-12 | 1.3E-09 | 1.3E-09 | 0.0E+00 | 1.3E-09 | 3.3E-11 | 4.3E-11 | 4.3E-11 | 4.3E-11 |
| Hydrogen Gas$_{(g)}$ | 98.7700 | 0.0000 | 0.0000 | 0.0000 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0 | 0 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| $NO_{(g)}$ | 0.00E+00 | 1.31 | 1.07 | 0 | 0 | 1.06 | 0 | 0 | 0.00E+00 | 0 | 1.06 | 1.01 | 1.01 | 1.01 |
| $NO_{2(g)}$ | 0.00E+00 | 0.31 | 0.19 | 0 | 0 | 0.17 | 0 | 0 | 0 | 0 | 1.70E-01 | 0.16 | 0.16 | 0.16 |
| $CO_{(g)}$ | 0 | 0.65 | 0.76 | 0 | 0 | 0.67 | 0 | 0 | 0.00E+00 | 0 | 0.67 | 0.65 | 0.65 | 0.65 |
| $HCl_{(g)}$ | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0 | 0.00E+00 | 0.00E+00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $SO_{2(g)}$ | 0 | 0.04 | 0.05 | 0.00E+00 | 0 | 0.01 | 0 | 0 | 0 | 0 | 0.02 | 0.02 | 0.02 | 0.02 |
| $H_2SO_{4(g)}$ | 13.91 | 0 | 0 | 0 | 0 | 0 | 0.00E+00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $CH_{4(g)}$ | 0 | 0.00E+00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00E+00 | 0 | 0 | 0 | 0 |
| $HBrO_{4(g)}$ | 0 | 0 | 0.00E+00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $HNO_{3(g)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $Al_{(g)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $CaO_{(g)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $Cr_{(g)}$ | 0.02 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $CO_{2(g)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $CrO_{(g)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $F_{(g)}$ | 0.01 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $FeO_{(g)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $K_{(g)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $Li_{(g)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $Mg_{(g)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $MnO_{(g)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $Na_{(g)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $NiO_{(g)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $NiS_{(g)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $NiSO_{(g)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $NiO_{(g)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $Ni_{(g)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $Pb_{(g)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $PO_{4(g)}$ | 0.01 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $Sb_{(g)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $Se_{(g)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $Sn_{(g)}$ | 0.02 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $SO_{4(g)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $Zn_{(g)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $HCl_{(g)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $CaSO_{4(s)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $CaSO_{4(s)}H_2O_{(s)}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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DEMONSTRATION BULK VITRIFICATION SYSTEM (DBVS) MASS BALANCE

FEBRUARY 7, 2005

| | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | DUST RECYCLE | QUENCH FEED | QUENCHER DISCHARGE | QUENCH RETURN | SCRUB RETURN | SCRUB DISCHARGE | QUENCH SOLUTION | SCRUB SOLUTION | CAUSTIC MAKE-UP | SCRUB RETURN BLEED | CONDENSER FEED | CONDENSER DISCHARGE | HEATER FEED | HEPA FEED |
| CaCl2_aq | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CaSO4_aq | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Glass | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CO_g | 0 | 0.22 | 0.22 | 0 | 0 | 0.22 | 0 | 0 | 0 | 0 | 0.22 | 0.21 | 0.21 | 0.21 |
| CaCO3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CaCO3_aq | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NaCO3_aq | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NH3_g | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| HF_aq | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| HF_g | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CaF2_aq | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Al2O3_s | 0.38 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CrO2_s | 0.14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| K2O_s | 0.32 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Na2O3_s | 0.34 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PbO2_s | 0.34 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PCB | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| I_aq | 4.56E-04 | 2.23E-03 | 2.34E-03 | 5.11E-01 | 4.88E-01 | 2.23E-04 | 4.88E-01 | 4.88E-01 | 0.00E+00 | 4.88E-01 | 2.23E-04 | 2.17E-04 | 2.17E-04 | 2.17E-04 |
| I_g | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| C_14 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Hg_l | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| N_3 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| CaO | 0.81 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NaOH_aq | 0 | 0 | 0 | 0.47 | 0.47 | 0 | 0.53 | 0.53 | 0 | 0.47 | 0 | 0 | 0 | 0 |
| Na2SO4_aq | 0 | 0 | 0 | 1.11 | 1.26 | 0 | 1.08 | 1.08 | 0 | 1.08 | 0 | 0 | 0 | 0 |
| NaCl | 0 | 0 | 0 | 0.05 | 0.05 | 0 | 0.05 | 0.05 | 0 | 0.05 | 0 | 0 | 0 | 0 |
| NaF | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NaNO3_aq | 0 | 0 | 0 | 1.66 | 1.53 | 0 | 1.53 | 1.53 | 0 | 1.64 | 0 | 0 | 0 | 0 |
| NaNO2_aq | 0 | 0 | 0 | 0.53 | 0.85 | 0 | 0.45 | 0.45 | 0 | 0.57 | 0 | 0 | 0 | 0 |
| NaClO2_aq | 0 | 0 | 0 | 0 | 0.00E+00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Na2B_aq | 0 | 0 | 0 | 0 | 0.00E+00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CECR | 0 | 0 | 0 | 0 | 0.00E+00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NaNO2_aq | 0 | 0 | 0 | 0 | 0.00E+00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Na2SO4_aq | 0 | 0 | 0 | 0 | 0.00E+00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BaO_s | 5 | 0 | 0 | 0 | 0.00E+00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ZrO2_s | 7 | 0 | 0 | 0 | 0.00E+00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Al | 0 | 0 | 0 | 0 | 0.00E+00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NaHSO4_aq | 0 | 0 | 0 | 0 | 0.00E+00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0.00E+00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0.00E+00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0.00E+00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0.00E+00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | 108.010303 | | | | | | | | |

9.999999999

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# DEMONSTRATION BULK VITRIFICATION SYSTEM (DBVS) MASS BALANCE

FEBRUARY 7, 2005

**Stream**

| | 32 C-FILTER INLET | 33 36% SULFURIC ACID | 34 NaOCl | 35 Na2S | 36 50% NaOH | 37 RETURN SOLUTION | 38 C-FILTER DISCHARGE | 39 DILUTION AIR | 40 TRIMER FEED | 41 PART HEATED SCR FEED | 42 HEATED SCR FEED | 43 AMMONIA FEED | 44 AMBIENT AIR | 45 TRIMER DISCHARGE | 46 FAN EXHAUST |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Not Used | | | | | | | | | | | | | | | |
| Water | 0 | 64 | 88 | 80 | 50 | 54.22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam | 8.17 | 0 | 0 | 0 | 0 | 0 | 8.17 | 0 | 8.17 | 0 | 0 | 0 | 0 | [illegible] | [illegible] |
| N2_g | 71.34 | 0 | 0 | 0 | 0 | 0 | 71.34 | 76.71 | 71.34 | 0 | 0 | 0 | 0 | [illegible] | [illegible] |
| O2_g | [illegible] | 0 | 0 | 0 | 0 | 0 | [illegible] | 23.29 | [illegible] | 0 | 0 | 0 | 0 | [illegible] | [illegible] |
| Al3+ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ca2+_aq | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cl-_aq | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CO3-2_aq | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CrO4-_aq | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| F-_aq | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Fe3+_aq | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| K+_aq | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Li+_aq | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mg2+_aq | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mn2+_aq | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NH3_aq | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NH4+_aq | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NO2-_aq | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NO3-_aq | 0 | 0 | 0 | 0 | 0 | 3.71 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| OH_aq | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pb2+_aq | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PO4-3_aq | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sb5+_aq | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Se6+_aq | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Si4+_aq | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SO4-2_aq | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sn4+ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Na+_aq | 0 | 0 | 0 | 0 | 0 | 1.02 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pu | [illegible] | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | [illegible] | [illegible] | 0.0E+00 | [illegible] | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 |
| Cs | [illegible] | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | [illegible] | [illegible] | 0.0E+00 | [illegible] | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 |
| Sr-90 | [illegible] | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | [illegible] | [illegible] | 0.0E+00 | [illegible] | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 |
| Tc | [illegible] | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | [illegible] | [illegible] | 0.0E+00 | [illegible] | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 |
| Co | [illegible] | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | [illegible] | [illegible] | 0.0E+00 | [illegible] | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 |
| Eu | [illegible] | 0.0E+00 | [illegible] | 0.0E+00 | 0.0E+00 | [illegible] | [illegible] | 0.0E+00 | [illegible] | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 |
| Nonfixed Salt_s | 0 | 0 | 0 | 0.00E+00 | 0.00E+00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NO_g | 1.81 | 0 | 0.00E+00 | 0 | 0 | 0 | 1.81 | 0 | 1.81 | 0 | 0 | 0 | 0 | 0 | 0 |
| NO2_g | 0.16 | 0 | 0 | 0.000 | 0 | 0.000 | 0.16 | 0 | 0.16 | 0 | 0 | 0 | 0 | 0.04 | 0.04 |
| CO2_g | 0.05 | 0 | 0 | 0 | 0 | 0 | 0.05 | 0 | 0.05 | 0 | 0 | 0 | 0 | 0.1 | 0.1 |
| HCl_g | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SO2_g | 0.02 | 0 | 0 | 0 | 0 | 0 | 0.02 | 0 | 0.02 | 0 | 0 | 0 | 0 | 0 | 0 |
| NaSO_g | 0 | 0 | 0 | 0 | 0.00E+00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CH4_g | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| H2SO4_l | 0 | 36 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| HNO3_aq | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Al3+_s | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ca2+_s | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cl-_s | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CO3-2_s | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CrO4-_s | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| F-_s | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Fe3+_s | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| K+_s | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Li+_s | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mg2+_s | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mn2+_s | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Na+_s | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NH3_s | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NH4+_s | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NO2-_s | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NO3-_s | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| OH_s | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pb2+_s | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PO4-3_s | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sb5+_s | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Se6+_s | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Si4+_s | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SO4-2_s | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sn4+_s | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| HCl_aq | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CaCl2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CaSO4.2H2O_s | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

DEMONSTRATION BULK VITRIFICATION SYSTEM (DBVS) MASS BALANCE

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| | 31 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | C-FILTER INLET | 34% SULFURIC ACID | NaClO2 | NaOH | 50% NaOH | RETURN SOLUTION | C-FILTER DISCHARGE | DILUTION AIR | TRI-MER FEED | PART HEATED SCR FEED | HEATED SCR FEED | AMMONIA FEED | AMBIENT AIR | TRI-MER DISCHARGE | FAN EXHAUST |
| CaCl2_aq | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CaSO4_aq | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Glass | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| O2_g | 0.21 | 0 | 0 | 0 | 0 | 0 | 0.21 | 0 | 0.21 | 0 | 0 | 0 | 0 | 0.20 | 0.20 |
| CaCO3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CaCO3_aq | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| HCO3_aq | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NH3_g | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| HF_aq | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| HF_g | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CaF2_aq | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| AlCO3_g | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CrCl_g | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| K2O_g | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Fe2O3_g | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PbCl_g | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PCB | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| N_g | 2.17E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.15E-06 | 2.17E-06 | 0.00E+00 | 2.17E-06 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| O_g | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| H_g | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| K_g | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| CaO | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NaOH_aq | 0 | 0 | 0 | 0 | 50 | 6.10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Na2SO3_aq | 0 | 0 | 0 | 0 | 0 | 2.95 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NaCl | 0 | 0 | 0 | 0 | 0 | 2.50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NaF | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NaNO3_aq | 0 | 0 | 0 | 0 | 0 | 0.37 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Na2CO3_aq | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NaClO2_aq | 0 | 0 | 12.5 | 0 | 0 | 1.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NaSS_aq | 0 | 0 | 0 | 10 | 0 | 1.34 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ClO2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.11 | 0.11 |
| NaNO2_aq | 0 | 0 | 0 | 0 | 0 | 0.02 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Na2SO4_aq | 0 | 0 | 0 | 0 | 0 | 3.08 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| B2O3_l | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ZrO2_l | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Air | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| H2NHSO4_aq | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | | 0 | | | 0 | 0 | | 0 | 0 | | | | 0 | 0 |
| | 0 | | 0 | | | 0 | 0 | | 0 | 0 | | | | 0 | 0 |
| | 0 | | 0 | | | 0 | 0 | | 0 | 0 | | | | 0 | 0 |
| | 0 | | 0 | | | 0 | 0 | | 0 | 0 | | | | 0 | 0 |
| | 0 | | | | | 0 | | | | 0 | | | | | |

1.20

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DEMONSTRATION BULK VITRIFICATION SYSTEM (DBVS) MASS BALANCE

FEBRUARY 7, 2005

**Stream**

Not Used
Water
Steam
$N_2$_g
$O_2$_g
Ag+
$Ca_{2+}$_aq
$Cl_-$_aq
$CO_{3-2}$_aq
$Cr_{2+}$_aq
$F_-$_aq
$Fe_{3+}$_aq
$K_+$_aq
$Li_+$_aq
$Mg_{2+}$_aq
$Mn_{2+}$_aq
$NH_3$_aq
$NH_{4+}$_aq
$NO_{3-}$_aq
$NO_{2-}$_aq
$OH_-$_aq
$Pb_{2+}$_aq
$PO_{4-3}$_aq
$Sb_{4+}$_aq
$Se_{4+}$_aq
$Sn_{4+}$_aq
$SO_{4-2}$_aq
$Sr_{2+}$
C
$Al_{3+}$_aq
Fe
Cs
Sr-90
Tc
Cs
U
Normal $SiO_2$_s
$HO_2$_g
$NO_2$_g
$CO_2$_g
$HCl_g$
$SO_2$_g
$H_2O$_g
$CH_4$_g
$H_2SO_4$_l
$HNO_3$_aq
$Ag_+$_l
$Ca_{2+}$_l
$Cl_-$_l
$CO_{3-2}$_l
$Cr_{2+}$_l
$F_-$_l
$Fe_{3+}$_l
$K_+$_l
$Li_+$_l
$Mg_{2+}$_l
$Mn_{2+}$_l
$Na_+$_l
$NH_3$_l
$NH_{4+}$_l
$NO_{2-}$_l
$NO_{3-}$_l
$OH_-$_l
$Pb_{2+}$_l
$PO_{4-3}$_l
$Sb_{4+}$_l
$Se_{4+}$_l
$Sn_{4+}$_l
$SO_{4-2}$_l
$Sr_{2+}$_l
$HCl_{aq}$
$CaCl_2$
$CaSO_4 \cdot 2H_2O$_s

ATTACHMENT 1
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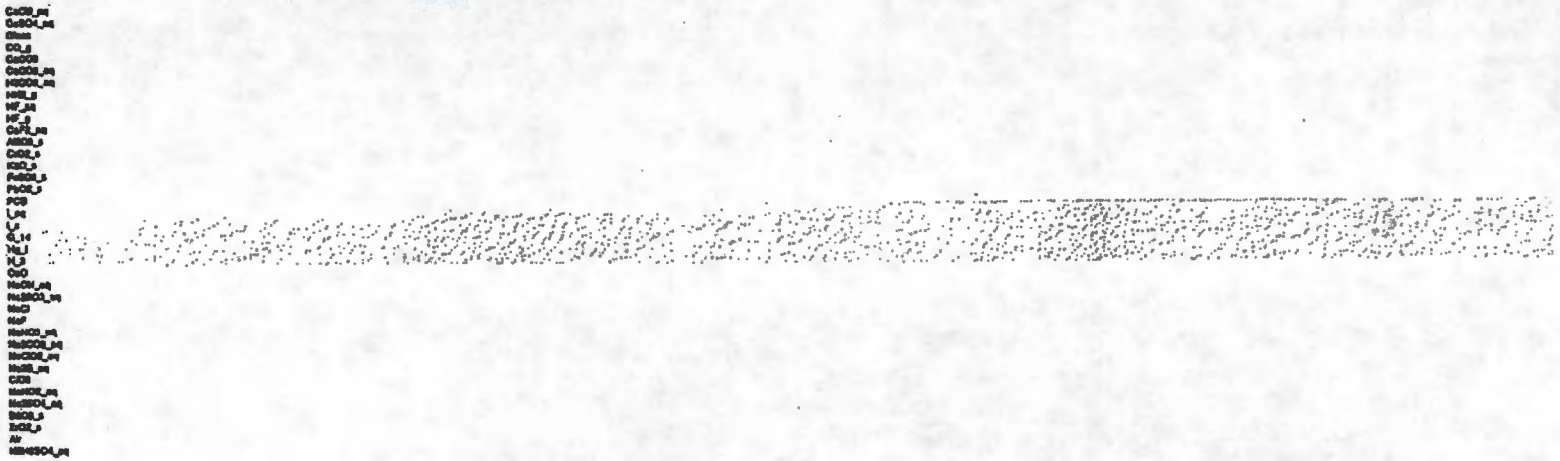
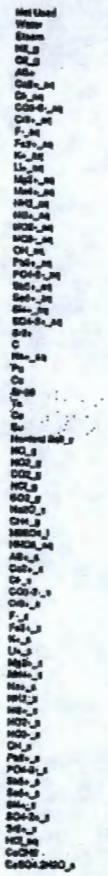


DEMONSTRATION BULK VITRIFICATION SYSTEM (DBVS) MASS BALANCE

FEBRUARY 7, 2005

Stream



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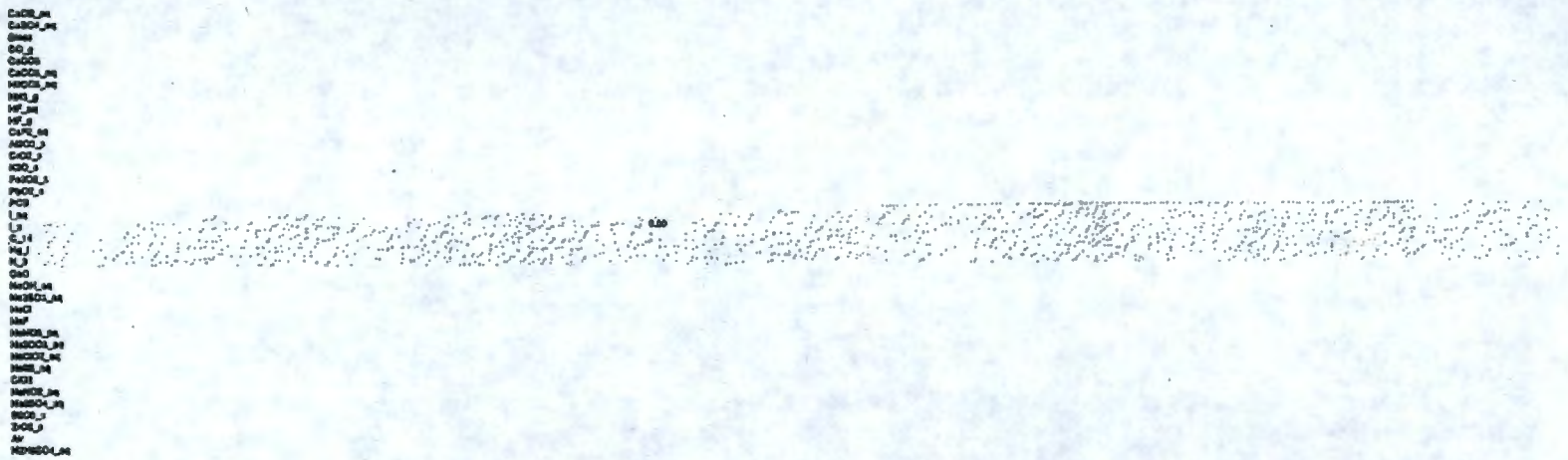
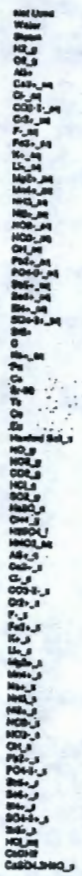


DEMONSTRATION BULK VITRIFICATION SYSTEM (DBVS) MASS BALANCE

FEBRUARY 7, 2005

Stream



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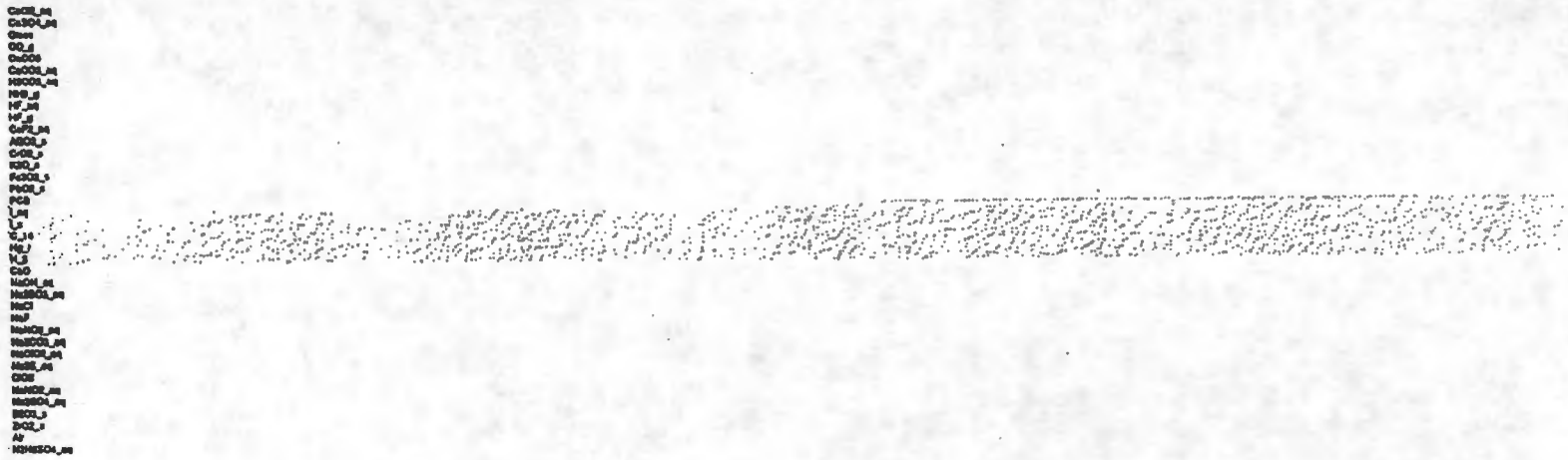

DEMONSTRATION BULK VITRIFICATION SYSTEM (DBVS) MASS BALANCE

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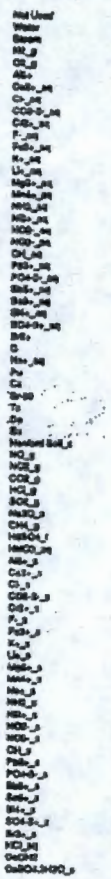
**Stream**



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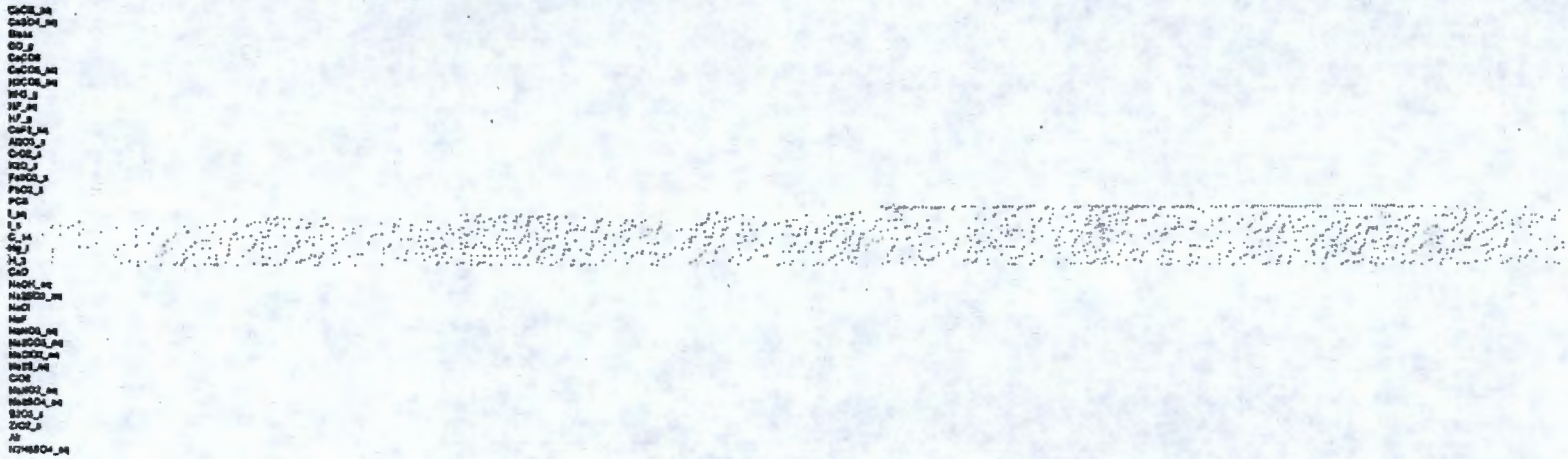

DEMONSTRATION BULK VITRIFICATION SYSTEM (DBVS) MASS BALANCE

FEBRUARY 7, 2005

**Stream**

Not Used
Water
Silicate
$NO_3$
$Cl_3$
$Al_3$
$Ca_{2+}$_M
$Cl_-$M
$CO_{3-2}$_M
$Cr_{6+}$M
$F_-$M
$Fe_{2+}$M
$K_+$M
$Li_+$M
$Mg_{2+}$M
$Mn_{2+}$M
$NH_4$M
$Na_+$M
$NO_{2-}$M
$NO_{3-}$M
OH_M
$Pb_{2+}$M
$PO_{4-3}$_M
$Sr_{2+}$M
$SO_{4-2}$_M
$Zn_{2+}$
C
$Al_{3+}$_M
Fe
Cs
Sr
Y
Ce
Eu
Hardness $CaCO_3$
$NO_3$
$NO_2$
$CO_3$
$HCl_3$
$SCl_3$
$NaNO_3$
$CH_3$
$H_2SO_4$
$HNO_3$_M
$Al_{3+}$
$Ca_{2+}$
$Cl_-$
$CO_{3-2}$
$Cr_{6+}$
$F_-$
$Fe_{2+}$
$K_+$
$Li_+$
$Mg_{2+}$
$Mn_{2+}$
$Na_+$
$NH_4$
$Na_+$
$NO_{2-}$
$NO_{3-}$
OH
$Pb_{2+}$
$PO_{4-3}$
$Sr_{2+}$
$Sr_{2+}$
$Zn_{2+}$
$SO_{4-2}$
$Br_{2+}$
HCl_M
$CaCO_3$
$CaSO_4 \cdot 2H_2O$

ATTACHMENT 1
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| |
|---|
| $CaCO_{3(s)}$ |
| $CaSO_{4(s)}$ |
| $CaH_2$ |
| $CO_{2(g)}$ |
| $CaCO_3$ |
| $CaCO_{3(s)}$ |
| $NaNO_{3(s)}$ |
| $NiO_{(s)}$ |
| $HF_{(aq)}$ |
| $HF_{(g)}$ |
| $CaF_{2(s)}$ |
| $Al_2O_{3(s)}$ |
| $CrO_{3(s)}$ |
| $K_2O_{(s)}$ |
| $Fe_2O_{3(s)}$ |
| $FeO_{(s)}$ |
| $PbO$ |
| $I_{(aq)}$ |
| $I_{2(s)}$ |
| $O_{2(g)}$ |
| $H_2O$ |
| $H_2O$ |
| $CaO$ |
| $NaOH_{(aq)}$ |
| $Na_2SO_{4(s)}$ |
| $NaCl$ |
| $NaF$ |
| $NaNO_{3(s)}$ |
| $Na_2CO_{3(s)}$ |
| $NaClO_{(aq)}$ |
| $Na_2S_{(aq)}$ |
| $ClO_2$ |
| $NaNO_{2(s)}$ |
| $Na_2SO_{4(aq)}$ |
| $SiO_{2(s)}$ |
| $SrO_{(s)}$ |
| $Air$ |
| $NH_4NO_{3(aq)}$ |

DEMONSTRATION BULK VITRIFICATION SYSTEM (DBVS) MASS BALANCE

FEBRUARY 7, 2005

**Stream**

Not Used
Water
Gases
$N_2$_g
$O_2$_g
$Al^{3+}$
$Ca^{2+}$_aq
$Cl^-$_aq
$CO_3^{2-}$_aq
$Cr^{3+}$_aq
$F^-$_aq
$Fe^{3+}$_aq
$K^+$_aq
$Li^+$_aq
$Mg^{2+}$_aq
$Mn^{2+}$_aq
$NH_4^+$_aq
$Na^+$_aq
$NO_2^-$_aq
$NO_3^-$_aq
$OH^-$_aq
$Pb^{2+}$_aq
$PO_4^{3-}$_aq
$Sb^{3+}$_aq
$Se^{4+}$_aq
$Sr^{2+}$_aq
$SO_4^{2-}$_aq
$Sr^{2+}$
C
$Na^+$_aq
Pu
Cs
Sr-90
Fe
Cr
Cs
Analyzed Soil_s
$NO_2$_g
$NO_2$_g
$CO_2$_g
$HCl$_g
$SO_2$_g
$NaNO_3$_s
$CH_4$_g
$NaSO_4$_s
$NaNO_3$_aq
$Al^+$_s
$CaSi$_s
$Cl^-$_s
$CO_3^{2-}$_s
$Cr^{3+}$_s
$F^-$_s
$Fe^{3+}$_s
$K^+$_s
$Li^+$_s
$Mg^{2+}$_s
$Mn^{2+}$_s
$Na^+$_s
$NH_4^+$_s
$N_2^+$_s
$NO_2^-$_s
$NO_3^-$_s
$OH^-$_s
$Pb^{2+}$_s
$PO_4^{3-}$_s
$Sb^{3+}$_s
$Se^{4+}$_s
$Sr^{2+}$_s
$SO_4^{2-}$_s
$SiO_2$_s
$HCl$_aq
$CaOH^2$
$CaSO_4 \cdot 2H_2O$_s

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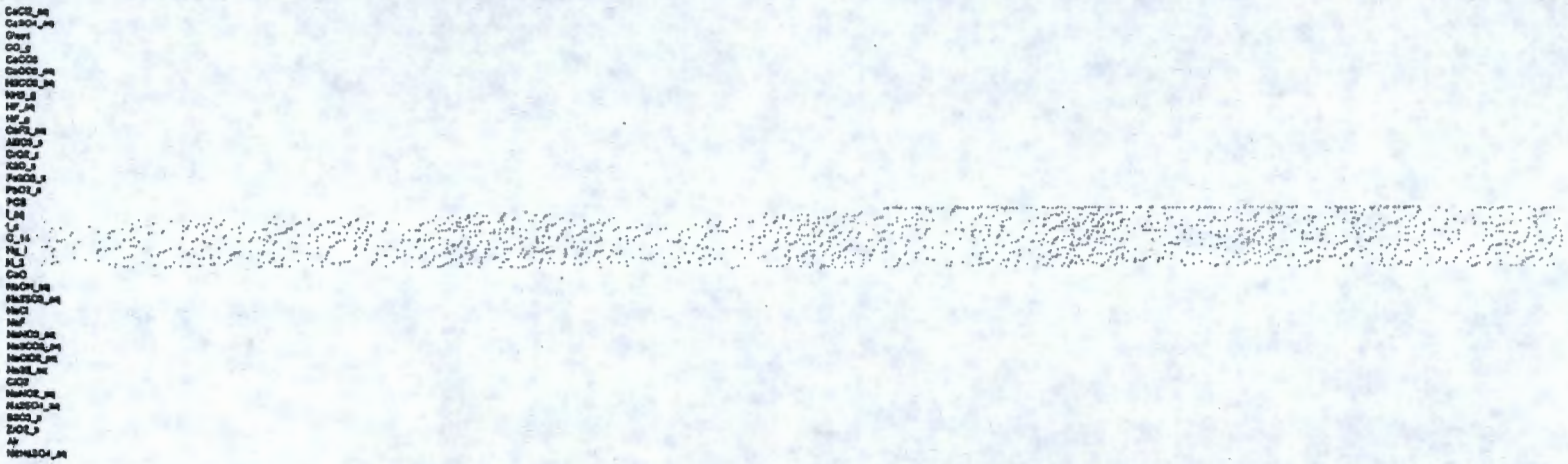
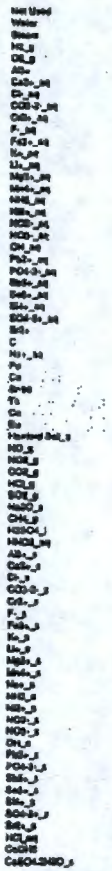


DEMONSTRATION BULK VITRIFICATION SYSTEM (DBVS) MASS BALANCE

FEBRUARY 7, 2005

Stream



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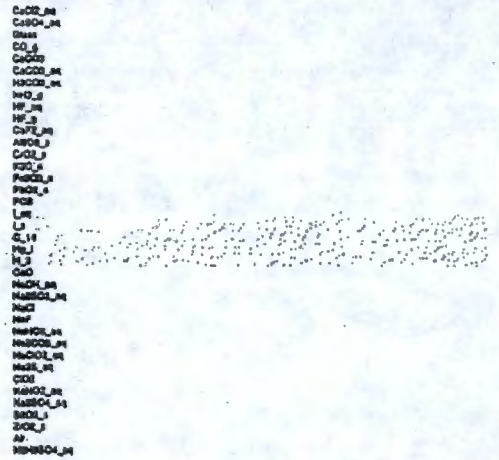

DEMONSTRATION BULK VITRIFICATION SYSTEM (DBVS) MASS BALANCE

FEBRUARY 7, 2005

RAD CONC PPB

| Str No. | Units | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Stream Name | | WASTE RECEIPTS | SPRING FLOW | STARTER PATHS | SOIL | ICV FEED | DRYER CONDENSATE | DRYER AIR | OFF GAS AIR | ICV AIR | HOT ICV PRODUCT | TOP UP SOIL | COOLED ICV PRODUCT | ICV OFF GAS | COOLING ICV AIR | ICV OFF GAS | SCRUBBER AIR DILUTION | FILTERED OFF GAS | DUST RECYCLE | QUENCH FEED |
| Pu | ppb | 45.39 | 0 | 0 | 0 | 52.51 | 0 | 0 | 0 | 0 | 52.43 | 0 | 52.43 | 6.21E-03 | 0 | 3.03E-03 | 0 | 1.11E-06 | 4.40E-01 | 3.19E-07 |
| Cs | ppb | 58.51 | 0 | 0 | 0 | 68.87 | 0 | 0 | 0 | 0 | 52.55 | 0 | 52.53 | 7.60E-01 | 0 | 4.53E-01 | 0 | 1.36E-04 | 7.33E+01 | 3.91E-05 |
| Sr-90 | ppb | 18.74 | 0 | 0 | 0 | 14.60 | 0 | 0 | 0 | 0 | 16.81 | 0 | 16.81 | 1.74E-03 | 0 | 1.04E-03 | 0 | 3.13E-07 | 1.80E-01 | 8.94E-06 |
| Tc | ppb | 3140.35 | 0 | 0 | 0 | 3391.96 | 0 | 0 | 0 | 0 | 3220.51 | 0 | 3220.51 | 1.54E-02 | 0 | 9.17E+01 | 0 | 2.77E-02 | 1.50E+04 | 7.53E-03 |
| Cs | ppb | 0.00377 | 0 | 0 | 0 | 4.32E-03 | 0 | 0 | 0 | 0 | 0.0057 | 0 | 0.0057 | 5.19E-07 | 0 | 3.07E-07 | 0 | 9.3E-11 | 5.31E-05 | 2.69E-11 |
| Sr | ppb | 0.07 | 0 | 0 | 0 | 0.0089 | 0 | 0 | 0 | 0 | 0.1091 | 0 | 0.1091 | 9.57E-09 | 0 | 5.66E-06 | 0 | 1.79E-10 | 1.02E-03 | 5.06E-10 |
| | ppb | 397.84 | | | 0 | 4.14E+02 | 5.20E-02 | 0 | 0 | 0 | 54.52 | 0 | 54.52 | 445.49 | 0 | 264.50 | 0 | 8.9E-02 | 45972.78 | 2.28E-03 |

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DEMONSTRATION BULK VITRIFICATION SYSTEM (DBVS) MASS BALANCE

FEBRUARY 7, 2005

RAD CC

| Sv No. | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Stream Name | QUENCHER DISCHARGE | QUENCH RETURN | SCRUB RETURN | SCRUB DISCHARGE | CO | ENCH SOLUTION | SCRUB SOLUTION | CAUSTIC MAKE-UP | SCR | BLEED | CONDENSER FEED | CONDENSER | DISCHARGE | HEATER | | FILTER INLET | SULFURIC ACID | NaOOH | Na2S |
| Pu | 2.12E-08 | 7.44E-06 | 7.45E-06 | 3.13E-09 | 7.17E-06 | 7.17E-06 | 0.00E+00 | 7.27E-06 | 3.13E-09 | 3.88E-09 | 3.88E-09 | 3.88E-09 | 2.62E-11 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Cs | 3.82E-06 | 9.19E-04 | 9.77E-04 | 3.94E-07 | 6.77E-04 | 6.77E-04 | 0.00E+00 | 6.88E-04 | 3.94E-07 | 3.70E-07 | 3.70E-07 | 3.70E-07 | 3.70E-09 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Sr-90 | 3.76E-09 | 2.09E-06 | 2.01E-06 | 8.90E-10 | 2.01E-06 | 2.01E-06 | 0.00E+00 | 2.04E-06 | 8.90E-10 | 6.48E-10 | 6.48E-10 | 6.48E-10 | 6.48E-12 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Tc | 7.75E-04 | 1.84E-01 | 1.77E-01 | 7.78E-05 | 1.77E-01 | 1.77E-01 | 0.00E+00 | 1.76E-01 | 7.78E-05 | 7.51E-05 | 7.51E-05 | 7.51E-05 | 7.51E-07 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Cs | 2.90E-12 | 6.18E-10 | 5.90E-10 | 2.66E-13 | 5.90E-10 | 5.90E-10 | 0.00E+00 | 6.03E-10 | 2.66E-13 | 2.51E-13 | 2.51E-13 | 2.51E-13 | 2.51E-15 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Sm | 4.39E-11 | 1.10E-08 | 1.14E-08 | 5.00E-12 | 1.14E-08 | 1.14E-08 | 0.00E+00 | 1.16E-08 | 5.00E-11 | 4.82E-11 | 4.82E-11 | 4.82E-11 | 4.82E-13 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| I | 2.24E-03 | 5.11E-01 | 4.92E-01 | 2.25E-04 | 4.92E-01 | 4.92E-01 | 0.00E+00 | 4.89E-01 | 2.25E-04 | 2.17E-04 | 2.17E-04 | 2.17E-04 | 2.17E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

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DEMONSTRATION BULK VITRIFICATION SYSTEM (DBVS) MASS BALANCE

FEBRUARY 7, 2005

RAD CC

| Str No. | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Stream Name | NaOH | RETURN SOLUTION | C-FILTER DISCHARGE | DILUTION AIR | SCR FEED | PART HEATED SCR FEED | HEATED SCR FEED | AMMONIA FEED | SCR AMBIENT AIR | SCR DISCHARGE | FAN DISCHARGE |
| Pu | 0.00E+00 | 4.29E-11 | 3.08E-11 | 0.00E+00 | 3.02E-11 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Cs | 0.00E+00 | 5.42E-09 | 3.78E-09 | 0.00E+00 | 3.70E-09 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Sr-90 | 0.00E+00 | 1.83E-11 | 6.49E-12 | 0.00E+00 | 6.49E-12 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Tc | 0.00E+00 | 1.09E-06 | 7.61E-07 | 0.00E+00 | 7.51E-07 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Co | 0.00E+00 | 3.64E-15 | 2.51E-15 | 0.00E+00 | 2.51E-15 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Eu | 0.00E+00 | 7.00E-14 | 4.82E-13 | 0.00E+00 | 4.82E-13 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| I | 0.00E+00 | 3.15E-06 | 2.17E-06 | 0.00E+00 | 2.17E-06 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

ATTACHMENT 1
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DEMONSTRATION BULK VITRIFICATION SYSTEM (DBVS) MASS BALANCE

FEBRUARY 7, 2005

## STREAM PRESSURES

| STREAM No. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STREAM NAME | UNITS | WASTE RECEIPT | SPIKING FLOW | STARTER PATHE SOIL | | ICV FEED | DRYER CONDENSATE | DRYER AIR | OFF GAS AIR | ICV HOT ICV PRODUCT | TOP UP SOIL | COOLING ICV PRODUCT | ICV OFF GAS | COOLING ICV AIR | ICV OFF GAS | SCRUBBER AIR | [illegible] |
| GAS PRESSURE, delta P, kPa | | | | | | | | | | | | | | | | | |
| GAS PRESSURE, delta P, kPa | kPa | n/a | n/a | n/a | n/a | n/a | n/a | -6.21 n/a | -0.44 n/a | n/a | n/a | | -0.60 | -0.63 | -0.63 | | -3.66 |
| Absolute Gas Pressure, kPa | kPa | n/a | n/a | n/a | n/a | n/a | n/a | 96.32 n/a | 100.37 n/a | n/a | n/a | | 100.73 | 100.70 | 100.70 | | 96.24 |
| Gas Pressure for new J and [illegible] [illegible] from 145579-V-CA-002 [illegible] | | | | | | | | | | | | | | | | | |

Note:
Pressure values shown in yellow cells are not from the Duct Pressure Calculation Spreadsheet.
Stream 7 (Cell I6) pressure is assumed to be equal to that of the ICV [illegible].
Stream 10 (Cell AP6) pressure is assumed to be equal to that of stream [illegible].
Stream 14 (Cell AY6) pressure is assumed to be equal to that of stream [illegible].

CHECKER NOTES:
1. ICV Air (Stream 9) Cell I46 does not match value shown in 145579-V-CA-002 (Ductwork Pressure) InProgress1.xls
2. Cooling ICV Air (Stream 14) Cell P6 does not match value shown in 145579-V-CA-002 (Ductwork Pressure) InProgress1.xls
3. Scrubber Air Dilution (Stream 16) Cell R6 does not match value shown in 145579-V-CA-002 (Ductwork Pressure) InProgress1.xls
4. Container Discharge (Stream 29) Cell AE6 does not match value shown in 145579-V-CA-002 (Ductwork Pressure) InProgress1.xls
5. Fan Discharge (Stream 46) Cell AV6 does not match value shown in 145579-V-CA-002 (Ductwork Pressure) InProgress1.xls
6. Cells for Notes 1-5 above have been highlighted in RED. Values in GREEN on Page 6 correspond to 145579-V-CA-002 (Ductwork Pressure) InProgress1.xls 6
7. Checked by William B. (Rusty) Cash. Dated April 12, 2005.

DEMONSTRATION BULK VITRIFICATION SYSTEM (DBVS) MASS BALANCE

FEBRUARY 7, 2005

| 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FILTERED OFF GAS | DUST RECYCLE | QUENCH FEED | QUENCHER DISCHARGE | QUENCH RETURN | SCRUB RETURN | SCRUB DISCHARGE | QUENCH SOLUTION | SCRUB SOLUTION | CAUSTIC MAKE-UP | SCRUB RETURN BLEED | CONDENSER FEED | CONDENSER DISCHARGE | HEATER FEED | HEPA FEED | C-FILTER INLET |
| | | | | | | | | | | | | | | | |
| -3.00 m/s | | -3.14 | -3.17 m/s | m/s | | -1.92 m/s | m/s | m/s | m/s | | -4.84 | -5.01 | -5.03 | -5.04 | -5.21 |
| 99.34 m/s | | 98.19 | 98.18 m/s | m/s | | 98.41 m/s | m/s | m/s | m/s | | 98.38 | 98.32 | 98.30 | 98.25 | 96.17 |

762 1.448943165 1136.80875

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DEMONSTRATION BULK VITRIFICATION SYSTEM (DBVS) MASS BALANCE

FEBRUARY 7, 2005

| | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SULFURIC ACID | $H_2CO_3$ | $H_2S$ | NaOH | | RETURN SOLUTION | D-FILTER DISCHARGE | DILUTION AIR | SCR FEED | PART HEATED SCR FEED | HEATED SCR FEED | AMMONIA FEED | SCR AMBIENT AIR | SCR DISCHARGE | FAN DISCHARGE |
| n/a | n/a | n/a | n/a | n/a | | | n/a | -21.36 n/a | n/a | n/a | n/a | -34.37 | | |
| n/a | n/a | n/a | n/a | n/a | | -5.31 n/a | | -5.31 n/a | n/a | n/a | -4.71 | -4.71 | | 0.17 |
| n/a | n/a | n/a | n/a | n/a | | 94.02 n/a | | 94.02 n/a | n/a | n/a | 92.68 | 92.82 | | 101.60 |

ATTACHMENT 1
145579-A-CA-004-REV A

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| Criteria | Value | Units | Reference |
|---|---|---|---|
| No. of liquid waste batches | 8 | # | 145579-A-DC-002 Section 3.4.2 |
| Hours per ICV Melt | 201 | hrs | 145579-A-DC-002 Section 3.5.1 |
| ICV Melt Duration | 139 | hrs | 145579-A-DC-002 Section 3.5.1 |
| Waste Batch Trans. Rate | 24 | USGPM | 145579-A-DC-002 Section 3.1 |
| Starter Path Trans. Time | 0.5 | hrs | 145579-A-DC-002 Section 3.5.1 |
| Soil Transfer Time | 0.25 | hrs | 145579-A-DC-002 Section 3.3 |
| Soil Bulk Density | 1.43 | Kg/litre | 145579-A-DC-002 Section 3.3 |
| Starter Path Bulk Density | 1.5 | Kg/litre | 145579-A-DC-002 Section 3.5.1 |
| B2O3 Bulk Density | 1.03 | Kg/litre | 145579-A-DC-002 Section 3.3 |
| ZrO2 Bulk Density | 1.96 | Kg/litre | 145579-A-DC-002 Section 3.3 |
| ICV FEED BULK Density | 1.49 | Kg/litre | 145579-A-DC-002 Section 3.5.1 |
| B2O3 Mass Transfer Time | 0.25 | hrs | 145579-A-DC-002 Section 3.3 |
| ZrO2 Mass Transfer Time | 0.25 | hrs | 145579-A-DC-002 Section 3.3 |
| ICV Feed Min. Transfer Time | 1 | hrs | 145579-A-DC-002 Section 3.5.1 |
| General Design Factor (DF) | 1 | Dimensionless Ratio | 145579-A-DC-002 Section 1 |
| Condensate Dischrge DF | 1.1 | Dimensionless Ratio | 145579-A-DC-002 Section 1 |
| Dryer Vent Air Flow | 600 | ACFM | 145579-A-DC-002 Section 3.4.2 |
| Clean Soil Off-Gas Air Flow | 1000 | ACFM | 145579-A-DC-002 Section 3.3 |
| Clean Soil Transfer Time | 5 | hrs | 145579-A-DC-002 Section 3.3 |
| Top-up Soil Transfer Time | 4 | hrs | 145579-A-DC-002 Section 3.5.1 |
| Off-Gas Cont./Batch Factor | 1.446 | Dimensionless (=201h/139h) | 145579-A-DC-002 Section 3.5.1 |
| Recycle Dust Bulk density | 1.5 | Kg/litre | 145579-A-DC-002 Section 3.6 |
| Melt-Off Duration | 62 | Hrs | 145579-A-DC-002 Section 3.5.1 |
| Atm. Pressure | 101.33 | kPa | IDEAS Software |
| Dryer batch time | 8.00 | Hr | 145579-A-DC-002 Section 3.4.2 |
| TRU Spec. Activity | 0.06202 | C i/ g | 145579-A-DC-002 Section 3.2 |
| $^{137}$Cs Spec. Activity | 86.55 | C i/ g | 145579-A-DC-002 Section 3.2 |
| $^{90}$Sr Spec. Activity | 138.8 | C i/ g | 145579-A-DC-002 Section 3.2 |
| $^{99}$Tc Spec. Activity | 0.01711 | C i/ g | 145579-A-DC-002 Section 3.2 |
| $^{154}$Eu Spec. Activity | 270.3 | C i/ g | 145579-A-DC-002 Section 3.2 |
| $^{60}$Co Spec. Activity | 1131 | C i/ g | 145579-A-DC-002 Section 3.2 |
| $^{129}$I Spec. Activity | 0.000177 | C i/ g | 145579-A-DC-002 Section 3.2 |
| Stream 7 (Upstream of Vacuum Pump) | 11.2 | ACFM | 145579-A-CA-005 Rev A Pp 26 of 29 |
| Dryer Air Temperature | 100 | Degrees Celsius | 145579-A-CA-005 Rev A Pp 26 of 29 |

**CHECKER NOTES:**

1. Cells highlighted in YELLOW correspond to values stated in Reference or are acceptable conve
2. Checked by William B. (Rusty) Craft. Dated April 12, 2005.

| Unit Converion | | to | | |
|---|---|---|---|---|
| to convert | kg | lb | multiply by | 2.2 |
| to convert | US gallon | Litres | multiply by | 3.785 |
| to convert | Hour | Minutes | multiply by | 60 |
| to convert | m 3 | Litres | multiply by | 1000 |
| to convert | m 3 | Cub. Ft | multiply by | 35.315 |
| to convert | kPa | inch water | multiply by | 0.249089 |

ersions or ratios.

DEMONSTRATION BULK VITRIFICATION SYSTEM (DBVS) MASS BALANCE

FEBRUARY 7, 2005

MASS BALANCE

| Str No. | | 1 | 2 | 3 | 4 | 4A | 4B | 5 | 6 | 7 | 7A | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Stream Name | | WASTE RECEIPT | SPIKING FLOW | STRTGH PATHS | SOIL | ZnO ADDITION | ZnO ADDITION | IOV FEED | DRYER CONDENSATE | DRYER AIR | DRYER VENT | OFF GAS AIR | IOV AIR | HOT IOV PRODUCT | TOP UP SOIL | COOLED IOV PRODUCT | IOV OFF GAS | COOLING IOV AIR |
| Solids | kg/hr | 0.00 | 0.00 | 7.38 | 142.31 | 10.61 | 14.65 | 275.03 | 0.00 | 0.00 | | 0.00 | 0.00 | 212 | 30 | 212 | 5.87 | 0.00 |
| Solution | kg/hr | 319.62 | - | 0.19 | 7.48 | | | 2.79 | 216.10 | - | | - | - | - | - | - | - | - |
| Stream | kg/hr | 319.78 | - | 7.46 | 149.79 | 10.61 | 14.65 | 275.82 | 216.10 | 51 | 203 | 2,006.39 | 108 | 212 | 30 | 212 | 234 | 159 |
| Solution | m3/hr | 0.25 | 0.00 | 0.000 | 0.01 | | | 0.00 | 0.22 | 0 | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Vapor | Nm3/hr | 0 | 0 | 0 | 0 | | | 0 | 0 | 33.41 | 158 | 1558.54 | 123.53 | 0 | 0 | 0 | 174 | 123.520 |
| Stream | m3/hr | 0.25 | 0 | 0.0 | 0.05 | | | 0.13 | 0.22 | 55.12 | 173 | 1669.01 | 135.71 | 0.0001 | 0.02 | 0.08 | 477 | 135.710 |
| Solids SG | | 2.39 | 0 | 2.4 | 2.39 | 3.01 | 4.09 | 2.12 | 0.00253 | 0 | 0 | 0 | 0 | 2.55 | 2.40 | 2.55 | 2.54 | 0.000 |
| Solution SG | | 1.28 | 0 | 0.947 | 0.947 | | | 0.999 | 0.999 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.153 | 0 |
| Stream SG | | 1.28 | 0.947 | 2.32 | 2.4 | 1.51 | 6.7 | 2.09 | 0.375 | 0.001 | 0.001 | 0.001 | 0.001 | 2.55 | 2.4 | 2.55 | 0.900 | 0.001 |
| Solids Content | % | 0.00 | 0.0 | 97.5 | 95.0 | 100 | 100 | 99.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 | 100.0 | 100.0 | 1.0 | 0.0 |
| Temperature | °C | 25 | 25 | 25 | 25 | 25 | 25 | 26.1 | 50 | 50 | 25 | 25 | 25 | 1300 | 25 | 50 | 466 | 25 |
| Pressure | in. H2O | | | | | NA | NA | | | -20.1 | 0 | 0 | -1.0 | | | | -0.4 | -0.51 |
| $H_2O$ Liquid | kg/hr | 313.4 | - | 0 | 7 | | | 3 | 216 | 0 | 0 | 0 | 0 | 0 | 2 | - | 0 | 0 |
| $H_2O$ Gas | kg/hr | - | - | - | - | | | - | - | - | - | - | - | - | - | - | 3 | 0 |
| $N_2$ | kg/hr | 28.45 | 0.0 | 0.1 | 2.8 | | | 21.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 21.5 | 0.4 | 21.5 | 0.33 | 0 |
| $SO_2$ Gas | ppmV | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1294 | 0 |
| $NO_x$ Gases | ppmV | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 119141 | 0 |
| HCl Gas | ppmV | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 110 | 0 |
| $^{137}Cs$ | ppm | 5.50E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | | | 5.37E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.29E-02 | 0.00E+00 | 5.29E-02 | 7.60E-04 | 0.00E+00 |
| $^{137}Cs$ | Ci/hr | 1.53E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.54E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.53E+00 | 0.00E+00 | 1.53E+00 | 1.54E-02 | 0.00E+00 |
| $^{137}Cs$ | g/hr | 1.20E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | | | 1.79E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.76E-02 | 0.00E+00 | 1.76E-02 | 1.79E-04 | 0.00E+00 |
| $^{90}Sr$ | ppm | 1.27E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | | | 1.46E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.92E-02 | 0.00E+00 | 1.92E-02 | 1.74E-04 | 0.00E+00 |
| $^{90}Sr$ | Ci/hr | 5.65E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.53E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.66E-01 | 0.00E+00 | 5.66E-01 | 5.64E-05 | 0.00E+00 |
| $^{90}Sr$ | g/hr | 4.07E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | | | 4.07E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.07E-03 | 0.00E+00 | 4.07E-03 | 4.08E-07 | 0.00E+00 |
| $^{99}Tc$ | ppm | 2.14035 | 0 | 0 | 0 | | | 2.54195 | 0 | 0 | 0 | 0 | 0 | 3.23681 | 0 | 3.23681 | 0.184179 | 0 |
| $^{99}Tc$ | Ci/hr | 1.17E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.23E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.17E-03 | 0.00E+00 | 1.17E-03 | 6.16E-04 | 0.00E+00 |
| $^{99}Tc$ | g/hr | 6.84E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | | | 7.20E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 6.84E-01 | 0.00E+00 | 6.84E-01 | 3.60E-02 | 0.00E+00 |
| $^{60}Co$ | ppm | 3.8E-06 | 0.0E+00 | 0.0E+00 | 0.0E+00 | | | 4.3E-06 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 5.7E-06 | 0.0E+00 | 5.7E-06 | 5.2E-10 | 0.0E+00 |
| $^{60}Co$ | Ci/hr | 1.35E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.34E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.36E-03 | 0.00E+00 | 1.36E-03 | 1.36E-07 | 0.00E+00 |
| $^{60}Co$ | g/hr | 1.29E-06 | 0.00E+00 | 0.00E+00 | 0.00E+00 | | | 1.20E-06 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.20E-06 | 0.00E+00 | 1.20E-06 | 1.21E-10 | 0.00E+00 |
| $^{125}Sb$ | ppm | 7.2E-06 | 0.0E+00 | 0.0E+00 | 0.0E+00 | | | 6.3E-06 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 1.1E-04 | 0.0E+00 | 1.1E-04 | 1.0E-08 | 0.0E+00 |
| $^{125}Sb$ | Ci/hr | 6.25E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.25E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 6.25E-03 | 0.00E+00 | 6.25E-03 | 5.25E-07 | 0.00E+00 |
| $^{125}Sb$ | g/hr | 2.31E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | | | 2.31E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.31E-05 | 0.00E+00 | 2.31E-05 | 2.31E-09 | 0.00E+00 |
| $^{106}Ru$ | ppm | 0.04534 | 0 | 0 | 0 | | | 0.05201 | 0 | 0 | 0 | 0 | 0 | 0.06842 | 0 | 0.06842 | 0.000094212 | 0 |
| $^{106}Ru$ | Ci/hr | 9.00E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 9.00E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 9.00E-04 | 0.00E+00 | 9.00E-04 | 8.30E-08 | 0.00E+00 |
| $^{106}Ru$ | g/hr | 1.45E-02 | 0.00 | 0.00 | 0.00 | | | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 |
| $^{241}Am$ | ppm | 3.98E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | | | 4.14E-01 | 5.30E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 8.45E-02 | 0.00E+00 | 8.45E-02 | 4.45E-01 | 0.00E+00 |
| $^{241}Am$ | Ci/hr | 2.25E-06 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.05E-03 | 2.05E-06 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.05E-06 | 0.00E+00 | 2.05E-06 | 1.84E-05 | 0.00E+00 |
| $^{241}Am$ | g/hr | 1.27E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | | | 1.16E-01 | 1.16E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.16E-02 | 0.00E+00 | 1.16E-02 | 1.04E-01 | 0.00E+00 |
| Cd | ppb | 3 | | | | | | 3 | | | | | | 3 | | 3 | 1.3 | |
| Ag | ppb | 1.856 | | | | | | 2.318 | | | | | | 2.859 | | 2.859 | 54.3 | |
| As | ppb | 42 | | | | | | 70 | | | | | | 64 | | 64 | 20 | |
| Se | ppb | 21 | | | | | | 35 | | | | | | 32 | | 32 | 0.8 | |
| TOC | ppm | 244 | | | | | | 200 | | | | | | | | | | |
| $Al3+$ | ppm | 974 | | | | | | | | | | | | | | | | |
| $Ca2+$ | ppm | 38 | | | | | | | | | | | | | | | | |
| $Cl-$ | ppm | 304 | | | | | | | | | | | | | | | | |
| $Cr3+$ | ppm | 394 | | | | | | | | | | | | | | | | |
| $F-_{eq}$ | ppm | 96 | | | | | | | | | | | | | | | | |
| $Fe3+$ | ppm | 267 | | | | | | | | | | | | | | | | |
| $K+$ | ppm | 137 | | | | | | | | | | | | | | | | |
| $Li+$ | ppm | | | | | | | | | | | | | | | | | |
| $Mg2+$ | ppm | | | | | | | | | | | | | | | | | |
| $Mn4+$ | ppm | 4.09 | | | | | | | | | | | | | | | | |
| $NH3\_$ | ppm | | | | | | | | | | | | | | | | | |
| $Ni2+$ | ppm | 4.94 | | | | | | | | | | | | | | | | |
| $OH\_$ | ppm | | | | | | | | | | | | | | | | | |
| $Pb2+$ | ppm | 22 | | | | | | | | | | | | | | | | |
| $PO4-3-$ | ppm | 4265 | | | | | | | | | | | | | | | | |
| $Sb5+$ | ppm | | | | | | | | | | | | | | | | | |
| $Se4+$ | ppm | 0.042 | | | | | | | | | | | | | | | | |
| $Si4+$ | ppm | 120 | | | | | | | | | | | | | | | | |
| $SO4-2$ | ppm | 3997 | | | | | | | | | | | | | | | | |
| $Sr2+$ | ppm | 2.22 | | | | | | | | | | | | | | | | |

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RPP-24544 REV 1

DEMONSTRATION BULK VITRIFICATION SYSTEM (DBVS) MASS BALANCE

FEBRUARY 7, 2005

| Stream No. / Stream Name | | 1 WASTE SLURRY | 2 SPIKING FLOW | 3 STRYER PATHS | 4 SOIL | 4A FOOD ADDITION | 4B SUGAR ADDITION | 5 IOV FEED | 6 DRYER CONDENSATE | 7 DRYER AIR | 7A DRYER VENT | 8 OFF GAS AIR | 9 IOV AIR | 10 HOT IOV PRODUCT | 11 TOP OF SOIL | 12 COOLED IOV PRODUCT | 13 IOV OFF GAS | 14 COOLING IOV AIR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mass | gpm | | | | | | | | | | | | | | | | | |
| Hanford Soil_o | ppm | | | | | | | | | | | | | | | | | |

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DEMONSTRATION BULK VITRIFICATION SYSTEM (DBVS) MASS BALANCE

FEBRUARY 7, 2005

MASS BALANCE

| Stream Number | | 15 ICV OFF GAS | 16 BOHAMBER AIR DILUTION | 17 FILTERED OFF GAS | 18 DUST RECYCLE | 19 QUENCH FEED | 20 QUENCHER DISCHARGE | 21 QUENCH RETURN | 22 SCRUB RETURN | 23 SCRUB DISCHARGE | 24 QUENCH SOLUTION | 25 SCRUB SOLUTION | 26 CAUSTIC MAKE-UP | 27 SCRUB RETURN FEED | 28 CONDENSER FEED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Solids | kg/hr | 2.27 | 0.00 | 0.00 | 2.27 | 0.00 | 0.00 | 0.00 | 0.05 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Solution | kg/hr | - | - | - | - | - | 0 | 2,370 | 4,608 | 0 | 2,401 | 4,608 | 91 | 98 | 0 |
| Stream | kg/hr | 340 | 373 | 391 | 2.27 | 1,363 | 1,394 | 2,370 | 4,608 | 1,369 | 2,401 | 4,608 | 91 | 98 | 1,369 |
| Solution | m3/hr | 0 | 0 | 0.0 | 0 | 2.11 | 4.22 | 2.24 | 2.1 | 0.422 | 2.27 | 4.54 | 0.046 | 0.062 | 0.00 |
| Vapor | Nm3/hr | 390 | 755 | 357.51 | 0 | 1051.94 | 1091.11 | 0 | 0 | 1088.38 | 0.0 | 0 | 0 | 0 | 1085 |
| Stream | m3/hr | 439 | 860 | 644.33 | 0.000001 | 2.11 | 4.22 | 4.22 | 2.1 | 0.422 | 2 | 2 | 0 | 0 | 1252 |
| Solids SG | | 2.54 | 0 | 2.54 | 2.54 | 2.54 | 2.54 | 2.54 | 2.54 | 2.54 | 2.54 | 2.54 | 0 | 2.54 | 2.54 |
| Solution SG | | 0.967 | 0 | 0.967 | 0 | 0.903 | 0.996 | 1.06 | 1.06 | 0.997 | 1.06 | 1.06 | 1.03 | 1.06 | 0.997 |
| Stream SG | | 0.000000 | 0.00 | 0.00 | 2.54 | 0.000000 | 0.00112 | 1.06 | 1.06 | 0.001 | 1.06 | 1.06 | 1.030 | 1.060 | 0.001 |
| Solids Content | % | 0.0 | 0.0 | 0.0 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Temperature | °C | 200 | 33 | 300 | 300.0 | 119.81 | 29.50 | 26.13 | 26.16 | 26.53 | 25.2 | 25.2 | 40 | 25 | 26.36 |
| Pressure | in. H2O | -2.5 | -12.30 | -12.4 | n/a | -12.5 | -10.7 | n/a | n/a | -10.7 | n/a | n/a | n/a | n/a | -10.3 |
| $H_2O$ Liquid | kg/hr | 0 | 0 | 0 | 0 | 0 | 0 | 2,193 | 4,334 | 0 | 2167 | 4332 | 90 | 98 | 0 |
| $H_2O$ Gas | kg/hr | 3 | 0 | 3 | - | 3 | 33 | - | - | 31 | - | - | - | - | 31.1 |
| Na | kg/hr | 0.25 | 0 | 0.0 | 0.24 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 0 |
| $SO_2$ Gas | ppmV | 723 | 0 | 724 | 0 | 226 | 116 | 0 | 0 | 61.4 | 0 | 0 | 0 | 0 | 61.4 |
| $NO_x$ Gases | ppmV | 55664 | 0 | 70072 | 0 | 19,834 | 13946 | 0 | 0 | 10965 | 0 | 0 | 0 | 0 | 13960 |
| HCl Gas | ppmV | 70 | 0 | 70 | 0 | 20 | 16 | 0 | 0 | 0.0 | 0 | 0 | 0 | 0 | 0.0 |
| $^{137}Cs$ | ppm | 4.52E-04 | 0.00E+00 | 1.36E-07 | 7.63E-05 | 3.31E-08 | 3.83E-09 | 6.10E-07 | 8.77E-07 | 3.64E-10 | 8.77E-07 | 6.77E-07 | 0.00E+00 | 9.88E-07 | 3.84E-10 |
| $^{137}Cs$ | Ci/hr | 1.54E-08 | 0.00E+00 | 4.60E-06 | 1.54E-05 | 4.81E-08 | 4.81E-07 | 1.87E-04 | 3.86E-04 | 4.81E-08 | 1.62E-04 | 3.93E-04 | 0.00E+00 | 5.24E-06 | 4.81E-08 |
| $^{137}Cs$ | g/hr | 1.78E-04 | 0.00E+00 | 5.31E-06 | 1.78E-04 | 5.33E-08 | 5.33E-07 | 2.16E-06 | 4.27E-06 | 5.33E-10 | 2.11E-06 | 4.21E-06 | 0.00E+00 | 5.43E-08 | 5.33E-10 |
| $^{90}Sr$ | ppm | 1.04E-04 | 0.00E+00 | 3.13E-10 | 1.88E-04 | 8.84E-11 | 3.76E-12 | 3.86E-09 | 2.01E-09 | 8.84E-13 | 3.61E-09 | 2.01E-09 | 0.00E+00 | 2.04E-09 | 9.88E-13 |
| $^{90}Sr$ | Ci/hr | 3.55E-06 | 0.00E+00 | 1.74E-08 | 3.86E-05 | 1.78E-08 | 1.78E-09 | 3.87E-07 | 1.34E-06 | 1.70E-10 | 6.71E-07 | 1.34E-06 | 0.00E+00 | 1.06E-06 | 1.78E-10 |
| $^{90}Sr$ | g/hr | 4.07E-07 | 0.00E+00 | 1.23E-10 | 4.08E-07 | 1.22E-10 | 1.22E-11 | 4.35E-09 | 9.86E-09 | 1.22E-12 | 4.84E-09 | 9.87E-09 | 0.00E+00 | 1.24E-10 | 1.22E-12 |
| $^{99}Tc$ | ppm | 0.0015454 | 0 | 0.00002566 | 15.67917 | 0.00002792 | 7.74E-07 | 0.00010376 | 0.00017715 | 7.74E-08 | 0.00017715 | 0.00017715 | 0 | 0.00017715 | 7.78E-09 |
| $^{99}Tc$ | Ci/hr | 6.19E-04 | 0.00E+00 | 1.86E-07 | 6.17E-04 | 1.86E-07 | 1.86E-08 | 7.45E-06 | 1.44E-05 | 1.85E-09 | 7.89E-06 | 1.46E-05 | 0.00E+00 | 2.01E-07 | 1.86E-09 |
| $^{99}Tc$ | g/hr | 3.69E-07 | 0.00E+00 | 1.08E-08 | 3.80E-05 | 1.08E-09 | 1.08E-10 | 4.34E-04 | 8.52E-04 | 1.08E-07 | 4.35E-04 | 8.51E-04 | 0.00E+00 | 1.18E-05 | 1.04E-07 |
| $^{60}Co$ | ppm | 3.1E-10 | 0.0E+00 | 9.3E-14 | 5.3E-08 | 2.7E-14 | 2.8E-16 | 6.8E-13 | 6.4E-13 | 8.7E-16 | 6.8E-13 | 6.6E-13 | 0.0E+00 | 6.0E-13 | 2.4E-16 |
| $^{60}Co$ | Ci/hr | 1.21E-07 | 0.00E+00 | 4.09E-11 | 1.36E-07 | 4.09E-11 | 4.36E-12 | 1.66E-09 | 3.24E-09 | 4.16E-13 | 1.62E-09 | 3.23E-09 | 0.00E+00 | 4.47E-11 | 4.09E-13 |
| $^{60}Co$ | g/hr | 1.30E-10 | 0.00E+00 | 3.61E-14 | 1.21E-10 | 3.61E-14 | 3.61E-15 | 1.46E-12 | 2.84E-12 | 3.70E-16 | 1.43E-12 | 2.86E-12 | 0.00E+00 | 3.94E-14 | 3.61E-16 |
| $^{152}Eu$ | ppm | 3.3E-09 | 0.0E+00 | 1.3E-12 | 1.0E-06 | 5.1E-13 | 5.0E-14 | 1.2E-11 | 1.1E-11 | 5.0E-15 | 1.1E-11 | 1.1E-11 | 0.0E+00 | 1.2E-11 | 5.0E-14 |
| $^{152}Eu$ | Ci/hr | 6.52E-07 | 0.00E+00 | 1.86E-10 | 6.26E-07 | 1.86E-10 | 1.86E-11 | 7.80E-09 | 1.49E-08 | 1.86E-12 | 7.42E-08 | 1.48E-08 | 0.00E+00 | 2.06E-10 | 1.86E-11 |
| $^{152}Eu$ | g/hr | 2.31E-08 | 0.00E+00 | 6.84E-13 | 2.23E-08 | 6.84E-13 | 6.94E-14 | 2.81E-11 | 5.30E-11 | 6.94E-15 | 2.76E-11 | 5.49E-11 | 0.00E+00 | 7.60E-13 | 6.94E-14 |
| $^{239}Pu$ | ppm | 3.09+06E-06 | 0 | 1.31+06E-09 | 0.00002977 | 3.192E-10 | 3.19E-11 | 7.4E-09 | 7.2E-09 | 3.12E-12 | 7.17E-09 | 7.17E-09 | 0 | 7.2656E-09 | 3.1944E-12 |
| $^{239}Pu$ | Ci/hr | 9.00E-06 | 0.00E+00 | 2.70E-11 | 8.01E-06 | 2.70E-11 | 2.70E-12 | 1.08E-09 | 2.14E-09 | 2.70E-13 | 1.07E-09 | 2.14E-09 | 0.00E+00 | 2.96E-11 | 2.70E-13 |
| $^{239}Pu$ | g/hr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 4.77E-10 | 0.00 |
| $^{137}Cl$ | ppm | 2.65E-01 | 0.00E+00 | 8.00E-06 | 4.58E-03 | 2.29E-06 | 2.24E-08 | 5.11E-04 | 4.92E-04 | 2.26E-07 | 4.88E-04 | 4.88E-04 | 0.00E+00 | 4.84E-04 | 2.25E-07 |
| $^{137}Cl$ | Ci/hr | 1.84E-03 | 0.00E+00 | 5.53E-09 | 1.84E-03 | 5.52E-10 | 5.52E-10 | 3.14E-07 | 4.18E-07 | 5.62E-11 | 2.08E-07 | 4.16E-07 | 0.00E+00 | 5.79E-09 | 5.52E-11 |
| $^{137}Cl$ | g/hr | 1.04E-01 | 0.00E+00 | 3.12E-05 | 1.04E-01 | 3.12E-06 | 3.12E-06 | 1.21E-03 | 2.37E-03 | 3.12E-07 | 1.18E-03 | 2.36E-03 | 0.00E+00 | 3.27E-05 | 3.12E-07 |
| Cd | ppb | 0.22 | | 0.00E+00 | 123 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | | 0.00E+00 | 0.00E+00 |
| Ag | ppb | 22 | | 0.00E+00 | 5,757 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | | 0.00E+00 | 0.00E+00 |
| As | ppb | 15 | | 0.00E+00 | 2,543 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | | 0.00E+00 | 0.00E+00 |
| Se | ppb | 0.4 | | 0.00E+00 | 63 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | | 0.00E+00 | 0.00E+00 |
| TOC | ppm | | | | | | | | | | | | | | |
| $Al_3+$ | ppm | | | | | | | | | | | | | 0 | |
| $CaI_2$ | ppm | | | | | | | | | | | | | 0 | |
| $Cl_-$ | ppm | | | | | | | | | | | | | 2.60E-01 | |
| $CrO_4$ | ppm | | | | | | | | | | | | | 0 | |
| $F_-$ | ppm | | | | | | | | | | | | | 0 | |
| $Fe_2+$ | ppm | | | | | | | | | | | | | 0 | |
| $K_+$ | ppm | | | | | | | | | | | | | 0 | |
| $Li_+$ | ppm | | | | | | | | | | | | | 0 | |
| $Mg_2+$ | ppm | | | | | | | | | | | | | 0 | |
| $Mn_2+$ | ppm | | | | | | | | | | | | | 0 | |
| $NO_3$ | ppm | | | | | | | | | | | | | 0 | |
| $Na_+$ | ppm | | | | | | | | | | | | | 0 | |
| $OH_-$ | ppm | | | | | | | | | | | | | 0 | |
| $Pb_2+$ | ppm | | | | | | | | | | | | | 0 | |
| $PO_4$ | ppm | | | | | | | | | | | | | 0 | |
| $SiO_2$ | ppm | | | | | | | | | | | | | 0.0065 | |
| $SeO_4$ | ppm | | | | | | | | | | | | | 0 | |
| $Na_+$ | ppm | | | | | | | | | | | | | 0 | |
| $SO_4$ | ppm | | | | | | | | | | | | | 0 | |
| $Sr_2+$ | ppm | | | | | | | | | | | | | 0 | |

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DEMONSTRATION BULK VITRIFICATION SYSTEM (DBVS) MASS BALANCE

FEBRUARY 7, 2005

| Stream No. | | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Stream Name | | IDV OFF GAS | SCRUBBER AIR SOLUTION | FILTERED OFF GAS | DUST RECYCLE | QUENCH FEED | QUENCHER DISCHARGE | QUENCH RETURN | SCRUB RETURN | SCRUB DISCHARGE | QUENCH SOLUTION | SCRUB SOLUTION | CAUSTIC MAKE-UP | SCRUB RETURN BLEED | CONDENSER FEED |
| Units | ppm | | | | | | | | | | | | | | |
| Hanford Soil_s | ppm | | | | | | | | | | | | | | |
| | | | 65300.17 | | | 9461.47 | | | | | | | | | |
| | | | 4755.46 | | | 468.39 | | | | | | | | | |

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DEMONSTRATION BULK VITRIFICATION SYSTEM (DBVS) MASS BALANCE

FEBRUARY 7, 2005

MASS BALANCE

| No. | Stream Name | | 19 CONDENSER DISCHARGE | 20 HEATER FEED | 21 HEPA FEED | 22 D-FILTER INLET | 23 34% SULFURIC ACID | 24 NaOHOE | 25 NaOH | 26 50% NaOH | 27 RETURN SOLUTION | 28 D-FILTER DISCHARGE | 29 DILUTION AIR | 40 TRI-NOX FEED | 41 PART HEATED SCR FEED | 42 HEATED SCR FEED | 43 AMMONIA FEED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Solids | kg/hr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.000 |
| | Solution | kg/hr | - | - | - | - | 93 | 456 | 394 | 44 | 1,002 | - | - | - | - | 0 | 0 |
| | Stream | kg/hr | 1,439 | 1,439 | 1,439 | 1,439 | 93 | 456 | 394 | 44 | 1,002 | 1,439 | - | 1,439 | - | - | - |
| | Solution | m3/hr | 0.00 | 0.00 | 0.00 | 0.00 | 0.08 | 0.453 | 0.345 | 0.0555 | 0.876 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | Vapor | Nm3/hr | 1125 | 1124.89 | 1124.89 | 1124.89 | 0 | 0 | 0 | - | 0 | 1,125 | - | 1,125 | - | - | 0 |
| | Stream | m3/hr | 1300 | 1347.43 | 1514.23 | 1516.19 | 0.0762 | 2.1 | 0 | 0 | 0.876 | 1,516 | - | 1,516 | - | - | 0 |
| | Solids SG | | 2.54 | 2.54 | 2.54 | 2.516 | 0 | 2.1 | 0 | 0 | 2.53 | 2.54 | 0 | 2.54 | 0 | 0 | 0 |
| | Solution SG | | 0 | 0 | 0 | 0 | 1.19 | 1.07 | 1.00 | 1.31 | 1.02 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Stream SG | | 0.001 | 0.001 | 0.001 | 0.000949 | 1.19 | 0.994 | 1.000 | 1.516 | 1.020 | 0.001 | 0.001 | 0.001 | 0.000 | 0.000 | 0.001 |
| | Solids Content | % | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | Temperature | °C | 26.46 | 26.46 | 75 | 74.58 | 25 | 25 | 25 | 25 | 25 | 74.96 | 25 | 74.96 | 110 | 110.3 | 35 |
| | Pressure | in. H2O | -20.1 | -20.2 | -20.6 | -20.8 | n/a | n/a | n/a | n/a | n/a | -21.3 | n/a | -21.3 | n/a | n/a | n/a |
| | $H_2O$ Liquid | kg/hr | 0 | 0 | 0 | 0 | 56 | 394 | 341 | 42 | 844 | 0 | 0 | 0 | 0 | 0 | 0 |
| | $H_2O$ Gas | kg/hr | 31.2 | 31.2 | 31.2 | 31.2 | - | - | - | - | - | 31 | - | 31 | - | - | - |
| | Na | kg/hr | 0 | 0 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 10.2 | 0.0 | 0.0 | 0.00 | 0.0 | 0.0 | 0.0 |
| | $SO_2$ Gas | ppmV | 79.5 | 79.5 | 79.5 | 79.5 | 0 | 0 | 0.0 | 0 | 0.0 | 79.5 | 0.0 | 79.5 | 0.0 | 0.0 | 0.0 |
| | $NO_x$ Gases | ppmV | 18294 | 18294 | 18294 | 18294 | 0 | 0 | 0 | - | 0 | 18294 | 0 | 18294 | 0.0 | 0.0 | 0.0 |
| | HCl Gas | ppmV | 0.3 | 0.3 | 0.3 | 0.3 | 0 | 0 | 0.0 | 0 | 0.0 | 0.3 | 0.0 | 0.3 | 0.0 | 0.0 | 0.0 |
| | $^{137}Cs$ | ppm | 2.70E-12 | 2.70E-12 | 2.70E-12 | 2.70E-12 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.45E-12 | 2.70E-12 | 0.00E+00 | 2.70E-12 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| | $^{137}Cs$ | Ci/hr | 4.61E-09 | 4.61E-09 | 4.61E-09 | 4.61E-09 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.73E-10 | 4.61E-10 | 0.00E+00 | 4.61E-10 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| | $^{137}Cs$ | g/hr | 5.33E-10 | 5.33E-10 | 5.33E-10 | 5.33E-10 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.46E-12 | 5.33E-12 | 0.00E+00 | 5.33E-12 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| | $^{79}Br$ | ppm | 8.49E-13 | 8.49E-13 | 8.49E-13 | 8.49E-13 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.23E-14 | 8.49E-15 | 0.00E+00 | 8.49E-15 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| | $^{79}Br$ | Ci/hr | 1.70E-10 | 1.70E-10 | 1.70E-10 | 1.70E-10 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.21E-13 | 1.70E-12 | 0.00E+00 | 1.70E-12 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| | $^{79}Br$ | g/hr | 1.23E-13 | 1.23E-13 | 1.23E-13 | 1.23E-13 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.24E-14 | 1.23E-14 | 0.00E+00 | 1.23E-14 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| | $^{99}Tc$ | ppm | 7.30E-08 | 7.30E-08 | 7.30E-08 | 7.30E-10 | 0 | 0 | 0 | 0 | 1.08E-09 | 7.80E-10 | 0 | 7.80E-10 | 0.00E+00 | 0.00E+00 | 0 |
| | $^{99}Tc$ | Ci/hr | 1.85E-09 | 1.85E-09 | 1.85E-09 | 1.85E-11 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.67E-11 | 1.85E-11 | 0.00E+00 | 1.85E-11 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| | $^{99}Tc$ | g/hr | 1.08E-07 | 1.08E-07 | 1.08E-07 | 1.08E-09 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.09E-09 | 1.08E-09 | 0.00E+00 | 1.08E-09 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| | $^{60}Co$ | ppm | 2.5E-16 | 2.5E-16 | 2.5E-16 | 2.5E-16 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 3.8E-18 | 2.5E-18 | 0.0E+00 | 2.5E-18 | 0.0E+00 | 0.0E+00 | 0.0E+00 |
| | $^{60}Co$ | Ci/hr | 4.69E-15 | 4.69E-15 | 4.69E-15 | 4.69E-15 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.13E-15 | 4.69E-15 | 0.00E+00 | 4.69E-15 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| | $^{60}Co$ | g/hr | 3.81E-16 | 3.81E-16 | 3.81E-16 | 3.81E-18 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.65E-18 | 3.81E-18 | 0.00E+00 | 3.81E-18 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| | $^{152}Eu$ | ppm | 4.8E-14 | 4.8E-14 | 4.8E-14 | 4.8E-16 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 7.0E-17 | 4.8E-16 | 0.0E+00 | 4.8E-16 | 0.0E+00 | 0.0E+00 | 0.0E+00 |
| | $^{152}Eu$ | Ci/hr | 1.86E-11 | 1.86E-11 | 1.86E-11 | 1.86E-13 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.98E-14 | 1.86E-13 | 0.00E+00 | 1.86E-13 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| | $^{152}Eu$ | g/hr | 8.94E-14 | 8.94E-14 | 8.94E-14 | 8.94E-16 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 7.00E-17 | 8.94E-16 | 0.00E+00 | 8.94E-16 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| | $^{239}Pu$ | ppm | 3.024E-12 | 3.024E-12 | 3.024E-12 | 3.024E-14 | 0 | 0 | 0 | 0 | 4.23E-14 | 3.024E-14 | 0 | 3.024E-14 | 0 | 0 | 0 |
| | $^{239}Pu$ | Ci/hr | 2.70E-13 | 2.70E-13 | 2.70E-13 | 2.70E-15 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.72E-16 | 2.70E-15 | 0.00E+00 | 2.70E-15 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| | $^{239}Pu$ | g/hr | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 4.40E-14 | 4.35E-14 | 0.00E+00 | 4.35E-14 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| | $^{55}Fe$ | ppm | 2.17E-07 | 2.17E-07 | 2.17E-07 | 2.17E-07 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.13E-09 | 2.17E-09 | 0.00E+00 | 2.17E-09 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| | $^{55}Fe$ | Ci/hr | 5.52E-11 | 5.52E-11 | 5.52E-11 | 5.52E-11 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.54E-13 | 5.52E-13 | 0.00E+00 | 5.52E-13 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| | $^{55}Fe$ | g/hr | 3.12E-07 | 3.12E-07 | 3.12E-07 | 3.12E-07 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.19E-09 | 3.12E-09 | 0.00E+00 | 3.12E-09 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| | Cd | ppb | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | | | | | | 0.00E+00 | | 0.00E+00 | 0.00E+00 | 0.00E+00 | |
| | Ag | ppb | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | | | | | | 0.00E+00 | | 0.00E+00 | 0.00E+00 | 0.00E+00 | |
| | As | ppb | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | | | | | | 0.00E+00 | | 0.00E+00 | 0.00E+00 | 0.00E+00 | |
| | Se | ppb | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | | | | | | 0.00E+00 | | 0.00E+00 | 0.00E+00 | 0.00E+00 | |
| | TOC | ppm | | | | | | | | | | 0.00E+00 | | | | | |
| | $Al_3+$ | ppm | | | | | | | | | | | | | | | |
| | $Ca_2+$ | ppm | | | | | | | | | | | | | | | |
| | Cr | ppm | | | | | | | | | | | | | | | |
| | $CrO_4-$ | ppm | | | | | | | | | | | | | | | |
| | $F_-$ | ppm | | | | | | | | | | | | | | | |
| | $Fe_3+$ | ppm | | | | | | | | | | | | | | | |
| | $K_+$ | ppm | | | | | | | | | | | | | | | |
| | $Li_+$ | ppm | | | | | | | | | | | | | | | |
| | $Mg_2+$ | ppm | | | | | | | | | | | | | | | |
| | $Na_+$ | ppm | | | | | | | | | | | | | | | |
| | $NH_3$ | ppm | | | | | | | | | | | | | | | |
| | $NO_3-$ | ppm | | | | | | | | | | | | | | | |
| | $OH_-$ | ppm | | | | | | | | | | | | | | | |
| | $PO_4_3-$ | ppm | | | | | | | | | | | | | | | |
| | $Sb_3+$ | ppm | | | | | | | | | | | | | | | |
| | $Se_4+$ | ppm | | | | | | | | | | | | | | | |
| | $Si_4+$ | ppm | | | | | | | | | | | | | | | |
| | $SO_4-2$ | ppm | | | | | | | | | | | | | | | |
| | $Sr_2+$ | ppm | | | | | | | | | | | | | | | |

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DEMONSTRATION BULK VITRIFICATION SYSTEM (DBVS) MASS BALANCE

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| Str No. | | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Stream Name | | CONDENSER DISCHARGE | HEATER FEED | NaOH FEED | C-FILTER INLET | 20% SULFURIC ACID | NaClO3 | NaNO3 | 50% NaOH | RETURN SOLUTION | C-FILTER DISCHARGE | DILUTION AIR | TRIMMER FEED | PART HEATED SCR FEED | HEATED SCR FEED | AMMONIA FEED |
| Kg/ | ppm | | | | | | | | | | | | | | | |
| Hanford Soil_o | ppm | | | | | | | | | | | | | | | |

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DEMONSTRATION BULK VITRIFICATION SYSTEM (DBVS) MASS BALANCE

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| MASS BALANCE | | | | |
|---|---|---|---|---|
| Stream Name | | 41 AMBIENT AIR | 46 LIFTED TRIMER OFF GAS | 48 FAN EXHAUST |
| Solids | kg/hr | 0.00 | 0.00 | 0.00 |
| Solution | kg/hr | 0 | 0.00 | 0 |
| Stream | kg/hr | 8087.9 | 8,464 | 8,464 |
| Solution | m3/hr | 0.00 | 0.0000 | 0.0000 |
| Vapor | Nm3/hr | 6212.79 | 7,367 | 7,357 |
| Stream | m3/hr | 7417.68 | 8,834 | 8,834 |
| Solids SG | | 0 | 0 | 0 |
| Solution SG | | 0 | 0 | 0 |
| Stream SG | | 0.001 | 0.001 | 0.001 |
| Solids Content | % | 0.0 | 0.0 | 0.0 |
| Temperature | °C | 25 | 27 | 96 |
| Pressure | in. H2O | -35 | -36.6 | 0.70 |
| $H_2O$ Liquid | kg/hr | 0 | 0 | 0 |
| $H_2O$ Gas | kg/hr | - | 69 | 69 |
| Na | kg/hr | 0.0 | 0 | 0 |
| $SO_2$ Gas | ppmV | 0.0 | 12.1 | 12.1 |
| $NO_x$ Gases | ppmV | 0.0 | 328.0 | 328.0 |
| HCl Gas | ppmV | 0.0 | 0.97 | 0.97 |
| $^{60}Co$ | ppm | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| $^{60}Co$ | Ci/hr | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| $^{60}Co$ | g/hr | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| $^{90}Sr$ | ppm | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| $^{90}Sr$ | Ci/hr | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| $^{90}Sr$ | g/hr | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| $^{137}Cs$ | ppm | 0 | 0.00E+00 | 0.00E+00 |
| $^{137}Cs$ | Ci/hr | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| $^{137}Cs$ | g/hr | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| $^{60}Co$ | ppm | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| $^{60}Co$ | Ci/hr | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| $^{60}Co$ | g/hr | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| $^{152}Eu$ | ppm | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| $^{152}Eu$ | Ci/hr | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| $^{152}Eu$ | g/hr | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| $^{154}Eu$ | ppm | 0 | 0 | 0 |
| $^{154}Eu$ | Ci/hr | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| $^{154}Eu$ | g/hr | 0.00 | 0.00 | 0.00 |
| $^{137}Cs$ | ppm | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| $^{137}Cs$ | Ci/hr | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| $^{137}Cs$ | g/hr | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Cd | ppm | | 0.00E+00 | 1.14E-07 |
| Ag | ppm | | 0.00E+00 | 4.77E-08 |
| As | ppm | | 0.00E+00 | 2.29E-06 |
| Ga | ppm | | 0.00E+00 | 5.32E-09 |
| TOC | ppm | | | |
| $Al_3+$ | ppm | | | 0.00 |
| $Ca_2+$ | ppm | | | 0.00 |
| Cr | ppm | | | 1.30E-09 |
| $Cr_2+$ | ppm | | | |
| $F_-$ | ppm | | | 1.20E-06 |
| $Fe_3+$ | ppm | | | |
| $K_+$ | ppm | | | |
| $Li_+$ | ppm | | | |
| $Mg_2+$ | ppm | | | |
| $NH_4+$ | ppm | | | 7.78E-11 |
| $NH_3$ | ppm | | | 5.96 |
| $NH_2+$ | ppm | | | 6.15E-11 |
| $OH_-$ | ppm | | | |
| $Pb_2+$ | ppm | | | |
| $PO_4-3$ | ppm | | | 5.43E-06 |
| $Sb_3+$ | ppm | | | |
| $Se_4+$ | ppm | | | 5.36E-13 |
| $Si_4+$ | ppm | | | 1.54E-08 |
| $SO_4-2$ | ppm | | | 3.64E-11 |
| $Sr_2+$ | ppm | | | 2.32E-11 |

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DEMONSTRATION BULK VITRIFICATION SYSTEM (DBVS) MASS BALANCE

FEBRUARY 7, 2005

| Stream No. | | 44 | 45 | 46 |
|---|---|---|---|---|
| Stream Name | | AUGMENT AIR | SLUTRI TRIAGE OFF GAS | FAN EXHAUST |
| Flow | kgph | | | |
| Hanford Soil_a | kgph | | | |

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PFD 30

| STREAM No. | | 1 | 2 | 14 | 3 | 4 | 4A | 4B | 5 | 6 | 7 | 7A | 8 | 9 | 10 | 11 | 12 | 13 | 13A | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STREAM NAME | UNITS | WASTE RECEIPT | SPIKING FLOW | WASTE FLOW | STRTER PATHE | SOIL | ESOS ADDITION | Z/O2 ADDITION | ICV PEBO | DRYER CONDENSATE | DRYER AIR | DRYER VENT AIR | OFF GAS AIR | ICV AIR | HOT ICV PRODUCT | TOP UP SOIL | COOLED ICV PRODUCT | ICV OFF GAS | AWTE VENT AIR | DUST RECYCLE |
| PHASE | | LIQUID | LIQUID | LIQUID | SOLID | SOLID | SOLID | SOLID | SOLID | LIQUID | GAS | GAS | GAS | GAS | SOLID | SOLID | SOLID | GAS | GAS | SOLID |
| CONTINUOUS MASS FLOWRATE | lb/hr | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [redacted] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| CONT. VOL. FLOW RATE (LIQUIDS) | GPM/ACFM | [illegible] | | [illegible] | | | | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | | [illegible] | [illegible] | |
| BATCH VOLUME | USGPM/CF | [illegible] | | [illegible] | | | | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | | [illegible] | [illegible] | |
| BATCH MASS | lb | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [redacted] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| BATCH TRANSFER TIME | hr | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] |
| BATCH VOLUME FLOW | USGPM/ACFM | [illegible] | | [illegible] | | | | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | | [illegible] | [illegible] | |
| BATCH MASS FLOW | lb/hr | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [redacted] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| DESIGN FACTOR | DIMENSIONLESS | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | | [illegible] | [illegible] | [illegible] |
| DESIGN VOLUME FLOW | USGPM/ACFM | [illegible] | | [illegible] | | | | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | | [illegible] | [illegible] | |
| DESIGN MASS FLOW | lb/hr | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [redacted] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| SpG | | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | | [illegible] | [illegible] |
| SpG (BULK SOLIDS ONLY) | | | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | | | | [illegible] | | | | | [illegible] |
| PRESSURE | in. WG | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| TEMPERATURE | °F | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| H2O LIQUID | lb/hr | [illegible] | | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | | | | | | | | | | |
| H2O GAS | lb/hr | | | | | | | | | | | | | | | | | [illegible] | | |
| FEED Na | lb/hr | [illegible] | | [illegible] | [illegible] | [illegible] | | | [illegible] | | | | | | [illegible] | | [illegible] | | | [illegible] |
| SO2 GAS | ppmV | | | | | | | | | | | | | | | | | [illegible] | | |
| HCN GAS | ppmV | | | | | | | | | | | | | | | | | [illegible] | | |
| HCl GAS | ppmV | | | | | | | | | | | | | | | | | [illegible] | | |
| 137Cs | Ci/hr | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 1.5E+00 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 99Tc | Ci/hr | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 1.2E-02 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| TRU | Ci/hr | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 129I | Ci/hr | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |

CHECKER NOTES:

1. YELLOW cells have been checked, use the stated input data and are accurate for the stated conditions.
2. If Spiking (Feedstream 2) is added, the spreadsheet mass balance will be incorrect as the formulas do not currently account for its addition.
3. Cells in RED show different values than the process flow diagram (F-145579-00-A-0033 Rev F). Equations in spreadsheet are correct.
4. Checked by William S. (Rusty) Cook, Dated April 15, 2005.

DEMONSTRATION BULK VITRIFICATION SYSTEM (DBVS) MASS BALANCE

FEBRUARY 7, 2005

PFD 31

| STREAM No. | | 7 | 7B | 7C | 13 | 13A | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STREAM NAME | UNITS | DRYER AIR | DILUTION AIR | DILUTION AIR | ICV OFF GAS | AWTE VENT AIR | ALTERNATE AIR | ICV OFF GAS | SCRUBBER AIR DILUTION | FILTERED OFF GAS | DUST RECYCLE | QUENCH FEED |
| PHASE | | GAS | GAS | GAS | GAS | GAS | GAS | GAS | GAS | GAS | SOLID | GAS |
| CONTINUOUS MASS FLOWRATE | lb/hr | [redacted] | 1312 | 1312 | 1814 | 350 | 724 | 844 | 2145 | 857 | 5 | 2999 |
| CONT. VOL. FLOW RATE (LIQUIDS) | GPM/ACFM | [redacted] | 22 | 22 | 381 | 90 | 145 | 170 | 600 | 179 | | 908 |
| BATCH VOLUME | USG/ACF | 1712 | 311 | 311 | 3583 | 963 | 1866 | 2444 | 6400 | 2444 | | 13861 |
| BATCH MASS | lb | [redacted] | 22444 | 22444 | 51023 | 17040 | 41457 | 173498 | 201001 | 173498 | 125 | 64275 |
| BATCH TRANSFER TIME | Hr | 0 | 139 | 139 | 135 | 139 | 139 | 139 | 139 | 139 | 139 | 139 |
| BATCH VOLUME FLOW | USGPM/ACFM | [redacted] | 47 | 47 | 406 | 316 | 535 | 535 | 723 | 548 | | 1430 |
| BATCH MASS FLOW | lb/hr | [redacted] | 162 | 162 | 743 | 506 | 2546 | 1250 | 3094 | 1242 | 7.2 | 4357 |
| DESIGN FACTOR | DIMENSIONLESS | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| DESIGN VOLUME FLOW | USGPM/ACFM | [redacted] | 47 | 47 | 406 | 316 | 535 | 535 | 723 | 548 | | 1430 |
| DESIGN MASS FLOW | lb/hr | [redacted] | 162 | 162 | 743 | 506 | 2546 | 1250 | 3094 | 1242 | 7.2 | 4357 |
| SpG | | 0.001 | 0.001 | 0.001 | 0.0009 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | | 0.001 |
| SpG (BULK SOLIDS ONLY) | | | | | | | | | | | 2.50 | |
| PRESSURE | in. WG | 20.1 | 28.1 | 28.1 | 2.38 | 2.51 | [redacted] | 2.5 | 12.4 | 12.4 | [redacted] | 12.5 |
| TEMPERATURE | °F | 212 | 194 | 194 | 874 | 77 | 772 | 572 | 77 | 572 | 572 | 232 |
| H2O LIQUID | lb/hr | | | | | | | | | | | |
| H2O GAS | lb/hr | | | | 6.5 | | | 6.5 | | 6.5 | | 6.5 |
| FEED Na | lb/hr | | | | 0.7 | | | 0.7 | | | 0.7 | 0.00 |
| SO2 GAS | ppmV | | | | 1230 | | | 722 | | 724 | | 206 |
| NOx GAS | ppmV | | | | 119141 | | | 69664 | | 70072 | | 19438 |
| HCl GAS | ppmV | | | | 119 | | | 70 | | 70 | | 20 |
| 137Cs | Ci/hr | 0.0E+00 | 0.0E+00 | 0.0E+00 | 1.5E-02 | 0.0E+00 | 8.8E+00 | 8.8E-02 | 0.0E+00 | 4.5E-04 | 1.5E-02 | 4.8E-04 |
| 99Tc | Ci/hr | 0.0E+00 | 0.0E+00 | 0.0E+00 | 6.8E-04 | 0.0E+00 | 8.0E+00 | 6.8E-04 | 0.0E+00 | 3.1E-07 | 6.2E-04 | 1.4E-07 |
| TRU | Ci/hr | 0.0E+00 | 0.0E+00 | 0.0E+00 | 3.0E-08 | 0.0E+00 | 0.0E+00 | 3.0E-08 | 0.0E+00 | 2.7E-11 | 0.0E-00 | 2.7E-11 |
| 129I | Ci/hr | 0.0E+00 | 0.0E+00 | 0.0E+00 | 1.8E-06 | 0.0E+00 | 0.0E+00 | 1.8E-06 | 0.0E+00 | 8.5E-05 | 3.8E-06 | 1.8E-05 |

| STREAM No. | | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STREAM NAME | UNITS | QUENCHER DISCHARGE | QUENCH RETURN | SCRUB RETURN | SCRUB DISCHARGE | QUENCH SOLUTION | SCRUB SOLUTION | CAUSTIC MAKE-UP | SCRUB RETURN BLEED | CONDENSER FEED | CONDENSER DISCHARGE | HEATER FEED | HEPA FEED | C-FILTER INLET |
| PHASE | | GAS | LIQUID | LIQUID | GAS | LIQUID | LIQUID | LIQUID | LIQUID | GAS | GAS | GAS | GAS | GAS |
| CONTINUOUS MASS FLOWRATE | lb/hr | 3397 | 4314 | 10678 | 3095 | 7283 | 10645 | 200 | 144 | 3665 | 3187 | 3187 | 3187 | 3187 |
| CONT. VOL. FLOW RATE (LIQUIDS) | GPM/ACFM | 781 | 8.9 | 20.0 | 728 | 18.0 | 20.0 | 0.53 | 0.27 | 737 | 737 | 737 | 737 | 692 |
| BATCH VOLUME | USG/ACF | 7903 | 11864 | 31638 | 6777010 | 20054 | 341064 | 4179 | 3361 | 6429879 | 6429879 | 1671000 | 1671000 | 1671000 |
| BATCH MASS | lb | 8 | 84000 | 21261 | 811400 | 16176 | 213181 | 4053 | 2700 | 814009 | 814009 | 154494 | 154494 | 154494 |
| BATCH TRANSFER TIME | Hr | 139 | 139 | 139 | 139 | 139 | 139 | 139 | 139 | 139 | 139 | 139 | 139 | 139 |
| BATCH VOLUME FLOW | USGPM/ACFM | 33 | 14.3 | 25.0 | 1052 | 14.5 | 26.9 | 0.38 | 0.39 | 1064 | 1113 | 1113 | 1299 | 1299 |
| BATCH MASS FLOW | lb/hr | 1360 | 5340 | 15296 | 4417 | 7630 | 15278 | 290 | 200 | 4417 | 4579 | 4579 | 4579 | 4579 |
| DESIGN FACTOR | DIMENSIONLESS | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| DESIGN VOLUME FLOW | USGPM/ACFM | 33 | 14.3 | 25.0 | 1052 | 14.5 | 26.9 | 0.38 | 0.39 | 1064 | 1113 | 1113 | 1299 | 1299 |
| DESIGN MASS FLOW | lb/hr | 1360 | 5340 | 15296 | 4417 | 7630 | 15278 | 290 | 200 | 4417 | 4579 | 4579 | 4579 | 4579 |
| SpG | | 1.00 | 1.00 | 1.00 | 0.001 | 1.00 | 1.00 | 1.00 | 1.00 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| SpG (BULK SOLIDS ONLY) | | | | | | | | | | | | | | |
| PRESSURE | in. WG | [redacted] | [redacted] | [redacted] | 18.7 | [redacted] | [redacted] | [redacted] | [redacted] | 18.5 | 20.1 | 20.2 | 20.2 | 20.9 |
| TEMPERATURE | °F | 80 | 80 | 79 | 80 | 77 | 77 | 104 | 77 | 79 | 93 | 93 | 167 | 167 |
| H2O LIQUID | lb/hr | 4408 | | 9443 | | 4768 | 8533 | 190 | 130 | | | | | |
| H2O GAS | lb/hr | | | | 68 | | | | | 69 | 69 | 69 | 69 | 69 |
| FEED Na | lb/hr | | | | 0.00 | | | | | 0.00 | | | | |
| SO2 GAS | ppmV | | | | 81 | | | | | 81 | 78 | 78 | 79 | 79 |
| NOx GAS | ppmV | | | | 19960 | | | | | 19960 | 18296 | 18296 | 18296 | 18296 |
| HCl GAS | ppmV | | | | 71 | | | | | 71 | 18 | 18 | 18 | 18 |
| 137Cs | Ci/hr | 0.0E+00 | 1.3E-04 | 3.8E-04 | 1.8E-04 | 1.6E-04 | 1.3E-04 | 0.0E+00 | 1.8E-06 | 4.8E-06 | 4.8E-06 | 4.8E-06 | 4.8E-06 | 4.8E-10 |
| 99Tc | Ci/hr | 1.3E-04 | 1.3E-04 | 3.3E-05 | 1.8E-09 | 8.0E-04 | 1.3E-04 | 0.0E+00 | 8.0E-07 | 1.3E-05 | 1.8E-05 | 1.8E-05 | 1.8E-05 | 1.8E-11 |
| TRU | Ci/hr | 2.1E-07 | 2.1E-07 | 4.2E-07 | 2.7E-13 | 2.1E-07 | 4.2E-07 | 0.0E+00 | 2.8E-11 | 2.7E-13 | 2.7E-13 | 2.7E-13 | 2.7E-13 | 2.7E-13 |
| 129I | Ci/hr | 2.1E-07 | 2.1E-07 | 4.2E-07 | 5.5E-11 | 2.1E-07 | 4.2E-07 | 0.0E+00 | 5.5E-09 | 5.5E-11 | 5.5E-11 | 5.5E-11 | 5.5E-11 | 5.5E-11 |

CHECKER NOTES:

1. YELLOW cells have been checked, use the stated input data and are accurate for the stated conditions.
2. Cells in RED show different values than the process flow diagram (P-145579-00-A-0001 Rev F). Equations in spreadsheet are correct.
3. Checked by William S. (Russ) Cook, Dated April 12, 2005.



ATTACHMENT 1
145579-A-CA-004-REV A

SHEET 44 of 46

DEMONSTRATION BULK VITRIFICATION SYSTEM (DBVS) MASS BALANCE

FEBRUARY 7, 2005

| 35 | 34A | 36 |
|---|---|---|
| 50% NaOH | TRI-MER WATER ADDITION | C-FILTER DISCHARGE |
| LIQUID | LIQUID | GAS |
| 186 | 1872 | [illegible] |
| 0.34 | 0.95 | [illegible] |
| 2547 | [illegible] | 10772756 |
| 37176 | [illegible] | [illegible] |
| 116 | [illegible] | [illegible] |
| 0.4 | 0.76 | [illegible] |
| 567 | 365 | [illegible] |
| 1 | [illegible] | 1 |
| 0.35 | 0.76 | 1291.7 |
| 287 | 383 | 4878.1 |
| 1.51 | 1.86 | [illegible] |
| | | |
| n/a | | 21.9 |
| 77 | 77 | 167 |
| | 278 | |
| | | 59 |
| | | |
| | | 79 |
| | | [illegible] |
| | | 4 |
| 0.0E+00 | | 4.8E-10 |
| 0.0E+00 | | 1.8E-11 |
| 0.0E+00 | | 2.7E-15 |
| 0.0E+00 | | 5.5E-13 |

DEMONSTRATION BULK VITRIFICATION SYSTEM (DBVS) MASS BALANCE

FEBRUARY 7, 2005

PFD 32

| STREAM No. | | 33 | 34 | 35 | 36 | 36A | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STREAM NAME | UNITS | 98% SULFURIC ACID | NaClO2 | Na2S | 50% NaOH | TRAMER WATER ADDITION | RETURN SOLUTION | C-FILTER DISCHARGE | DILUTION AIR | TRAMER FEED | PART HEATED SCR FEED | HEATED SCR FEED | AMMONIA FEED | AMBIENT AIR | DILUTED TRAMER OFF GAS | FAN EXHAUST |
| PHASE | | LIQUID | LIQUID | LIQUID | LIQUID | LIQUID | LIQUID | GAS | GAS | GAS | GAS | GAS | GAS | GAS | GAS | GAS |
| CONTINUOUS MASS FLOWRATE | lb/hr | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | | | | [illegible] | [illegible] | [illegible] |
| CONT. VOL. FLOW RATE (LIQ/GAS) | GPM/ACFM | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | | | | [illegible] | [illegible] | [illegible] |
| BATCH VOLUME | USG/ACF | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | | | | [illegible] | [illegible] | [illegible] |
| BATCH MASS | lb | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | | | | [illegible] | [illegible] | [illegible] |
| BATCH TRANSFER TIME | Hr | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | | | | [illegible] | [illegible] | [illegible] |
| BATCH VOLUME FLOW | USGPM/ACFM | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | | | | [illegible] | [illegible] | [illegible] |
| BATCH MASS FLOW | lb/hr | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | | | | [illegible] | [illegible] | [illegible] |
| DESIGN FACTOR | DIMENSIONLESS | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | | | | [illegible] | [illegible] | [illegible] |
| DESIGN VOLUME FLOW | USGPM/ACFM | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | | | | [illegible] | [illegible] | [illegible] |
| DESIGN MASS FLOW | lb/hr | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | | | | [illegible] | [illegible] | [illegible] |
| Sp3 | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | | | | [illegible] | [illegible] | [illegible] |
| Sp3 (BULK SOLIDS ONLY) | | | | | | | | | | | | | | | | |
| PRESSURE | in WG | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | | [illegible] | | | | [illegible] | [illegible] | [illegible] |
| TEMPERATURE | °F | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | | | | [illegible] | [illegible] | [illegible] |
| H2O LIQUID | lb/hr | | | | | [illegible] | | | | | | | | | | |
| H2O GAS | lb/hr | | | | | | | [illegible] | | [illegible] | | | | | [illegible] | [illegible] |
| FEED Na | lb/hr | | | | | | | | | | | | | | | |
| HCl GAS | ppmV | | | | | | | [illegible] | | [illegible] | | | | | [illegible] | [illegible] |
| NOx GAS | ppmV | | | | | | | [illegible] | | [illegible] | | | | | [illegible] | [illegible] |
| HCl GAS | ppmV | | | | | | | [illegible] | | [illegible] | | | | | [illegible] | [illegible] |
| 137Cs | Ci/hr | [illegible] | [illegible] | [illegible] | [illegible] | | [redacted] | [illegible] | | [illegible] | | | | [illegible] | [illegible] | [illegible] |
| 99Tc | Ci/hr | [illegible] | [illegible] | [illegible] | [illegible] | | [redacted] | [illegible] | | [illegible] | | | | [illegible] | [illegible] | [illegible] |
| TRU | Ci/hr | [illegible] | [illegible] | [illegible] | [illegible] | | [redacted] | [illegible] | | [illegible] | | | | [illegible] | [illegible] | [illegible] |
| 129I | Ci/hr | [illegible] | [illegible] | [illegible] | [illegible] | | [redacted] | [illegible] | | [illegible] | | | | [illegible] | [illegible] | [illegible] |

CHECKER NOTES:

1. YELLOW cells have been checked, use the stated input data and are accurate for the stated conditions.
2. If Streams 39, 41, 42 and/or 43 are added, the spreadsheet mass balance will be incorrect as the formulas do not currently account for its such an.
3. Cells in RED show different values than the process flow diagram (P-1 [illegible] Rev F). Equations in spreadsheet are correct.
4. Checked by William S. (Russ) Crell. Dated April 13, 2005.

A3-96

ATTACHMENT 1
145579-A-CA-004-REV A

SHEET 46 of 46

# 145579-A-CA-005

## Attachment 2

## IDEAS Stream Data

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Worksheet Dialogs

[41] Worksheet Data

Display Parameters | General Set-up | Solids | Liquids | Vapors | Solution

OK | Cancel | MP Database: IDEAS MP-2

Read Results Now | Accept Selections

| | Property | Units | Stream No | Stream No | Stream No | Stream No | Stream No |
|---|---|---|---|---|---|---|---|
| 0 | Stream No. | | 1 | 2 | 3 | 4 | 5 |
| 1 | Stream Name | | WASTE RECEIPT | SPIKING FLOW | STRTER PATHS | SOIL | ICV FEED |
| 2 | Solids | kg/hr | 0.0786 | | 7.25 | 142.21 | 276.23 |
| 3 | Solution | kg/hr | 319.62 | | 0.187 | 7.48 | 2.79 |
| 4 | Stream | kg/hr | 319.70 | | 7.46 | 149.70 | 279.02 |
| 5 | Solution | m3/hr | 0.246 | | 0.000187 | 0.00751 | 0.0028 |
| 6 | Vapor | Nm3/hr | | | | | |
| 7 | Stream | m3/hr | 0.248 | | 0.00821 | 0.0624 | 0.133 |
| 8 | Solids SG | | 2.28 | | 2.40 | 2.59 | 2.12 |
| 9 | Solution SG | | 1.29 | | 0.997 | 0.997 | 0.998 |
| 10 | Stream SG | | 1.29 | 0.997 | 2.32 | -2.40 | 2.09 |
| 11 | Solids Content | % | 0.0249 | | 97.50 | 95.00 | 99.00 |
| 12 | Temperature | °C | 25.00 | 25.00 | 25.00 | 25.00 | 28.19 |
| 13 | Pressure | kPa | 101.33 | 101.33 | 101.33 | 101.33 | 101.33 |
| 14 | | | | | | | |
| 15 | S: Na | kg/hr | | | 0.0793 | 2.94 | 31.73 |
| 16 | L: Water | kg/hr | 213.40 | | 0.187 | 7.48 | 2.79 |
| 17 | L: Na | kg/hr | 26.46 | | | | |
| 18 | V: Steam | kg/hr | | | | | |
| 19 | S: Na | % | | | 1.01 | 2.07 | 11.49 |

IDEAS v 4.0.6

Full DBUS_6BBU2_trimer-Jan 28_95.mox - 1

Attachment: 2
Calc. No.: 145579-A-CA-005
Rev.: A
Sheet 1 of 8

Worksheet Dialogs

## [41] Worksheet Data

| | Property | Units | Stream No | Stream No | Stream No | Stream No | Stream No | Stream No | Stream No | Stream No | Stream No | Stream No | Stream No | Stream No | Stream |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Stream No. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| 1 | Stream Name | | WASTE RECEIPT | SPIKING FLOW | STRTER PATHS | SOIL | ICV FEED | DRYER CONDEN | DRYER AIR | OFF GAS AIR | ICV AIR | HOT ICV PRODU | TOP UP SOIL | COOLED ICV P... | ICV OFF |
| 2 | Solids | kg/hr | 0.0795 | | 7.28 | 142.21 | 276.23 | 0.000116 | | | | 212.10 | 28.80 | 212.10 | 2.27 |
| 3 | Solution | kg/hr | 319.62 | | 0.167 | 7.48 | 2.79 | 218.10 | | | | | 1.51 | | |
| 4 | Stream | kg/hr | 319.70 | | 7.46 | 149.70 | 279.02 | 218.10 | 59.80 | 2006.28 | 159.22 | 212.10 | 30.11 | 212.10 | 233.56 |
| 5 | Solution | m3/hr | 0.248 | | 0.000187 | 0.00751 | 0.0028 | 0.221 | | | | | 0.00151 | | |
| 6 | Vapor | Nm3/hr | | | | | | | 39.41 | 1556.54 | 123.53 | | | | 174.37 |
| 7 | Stream | m3/hr | 0.248 | | 0.00321 | 0.0624 | 0.133 | 0.223 | 56.12 | 1699.01 | 135.71 | 0.0601 | 0.0125 | 0.0601 | 476.65 |
| 8 | Solids SG | | 2.29 | | 2.40 | 2.59 | 2.12 | 0.00293 | | | | 2.65 | 2.60 | 2.65 | 2.54 |
| 9 | Solution SG | | 1.29 | | 0.997 | 0.997 | 0.996 | 0.988 | | | | | 0.997 | | 0.153 |
| 10 | Stream SG | | 1.29 | 0.997 | 2.32 | 2.40 | 2.09 | 0.976 | 0.000922 | 0.00118 | 0.00117 | 2.65 | 2.41 | 2.65 | 0.0004 |
| 11 | Solids Content | % | 0.0249 | | 97.50 | 95.00 | 99.00 | 5.30e-05 | | | | 100.00 | 95.00 | 100.00 | 0.971 |
| 12 | Temperature | °C | 25.00 | 25.00 | 25.00 | 25.00 | 25.10 | 50.00 | 90.00 | 25.00 | 25.00 | 1300.00 | 25.00 | 50.00 | 467.82 |
| 13 | Pressure | kPa | 101.33 | 101.33 | 101.33 | 101.33 | 101.33 | 101.33 | 96.32 | 101.33 | 100.67 | 101.33 | 101.33 | 101.33 | 100.75 |
| 14 | | | | | | | | | | | | | | | |
| 15 | S: Na | kg/hr | | | 0.0733 | 2.94 | 31.73 | | | | | 31.47 | | 31.47 | 0.336 |
| 16 | L: Water | kg/hr | 213.40 | | 0.167 | 7.48 | 2.79 | 218.10 | | | | | 1.51 | | |
| 17 | L: Na | kg/hr | 28.45 | | | | | | | | | | | | |
| 18 | V: Steam | kg/hr | | | | | | | | | | | | | 2.87 |
| 19 | S: Na | % | | | 1.01 | 2.07 | 11.49 | | | | | 14.84 | | 14.84 | 14.83 |

Full DBUS_60BU2_trimer-Jan 28_05.mox - 2

Attachment: 2
Calc. No.: 145579-A-CA-005
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Sheet 2 of 8

Worksheet Dialogs

[41] Worksheet Data

| No | Stream No | Stream No | Stream No | Stream No | Stream No | Stream No | Stream No |
|---|---|---|---|---|---|---|---|
| | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| GAS | COOLING ICV A | ICV OFF GAS | SCRUBBER AIR | FILTERED OFF ... | DUST RECYCLE | QUENCH FEED | QUENCHER DIS |
| | | 2.27 | | 0.00068 | 2.27 | 0.00068 | 6.60e-05 |
| | | | | | | | 0.218 |
| | 159.22 | 392.51 | 972.64 | 390.54 | 2.27 | 1363.18 | 1394.32 |
| | | | | | | | 0.000219 |
| | 123.53 | 297.82 | 764.60 | 297.82 | | 1061.95 | 1091.12 |
| | 135.71 | 638.92 | 849.51 | 644.33 | 0.000681 | 1509.79 | 1343.05 |
| | | 2.54 | | 2.54 | 2.54 | 2.54 | 2.54 |
| | | 0.606 | | 0.606 | | 0.903 | 0.996 |
| | 0.00117 | 0.000825 | 0.00114 | 0.000808 | 2.54 | 0.000892 | 0.00112 |
| | | 0.577 | | 0.000174 | 100.00 | 4.99e-05 | 4.88e-05 |
| | 25.00 | 299.96 | 25.00 | 299.96 | 299.96 | 110.91 | 28.59 |
| | 100.70 | 100.70 | 98.34 | 98.34 | 101.33 | 98.19 | 98.16 |
| | | 0.336 | | 0.000101 | 0.336 | 0.000101 | 1.01e-05 |
| | | | | | | | 0.218 |
| | | | | | | | |
| | | 2.97 | | 2.97 | | 2.97 | 35.05 |
| | | 14.83 | | 14.83 | 14.83 | 14.83 | 14.83 |

Full DBUS_60802_trimer-Jan 28_05.mox - 3

Attachment: 2
Calc. No.: 145579-A-CA-005
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Sheet 3 of 8

Worksheet Dialogs

[985] Worksheet Data

Display Parameters | General Set-up | Solids | Liquids | Vapors | Solution

OK | Cancel | MP Database: IDEAS MP-2

Read Results Now | Accept Selections

| | Property | Units | Stream No | Stream No | Stream No | Stream No | Stream No |
|---|---|---|---|---|---|---|---|
| 0 | Stream No. | | 21 | 22 | 23 | 24 | 25 |
| 1 | Stream Name | | QUENCH RETUR | SCRUB RETURN | SCRUB DISCHA | QUENCH SOLUT | SCRUB SOLUT |
| 2 | Solids | kg/hr | 0.025 | 0.0489 | 6.80e-06 | 0.0244 | 0.0489 |
| 3 | Solution | kg/hr | 2369.96 | 4807.56 | 0.0923 | 2401.13 | 4802.26 |
| 4 | Stream | kg/hr | 2370.02 | 4808.03 | 1385.60 | 2401.16 | 4802.31 |
| 5 | Solution | m3/hr | 2.24 | 4.55 | 9.26e-05 | 2.27 | 4.54 |
| 6 | Vapor | Nm3/hr | | | 1085.40 | | |
| 7 | Stream | m3/hr | 2.24 | 4.55 | 1258.58 | 2.27 | 4.54 |
| 8 | Solids SG | | 2.12 | 2.12 | 2.54 | 2.12 | 2.12 |
| 9 | Solution SG | | 1.06 | 1.06 | 0.967 | 1.06 | 1.06 |
| 10 | Stream SG | | 1.06 | 1.06 | 0.55112 | 1.06 | 1.06 |
| 11 | Solids Content | % | 0.00108 | 0.00102 | 4.90e-07 | 0.00102 | 0.00102 |
| 12 | Temperature | °C | 26.13 | 26.16 | 26.63 | 25.20 | 25.20 |
| 13 | Pressure | kPa | 101.33 | 95.80 | 96.39 | 95.00 | 101.33 |
| 14 | | | | | | | |
| 15 | S: Na | kg/hr | 0.0037 | 0.00723 | 1.01e-05 | 0.00361 | 0.00722 |
| 16 | L: Water | kg/hr | 2124.57 | 4337.84 | 0.0923 | 2156.51 | 4338.02 |
| 17 | L: Na | kg/hr | | | | | |
| 18 | V: Steam | kg/hr | | | 31.16 | | |
| 19 | S: Na | % | 14.77 | 14.77 | 14.83 | 14.77 | 14.77 |

IDEAS v 4.8.6

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Attachment: 2
Calc. No.: 145579-A-CA-005
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Sheet 4 of 8

**Worksheet Dialogs**

**[985] Worksheet Data**

| | Property | Units | Stream No | Stream No | Stream No | Stream No | Stream No | Stream No | Stream No | Stream No | Stream No | Stream No | Stream No | Stream No | Stream |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Stream No. | | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 |
| 1 | Stream Name | | QUENCH RETUR | SCRUB RETURN | SCRUB DISCHA | QUENCH SOLUT | SCRUB SOLUTI... | CAUSTIC MAKE- | SCRUB RETURN | CONDENSER FE | CONDENSER DI | HEATER FEED | HEPA FEED | C-FILTER INLET | DILUTE SU |
| 2 | Solids | kg/hr | 0.025 | 0.0489 | 6.80e-06 | 0.0244 | 0.0489 | | 0.000676 | 6.80e-06 | 6.80e-06 | 6.80e-06 | 6.80e-06 | 6.84e-06 | |
| 3 | Solution | kg/hr | 2369.99 | 4607.98 | 0.0923 | 2401.13 | 4602.26 | 91.03 | 65.61 | 0.0923 | | | | | 93.47 |
| 4 | Stream | kg/hr | 2370.02 | 4608.03 | 1368.80 | 2401.16 | 4602.31 | 91.03 | 65.61 | 1368.80 | 1439.40 | 1439.40 | 1439.40 | 1439.40 | 93.47 |
| 5 | Solution | m3/hr | 2.54 | 4.55 | 9.26e-05 | 2.27 | 4.54 | 0.088 | 0.062 | 9.26e-05 | | | | | 0.0782 |
| 6 | Vapor | Nm3/hr | | | 1066.40 | | | | | 1066.40 | 1124.90 | 1124.90 | 1124.90 | 1124.90 | |
| 7 | Stream | m3/hr | 2.24 | 4.83 | 1236.58 | 2.27 | 4.54 | 0.088 | 0.062 | 1252.35 | 1307.57 | 1307.84 | 1314.26 | 1518.21 | 0.0782 |
| 8 | Solids SG | | 2.12 | 2.12 | 2.54 | 2.12 | 2.12 | | 2.12 | 2.54 | 2.54 | 2.54 | 2.54 | 0.516 | |
| 9 | Solution SG | | 1.06 | 1.06 | 0.997 | 1.06 | 1.06 | 1.03 | 1.06 | 0.997 | | | | | 1.19 |
| 10 | Stream SG | | 1.06 | 1.06 | 0.00112 | 1.06 | 1.06 | 1.03 | 1.06 | 0.00111 | 0.0011 | 0.0011 | 0.000961 | 0.000948 | 1.19 |
| 11 | Solids Content | % | 0.00106 | 0.00102 | 4.90e-07 | 0.00102 | 0.00102 | | 0.00103 | 4.90e-07 | 4.73e-07 | 4.73e-07 | 4.73e-07 | 4.75e-06 | |
| 12 | Temperature | °C | 28.13 | 28.16 | 28.53 | 25.30 | 25.30 | 40.00 | 25.00 | 28.38 | 28.48 | 28.48 | 75.00 | 74.38 | 25.00 |
| 13 | Pressure | kPa | 101.33 | 95.00 | 96.38 | 85.00 | 101.33 | 101.33 | 101.33 | 96.38 | 96.32 | 96.25 | 96.25 | 96.12 | 101.33 |
| 14 | | | | | | | | | | | | | | | |
| 15 | S: Na | kg/hr | 0.0037 | 0.00723 | 1.01e-06 | 0.00361 | 0.00722 | | 2.99e-05 | 1.01e-06 | 1.01e-06 | 1.01e-06 | 1.01e-06 | 1.01e-06 | |
| 16 | L: Water | kg/hr | 2154.57 | 4337.54 | 0.0923 | 2166.61 | 4333.02 | 86.46 | 59.16 | 0.0923 | | | | | 59.82 |
| 17 | L: Na | kg/hr | | | | | | | | | | | | | |
| 18 | V: Steam | kg/hr | | | 31.16 | | | | | 31.16 | 31.25 | 31.25 | 31.25 | 31.25 | |
| 19 | S: Na | % | 14.77 | 14.77 | 14.83 | 14.77 | 14.77 | | 14.77 | 14.83 | 14.83 | 14.83 | 14.83 | 14.76 | |

Full DBUS_688U2_trimer-Jan 28_05.mox - 2

Attachment: 2
Calc. No.: 145579-A-CA-005
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Sheet 5 of 8

**Worksheet Dialogs**

**[985] Worksheet Data**

| No | Stream No | Stream No | Stream No | Stream No | Stream No | Stream No | Stream No |
|---|---|---|---|---|---|---|---|
| | 34 | 35 | 36 | 37 | 38 | 39 | 40 |
| LFUR | DILUTE NaClO2 | DILUTE Na2S | DILUTE NaOH | RETURN SOLUT | C-FILTER DISCH | DILUTION AIR | TRI-MER FEED |
| | | | | 6.74e-08 | 6.81e-08 | | 6.81e-08 |
| | 450.00 | 287.85 | 84.07 | 1002.19 | | | |
| | 450.00 | 287.85 | 84.07 | 1002.19 | 1439.40 | | 1439.40 |
| | 0.453 | 0.248 | 0.0565 | 0.979 | | | |
| | | | | | 1124.90 | | 1124.90 |
| | 0.453 | 0.248 | 0.0565 | 0.979 | 1617.70 | | 1617.70 |
| | | | | 2.56 | 2.56 | | 2.56 |
| | 0.994 | 1.09 | 1.51 | 1.02 | | | |
| | 0.994 | 1.09 | 1.51 | 1.02 | 0.000948 | 0.00118 | 0.000948 |
| | | | | 6.73e-09 | 4.73e-09 | | 4.73e-09 |
| | 25.00 | 25.00 | 25.00 | 25.00 | 74.96 | 25.00 | 74.96 |
| | 101.33 | 101.33 | 101.33 | 101.33 | 97.36 | 101.33 | 96.02 |
| | | | | | | | |
| | | | | 9.90e-09 | 1.01e-08 | | 1.01e-08 |
| | 393.75 | 240.89 | 42.03 | 846.56 | | | |
| | | | | 10.0 | | | |
| | | | | | 31.25 | | 31.25 |
| | | | | 14.82 | 14.82 | | 14.82 |

Full DBUS_60BU2_trimer-Jan 28_85.mox - 3

Attachment: 2
Calc. No.: 145579-A-CA-005
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Worksheet Dialogs

[1267] Worksheet Data

Display Parameters | General Set-up | Solids | Liquids | Vapors | Solution

OK | Cancel | MP Database: IDEAS MP-2

Read Results Now | Accept Selections

| | Property | Units | Stream No | Stream No | Stream No | Stream No | Stream No |
|---|---|---|---|---|---|---|---|
| 0 | Stream No. | | 41 | 42 | 43 | 44 | 45 |
| 1 | Stream Name | | PAR HEATED B | HEATED SCR F... | AMMONIA FEED | SCR AMBIENT A | DILUTEDC DF |
| 2 | Solids | kg/hr | | | | | |
| 3 | Solution | kg/hr | | | | | |
| 4 | Stream | kg/hr | | | | 6007.90 | 9466.41 |
| 5 | Solution | m3/hr | | | | | |
| 6 | Vapor | Nm3/hr | | | | 6212.79 | 7367.36 |
| 7 | Stream | m3/hr | | | | 7417.96 | 8653.70 |
| 8 | Solids SG | | | | | | |
| 9 | Solution SG | | | | | | |
| 10 | Stream SG | | 0.000433 | 0.00043 | 0.000698 | 0.00108 | 0.00107 |
| 11 | Solids Content | % | | | | | |
| 12 | Temperature | °C | 110.00 | 110.00 | 25.00 | 25.00 | 27.08 |
| 13 | Pressure | kPa | 75.30 | 75.30 | 101.33 | 92.62 | 92.62 |
| 14 | | | | | | | |
| 15 | S: Na | kg/hr | | | | | |
| 16 | L: Water | kg/hr | | | | | |
| 17 | L: Na | kg/hr | | | | | |
| 18 | V: Steam | kg/hr | | | | | 59.91 |
| 19 | S: Na | % | | | | | |

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Full DBUS_688U2_trimer-Jan 28_85.mox - 1

Attachment: 2
Calc. No.: 145579-A-CA-005
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Worksheet Dialogs

[1267] Worksheet Data

| | Property | Units | Stream No | Stream No | Stream No | Stream No | Stream No | Stream No | Stream No | Stream No | Stream No | Stream No | Stream No | Stream No | Stream |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Stream No. | | 41 | 42 | 43 | 44 | 45 | 46 | 50 | 51 | 52 | | | | |
| 1 | Stream Name | | PAR HEATED B... | HEATED SCR F... | AMMONIA FEED | SCR AMBIENT A | DILUTEDC OFF | STACK DISCHA... | B2O3 ADDITION | ZrO2 ADDITION | Tri-Mer Water Ad | | | | |
| 2 | Solids | kg/hr | | | | | | | 10.61 | 14.85 | | | | | |
| 3 | Solution | kg/hr | | | | | | | | | 126.10 | | | | |
| 4 | Stream | kg/hr | | | | 8007.90 | 9466.41 | 9466.41 | 10.61 | 14.85 | 126.10 | | | | |
| 5 | Solution | m3/hr | | | | | | | | | 0.126 | | | | |
| 6 | Vapor | Nm3/hr | | | | 6212.79 | 7357.36 | 7357.36 | | | | | | | |
| 7 | Stream | m3/hr | | | | 7417.86 | 8853.70 | 9087.39 | 0.00267 | 0.00304 | 0.126 | | | | |
| 8 | Solids SG | | | | | | | | 3.96 | 4.89 | | | | | |
| 9 | Solution SG | | | | | | | | | | 0.997 | | | | |
| 10 | Stream SG | | 0.000433 | 0.00043 | 0.000695 | 0.00108 | 0.00107 | 0.000953 | 3.96 | 4.89 | 0.997 | | | | |
| 11 | Solids Content | % | | | | | | | 100.00 | 100.00 | | | | | |
| 12 | Temperature | °C | 110.00 | 110.00 | 25.00 | 25.00 | 27.08 | 95.56 | 25.00 | 25.00 | 25.00 | | | | |
| 13 | Pressure | kPa | 75.30 | 75.30 | 101.33 | 92.62 | 92.62 | 101.42 | 101.33 | 101.33 | 101.33 | | | | |
| 14 | | | | | | | | | | | | | | | |
| 15 | S: Na | kg/hr | | | | | | | | | | | | | |
| 16 | L: Water | kg/hr | | | | | | | | | 126.10 | | | | |
| 17 | L: Na | kg/hr | | | | | | | | | | | | | |
| 18 | V: Steam | kg/hr | | | | | 59.91 | 59.91 | | | | | | | |
| 19 | S: Na | % | | | | | | | | | | | | | |

Full DBUS_608U2_trimer-Jan 28_95.mcx - 2

Attachment: 2
Calc. No.: 145579-A-CA-005
Rev. No.: A
Sheet 8 of 8

**Figure 1. Subcontractor Calculation Review Checklist.**

**Page 1 of 2**

**Subject: Full DBVS Process Mass Balance Conversion (Tri-Mer Scrubber Operating)**

**The subject document has been reviewed by the undersigned.**
**The checker reviewed and verified the following items as applicable.**

Documents Reviewed: 145579-A-CA-005 Rev A

Analysis Performed By: Thomas H May

- Design Input
- Basic Assumptions
- Approach/Design Methodology
- Consistency with item or document supported by the calculation
- Conclusion/Results Interpretation
- Impact on existing requirements
- _____

Thomas H May 4/19/05

Checker (printed name, signature, and date)
Thomas H May

Organizational Manager (printed name, signature and date)
David H Shuford
David H Shuford 4/19/05

The calculation is acceptable with the following comments which will be incorporated at the next logical revision of the Mass Balance, and are not needed to approve the calculation. The calculation references V-CA-002 which is not yet available.

4/18/2005

**COMMENTS ON A-CA-005 MASS BALANCE**

This calculation is acceptable with comments noted below. However, the calculation references V-CA-002 which is not yet available.

Per **TFC-ENG-DESIGN-C-10, REV A-7** the calculation review checklist must become part of the calculation when the calculation is released as rev. 0. For the purposes of the IQRPE package, the checklist may be inserted after the calculation.

The following comments should be fixed at the next logical revision of the Mass Balance, and are not needed to approve the calculation.

1. Page 20 section 5.1.7 Cell L6 - the equation listed in the text is correct. The equation listed in the spreadsheet is not correct. Consequently the values on PFD 00-A-0021 stream 7 are not correct. Down stream values are correct.

2. Page 23 section 5.1.7 – The statement is made that: "The volumetric design flow for Stream 7 in Cells D13 and L13 in worksheet page "PFD 030" is set equal to 11.2 ACFM at 212 °F, based on the following calculation:." Cell C13 (not D13) of the spreadsheet lists stream temperature as 212 °F. No explanation could be found for 212 °F. This temperature is the outlet of a liquid ring vacuum pump operating with an outlet pressure of -20 " W.G. At this temperature and pressure, the water in the pump will boil and the pump will not operate. When the vendor information becomes available, update this value.

3. In the spreadsheet worksheet PFD 31, which lists values for PFD 00-A-0031, cell T15 lists a value of 1.04 SpG. This density is for 5% caustic. It is understood that 15% caustic will be used. The PDC A-DC-002 page 4 and 5 list caustic solution concentration as 5% and will also have to be changed at the next logical revision.

4. In the spreadsheet worksheet PFD 31, which lists values for PFD 00-A-0031, cell U15 lists a value of 1.07 SpG. If 15% caustic is used, this density will also be higher. The PDC A-DC-002 page 4 and 5 list caustic solution concentration as 5% and will also have to be changed at the next logical revision.

5. Page 44 PFD 31 stream 19 – Temperature is listed as 232°F. However, the scrubber specification indicates a maximum inlet temperature of 160°F. This is not considered a problem because if the Tri-Mer operates, it is an upset condition and quenchers routinely handle much higher temperatures. When the vendor is selected, verify that 232 °F is acceptable.

# Permit Attachment KK Tank Management

## Appendix 4 Secondary Waste System

Section 2 Independent Qualified Registered Professional Engineer Design Assessment Reports

DR-010, Revision 1 IQRPE Design Assessment Report, Section 2.3, Secondary Waste System (90 Percent Design)

**Independent Qualified Registered Professional Engineer**
**Support to Demonstration Bulk Vitrification Project**

CH2M Hill Requisition # 114648

# IQRPE Design Assessment Report No. DR-010, Rev. 1

Review of

## Demonstration Bulk Vitrification System IQRPE/RCRA Design Review Package, RPP-24544, Revision C

## Section 2.3, Secondary Waste System (90 Percent Design)

Prepared by:

Robert L. Goodman, Jr., PE
**TechnoGeneral Services Company**
710 N. 4th Avenue
Pasco, Washington 99301

Reviewed by:

Karl M. Walterskirchen, PE, Chief Engineer
**TechnoGeneral Services Company**
710 N. 4th Avenue
Pasco, Washington 99301

At the request of

**CH2M Hill Hanford Group, Inc.**
POB 1500
Richland, Washington 99352

June 2, 2005

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Figure 2. Secondary Waste System Three-Dimensional View ..... 12

## Attachments

A Secondary Waste System IQRPE Disposition of Calculations, Specifications, and Drawings

B Secondary Waste System Design Deliverables to be Reviewed as Part of the Installation Certification Package

C Secondary Waste System Preliminary IQRPE Inspection Points

D Secondary Waste System Piping & Instrumentation Diagrams

E Engineering Corrosion Review

# 1.0 INTRODUCTION

The Washington State Department of Ecology (Ecology) has issued a permit for the Demonstration Bulk Vitrification System (DBVS) that mandates the use of an Independent Qualified Registered Professional Engineer (IQRPE) to perform a third-party independent review of the design of Ecology sensitive portions of the DBVS project. TechnoGeneral Services Company (TGS) has prepared this IQRPE Design Assessment Report at the request of CH2M HILL Hanford Group, Inc. (CH2M HILL), the project co-operator. TGS is the IQRPE of record for this project.

## 1.1 Project Description

The DBVS is a demonstration waste treatment plant operated under a Research, Development and Demonstration (RD&D) Permit issued by Ecology. The RD&D Permit is issued to the U.S. Department of Energy, Office of River Protection (DOE-ORP) and CH2M HILL. The DBVS plant will be located at the 200 West Area of the Hanford Site. The DBVS is being designed, constructed, and operated by AMEC, an engineering/services company from Vancouver, British Columbia, under contract to CH2M HILL. AMEC is tasked to comply with the RD&D Permit. Figure 1 shows a three-dimensional graphic view of the DBVS project.

The DBVS is designed to process a liquid salt solution of low-activity mixed waste (LAW) originating from Tank 241-S-109. Tank 241-S-109 is located adjacent to the DBVS facility. The LAW is to be converted into solid glass form by drying the LAW, mixing the LAW in dried form with soil, and melting it with an electric current. The project is intended to demonstrate the viability of immobilizing LAW from the tank farms utilizing a proprietary AMEC vitrification system. The demonstration is to involve treating up to 600,000 gal of waste in 18 months, producing up to 50 In-Container Vitrification (ICV™) melt boxes of stabilized vitrified waste.

About 13,170 gal of LAW are to be processed in each melt box. A detailed description of the process is provided in Attachments AA and BB of the RD&D Permit.

## 1.2 Design Review Requirements

Many of the components of the DBVS will handle dangerous or mixed waste and are regulated by Ecology in the RD&D Permit. The RD&D Permit requires an IQRPE review of the design of these components prior to installation.

The Compliance Schedules, Sections IV.A.8 and V.I of the RD&D Permit, define the design documents to include drawings, specifications, calculations and other information as deemed necessary to support the design. The RD&D Permit identifies 7 systems, including the foundations system that will have design packages prepared for IQRPE review. CH2M HILL is providing the IQRPE with design review packages as AMEC completes the design.

As a basis for the IQRPE certification, a review is performed for each System Package on a final version of the document "Demonstration Bulk Vitrification System IQRPE/RCRA Design Review Package", RPP-24544 as prepared by AMEC and reviewed and approved by CH2M

HILL. Each design review package includes a body of text that explains the purpose and scope of the DBVS and describes the overall process as well as the specific system addressed in the design package. Included as supporting information (appendices) are calculations, site maps, drawings, sketches, piping and instrumentation drawings (P&ID), process flow diagrams (PFD), waste characteristic assessments, technical specifications for materials and equipment, and miscellaneous supporting data. Each design review package will consist of a revision of the RPP-24544 document, specific to the system addressed in the package. CH2M HILL is not requiring AMEC to seal/stamp final design documents per WAC requirements for any DBVS work other than the Site Improvements work (foundations and site work). Documents such as drawings, calculations, and specifications included in the design review package that are marked as final and have signatures for the preparer, checker, and approver, will be reviewed by the IQRPE as a complete document. All other documents will be reviewed as preliminary or supportive information.

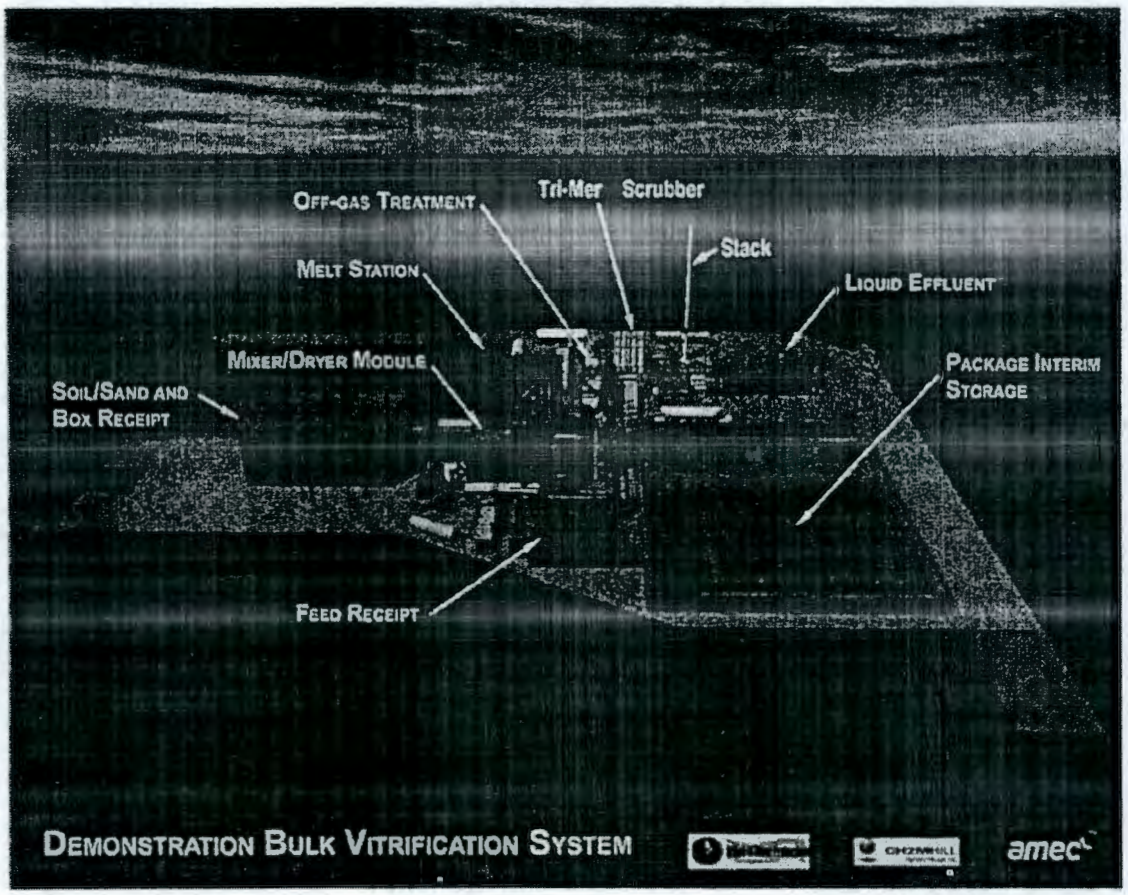


Figure 1. Demonstration Bulk Vitrification System Site Three-Dimensional View.

Preliminary design data was submitted and reviewed by the IQRPE reviewer as part of this certification, but only in an effort to familiarize the reviewer with the design until receipt of the final version.

The third system identified for IQRPE design review is the Secondary Waste System, Section 2.3 of RPP-24544, Rev. C, hereafter known as Design Package 2.3. The primary functions of the Secondary Waste System are to:

(1) Receive waste from the dryer condensate, selective catalytic reduction (SCR) wet scrubber system, and the Tri-Mer scrubber system (in the event that the SCR unit is not operating);

(2) Store the waste;

(3) Allow for the collection of samples; and

(4) Transfer the waste to a tanker for transport to the Effluent Treatment Facility (ETF).

### 1.3 Secondary Waste System Design Overview

This certification of the Secondary Waste System is based on the information presented in the Design Package 2.3. This design package includes multiple calculations, specifications, and drawings, as summarized in Attachment A. TGS is providing one IQRPE design review report for the Secondary Waste System.

The Secondary Waste System receives waste from the dryer condensate, wet scrubber, and Tri-Mer systems; stores the waste; allows for the collection of samples; and transfers the waste to a tanker for transport to the Effluent Treatment Facility (ETF). The three waste streams are segregated through valve alignment; however, should a valve mis-alignment occur, the three streams are compatible with each other. The system consists of six secondary waste storage tanks, the secondary waste pump skid, an ETF tanker loadout station, and the interconnecting HIHTLs.

The Secondary Waste System includes the following major components:

- Secondary Waste Storage Tanks (SP-031, Rev. 1)
- Secondary Waste Pump Skid (SP-011, Rev. 1)
- Secondary Waste Loadout Station
- Hose-in-Hose Transfer Line (HIHTL) Assemblies (SP-010, Rev. 0)

A preliminary interlock approach for the normal process control system has been developed by AMEC for the Secondary Waste System and is shown on P&IDs F-145579-37-A-0100, Rev. 0C and F-145579-37-A-0101, Rev. 0B. The identification and tracking method used for these interlocks is provided on P&ID F-145579-00-A-0099, Rev. G. For the Secondary Waste System, the interlocks are associated with the waste level in the secondary waste storage tanks, the transfer discharge pressure from the pumps, and leak detection. The primary interlocks are summarized in Table 1.

**Table 1. Secondary Waste System Primary Interlocks ***

| Condition | Interlock Code | Action |
|---|---|---|
| Dryer Condensate Tank Level High-High Alarm (37-LAHH-108 and 37-LAHH-208) | HAN<br>HAO | Shut down Waste Dryer Off-Gas Condensate Pump |
| Scrubber Bleed Tank Level High-High Alarm (37-LAHH-308 and -408) | HAP<br>HAQ | Close discharge valve from Wet Scrubber Skid to Bleed Tank |
| Tri-Mer Effluent Tank Level High-High Alarm (37-LAHH-508 and -608) | HAR<br>HAS | Shut down Tri-Mer Bleed Sump Pump |
| Tank Level Low-Low Alarm (37-LALL-107, -207, -307, -407, -507, and -607) | HAF, HAG<br>HAH, HAI<br>HAJ, HAK | Shut down Secondary Waste Transfer Pumps (37-XC-002 and -003) |
| Discharge Line Pressure High-High Alarm (37-PAH- 003) | HAE | Shut down Secondary Waste Transfer Pumps (37-XC-002 and -003) |
| Leak Detected in Secondary Waste Pump Skid (37-LAH-007) | HAA | Shut down Secondary Waste Transfer Pumps (37-XC-002 and -003) |
| Shutdown of Secondary Waste Transfer Pumps (37-XC-002 and -003) | HAL, HAM | Close discharge valve 37-HV-004 after time delay. |

*Instrumentation tag numbers are found on Drawings F-145579-37-A-0100 and F-145579-37-A-0101 in Appendix D3.

The following sections describe the major components included as part of the Secondary Waste System. Piping and instrumentation diagrams (P&ID) for these subsystems are shown on Drawing F-145579-37-A-0101, Revision 0B (Bulk Vitrification Secondary Waste Storage), and Drawing F-145579-37-A-0100, Revision 0C (Bulk Vitrification Secondary Waste Pump Skid/Loadout), from Appendix D3 of System 2.3. These two drawings are included in Attachment D of this report.

### 1.3.1 Secondary Waste Storage Tanks Overview

Dedicated tanks store secondary waste generated by various DBVS process systems until the waste is transferred to a tanker truck for transport to the ETF. Three secondary waste streams feed into six storage tanks with two tanks serving each waste stream. The secondary waste streams include the dryer condensate, the Main Off-Gas Treatment System (OGTS) scrubber waste solution, and the Tri-Mer scrubber waste solution. The three waste streams are segregated through valve alignment; however, should a valve mis-alignment occur, the three streams are compatible with each other. The storage tanks are depicted on P&ID F-145579-37-A-0101, Rev. 0B (Appendix D3 of System 2.3).

Each storage tank consists of a primary containment tank, a secondary containment tank, the inlet and outlet isolation valves, safety relief valves, vacuum breakers, breather filters, immersion heaters, and the associated instrumentation. Each primary containment tank has a working volume of 15,000 gal and a total capacity of up to 18,000 gal.

The secondary waste tanks are double-walled tanks that are nearly identical to the liquid waste staging tanks for the Waste Receipt System 2.1. The major difference is related to the lower level of radioactivity predicted for the secondary waste streams. As a result, for secondary waste all the valves are manually operated, the sump drain and annulus gas monitoring lines are not extended to permit remote use, and a sample port will be located on the top of each tank to support analyzing the contents before it is discharged to the ETF.

The primary containment tanks are fully enclosed and are maintained at a vacuum by the OGTS to prevent the release of vapors. Air flows into the tanks through a breather filter and is vented to the OGTS. When the OGTS is shut down, the breather filter maintains atmospheric pressure inside the tanks.

### 1.3.2 Secondary Waste Pump Skid Overview

The secondary waste pump skid pumping station draws waste from a storage tank and transfers it to the loadout station. Waste not transferred into the tanker returns to the storage tank of origin. The pump skid is depicted on P&ID F-145579-37-A-0100, Rev. 0C (Appendix D3 of System 2.3).

The secondary waste pump skid includes two centrifugal pumps, dual duplex cartridge filter assemblies, and associated piping and valves. The secondary waste storage tank's outlets are connected by HIHTLs to the secondary waste pump skid's inlet connection point. The secondary waste can be passed through a cartridge filter or the filter can be by-passed. The cartridge filter will remove solids in the effluent to ensure compliance with ETF acceptance criteria (Leonard 2004). A three-way valve directs the secondary waste to either the loadout station or back to the storage tanks.

The secondary waste pump skid piping and equipment are inside an International Organization for Standardization (ISO) freight container. A sump equipped with a leak detector element is installed at the bottom of the pump skid. A connection point to the sump drain is located external to the secondary waste pump skid. In the event that secondary waste accumulates in the bottom of the sump, a drain connection is used to remove the liquids.

The potential for vapors to enter the secondary waste pump skid freight container is minimized because the piping system inside the skid will be pressure tested to verify integrity. If vapors escape to the freight container, radionuclide particulates are filtered by a HEPA-rated vent air filter. Organic vapor control in the waste receipt system, beyond what is already included by using the main off-gas system to ventilate the tanks, is not necessary (per CH2M HILL). Before the performance of maintenance activities, the secondary waste pump skid piping is flushed and drained.

### 1.3.3 Secondary Waste Loadout Station Overview

A tanker truck loadout area is provided to receive secondary waste from the secondary waste pump skid and load the waste into tanker trucks. The Loadout station is also designed to contain any leaks or spills that might occur during the filling process. All process piping and connections necessary for attachment to the tanker truck are provided by the Secondary Waste

System. The loadout station is depicted on P&ID F-145579-37-A-0100, Rev. 0C, Appendix D3 of System 2.3.

As a best-management practice, a spill confinement berm is provided for the loadout station. The spill confinement berm for the tanker truck is depicted on Drawings F-145579-37-D-0004, Rev. C, and F-145579-37-D-0005, Rev. C, in Appendix C3 of System 2.3. The spill confinement is designed specifically for the purpose of confining spills that might occur during tanker loading operations. The spill confinement includes reinforced tire track belts, a ground tarp, and a pullover cover. There are two interconnected berms: one for the loadout hose stand, and one for the tanker truck. The size of each spill confinement area is approximately 12 ft by 12 ft with 1-ft sidewalls. The total confinement capacity of each berm is approximately 1,100 gal, with a 1,000-gal working volume. This provides for a pump shutdown response time of approximately 14 minutes for a pump discharge rate of 70 gal/min.

The material of construction for the spill confinement is an ethylene copolymer, a geo-membrane type material. The rear wheels of the tanker truck can roll over the collapsible sidewall of the confinement system to facilitate frequent entry/exit and operational efficiency. The foundation for the spill confinement system is compacted, granular base material and a ground tarp to facilitate its transport to a new location. When warranted by weather conditions, a pullover cover can be manually placed over the spill confinement system.

A local pump control station is located near the loadout station for pump motor control and local indication of system operating status. The control panel is positioned near to the secondary waste loadout pad and allows the operator to visually monitor operations on the loadout pad. An Emergency Stop Button/Panel is located on the local control panel for quick access by the stationed operator. The Stop Button will stop the secondary waste transfer pump.

Transfer of secondary waste to the tanker truck requires an operator to be at the loadout station. Valves are set manually and then the pumps are operated from the local control station at the loadout station. The operator selects which pump to operate based on the valve alignment set at the pump skid. The station location will allow the operator to observe for signs of leaks during the tanker truck filling operation. This will allow the operator to immediately stop the pump at the loadout station if there is a leak.

### 1.3.4 Hose-in-Hose Transfer Line Assembly Overview

Waste is transferred between the secondary waste pump skid, the secondary waste storage tanks, and the loadout station through HIHTLs. A sketch of the HIHTLs is provided on DBVS-SK-M106, Rev. B, in Appendix C1 of System 2.3. The hoses consist of an inner, primary containment hose, and an outer, secondary containment hose. The secondary containment hose confines leakage from the primary containment hose and routes the leaked waste from the storage tanks or loadout station to the secondary waste pump skid. The HIHTLs are sloped to ensure leaked waste will drain to a leak detector. The HIHTLs are supported to ensure there are no low spots along the length of the hoses.

Appendix C of Technical Specification SP-010, Rev. 0, includes HIHTLs identified as Hose List Nos. 1 through 26. This certification involves only the review of the HIHTLs associated with the Secondary Waste System, identified as Nos. 11 through 26 in Technical Specification SP-010.

HIHTLs identified as 1 through 10 are part of the Waste Receipt Tank System and were previously reviewed by the IQRPE as documented in IQRPE Report DR-008, Rev. 1, Design Review Package 2.1. The structural calculations for all the HIHTL supports and foundations, 145579-B-CA-003, Rev. 2, *Utility Corridor Support Structure and Foundation,* were previously reviewed by the IQRPE as documented in IQRPE Report DR-008, Rev. 1.

## 1.4 Scope of IQRPE Design Assessment

This IQRPE design report number is DR-010. This IQRPE design assessment includes a comprehensive review of Design Package 2.3, in accordance with the requirements of the DBVS RD&D Permit IV.A.8.b.i through IV.A.8.b.viii, and IV.A.8.c.i. Any exceptions taken by the IQRPE to incomplete or unavailable items in Design Package 2.3 are listed in Section 2.2 at the end of each subsection. The documents included in this review and the level of each document review is summarized in Attachment A.

The following items are not covered by the WAC dangerous waste regulations or the RD&D Permit for the facility, and therefore are outside of the scope of this certification:

- Plant utilities, including instrument and plant air supply lines and electrical power beyond the first upstream valve or uninterruptible power supply systems.
- Structural features not related to hazardous waste secondary containment.
- Architectural features not related to hazardous waste containment.
- Lighting systems.
- System design features related to protection of the system due to vehicular traffic.
- Heating, ventilation, or air conditioning in the Secondary Waste Pump skid.
- Electrical or signal lines beyond the first upstream field termination box (FTB), motor control center (MCC), or instrument control panel (ICS). Specifications for electrical feed, including wiring, local hand switches, terminations, breakers, and other equipment or instruments located in motor control centers were reviewed. Specifications for instrument cabling and terminations were reviewed only between locally mounted devices and field termination boxes and/or local instrumentation and control panels.
- Radiation monitoring or detection components at various locations throughout the system.
- Verification of functional logic for operation and control of the Secondary Waste System.

This certification also excludes the review of the Design Package 2.3 to the following design standards included in RPP-17403 because the Design Review Package does not address these issues:

- Section 3.1.2.1.1.3 and Table 3-3 requirements regarding waste feed radionuclide properties, including all radioactive and radionuclide property considerations.
- Section 3.1 requirements for the DBVS that the design:
  - Ensure exposure of plant operating personnel to radioactive process streams (radiation) is as-low as reasonably achievable (ALARA). See also Sections 3.2.4 and 3.3.6.1.1.
  - Minimize the production of secondary waste streams.
  - Ensure that all process byproducts are safe for long-term storage or release into the environment.
- Section 3.3.1.6 requirements for the DBVS that the design include the capability for flushing components for decontamination.
- Section 3.3.6 requirements for the DBVS that the design related to the following:
  - Personnel Safety
  - Fire Protection
  - Non-Radioactive Airborne Emissions (Section 3.3.6.3.4)
  - Radioactive Airborne Emissions (Section 3.3.6.3.6)
- Section 3.3.8 (Decontamination and Deactivation) or Section 3.3.9 (Nuclear Safety) requirements for the DBVS.

Because the 90 percent design of the Secondary Waste System has been developed as a purchase specification, many of the 'design' activities have been designated as the responsibility of the equipment vendor or SELLER. Therefore, this information will not be available until fabrication of the equipment is underway and will require IQRPE review as part of the installation certification package. Design calculations and documentation to be reviewed by the IQRPE for inclusion with the installation certification package include the deliverables listed in Attachment B. A preliminary listing of inspection points requiring IQRPE review during fabrication and installation are given in Section 2.2.7 below.

## 2.0 ASSESSMENT

The IQRPE design assessment includes the following Secondary Waste System major components:

- Secondary Waste Storage Tanks (SP-031)
- Secondary Waste Pump Skid (SP-011)
- Secondary Waste Loadout Station

- Hose-in-Hose Transfer Line (HIHTL) Assemblies (SP-010)

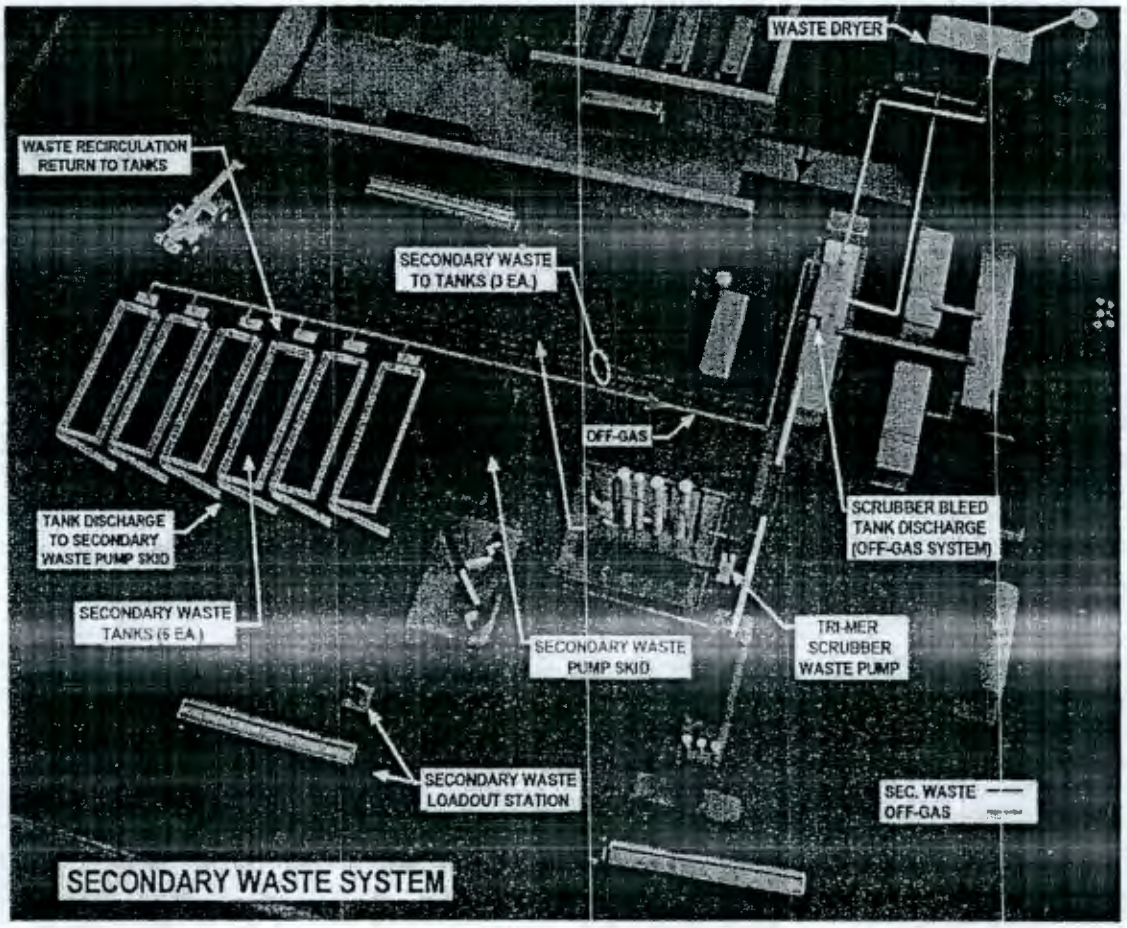


Figure 2. Secondary Waste System Three-Dimensional View.

Figure 2 shows a three-dimensional representation of the Secondary Waste System components at the DBVS site. The following subsections identify the basis and methods used to complete this IQRPE design certification.

## 2.1 Codes, Standards and Regulations

The codes, standards, and regulations specifically used during the preparation of this certification are referenced as necessary throughout this report.

A complete list of codes, standards, and regulations that have been incorporated into the Technical Specification packages is included as Attachment C to this report.

The IQRPE concurs with the use of the codes, standards, and regulations that have been designated in the Technical Specifications.

The DBVS has been evaluated in accordance with HNF-IP-1266, TFC-ENG-STD-13, and TFC-ENG-SB-C-06 to establish ignition source control applicability for the prevention of flammable gas accumulation and ignition. Ignition source controls were not considered routinely applicable to the DBVS waste receipt system equipment (RPP-23429). Only if flammable gas concentrations in the tank head space were to exceed 25% of the lower flammability limit (LFL) will ignition source controls be potentially required. This may require the use of administrative controls to ensure that any equipment or components not included in the ignition control set identified in TFC-ENG-STD-13 be de-energized should this situation arise. The IQRPE has reviewed the Technical Specifications and assess that the appropriate requirements have been incorporated into the design as a result of this classification.

## 2.2 Basis of Design

The Secondary Waste System is anticipated to operate for a minimum service life of 2 years and the equipment has been specified with a design life of 5 years. The primary operating characteristics are presented in Table 2 as obtained from the Technical Specifications for the Hose-in-Hose Transfer Line Assemblies, the Secondary Waste Pump Skid, and the Secondary Waste Storage Tanks Specification.

**Table 2. Secondary Waste System Primary Operating Characteristics**

| Operating Characteristic | Range |
|---|---|
| Liquid Waste Temperature | 50° to 150° F |
| Liquid Waste pH | 7 to >13 |
| Supernant Liquid Density | 0.98 to 1.07 g/mL |
| Liquid Waste Water Content | 84 – 100 % Analyte Weight |

The following sections highlight the structural design standards, waste compatibility, pressure control system, secondary containment system, ancillary equipment design, corrosion assessment, and inspection schedule recommendations for the Secondary Waste System.

### 2.2.1 Structural Design Standards

Ecology (1995) requires that an IQRPE certify that the proposed tank system will have a sufficient structural integrity and is acceptable for storing and treating dangerous waste in accordance with WAC 173-303-640(3)(a). This assessment must show that the foundation, structural support, seams, connections, and pressure controls are adequately designed and that the tank system has sufficient structural strength, compatibility with the wastes to be stored or treated, and corrosion protection to ensure that it will not collapse, rupture, or fail in accordance with WAC 173-303-640(3)(a).

The following activities have been conducted in the review of the design standards for the Secondary Waste System:

- The structural design standards and criteria used have been reviewed to ensure that they clearly and specifically reference applicable industry standards and recommended practice codes.

- Design criteria that apply to a specific tank or group of tanks have been reviewed to ensure that they are clearly indicated.

Structural calculations are normally part of the IQRPE review. Because the Technical Specifications prepared for the Secondary Waste System IQRPE/RCRA Design Review Package are purchase specifications that place the responsibility for the structural calculations on the SELLER, a complete review of the structural calculations has not been completed.

Structural calculations to be submitted by the SELLER and reviewed by the IQRPE at a later date are listed in Attachment B. The Secondary Waste System equipment and structures will be analyzed and designed in accordance with the requirements in TFC-ENG-STD-06. The calculations will demonstrate that equipment will withstand applied loads without loss of integrity or release of radioactive/hazardous material. The calculations will also show that the secondary waste pump skid and the secondary waste storage tanks will not tip over nor slide. The applicable structural analysis requirements from the standard have been flowed down into specifications to the equipment supplier. The equipment supplier is required to perform the structural analysis and provide structural calculations consistent with the design drawings submitted for equipment fabrication.

The Secondary Waste Pump Skid will be placed on DBVS Foundation No. 8. The anchoring requirements are identified in Specification 145579-D-SP-011, Rev. 1, Appendix D3 of System 2.3. A structural review of Foundation No. 8 was included as part of the certification of Calculation 145579-C-CA-009, Revision 1, PC-1 Foundation 8, IQRPE Design Certification Report DR-005, Rev. 0. A separate review of this calculation was not conducted as part of this IQRPE report.

The Secondary Waste Storage Tanks will be placed on compacted, granular base material. The storage tank soil/floor loading limit is 3,000 $lb/ft^2$ when the tanks are filled with waste. Adequacy of the granular base material to minimize settling will be evaluated using design information from the tank vendor and results from compaction testing of the granular base material in the area where the tanks will be located.

Where possible, the IQRPE has reviewed the report to ensure that the following activities have been incorporated into the Technical Specifications as part of the design basis:

- Structural calculations will be provided for the nonstandard "off-specification" Secondary Waste Storage Tanks.
- The Secondary Waste Storage Tank shells will be designed based on a full tank.
- Calculations will be provided that account for liquid specific gravity, external hydrostatic pressure, and variables such as internal vapor pressure.
- Provisions have been made such that the initially computed shell thickness will be increased to account for the assumed corrosion rate.
- Design parameters used in structural calculations will be clearly indicated and labeled on clarifying sketches.

- Seismic considerations, which are appropriate to the seismic risk zone in which the facility is located, will be accounted for in the structural calculations.
- The foundation underlying the tank system will support the load of a full tank plus the secondary containment structure per the requirements of WAC 173-303-640(3)(a)(v)(A). This was certified by the IQRPE as part of DR-005.
- The foundation has been designed to prevent failure due to settlement, compression, and uplift per the requirements of WAC 173-303-640(4)(c)(II). This was certified by the IQRPE as part of DR-005.
- The design plans require that homogeneous, porous, noncorrosive backfill material be placed below and around tank system foundations and underground piping to provide uniform structural support and prevent excessive settlement. This was certified by the IQRPE as part of DR-005.
- The tank systems have been designed to withstand the effects of frost heave per the requirements of WAC 173-303-640(3)(a)(v)(C). This was certified by the IQRPE as part of DR-005.

The following subsections highlight the IQRPE Structural Design Standard review for each of the major Secondary Waste System components, and also identify specific exceptions to this IQRPE certification report as they relate to the structural review..

#### 2.2.1.1 Hose-in-Hose Transfer Line Assemblies (SP-010)

This Technical Specification was reviewed to ensure that provisions for the proper loads, supports, and design basis had been incorporated. With the exception of those issues listed in Section 2.2.1.4 below, the appropriate structural considerations have been made.

#### 2.2.1.2 Secondary Waste Pump Skid (SP-011)

This Technical Specification was reviewed to ensure that provisions for the proper loads, supports, and design basis had been incorporated. With the exception of those issues listed in Section 2.2.1.4 below, the appropriate structural considerations have been made.

#### 2.2.1.3 Secondary Waste Storage Tanks (SP-031)

This Technical Specification was reviewed to ensure that provisions for the proper loads, supports, and design basis had been incorporated. With the exception of those issues listed in Section 2.2.1.4 below, the appropriate structural considerations have been made.

#### 2.2.1.4 Structural Design Exceptions

IQRPE Certification exceptions to the structural review are as follows:

- Appendix A1. Calculation 145579-B-CA-005, Rev. C, Section 6.0.

  The HIHTL calculations included in this appendix show the applied dead and seismic loads at the nozzles. Calculations verifying that the nozzles, fittings, or couplings to be used can support these loads are to be submitted as part of the deliverables for Technical Specifications SP-031 and SP-011.

- Appendix A1. Calculation 145579-B-CA-005, Rev. C, Section 6.0.

  This calculation assumes the weight of insulation equal to 1.0 lb/ft. The same weight is used for both 4 in and 6 in outside diameter HIHTL assemblies. No basis for this assumption is provided. In addition, Technical Specification SP-010 specified the use of "Armaflex Type AP by Armacell" insulation. According to the manufacturer's data sheets, the weight of this insulation ranges from 3.0 to 6.0 lb/ft. The use of these weights in the calculations presented in Calculation 145579-B-CA-005 would effectively double the calculated forces. The designer has indicated to the IQRPE that the purpose of the calculation was to provide an estimate of nozzle loads to the manufacturers of the DBVS components such as the Secondary Waste Pump Skid. The intent is to use supports to reduce the interface loads to a value less than the calculated forces. An increase in the calculated forces will require a stiffer interface in order to reduce the interface loads to a negligible value.

- Appendix C3, Drawing 145579-00-P-0008, Rev. C., and Drawing 145579-00-P-0013, Rev. C.

  Final calculations to evaluate the installed condition of the HIHTLs, taking into account the skid and tank design, specific HIHTL information, and individual hose support designs will be required prior to installation and the calculations will need to be completed on a per line/interface basis.

- Appendix C3, Drawings F-145579-00-P-0001, F-145579-00-P-0002, F-145579-00-P-0003, and F-145579-00-P-0004, all Rev. B.

  The typical pipe supports were reviewed for adequacy, but a final determination of pipe support methodology and the use of a specific support in specific applications can not be completed without final isometric drawings.

- Appendix G1. Technical Specification SP-010, Rev. 0, Section 1.1.

  This specification includes provisions for heat tracing of the HIHTLs; drawing DBVS-SK-M106 indicates that as much as 2 ft of heat tracing cable per foot of HIHTL hose will be used. The nozzle load calculations in Appendix A1, Calculation 145579-B-CA-005, Rev. C, do not include considerations for the added weight of the heat tracing. The designer has indicated to the IQRPE that the purpose of this calculation was not to evaluate a complete installed system (e.g., one that included an analysis of hose supports). The presence of heat tracing will need to be accounted for in the support calculations using the fabrication drawings for the Secondary Waste System components. The final calculations will determine the need for additional hose supports.

- Appendix G3. Technical Specification SP-031, Rev. 1, Section 3.2.2.

  Structural calculations demonstrating that the crushed stone will support these tanks will be completed during the detailed design.

These issues will require IQRPE review once vendor information is available. This review will be documented in the IQRPE installation assessment report.

### 2.2.2 Waste Compatibility

Ecology (1995) requires that an IQRPE certify that the proposed tank system has been designed of materials compatible with the waste to be stored or treated. The Secondary Waste System is capable of handling liquid waste with little or no solids. The physical and chemical properties of the secondary waste were provided in the technical specifications for the Secondary Waste System.

Conclusions from the review of the design standards, and physical and chemical properties of secondary waste for the Secondary Waste System are summarized below:

- The proposed materials for the tank system are compatible with the wastes to be stored or treated per the requirements of WAC 173-303-640(3)(a).

- The proposed dangerous wastes or treatment reagents may be placed into the proposed tank system without causing the tank system to rupture, leak, corrode, or otherwise fail per the requirements of WAC 173-303-640(5)(a).

The IQRPE reviewed the waste property information in conjunction with the design specifications. The IQRPE also reviewed systems designed to prevent freezing or precipitation of the waste materials within the system that might impact the basis for the assessment. This included a review of pipe heat tracing specifications, insulation requirements, and liquid waste storage tank heater requirements.

A completed waste compatibility evaluation is normally part of the IQRPE review and includes an assessment showing that the characteristics of the waste to be stored or treated are compatible with the material properties of the tank system—including material properties of any interior or exterior protective coatings. Since the Technical Specifications prepared for the Secondary Waste System IQRPE/RCRA Design Review Package are purchase specifications that place the responsibility for any interior or exterior coatings of the Secondary Waste Storage Tanks on the SELLER, a complete review of proposed coatings and the associated preparation and application procedures has not been completed by the IQRPE.

Coating information to be submitted by the SELLER and to be reviewed by the IQRPE at a later date is listed in Attachment B. Information regarding the waste properties to be stored in the Secondary Waste System components is given in the technical specifications for the Secondary Waste Pump Skid and the Secondary Waste Storage Tanks.

The following sections summarize the IQRPE Waste Compatibility reviews for each of the major Secondary Waste System components. Specific exceptions to this IQRPE certification report related to the waste compatibility review are also listed below.

#### 2.2.2.1 Hose-in-Hose Transfer Line Assemblies (SP-010)

The proposed HIHTLs are reinforced ethylene propylene diene monomer (EPDM) hose. Similar EPDM hose has been successfully used at Hanford for several years with no deterioration of the hose material. The liquid wastes from the dryer condensate, off-gas treatment system scrubber effluent, and the Tri-Mer scrubber effluent have been assessed and the waste characteristics have been specified in the hose procurement specification. The HIHTL assemblies used for the Secondary Waste System will handle liquid waste with little or no solids.

- The HIHTL assemblies are to include insulation and heat tracing to prevent freezing and maintain the temperature in the HIHTL at a minimum of 59 °F. The heat trace system is self-regulating and does not interface with the MCS.

The IQRPE concurs that this design basis meets the requirements of the DBVS RD&D Permit and WAC 173-303-640.

#### 2.2.2.2 Secondary Waste Pump Skid (SP-011)

- The piping and valves have been specified as unlined, uncoated carbon steel with reference to the appropriate ASTM standards. The secondary waste pump skid is located within a temperature controlled, insulated ISO freight container. Heaters for the secondary waste pump skid will be sized by the fabricator to maintain an interior design temperature of 59 °F.

The IQRPE concurs that this design basis meets the requirements of the DBVS RD&D Permit and WAC 173-303-640.

#### 2.2.2.3 Secondary Waste Storage Tanks (SP-031)

- The Secondary Waste Storage Tanks have been specified as interior and exterior coated, carbon steel tanks with reference to the appropriate ASTM standards. Provisions should be made to provide cathodic protection for the tanks if required by the final design. The properties of the secondary waste are very similar to water and to prevent the potential for freezing or precipitation, heaters will be installed to maintain the secondary waste storage tank contents at 59 °F.

The IQRPE concurs that this design basis meets the requirements of the DBVS RD&D Permit and WAC 173-303-640.

#### 2.2.2.4 Waste Compatibility Exceptions

IQRPE Certification exceptions to the waste compatibility review are as follows:

- Appendix A1, Calculation 145579-D-CA-014, Rev. A.

  This heater sizing calculation makes assumptions regarding the dimensions of the liquid waste staging tanks. The size, selection, and installed configuration of the heater will need to be evaluated once the tank configuration is determined.

- Appendix A1, Calculation 145579-D-CA-014, Rev. A.

  This heater sizing calculation assumes primary tank thickness of 0.25 in, secondary tank thickness of 0.1875 in, and interstitial space thickness of 5 in. Because the resistance to thermal conductivity of the steel has been assumed equal to 0, the interstitial air space is the controlling factor in the thermal calculation. Should the interstitial space be reduced to less than 5 in during the detailed design, this calculation will need to be revised.

- Appendix A1, Calculation 145579-D-CA-014, Rev. A.

  The heater sizing calculation assumes a heat transfer coefficient for the liquid waste that is not based on a specific reference or test. The final calculation will need to address the sensitivity of the sizing calculation to variations in the actual liquid waste heat transfer coefficient.

- Appendix G1. Technical Specification SP-010, Rev. 0, Section 3.2.2.5.

  This paragraph requires the use of conductive copper tape and EPDM tape with a butyl-based adhesive to secure heat tracing to the HIHTL assemblies. According to manufacturer literature, RayChem BTV heat tracing is to be secured with glass or aluminum tape. Additional information is required to assess the proper specification of the adhesive tape strategy. The designer has indicated to the IQRPE that the information provided in the specification is based on prior HIHTL procurement specifications and some information may be out of date. SP-010 allows the Seller to request clarification using the Request for Information form. A Change Notice against the specification will be generated as needed.

These issues will require IQRPE review once vendor information is available. This review will be documented in the IQRPE installation assessment report.

### 2.2.3 Pressure Control System

Ecology (1995) requires that an IQRPE certify that the proposed tank system has been designed with appropriate pressure control systems. A review of the pressure control system is normally part of the IQRPE review. Since the Technical Specifications prepared for the Secondary Waste System IQRPE/RCRA Design Review Package are purchase specifications that place the responsibility for the purchase of the pressure control system instrumentation, breather filters, and pressure relief valves for the Secondary Waste Storage Tanks on the SELLER, a complete review of the pressure control system has not been completed by the IQRPE.

Pressure control system information to be submitted by the SELLER and reviewed by the IQRPE at a later date is listed in Attachment B.

Conclusions from the review of the design standards for the Secondary Waste System are summarized below:

- The Technical Specifications include an acceptable preliminary piping and instrumentation system that will allow for adequate pressure control, per the requirements of WAC 173-303-640(3)(a).
- The Technical Specifications include the following basis for the detailed design of the tank system:
  - Tank capacity and design pressure.
  - The applicable characteristics of the waste to be stored.
  - Maximum inflow and outflow rates.
  - The type of roof and how it is attached to the tank.
  - Locations of pressure relief vents and other pressure controls.
  - The pressure control system discharge locations.

The following sections highlight the IQRPE Pressure Control System review for each of the major Secondary Waste System components, and also identify specific exceptions to this IQRPE certification report as they relate to the pressure control system review.

### 2.2.3.1 Hose-in-Hose Transfer Line Assemblies (SP-010)

The DBVS HIHTL assemblies are designed to withstand an intermittent maximum fluid pressure of 375 psig. The appropriate testing requirements have been specified to demonstrate this capacity.

The IQRPE concurs that this design basis meets the requirements of the DBVS RD&D Permit and WAC 173-303-640.

### 2.2.3.2 Secondary Waste Pump Skid (SP-011)

The DBVS secondary waste piping will be designed to a design pressure identified by the fabricator, but the pressure will not be less than 150 psig nor greater than 375 psig using the hydraulic data in the pump skid technical specification. The pump skid piping system and interconnecting piping from the compressed air and filtered water systems is to be designed, fabricated, inspected, and tested in accordance with ASME B31.3 code requirements for "Normal Fluid Service."

The Secondary Waste Pump Skid is fitted with the appropriate pressure measurement and indicating devices at the necessary locations.

The IQRPE concurs that this design basis meets the requirements of the DBVS RD&D Permit and WAC 173-303-640.

#### 2.2.3.3 Secondary Waste Storage Tanks (SP-031)

The secondary waste storage tanks are to be designed for four (4) psig over fully loaded condition or the minimum code or standard design pressure, whichever is greater at 150° F.; as well as a vacuum of at least -0.4 psig.

Each storage tank is to have vacuum/pressure devices capable of limiting the tank gas pressure/vacuum. The storage tank breather filters include pressure indicators. Pressure indicators for the primary and secondary containment tanks are installed at the filter elements and are read locally. Each storage tank has a vacuum/pressure relief device. This device vents the primary containment tank to the secondary containment tank. The secondary containment tank will then vent through its breather filter. The storage tanks are protected from overfilling by level instrumentation that will shut down the waste transfer pumps. The tank pressure/vacuum will be controlled within the design limits by operational procedures and/or administrative controls, as necessary.

The IQRPE concurs that this design basis meets the requirements of the DBVS RD&D Permit and WAC 173-303-640.

#### 2.2.3.4 Pressure Control System Exceptions

IQRPE Certification exceptions to the pressure control system review are as follows:

- Appendix G3. Technical Specification SP-031, Rev. 0.

  This specification does not include provisions for the vacuum/pressure relief valve specifications. Attachment B of this IQRPE Design Assessment Report lists the bidder's vacuum/pressure relief valve recommendation as an item to be reviewed by the IQRPE as part of the installation certification package.

- Appendix G3. Technical Specification SP-031, Rev. 0, Section 3.2.1.2.

  This section states that the Secondary Waste Storage Tanks shall be designed for four (4) psig over fully loaded conditions or standard design pressure, whichever is greater, at 150 F. A calculation is needed to determine values for these pressures.

These issues will require IQRPE review once vendor information is available. This review will be documented in the IQRPE installation assessment report.

### 2.2.4 Secondary Containment System

Ecology (1995) requires that an IQRPE certify that the proposed tank system has been designed with appropriate secondary containment system. Secondary containment for tank systems that

store, accumulate, or treat dangerous waste must be designed and installed to meet the requirements of WAC 170-303-640(4)(b). A review of the secondary containment system is normally part of the IQRPE review. Because the Technical Specifications prepared for the Secondary Waste System IQRPE/RCRA Design Review Package are purchase specifications that place the responsibility for the final design of the system components on the SELLER, a complete review of the secondary containment system has not been completed by the IQRPE.

Secondary containment system information to be submitted by the SELLER and reviewed by the IQRPE at a later date is listed in Attachment B of this IQRPE Design Assessment Report.

Conclusions from the review of the design standards for the Secondary Waste System are summarized below:

- The system is designed to prevent any migration of wastes or accumulated liquid out of the secondary containment system to the soil, groundwater, or surface water at any time during the use of the tank system.
- The system is capable of detecting and collecting releases and accumulated liquids until the collected material is removed.
- The system is constructed of materials that are compatible with the wastes to be placed in the tank system.
- The system has been specified to have sufficient strength to withstand stresses due to static head during a release, pressure gradients, climatic conditions, nearby vehicle traffic, and other stresses resulting from daily operations.
- The system will be placed on a foundation or base that will support the secondary containment system, provide resistance to pressure gradients above and below the system and prevent failure due to excessive settlement, compression, or uplift.
- The system will be provided with a leak detection system that will detect the failure of either the primary or secondary containment structure or the presence of any release of dangerous waste or accumulated liquid in the secondary containment system within 24 hours.
- The system will be sloped or otherwise designed or operated to drain and remove liquids resulting from leaks, spills, or precipitation.

Because the proposed Secondary Waste Storage Tanks are double walled tanks, they are subject to the additional requirements of WAC 173-303-640(4)(e)(iii). The requirements were incorporated into this IQRPE review and the results are given below:

- The inner tank is an integral structure with the outer shell and will be completely enclosed by the outer shell.
- Any release from the inner tank will be completely contained by the outer shell.

- Provisions have been made for the inclusion of measures to protect the tanks against corrosion, including the application of corrosion resistant coatings, and installation of cathodic protection, as determined necessary during the detailed design.

- The system will be provided with a built-in continuously operating leak detection system that is installed between the inner and outer tank walls, and is capable of detecting a release within 24 hours.

The following sections highlight the IQRPE Secondary Containment System review for each of the major Secondary Waste System components, and also identify specific exceptions to this IQRPE certification report as they relate to the secondary containment system review.

### 2.2.4.1 Hose-in-Hose Transfer Line Assemblies (SP-010)

The HIHTLs are designed to maintain the liquid waste inside the primary hose with the secondary, outer hose being used for 100 percent secondary containment. An exception to this is in the short lengths of HIHTLs between the storage tanks. Due to their short length, sloping of the hose is not required to meet leak detection requirements. The secondary waste pump skid HIHTL connection is designed to prevent flooding into the pump skid if a storage tank leaks. Waste leaked from a hose, valve, or the storage tanks will be contained within a secondary containment. Waste leaked into a secondary containment hose will be detected by either the secondary waste pump skid or the staging tank leak detectors depending on the direction of slope. The longest HIHTL is from the dryer to secondary waste storage tank (fluid in HIHTL secondary, secondary tank, and outlet housing) resulting in a maximum detectable leak volume of 227 gallons.

The IQRPE concurs that this design basis meets the requirements of the DBVS RD&D Permit and WAC 173-303-640.

### 2.2.4.2 Secondary Waste Pump Skid (SP-011)

The lower portion of the secondary waste pump skid equipment room provides secondary containment with a capacity of 800 gal. The basis for this volume is a large leak with a flow rate of 70 gal/min for 10 minutes plus a margin of safety. The secondary waste pump skid is sloped to drain any freestanding liquids in the skid to a floor sump. Fluid leaking into the pump skid covers the catch basin to a depth of ¼ inch before draining to the skid's leak detector sump. The floor sump is designed to collect any drained liquids such that 1.5 gallons of liquid in the sump will activate the leak detector. The worst case leak before detection inside the secondary waste pump skid is a 23 gal leak in the equipment room catch pan resulting in a ¼ in. liquid waste depth. ?

The IQRPE concurs that this design basis meets the requirements of the DBVS RD&D Permit and WAC 173-303-640.

### 2.2.4.3 Secondary Waste Storage Tanks (SP-031)

The secondary waste storage tanks have secondary containment tanks designed to contain one hundred percent of the primary tank volume. The secondary containment structures will envelope the four sides and the bottom of the primary containment tanks, and may also envelope the top of the primary containment tank (to be determined by the SELLER). Each secondary tank includes two secondary containment valve housings that will contain any leakage from the isolation valves and the HIHTLs. One housing is located on top of the tank, and the other housing is located on the front of the tank. The inlet and pressure relief valves are located inside the top secondary containment housing, and the outlet valve is located inside the front secondary containment housing.

The front secondary containment housing is equipped with a leak detector. The tank is sloped so leaked waste will drain from the top housing and the secondary containment tank to the leak detection sump in the front housing. The secondary waste staging tank design is capable of detecting a tank leak of 64 gal. A typical leak detector data sheet is provided in provided in Appendix H3. Factory acceptance testing will verify that leaked waste will flow from the top secondary containment housing to the sump.

The IQRPE concurs that this design basis meets the requirements of the DBVS RD&D Permit and WAC 173-303-640.

#### 2.2.4.4 Secondary Waste Loadout Station

A tanker truck loadout area is provided for the transfer of the secondary waste from the secondary waste pump skid to the tanker truck. The Loadout station is also used to contain any leaks or spills that might occur during the filling process. The spill confinement is designed specifically for the purpose of confining spills that might occur during tanker loading operations. The spill confinement includes reinforced tire track belts, a ground tarp, and a pullover cover. There are two interconnected berms: one for the loadout hose stand and one for the tanker truck. The size of each spill confinement area is approximately 12 ft by 12 ft with 1-ft sidewalls. The total confinement capacity of each berm is approximately 1,100 gal, with a 1,000-gal working volume. This provides for a pump shutdown response time of approximately 14 minutes for a pump discharge rate of 70 gal/min.

The material of construction for the spill confinement is an ethylene copolymer, a geo-membrane type material. The rear wheels of the tanker truck can roll over the collapsible sidewall of the confinement system to facilitate frequent entry/exit and operational efficiency. The foundation for the spill confinement system is compacted, granular base material and a ground tarp to facilitate its transport to a new location. When warranted by weather conditions, a pullover cover can be manually placed over the spill confinement system.

A local pump control station is located near the loadout station for pump motor control and local indication of system operating status. The control panel is positioned near to the secondary waste loadout pad and allows the operator to visually monitor operations on the loadout pad. An Emergency Stop Button/Panel is located on the local control panel for quick access by the operator. The Stop Button will stop the secondary waste transfer pump.

Transfer of secondary waste to the tanker truck requires an operator to be at the loadout station. Valves are set manually and then the pumps are operated from a local control station at the

loadout station. The station location will allow the operator to observe for signs of leaks during the tanker truck filling operation. This will allow the operator to immediately stop the pumps at the loadout station if there is a leak. The presence of the operator at the loadout station during transfer of secondary waste eliminates the need for a leak detector within the confinement berm.

The IQRPE concurs that this design basis meets the requirements of the DBVS RD&D Permit and WAC 173-303-640.

#### 2.2.4.5 Secondary Containment System Exceptions

IQRPE Certification exceptions to the secondary containment system review are listed below:

- Appendix G1. Technical Specification SP-010, Rev. 0, Section 3.2.1.5.

  This section requires that the SELLER evaluate potential effects of erosion. Information regarding maximum solids concentrations and flow rates for each hose are not clearly indicated in the technical specifications, waste feed information, or process flow diagrams included with the design package. The assumptions regarding maximum solids concentrations and flow rates presented in the detailed design will need to be reviewed to ensure they are comparable to the expected liquid waste properties.

- Appendix G3. Technical Specification SP-011, Rev. 0, Section 3.3.6.1.

  Painting Preparation. Insufficient information regarding the preparation procedures or testing requirements (e.g. blasting media or surface profiles) are presented to make a complete review of the design.

- Appendix G3. Technical Specification SP-031, Rev. 0, Section 3.1.2.

  The secondary containment described in this specification does not include provisions for the valve housings or breather filter specifications.

These issues will require IQRPE review once vendor information is available. This review will be documented in the IQRPE installation assessment report.

### 2.2.5 Ancillary Equipment Design

Ecology (1995) requires that an IQRPE certify that the proposed tank system has been designed with appropriate ancillary equipment in accordance with the requirements of WAC 170-303-640(3)(f) and (4)(f). A review of the ancillary equipment design is normally part of the IQRPE review. Because the Technical Specifications prepared for the Secondary Waste System IQRPE/RCRA Design Review Package are purchase specifications that place responsibility for the final piping configuration and the purchase of all instrumentation, valves, and electronics on the SELLER, a complete review of the ancillary equipment design has not been completed.

Ancillary equipment design information to be submitted by the SELLER and reviewed by the IQRPE at a later date is listed in Attachment B.

Conclusions from the review of the design standards for the Secondary Waste System are summarized below:

- The Technical Specifications provide for secondary containment for tank system ancillary equipment that cannot be visually inspected for leaks on a daily basis.
- Secondary containment has been provided for flanges, joints, and valves and other connections regardless of whether or not they are welded to the piping and visually inspected for leaks on a daily basis.
- Secondary containment has been provided where pumps and valves transfer dangerous wastes between tanks regardless of whether or not they are seamless and can be visually inspected on a daily basis.

The following sections highlight the IQRPE Ancillary Equipment Design review for the specifications, P&IDs, and data sheets for each of the major Secondary Waste System components, and also identify specific exceptions to this IQRPE certification report as they relate to the ancillary equipment design review.

#### 2.2.5.1 P&ID Review

All P&IDs were reviewed for the following basic considerations:

- Appropriate location of pressure, temperature, and flow sensing equipment.
- Necessary piping, valve, and instrumentation labeling.
- Proper positioning of instrumentation to prevent undue influence from upstream equipment.
- Necessary isolation valves to allow instrumentation maintenance.
- Identification of preliminary interlocks.
- Designation of valves as fail-open or fail-close.
- Location of check valves or back-flow preventers.
- General designation of appropriate alarms and recorded information.

#### 2.2.5.2 Data Sheet Review

Data sheets included as part of Technical Specification SP-011 were reviewed for the following:

- Appropriate materials of construction.
- Appropriate functionality.

- Hazard classification requirements.

#### 2.2.5.3 Instrument Loop Diagram Review

IQRPE review of instrument loop diagrams included identification of the appropriate wiring and terminations at the local instruments, junction boxes, termination panels, and MCS.

#### 2.2.5.4 Ancillary Equipment Exceptions

IQRPE Certification exceptions to the ancillary equipment review are as follows:

- General - Ancillary Equipment.

  WAC requirements specify that the IQRPE review the design of ancillary equipment to ensure that it is supported and protected against physical damage and excessive stress due to settlement, vibrations, expansions, or contractions. Sufficient information is not available at this time to complete this level of review.

- Appendix C3. General.

  All instrument loop diagrams included with the Secondary Waste System IQRPE/RCRA Design Review Report are preliminary and will be updated with Vendor-specific instrumentation information during the detailed design. Final drawings will need to be reviewed by the IQRPE.

- Appendix G3, Technical Specification SP-031, Section 3.3.1.2.5.

  The PSI, Inc. LineBacker sealing gaskets specified in this paragraph require that the torque value be specified (the manufacturer only lists 'suggested' torque values). This responsibility is not clearly directed to the SELLER. The designer has advised the IQRPE that this section does not discuss torque since the Seller isn't installing the instruments, valves, or piping. The torque requirements will be included in the construction specification for field assembly.

These issues will require IQRPE review once vendor information is available. This review will be documented in the IQRPE installation assessment report.

### 2.2.6 Corrosion Assessment

An IQRPE corrosion assessment is only required for the external shell of primary containment that is in direct contact with soil or water per the requirements of WAC 173-303-640(3)(a)(iii). Because all primary components are located within secondary containment on devices that are located on concrete pads or granular base material, these requirements do not apply to the IQRPE review of the Secondary Waste System IQRPE/RCRA Design Review Package; however, the IQRPE has performed an independent engineering corrosion review of the secondary waste system components.

The Secondary Waste System piping and equipment are all located aboveground will be protected from failure due to corrosion. The secondary waste pump skid will be sitting on a concrete pad and will not be in contact with soil. The exterior will be painted to protect the enclosure from corrosion. A corrosion allowance protects against failure of the piping due to corrosion.

The secondary waste storage tanks will be sitting on granular base material. The exterior will be painted to protect against corrosion. The interior of the tanks will be coated, which will be holiday-tested in accordance with ASTM D5162. The tanks will be protected against galvanic corrosion using a cathodic protection system, if determined to be necessary during final design.

A corrosion expert has reviewed the Secondary Waste System specifications and has identified concerns associated with the Tri-Mer Scrubber Secondary Waste solution pH. The planned actions to address this, and other items noted in the corrosion review, are described in a response letter to the corrosion expert in Appendix H3 of System 2.3. The Tri-Mer scrubber has been evaluated for operating the unit to keep the discharges from being "acidic" for both normal and upset conditions. For both normal and upset conditions, the scrubber will be operated to maintain a fluid pH above 7. The corrosion expert has accepted the planned actions stated in the response letter in Appendix H3. The IQRPE has performed an independent engineering corrosion assessment and takes no exceptions to the corrosion assessment and the response letter in Appendix H3 of System 2.3.

The following reviews of the design standards for the Secondary Waste System have been completed:

- A review of the design information for the presence of any stray electrical current from nearby equipment using external power sources.
- A review of the corrosion protection recommendation for coatings and a cathodic protection system.
- A review of the provisions for corrosion allowance.

The following sections highlight the IQRPE Corrosion Assessment review for each of the major Secondary Waste System components, and also identify specific exceptions to this IQRPE certification report as they relate to the corrosion assessment review.

### 2.2.6.1 Hose-in-Hose Transfer Line Assemblies (SP-010)

The HIHTL assemblies are adequately designed to prevent failure caused by corrosion. The HIHTL end fittings are stainless steel, which has been widely used at the Hanford Site and is compatible with caustic waste. The transfer line is EPDM and this material has been used successfully for similar caustic waste retrieval applications. The intermediate fittings are also stainless steel, they are isolated on both sides by EPDM, and do not include dissimilar materials.

The Technical Specifications make the appropriate provisions for grounding the HIHTLs to the DBVS grounding system.

The IQRPE concurs that this design basis meets the requirements of the DBVS RD&D Permit and WAC 173-303-640.

#### 2.2.6.2 Secondary Waste Pump Skid (SP-011)

The secondary waste pump skid piping and enclosure are made of carbon steel. A conservative corrosion allowance protects against piping failure. The enclosure will be sitting on a concrete pad and will not be in contact with soil or water. The exterior will be painted to protect the enclosure from exterior corrosion. The design of the Secondary Waste Pump Skid is based upon a corrosion review by an independent corrosion expert and professional engineer (Appendix H3). The IQRPE performed an independent engineering corrosion review and assessment for the Secondary Waste Pump Skid.

The IQRPE concurs that this design basis meets the requirements of the DBVS RD&D Permit and WAC 173-303-640.

#### 2.2.6.3 Secondary Waste Storage Tanks (SP-031)

The secondary waste storage tanks and nozzles are to be constructed of carbon steel. The interior of the tanks will have a chemical resistant coating that will be holiday-tested in accordance with ASTM D5162. The exterior will be painted to protect against corrosion. The tanks will be protected against galvanic corrosion using a cathodic protection system, if determined to be necessary during the detailed design. The design of the Secondary Waste Storage Tanks is based upon a corrosion review by an independent corrosion expert and professional engineer (Appendix H3). The IQRPE performed an independent engineering corrosion review and assessment for the Secondary Waste Storage Tanks.

The IQRPE concurs that this design basis meets the requirements of the DBVS RD&D Permit and WAC 173-303-640.

#### 2.2.6.4 Corrosion Assessment Exceptions

The IQRPE engineering corrosion assessment for the Secondary Waste System is included as Attachment E to this report. There are no exceptions to the IQRPE certification of the corrosion assessment.

### 2.2.7 Recommended Inspection Schedule

Inspection of the secondary waste pump skid, the secondary waste storage tanks, and the HIHTLs will be performed at the supplier's facility to ensure they comply with the design, and inspection and testing requirements. The IQRPE will also review the vendor inspection and testing reports, as they are available.

Additionally, before placing the Secondary Waste System into service, the HIHTL assemblies, the tanks, and the pump skid will be inspected by an IQRPE for structural damage and proper installation. This inspection will include the following:

- Evaluation of the welds to verify no cracking or lack of fusion.
- Confirmation that no punctures, scrapes of protective coating, cracks, corrosion, or other structure damage are present.
- Performance of tank tightness test to verify no leaks are present and that pressure or vacuum did not change beyond specifications over the test period.
- Verification of the protection of ancillary equipment against physical damage and stress.
- Installation inspection that conforms to consensus-recognized standards including the documentation of findings and corrective actions documented in a post-inspection report.

The system is only specified to operate for a service life of 2 years and since the equipment has been specified with a design life of 5 years; the IQRPE does not recommend any additional inspections after the system is placed into service. The need for additional annual inspections will be determined by the Owner/Operator in accordance with RD&D Permit Condition IV.A.8.d.i and WAC 173-303-640(6).

The following sections highlight the IQRPE Recommended Inspection Schedule items for each major component after completion of the final design, prior to the start of fabrication, and before placing the Secondary Waste System components into service.

#### 2.2.7.1 Hose-in-Hose Transfer Line Assemblies (SP-010)

The IQRPE recommends the following inspections for the HIHTL assemblies:

- Review the final design once completed.
- Review the final vendor design submittals prior to the start of fabrication, as highlighted in Attachment B.
- Review the vendor inspection and testing reports, as they become available, but prior to equipment installation on site.
- Complete the IQRPE inspection for structural damage and proper installation and complete the installation assessment report before placing the Secondary Waste System into service.

#### 2.2.7.2 Waste Transfer Pump Skid (SP-027)

The IQRPE recommends the following inspections for the Waste Transfer Pump Skid:

- Review the final design once completed.
- Review the final vendor design submittals prior to the start of fabrication, as highlighted in Attachment B.

- Review the vendor inspection and testing reports, as they become available, but prior to equipment installation on site.
- Complete the IQRPE inspection for structural damage and proper installation and complete the installation assessment report before placing the Secondary Waste System into service.

#### 2.2.7.3 Secondary Waste Storage Tanks (SP-031)

The IQRPE recommends the following inspections for the Secondary Waste Storage Tanks:

- Review the final design once completed.
- Review the final vendor design submittals prior to the start of fabrication, as highlighted in Attachment B.
- Review the vendor inspection and testing reports, as they become available, but prior to equipment installation on site.
- Complete the IQRPE inspection for structural damage and proper installation and complete the installation assessment report before placing the Secondary Waste System into service.

Table 3 lists additional IQRPE recommended inspections for the Secondary Waste Storage Tanks.

**Table 3. Secondary Waste Storage Tank – Additional IQRPE Inspection Points**

| Activity | Comments |
|---|---|
| Primary and Secondary Liner Welding | This step is critical to the successful fabrication of the tank system. The IQRPE or a QII or AWS-certified inspector working under the direction of the IQRPE should complete inspections of the fabrication process following the completion of this activity, rather than relying only on a documentation review once fabrication is complete. |
| Internal Liner Coating Preparation Activities | This step is critical to the successful fabrication of the tank system. The IQRPE or a QII or a NACE-certified inspector working under the direction of the IQRPE should complete inspections of the fabrication process following the completion of this activity, rather than relying only on a documentation review once fabrication is complete. |
| Internal Liner Coating Application | This step is critical to the successful fabrication of the tank system. The IQRPE or a QII or a NACE-certified inspector working under the direction of the IQRPE should complete inspections of the fabrication process following the completion of this activity, rather than relying only on a documentation review once fabrication is complete. |
| Internal Liner Coating Dry Film Thickness/Holiday Testing | This step is critical to the successful fabrication of the tank system. The IQRPE or a QII or a NACE-certified inspector working under the direction of the IQRPE should complete inspections of the fabrication process following the completion of this activity, rather than relying only on a documentation review once fabrication is complete. |

#### 2.2.7.4 Recommended Inspection Schedule Exceptions

IQRPE Certification exceptions to the recommended inspection schedule assessment review are as follows:

- The recommended inspection activities described in this section are based on the design basis operating life, operating conditions, and waste characteristics outlined in the Design Basis Report. Should any of these parameters change (for example: extended operating life, increased operating temperatures, lower waste pH), the inspection schedule must be re-evaluated by the IQRPE.

## 3.0 DESIGN REVIEW ASSESSMENT CERTIFICATIONS

The Secondary Waste System IQRPE/RCRA Design Review Package, RPP-24544, Revision C for System 2.3, has been reviewed by the IQRPE and, with the exceptions listed herein, was assessed to be in compliance with the applicable sections of WAC 173-303-640 and the RD&D Permit for the DBVS as stated in Section 1.4 of this report. These results are based on a review of the applicable codes, standards, and documents. The certifications below are in accordance with the requirements of WAC 173-303-640(2)(b) and 173-303-810(13)(a).

**Report Lead IQRPE:**

I certify under penalty of the law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine or imprisonment for knowing violations.

ROBERT L. GOODMAN, JR. STATE OF WASHINGTON 16717 REGISTERED PROFESSIONAL ENGINEER

Robert L. Goodman, Jr. 2 Jun 05.

EXPIRES 11/13/05

**Report Reviewed by:**

Karl M. Walterskirchen

June 2, 2005

Karl M. Walterskirchen, PE

Date

Chief Engineer, TGS

## 4.0 REFERENCES

Washington Administrative Codes (WAC)

WAC 173-303, "Dangerous Waste Regulations"

WAC 173-303-640, "Tank Systems"

WAC 173-303-640(3), "Design and Installation of New Tank Systems or Components"

WAC 173-303-640-810(13)(a), "Certification"

WAC 196-23, "Licensing, Department of Engineers and Land Surveyors, Board of Registration for Professional, Stamping and Seals"

WAC 196-23.020, "Seal/Stamp Usage"

Publication 94-114, "Guidance for Assessing and Certifying Tank Systems that Store and Treat Dangerous Waste", June 1994, Washington State Department of Ecology

Publication 95-420, "Guidance for Assessing Dangerous Waste Secondary Containment Systems", September 1995, Washington State Department of Ecology

ANSI/NEMA MG-1 Revision 1-2004, "NEMA Standards Publication Motors and Generators", September 3, 2004, National Electrical Manufacturers Association

HNF-SD-GN-ER-501, Rev. 1B, "Natural Phenomena Hazards, Hanford Site, South Central Washington."

RPP-6711, "Evaluation of Hose-in-Hose Transfer Line Service for Hanford Interim Stabilization Program", April, 2003, T.D. Torres

RPP-17403, Rev. 2, "Function and System Design Requirements for the Demonstration Bulk Vitrification System", 2004, CH2M Hill Hanford Group, Inc.

RPP-24544, Rev. 0, "Demonstration Bulk Vitrification System IQRPE/RCRA Design Review Package", February 21, 2004.

145579-Q-SP-001, Revision C DRAFT. "Construction Specification for the Demonstration Bulk Vitrification System", Division 15 Mechanical, AMEC Earth and Environmental. February 2005.

TFC-ENG-STD-13, Rev. D-1, "Ignition Source Control Evaluation", January 5, CH2M Hill Hanford Group, Inc.

TFC-ENG-STD-21, Rev. A, "Hose-in-Hose Transfer Lines", January 29, 2004, CH2M Hill Hanford Group, Inc.

TFC-ENG-DESIGN-P-26, Rev. B-4, "Determination of Equipment Safety Classification and Quality Assurance Level", November 2, 2004, CH2M Hill Hanford Group, Inc.

# ATTACHMENT A

## SECONDARY WASTE SYSTEM

## IQRPE DISPOSITION OF CALCULATIONS, SPECIFICATIONS, AND DRAWINGS

**(12 Sheets)**

# ATTACHMENT A

## SECONDARY WASTE SYSTEM

## IQRPE DISPOSITION OF CALCULATIONS, SPECIFICATIONS, AND DRAWINGS

| Document Number | Document Title | Comments |
|---|---|---|
| | **Calculations** | |
| 145579-B-CA-005<br>Revision C<br>(Appendix A1) | DBVS Hose-in-Hose Applied Nozzle Loads | This calculation was reviewed in its entirety. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. |
| 145579-B-CA-009<br>Revision 1<br>(Appendix A3) | PC-1 Basic Foundations (# 4-1, 4-2, 5, 6, 8, 9, 14, 15) | This calculation was reviewed and certified as part of IQRPE Design Certification Report DR-005. A separate review was not conducted for this report. |
| 145579-B-CA-014<br>Revision A<br>(Appendix A1) | DBVS Waste Receipt System Staging Tank Heater Sizing | This calculation was reviewed in its entirety. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. |
| 145579-B-CA-019<br>Revision A<br>(Appendix A1) | DBVS Hose-in-Hose Transfer Line Heat Trace Calculation | This calculation was reviewed in its entirety. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. |
| 145579-B-CA-031<br>Revision B<br>(Appendix A3) | DBVS Detectable Leak Volume for the Secondary Waste System | This calculation was reviewed in its entirety. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. |
| | **Site Maps** | |
| F-145579-00-D-0002<br>Revision F<br>(Appendix B3) | Bulk Vitrification Site Layout Plan | This drawing was used for information purposes only. The IQRPE certification for the Secondary Waste System does not address the specific content of this drawing. |
| | **Secondary Waste System Drawings** | |
| B-145579-37-F-0002<br>Revision C<br>(Appendix C3) | Bulk Vitrification Instrument Loop Diagram 32-F-002 | A preliminary review of this drawing was conducted. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. This drawing will need to be revised using Vendor-supplied instrument data during the detailed design. |

| Document Number | Document Title | Comments |
|---|---|---|
| B-145579-32-F-0003<br>Revision C<br>(Appendix C3) | Bulk Vitrification Instrument Loop Diagram 37-P-003 | A preliminary review of this drawing was conducted. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. This drawing will need to be revised using Vendor-supplied instrument data during the detailed design. |
| B-145579-37-F-0004<br>Revision C<br>(Appendix C3) | Bulk Vitrification Instrument Loop Diagram 37-H-004 | A preliminary review of this drawing was conducted. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. This drawing will need to be revised using Vendor-supplied instrument data during the detailed design. |
| B-145579-37-F-0006<br>Revision C<br>(Appendix C3) | Bulk Vitrification Instrument Loop Diagram 37-P-006 | A preliminary review of this drawing was conducted. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. This drawing will need to be revised using Vendor-supplied instrument data during the detailed design. |
| B-145579-37-F-0007<br>Revision C<br>(Appendix C3) | Bulk Vitrification Instrument Loop Diagram 37-L-007 | A preliminary review of this drawing was conducted. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. This drawing will need to be revised using Vendor-supplied instrument data during the detailed design. |
| B-145579-37-F-0102<br>Revision C<br>(Appendix C3) | Bulk Vitrification Instrument Loop Diagram 37-T-102 | A preliminary review of this drawing was conducted. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. This drawing will need to be revised using Vendor-supplied instrument data during the detailed design. |
| B-145579-37-F-0103<br>Revision C<br>(Appendix C3) | Bulk Vitrification Instrument Loop Diagram 37-L-103 | A preliminary review of this drawing was conducted. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. This drawing will need to be revised using Vendor-supplied instrument data during the detailed design. |

| Document Number | Document Title | Comments |
|---|---|---|
| B-145579-37-F-0107<br>Revision C<br>(Appendix C3) | Bulk Vitrification Instrument Loop Diagram 37-L-107 | A preliminary review of this drawing was conducted. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. This drawing will need to be revised using Vendor-supplied instrument data during the detailed design. |
| B-145579-37-F-0108<br>Revision C<br>(Appendix C3) | Bulk Vitrification Instrument Loop Diagram 37-L-108 | A preliminary review of this drawing was conducted. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. This drawing will need to be revised using Vendor-supplied instrument data during the detailed design. |
| B-145579-37-F-0202<br>Revision C<br>(Appendix C3) | Bulk Vitrification Instrument Loop Diagram 37-T-202 | A preliminary review of this drawing was conducted. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. This drawing will need to be revised using Vendor-supplied instrument data during the detailed design. |
| B-145579-37-F-0203<br>Revision C<br>(Appendix C3) | Bulk Vitrification Instrument Loop Dia Diagram 37-L-203 | A preliminary review of this drawing was conducted. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. This drawing will need to be revised using Vendor-supplied instrument data during the detailed design. |
| B-145579-37-F-0207<br>Revision C<br>(Appendix C3) | Bulk Vitrification Instrument Loop Diagram 37-L-207 | A preliminary review of this drawing was conducted. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. This drawing will need to be revised using Vendor-supplied instrument data during the detailed design. |
| B-145579-37-F-0208<br>Revision C<br>(Appendix C3) | Bulk Vitrification Instrument Loop Diagram 37-L-208 | A preliminary review of this drawing was conducted. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. This drawing will need to be revised using Vendor-supplied instrument data during the detailed design. |

| Document Number | Document Title | Comments |
|---|---|---|
| B-145579-37-F-0302<br>Revision D<br>(Appendix C3) | Bulk Vitrification Instrument Loop Diagram 37-T-302 | A preliminary review of this drawing was conducted. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. This drawing will need to be revised using Vendor-supplied instrument data during the detailed design. |
| B-145579-37-F-0303<br>Revision D<br>(Appendix C3) | Bulk Vitrification Instrument Loop Diagram 37-L-303 | A preliminary review of this drawing was conducted. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. This drawing will need to be revised using Vendor-supplied instrument data during the detailed design. |
| B-145579-37-F-0307<br>Revision C<br>(Appendix C3) | Bulk Vitrification Instrument Loop Diagram 37-L-307 | A preliminary review of this drawing was conducted. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. This drawing will need to be revised using Vendor-supplied instrument data during the detailed design. |
| B-145579-37-F-0308<br>Revision C<br>(Appendix C3) | Bulk Vitrification Instrument Loop Diagram 37-L-308 | A preliminary review of this drawing was conducted. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. This drawing will need to be revised using Vendor-supplied instrument data during the detailed design. |
| B-145579-37-F-0402<br>Revision D<br>(Appendix C3) | Bulk Vitrification Instrument Loop Diagram 37-T-402 | A preliminary review of this drawing was conducted. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. This drawing will need to be revised using Vendor-supplied instrument data during the detailed design. |
| B-145579-37-F-0403<br>Revision C<br>(Appendix C3) | Bulk Vitrification Instrument Loop Diagram 37-L-403 | A preliminary review of this drawing was conducted. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. This drawing will need to be revised using Vendor-supplied instrument data during the detailed design. |

| Document Number | Document Title | Comments |
|---|---|---|
| B-145579-37-F-0407<br>Revision C<br>(Appendix C3) | Bulk Vitrification Instrument Loop Diagram 37-L-407 | A preliminary review of this drawing was conducted. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. This drawing will need to be revised using Vendor-supplied instrument data during the detailed design. |
| B-145579-37-F-0408<br>Revision C<br>(Appendix C3) | Bulk Vitrification Instrument Loop Diagram 37-L-408 | A preliminary review of this drawing was conducted. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. This drawing will need to be revised using Vendor-supplied instrument data during the detailed design. |
| B-145579-37-F-0502<br>Revision D<br>(Appendix C3) | Bulk Vitrification Instrument Loop Diagram 37-T-502 | A preliminary review of this drawing was conducted. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. This drawing will need to be revised using Vendor-supplied instrument data during the detailed design. |
| B-145579-37-F-0503<br>Revision C<br>(Appendix C3) | Bulk Vitrification Instrument Loop Diagram 37-L-503 | A preliminary review of this drawing was conducted. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. This drawing will need to be revised using Vendor-supplied instrument data during the detailed design. |
| B-145579-37-F-0507<br>Revision C<br>(Appendix C3) | Bulk Vitrification Instrument Loop Diagram 37-L-507 | A preliminary review of this drawing was conducted. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. This drawing will need to be revised using Vendor-supplied instrument data during the detailed design. |
| B-145579-37-F-0508<br>Revision C<br>(Appendix C3) | Bulk Vitrification Instrument Loop Diagram 37-L-508 | A preliminary review of this drawing was conducted. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. This drawing will need to be revised using Vendor-supplied instrument data during the detailed design. |

| Document Number | Document Title | Comments |
|---|---|---|
| B-145579-37-F-0602<br>Revision D<br>(Appendix C3) | Bulk Vitrification Instrument Loop Diagram 37-T-602 | A preliminary review of this drawing was conducted. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. This drawing will need to be revised using Vendor-supplied instrument data during the detailed design. |
| B-145579-37-F-0603<br>Revision C<br>(Appendix C3) | Bulk Vitrification Instrument Loop Diagram 37-L-603 | A preliminary review of this drawing was conducted. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. This drawing will need to be revised using Vendor-supplied instrument data during the detailed design. |
| B-145579-37-F-0607<br>Revision C<br>(Appendix C3) | Bulk Vitrification Instrument Loop Diagram 37-L-607 | A preliminary review of this drawing was conducted. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. This drawing will need to be revised using Vendor-supplied instrument data during the detailed design. |
| B-145579-37-F-0608<br>Revision C<br>(Appendix C3) | Bulk Vitrification Instrument Loop Diagram 37-L-608 | A preliminary review of this drawing was conducted. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. This drawing will need to be revised using Vendor-supplied instrument data during the detailed design. |
| DBVS-SK-M001<br>Revision C<br>(Appendix C3) | Secondary Waste Pump Skid Container Interfaces | This drawing was used for information purposes only. The IQRPE certification for the Secondary Waste System does not address the specific content of this drawing. |
| DBVS-SK-M103, Sheet 1<br>Revision B<br>(Appendix C3) | Bulk Vitrification HIHTL Penetration Details | This drawing was used for information purposes only. The IQRPE certification for the Secondary Waste System does not address the specific content of this drawing. |
| F-145579-00-P-0001<br>Revision B<br>(Appendix C3) | Bulk Vitrification Typical Pipe Support Details, Sheet 1 of 4 | This drawing was reviewed in its entirety. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. |
| F-145579-00-P-0002<br>Revision B<br>(Appendix C3) | Bulk Vitrification Typical Pipe Support Details, Sheet 2 of 4 | This drawing was reviewed in its entirety. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. |

| Document Number | Document Title | Comments |
|---|---|---|
| F-145579-00-P-0003 Revision B (Appendix C3) | Bulk Vitrification Typical Pipe Support Details, Sheet 3 of 4 | This drawing was reviewed in its entirety. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. |
| F-145579-00-P-0004 Revision B (Appendix C3) | Bulk Vitrification Typical Pipe Support Details, Sheet 4 of 4 | This drawing was reviewed in its entirety. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. |
| F-145579-00-P-0008 Revision C (Appendix C3) | Bulk Vitrification Secondary Waste Storage Piping Layout | This drawing was used for information purposes only. The IQRPE certification for the Secondary Waste System does not address the specific content of this drawing. |
| F-145579-00-P-0013 Revision C (Appendix C3) | Bulk Vitrification Secondary Waste Storage Piping Sections | This drawing was used for information purposes only. The IQRPE certification for the Secondary Waste System does not address the specific content of this drawing. |
| F-145579-36-V-0001 Revision B (Appendix C3) | Bulk Vitrification Off-Gas Handling Plot Plan | This drawing was used for information purposes only. The IQRPE certification for the Secondary Waste System does not address the specific content of this drawing. |
| F-145579-36-V-0008 Revision C (Appendix C3) | Bulk Vitrification Off-Gas Treatment Secondary Waste Area Plan | This drawing was used for information purposes only. The IQRPE certification for the Secondary Waste System does not address the specific content of this drawing. |
| F-145579-36-V-0008 Revision C (Appendix C3) | Bulk Vitrification Off-Gas Treatment Secondary Waste Area Section "A" | This drawing was used for information purposes only. The IQRPE certification for the Secondary Waste System does not address the specific content of this drawing. |
| F-145579-37-D-0003 Revision E (Appendix C3) | Bulk Vitrification Secondary Waste Tank Assembly and Nozzle Arrangement | This drawing was reviewed in its entirety. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. |
| F-145579-37-D-0004 Revision C (Appendix C3) | Bulk Vitrification Secondary Waste Load-Out Details | This drawing was reviewed in its entirety. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. |
| F-145579-37-D-0005 Revision C (Appendix C3) | Bulk Vitrification Secondary Waste Load-Out G.A. | This drawing was reviewed in its entirety. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. |

| Document Number | Document Title | Comments |
|---|---|---|
| F-145579-37-D-0006<br>Revision C<br>(Appendix C3) | Bulk Vitrification Secondary Containment Details | This drawing was reviewed in its entirety. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. |
| H-14-106789<br>Revision 1<br>(Appendix C3) | Bulk Vitrification Civil Site Improvements Plan | This drawing was used for information purposes only. The IQRPE certification for the Secondary Waste System does not address the specific content of this drawing. |
| ECN 722466<br>Revision 0<br>(Appendix C3) | DBVS- Electrical Equipment Fnd – Plans & Sections | This drawing was used for information purposes only. The IQRPE certification for the Secondary Waste System does not address the specific content of this drawing. |
| H-14-106794<br>Revision 0<br>(Appendix C3) | Bulk Vitrification Waste Receipt Area FDNS - Plan & Sections | This drawing is included for reference purposes only. The IQRPE certification for the Secondary Waste System does not address the specific content of this drawing. |
| H-14-106796<br>Revision 0<br>(Appendix C3) | Bulk Vitrification Off-Gas Area - FDNS - Plan & Sections | This drawing is included for reference purposes only. The IQRPE certification for the Secondary Waste System does not address the specific content of this drawing. |
| F-145579-00-A-0099<br>Revision G<br>(Appendix D3) | Bulk Vitrification P&ID "Typicals" Legend | This drawing was reviewed in its entirety. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. |
| F-145579-00-A-0100<br>Revision J<br>(Appendix D3) | Bulk Vitrification P&ID Symbol Legend | This drawing was reviewed in its entirety. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report.<br>*Note that this revision is more recent than the revision of the same drawing included as part of SP-011 (Appendix G3) and is the basis for the IQRPE certification.* |
| F-145579-37-A-0100<br>Revision 0C<br>(Appendix D3) | Bulk Vitrification Secondary Waste Pump Skid / Loadout P&ID | This drawing was reviewed in its entirety. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. |
| F-145579-37-A-0101<br>Revision 0B<br>(Appendix D3) | Bulk Vitrification Secondary Waste Storage P&ID | This drawing was reviewed in its entirety. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. |

| Document Number | Document Title | Comments |
|---|---|---|
| F-145579-00-A-0021<br>Revision 0G<br>(Appendix E3) | Full DBVS Feed Preparation & Melt Process Flow Diagram | This drawing is included for reference purposes only. The IQRPE certification for the Secondary Waste System does not address the specific content of this drawing. |
| F-145579-00-A-0022<br>Revision 0G<br>(Appendix E3) | Full DBVS Trailer Off-Gas Treatment Process Flow Diagram | This drawing was used for information purposes only. The IQRPE certification for the Secondary Waste System does not address the specific content of this drawing. |
| F-145579-00-A-0023<br>Revision 0G<br>(Appendix E3) | Full DBVS Tri-Mer and SCR Process Flow Diagram | This drawing was used for information purposes only. The IQRPE certification for the Secondary Waste System does not address the specific content of this drawing. |
| F-145579-00-A-032<br>Revision F<br>(Appendix E3) | Full DBVS Tri-Mer Scrubber (Tri-Mer Operating) Process Flow Diagram | This drawing was used for information purposes only. The IQRPE certification for the Secondary Waste System does not address the specific content of this drawing. |
| | | |
| **Technical Specifications** | | |
| 145579-D-SP-010<br>Revision 0<br>(Appendix G1) | Hose-in-Hose Transfer Line Assemblies | This specification was reviewed in its entirety, except for Appendices D1 (Request for Information) and E1 (Instrumentation Naming and Tagging Convention). Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. |
| 145579-010-CN-001<br>Revision N/A<br>(Appendix G1) | Change Notice to the Hose-in-Hose Transfer Line Specification | This specification was reviewed in its entirety. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. |
| 145579-D-SP-011<br>Revision 1<br>(Appendix G3) | Secondary Waste Pump Skid | This specification was reviewed in its entirety, except for Appendices E (Control of Suspect/Counterfeit Items), F (Request for Information), and G (Instrumentation Naming and Tagging Convention). Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. |

| Document Number | Document Title | Comments |
|---|---|---|
| 145579-D-SP-031<br>Revision 1<br>(Appendix G3) | Secondary Waste Storage Tanks Specification | This specification was reviewed in its entirety, except for Appendix A (Control of Suspect/Counterfeit Items). Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. |
| DBVS-SK-M106<br>Revision B<br>(Appendix G1: SP-010, Appendix B) | Bulk Vitrification Hose-in-Hose Transfer Line Assembly | This drawing was reviewed in its entirety. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. |
| Hose Assembly List<br>Revision 0<br>(Appendix G1: SP-010, Appendix C) | Hose Assembly List | This list was reviewed in its entirety. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. |
| F-145579-00-A-0099<br>Revision G<br>(Appendix G3: SP-011, Appendix B) | Bulk Vitrification P&ID "Typicals" Legend | This drawing was used for information purposes only. The IQRPE certification for the Secondary Waste System does not address the specific content of this drawing. |
| F-145579-00-A-0100<br>Revision I<br>(Appendix G3: SP-011, Appendix B) | Bulk Vitrification P&ID Symbol Legend | This drawing was used for information purposes only. The IQRPE certification for the Secondary Waste System does not address the specific content of this drawing. |
| F-145579-37-A-0100<br>Revision 0C<br>(Appendix G3: SP-011, Appendix B) | Bulk Vitrification Secondary Waste Pump Skid / Loadout P&ID | This drawing was reviewed in its entirety. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. |
| DBVS-SK-E106<br>Revision A<br>(Appendix G3: SP-011, Appendix B) | DBVS Secondary Waste Pump Skid One-Line and Grounding Diagrams | This drawing was used for information purposes only. The IQRPE certification for the Secondary Waste System does not address the specific content of this drawing. |
| DBVS-SK-E107<br>Revision A, Sheet 1<br>(Appendix G3: SP-011, Appendix B) | Bulk Vitrification Sec. Waste Trans. Pump No. 1 Schematic Diagram | This drawing was used for information purposes only. The IQRPE certification for the Secondary Waste System does not address the specific content of this drawing. |

| Document Number | Document Title | Comments |
|---|---|---|
| DBVS-SK-E107<br>Revision A, Sheet 2<br>(Appendix G3: SP-011, Appendix B) | Bulk Vitrification Sec. Waste Trans. Pump No. 1 Wiring Diagram | This drawing was used for information purposes only. The IQRPE certification for the Secondary Waste System does not address the specific content of this drawing. |
| DBVS-SK-E108<br>Revision A, Sheet 1<br>(Appendix G3: SP-011, Appendix B) | Bulk Vitrification Sec. Waste Trans. Pump No. 2 Schematic Diagram | This drawing was used for information purposes only. The IQRPE certification for the Secondary Waste System does not address the specific content of this drawing. |
| DBVS-SK-E108<br>Revision A, Sheet 2<br>(Appendix G3: SP-011, Appendix B) | Bulk Vitrification Sec. Waste Trans. Pump No. 2 Wiring Diagram | This drawing was used for information purposes only. The IQRPE certification for the Secondary Waste System does not address the specific content of this drawing. |
| DBVS-SK-M001<br>Revision C<br>(Appendix G3: SP-011, Appendix B) | Secondary Waste Pump Skid Container Interfaces | This drawing was used for information purposes only. The IQRPE certification for the Secondary Waste System does not address the specific content of this drawing. |
| DBVS-SK-M103<br>Revision B, Sheet 1<br>(Appendix G3: SP-011, Appendix B) | Bulk Vitrification HIHTL Penetration Details | This drawing was reviewed in its entirety. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. Dimensions and details shown on this drawing were not reviewed as they have no bearing on the IQRPE review for the Permit requirements. |
| DBVS-SK-M103<br>Revision B, Sheet 2<br>(Appendix G3: SP-011, Appendix B) | Bulk Vitrification HIHTL Penetration Details | This drawing was reviewed in its entirety. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. Dimensions and details shown on this drawing were not reviewed as they have no bearing on the IQRPE review for the Permit requirements. |
| Data Sheets<br>Revision 1<br>(Appendix G3: SP-011, Appendix C) | Data Sheets | These data sheets were reviewed in their entirety. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. Because these data sheets are preliminary, they will require additional IQRPE review when final. |
| Table D-1<br>Revision 1<br>(Appendix G3: SP-011, Appendix D) | Secondary Waste Pump Skid Hydraulic Model Data | This table was reviewed in its entirety. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. |

| Document Number | Document Title | Comments |
|---|---|---|
| Data Sheets<br>Revision 0<br><br>(Appendix G3: SP-031.1, Revision 1) | Secondary Waste Storage Tanks Data Sheet | These data sheets were reviewed in their entirety. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. Because these data sheets are preliminary, they will require additional IQRPE review when final. |
| **Supporting Information** | | |
| Appendix H3<br><br>"A Corrosion Review"<br>Dated February 2, 2005 | Corrosion Review, SP-031 and SP-011 | This corrosion letter was reviewed in its entirety. The IQRPE performed an independent corrosion engineering review for the Secondary Waste System including the Secondary Waste Pump Skid and the Secondary Waste Storage Tanks. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report.<br>*The reference letter, dated February 2, 2005, in Appendix H3 refers to the Secondary Waste Pump Skid as Specification 145579-D-SP-001, Rev. 0. The correct specification number is 145579-D-SP-011, Rev. 0.* |
| Appendix H3<br><br>"Response to Corrosion Review for the Secondary Waste System", DBVS-LDS-005.<br>Dated March 10, 2005 | Response to Corrosion Review for the Secondary Waste System | This corrosion letter response was reviewed in its entirety. The IQRPE performed an independent corrosion engineering review for the Secondary Waste System including the Secondary Waste Pump Skid and the Secondary Waste Storage Tanks. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. |
| Appendix H3<br><br>Ref: DBVS-LDS-005; March 10, 2005.<br>Dated March 16, 2005 | ChemMet letter dated March 16, 2005.<br>Ref: DBVS-LDS-005; March 10, 2005. | This letter response was reviewed in its entirety. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. |
| Appendix H3<br>Typical Leak Detector Data Sheet | Typical Leak Detector Data Sheet | This data sheet was reviewed in its entirety. Specific IQRPE review activities and any exceptions are described in Section 2.2 of this report. Because the data sheet is preliminary, it will require additional IQRPE review when final. |

**ATTACHMENT B**

**SECONDARY WASTE SYSTEM DESIGN DELIVERABLES TO BE REVIEWED WITH THE INSTALLATION CERTIFICATION PACKAGE**

**(Five Sheets)**

## ATTACHMENT B

## SECONDARY WASTE SYSTEM DESIGN DELIVERABLES TO BE REVIEWED AS PART OF THE INSTALLATION CERTIFICATION PACKAGE

| Submittal Number | Submittal Title |
|---|---|
| SP-010<br>Appendix A, Bidder's Drawing & Data Commitments | Materials of Construction |
| SP-010<br>Appendix A, Bidder's Drawing & Data Commitments | 100 % Design and Fabrication Package including:<br>- Drawings<br>- Calculations<br>- Completed Hose Assembly Data Sheets<br>- Vendor Cut Sheets/Technical Brochures<br>- Bill of Materials |
| SP-010<br>Section 3.2.2.4<br>Appendix A, Bidder's Drawing & Data Commitments | Swage Connection Installation Procedure |
| SP-010<br>Section 3.2.3.4<br>Appendix A, Bidder's Drawing & Data Commitments | Manufacturer's Instructions for Joining End Connections |
| SP-010<br>Appendix A, Bidder's Drawing & Data Commitments | Certified Material Test Reports and Certificates of Conformance |
| SP-010<br>Appendix A, Bidder's Drawing & Data Commitments | Engineering Evaluations |
| SP-010<br>Appendix A, Bidder's Drawing & Data Commitments | Visual weld/NDE inspection procedures and personnel certifications |
| SP-010<br>Appendix A, Bidder's Drawing & Data Commitments | Welding procedures, procedure qualification records, and welder procedure qualification records |
| SP-010<br>Appendix A, Bidder's Drawing & Data Commitments | AWS CWI certificate |
| SP-010<br>Appendix A, Bidder's Drawing & Data Commitments | Material Control Procedures |
| SP-010<br>Appendix A, Bidder's Drawing & Data Commitments | Protective coating specifications |

| Submittal Number | Submittal Title |
|---|---|
| SP-010<br>Appendix A, Bidder's Drawing & Data Commitments | Fabrication travelers |
| SP-010<br>Appendix A, Bidder's Drawing & Data Commitments | Cleaning procedures |
| SP-010<br>Appendix A, Bidder's Drawing & Data Commitments | Storage and installation instructions |
| SP-010<br>Appendix A, Bidder's Drawing & Data Commitments | NCRs |
| SP-010<br>Appendix A, Bidder's Drawing & Data Commitments | Test Plan/Test Procedure and Sample Test Data Sheets |
| SP-010<br>Appendix A, Bidder's Drawing & Data Commitments | Final Data Package, including:<br>- As-Built Drawings and Weld Maps<br>- Fabrication Traveler Closeout<br>- System assembly instructions<br>- Operation and maintenance manuals<br>- Inspection reports<br>- COCs/CMTRs<br>- NEC Inspection certificate<br>- All final testing results (including document and video records of qualification and individual factory acceptance tests) |
| SP-011<br>Revision 1<br>Appendix A, Bidder's Drawing & Data Commitments | 100 % Design and Fabrication Package, including:<br>- Mechanical, Structural, and Electrical Drawings<br>- Mechanical, Structural, and Electrical Calculations<br>- Completed Equipment Data Sheets<br>- Vendor Cut Sheets/Technical Brochures<br>- Bill of Materials |
| SP-011<br>Revision 1<br>Appendix A, Bidder's Drawing & Data Commitments | Test Plan/Test Procedure |
| SP-011<br>Revision 1<br>Appendix A, Bidder's Drawing & Data Commitments | NDE personnel certifications |
| SP-011<br>Revision 1<br>Appendix A, Bidder's Drawing & Data Commitments | Visual Weld/NDE procedures |

| Submittal Number | Submittal Title |
|---|---|
| SP-011<br>Revision 1<br>Appendix A, Bidder's Drawing & Data Commitments | Visual weld examination procedure/weld map |
| SP-011<br>Revision 1<br>Appendix A, Bidder's Drawing & Data Commitments | Welding procedures, procedure qualification records, and welder procedure qualification records |
| SP-011<br>Revision 1<br>Appendix A, Bidder's Drawing & Data Commitments | AWS CWI certificate |
| SP-011<br>Revision 1<br>Appendix A, Bidder's Drawing & Data Commitments | Material Control Procedures |
| SP-011<br>Revision 1<br>Appendix A, Bidder's Drawing & Data Commitments | Protective coating specifications and application procedures |
| SP-011<br>Revision 1<br>Appendix A, Bidder's Drawing & Data Commitments | Fabrication travelers |
| SP-011<br>Revision 1<br>Appendix A, Bidder's Drawing & Data Commitments | Cleaning procedures |
| SP-011<br>Revision 1<br>Appendix A, Bidder's Drawing & Data Commitments | NCRs |
| SP-011<br>Revision 1<br>Appendix A, Bidder's Drawing & Data Commitments | Final Data Package, including:<br>- As-Built Drawings<br>- Fabrication Traveler Closeout<br>- Final Test Results<br>- Inspection Reports<br>- CoC's / CMTR's<br>- NEC Inspector Certificate, electromagnetic interference test results |
| SP-031<br>Revision 1<br>DS-031.1, Bidder's Drawing & Data Commitments | Test plan/test procedure |

| Submittal Number | Submittal Title |
|---|---|
| SP-031<br>Revision 1<br>DS-031.1, Bidder's Drawing & Data Commitments | Protective coating test procedures |
| SP-031<br>Revision 1<br>DS-031.1, Bidder's Drawing & Data Commitments | NDE personnel certifications |
| SP-031<br>Revision 1<br>DS-031.1, Bidder's Drawing & Data Commitments | Visual weld/NDE procedures |
| SP-031<br>Revision 1<br>DS-031.1, Bidder's Drawing & Data Commitments | Welding procedures, procedure qualification records and welder qualification records |
| SP-031<br>Revision 1<br>DS-031.1, Bidder's Drawing & Data Commitments | AWS CWI certificate |
| SP-031<br>Revision 1<br>DS-031.1, Bidder's Drawing & Data Commitments | Material control procedures |
| SP-031<br>Revision 1<br>DS-031.1, Bidder's Drawing & Data Commitments | Materials without CMTRs for review and approval |
| SP-031<br>Revision 1<br>DS-031.1, Bidder's Drawing & Data Commitments | Recommended Vacuum/Pressure Relief Valve |
| SP-031<br>Revision 1<br>DS-031.1, Bidder's Drawing & Data Commitments | Factory Acceptance Test procedure |
| SP-031<br>Revision 1<br>DS-031.1, Bidder's Drawing & Data Commitments | Final design and fabrication package, including:<br>- Final design drawings<br>- Bill of materials<br>- Final mechanical and structural calculations (including natural phenomena hazard analysis)<br>- Materials standards |

| Submittal Number | Submittal Title |
|---|---|
| SP-031<br>Revision 1<br>DS-031.1, Bidder's Drawing & Data Commitments | NCRs |
| SP-031<br>Revision 1<br>DS-031.1, Bidder's Drawing & Data Commitments | Final Data Package, including:<br>- As-Built drawings<br>- Rigging sketches<br>- Final Test results (document and video record)<br>- Inspection Results<br>- CoCs/CMTRs |

# ATTACHMENT C

## CODES, STANDARDS, AND REGULATIONS INCORPORATED INTO TECHNICAL SPECIFICATION PACKAGES

**(Nine Sheets)**

## ATTACHMENT C

## CODES, STANDARDS, AND REGULATIONS INCORPORATED INTO TECHNICAL SPECIFICATION PACKAGES

| | |
|---|---|
| 10 CFR 830 | "Nuclear Safety Management," *Code of Federal Regulations*, as amended. |
| 29 CFR 1910 | "Occupational Safety and Health Standards," *Code of Federal Regulations,* as amended. |
| 40 CFR 264 | "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," subpart J. *Code of Federal Regulations*, as amended. |
| 47 CFR 15 | "Radio Frequency Devices," *Code of Federal Regulations*, as amended. |
| DOE/RL-92-36 | *Hanford Site Hoisting and Rigging Manual,* U.S. Department of Energy, Richland, Washington. |
| AATCC Test Method 27 | *Water Resistance: Hydrostatic Pressure Test,* American Association of Textile Chemists and Colorists, Research Triangle Park, North Carolina. |
| AISC Allowable Stress Design | *Manual of Steel Construction – Allowable Stress Design,* Ninth Edition, American Institute of Steel Construction, Chicago, Illinois. |
| AISC Load and Resistance Factor Design | *Manual of Steel Construction – Load and Resistance Factor Design.* Third Edition, American Institute of Steel Construction, Chicago, Illinois. |
| ANSI/ASME B1.20.1 | *Pipe Threads, General Purpose (Inch).* American National Standards Institute, New York, New York. |
| ANSI/AWS D1.3 | *Structural Welding Code – Sheet Steel,* American Welding Society, Miami, Florida. |
| ANSI/AWWA D100 | *AWWA Standard for Welded Steel Tanks for Water Storage,* American Water Works Association, Denver, Colorado. |
| ANSI C63.16 | *American National Standard Guide for Electrostatic Discharge Test Methodologies and* |

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| | *Criteria for Electronic Equipment,* American National Standards Institute, Washington, D.C. |
| ANSI FCI 70-2 | *Control Valve Seat Leakage,* Fluid Controls Institute, Inc., Cleveland, Ohio. |
| ANSI/HI 3.1-3.5 | *American National Standard for Rotary Pumps for Nomenclature, Definitions, Applications and Operation,* Hydraulic Institute, Parsippany, New Jersey. |
| ANSI/HI 3.6 | *American National Standard for Rotary Pump Tests,* Hydraulic Institute, Parsippany, New Jersey. |
| ANSI/IESNA RP-7 | *Lighting Industrial Facilities,* Illuminating Engineering Society of North America, New York, New York. |
| ANSI Y14.1 | *Drawing Sheet Size and Format,* American National Standards Institute, Inc. New York, New York. |
| ANSI Y14.5M | *Dimensioning and Tolerancing,* American National Standards Institute, New York, New York. |
| API 620 | *Design and Construction of Large, Welded, Low-Pressure Storage Tank, Tenth Edition,* American Petroleum Institute, Washington, D.C. |
| ASCE 4-98 | *Seismic Analysis of Safety-Related Nuclear Structures,* American Society of Civil Engineers, Reston, Virginia. |
| ASCE 7-98 | *Minimum Design Loads for Buildings and Other Structures,* American Society of Civil Engineers, Reston, Virginia. |
| ASHRAE Fundamentals Handbook | *2001 ASHRAE Handbook – Fundamentals,* American Society of Heating, Refrigerating, and Air Conditioning Engineers, Atlanta, Georgia. |
| ASME B&PV Code Sections VIII and IX | *ASME Boiler and Pressure Vessel Code,* American Society of Mechanical Engineers, New York, New York. |
| ASME B16.5 | *Pipe Flanges and Flanged Fittings,* American Society of Mechanical Engineers, New York, New York. |

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| ASME B16.9 | *Factory-Made Wrought Steel Buttwelding Fittings,* American Society of Mechanical Engineers, New York, New York. |
| ASME B16.11 | *Forged Fittings, Socket Welding and Threaded,* American Society of Mechanical Engineers, New York, New York. |
| ASME B18.2.1 | *Square and Hex Bolts and Screws Inch Series,* American Society of Mechanical Engineers, New York, New York. |
| ASME B18.2.2 | *Square and Hex Nuts,* American Society of Mechanical Engineers, New York, New York. |
| ASME B30.20 | *Below-the-Hook Lifting Devices,* American Society of Mechanical Engineers, New York, New York. |
| ASME B31.3 | *Process Piping,* American Society of Mechanical Engineers, New York, New York. |
| ASME NQA-1, 1994 | *Quality Assurance Program Requirements for Nuclear Facilities,* American Society of Mechanical Engineers, New York, New York. |
| ASME PCC-1 | *Guidelines for Pressure Boundary Bolted Flange Joint Assembly,* American Society of Mechanical Engineers, New York, New York. |
| ASME Section VIII, Div 1 or Div 2 | *Boiler and Pressure Vessel Code,* Rules and/or Alternate Rules for Construction of Pressure Vessels, New York, New York. |
| ASNT SNT-TC-1A | *Recommended Practice,* American Society of Nondestructive Testing, Columbus, Ohio. |
| ASTM A36/A36M | *Standard Specification for Carbon Structural Steel, American Society of Testing and Materials,* New York, New York. |
| ASTM A53/A53M | *Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless,* American Society of Testing and Materials, New York, New York. |
| ASTM A105/A105M | *Standard Specification for Carbon Steel Forgings for Piping Applications,* American Society for Testing and Materials, West Conshohocken, Pennsylvania |

ASTM A106 — *Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service,* American Society for Testing and Materials, West Conshohocken, Pennsylvania

ASTM A108 — *Standard Specification for Steel Bars, Carbon, Cold-Finished, Standard Quality,* American Society for Testing and Materials, West Conshohocken, Pennsylvania

ASTM A182/A182M — *Standard Specification for Forged or Rolled Alloy Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High Temperature Service,* American Society for Testing and Materials, West Conshohocken, Pennsylvania

ASTM A193/A193M — *Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service,* American Society for Testing and Materials, West Conshohocken, Pennsylvania

ASTM A194/A194M — *Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Service or Both,* American Society for Testing and Materials, West Conshohocken, Pennsylvania

ASTM A234/A234M — *Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy for Moderate and High Temperature Service,* American Society for Testing and Materials, West Conshohocken, Pennsylvania

ASTM A240/A240M — *Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications,* American Society for Testing and Materials, West Conshohocken, Pennsylvania

ASTM A269 — *Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service,* American Society of Testing and Materials, New York, New York.

ASTM A276 — *Standard Specification for Stainless Steel Bars and Shapes,* American Society of Testing and Materials, New York, New York.

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| ASTM A307 | *Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength*, American Society for Testing and Materials, West Conshohocken, Pennsylvania. |
| ASTM A312/A312M | *Standard Specification for Seamless and Welded Austenitic Stainless Steel Pipes*, American Society for Testing and Materials, West Conshohocken, Pennsylvania |
| ASTM A325 | *Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength*, American Society for Testing and Materials, West Conshohocken, Pennsylvania |
| ASTM A354 | *Standard Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and other Externally Threaded Fasteners*, American Society for Testing and Materials, West Conshohocken, Pennsylvania |
| ASTM A403/A403M | *Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings*, American Society for Testing and Materials, West Conshohocken, Pennsylvania |
| ASTM A480/A480M | *Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip*, American Society for Testing and Materials, West Conshohocken, Pennsylvania |
| ASTM A500 | *Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes*, American Society for Testing and Materials, West Conshohocken, Pennsylvania |
| ASTM A563a | *Standard Specification for Carbon and Alloy Steel Nuts*, American Society for Testing and Materials, West Conshohocken, Pennsylvania |
| ASTM A569 | *Standard Specification for Steel, Carbon (0.15 Maximum, Percent) Hot-Rolled Sheet and Strip Commercial*, American Society for Testing and Materials, West Conshohocken, Pennsylvania |
| ASTM C518 | *Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus*, American Society for Testing and Materials, West Conshohocken, Pennsylvania |

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| ASTM D380 | *Standard Test Methods for Rubber Hose*, American Society for Testing and Materials, West Conshohocken, Pennsylvania. |
| ASTM D991 | *Standard Test Method for Rubber Property-Volume Resistivity of Electrically Conductive and Antistatic Products,* American Society for Testing and Materials, West Conshohocken, Pennsylvania. |
| ASTM D1621 | *Standard Test Method for Compressive Properties of Rigid Cellular Plastics,* American Society for Testing and Materials, West Conshohocken, Pennsylvania |
| ASTM D1622 | *Standard Test Method for Apparent Density of Rigid Cellular Plastics,* American Society for Testing and Materials, West Conshohocken, Pennsylvania |
| ASTM D5162 | *Standard Practice for Discountability (Holiday) Testing of Nonconductive Protective Coating on Metallic Substrates,* American Society for Testing and Materials, West Conshohocken, Pennsylvania. |
| ASTM E84 | *Standard Test Method for Surface Burning Characteristics of Building Materials,* American Society for Testing and Materials, West Conshohocken, Pennsylvania |
| ASTM E96 | *Standard Test Methods for Water Vapor Transmission of Materials,* American Society for Testing and Materials, West Conshohocken, Pennsylvania |
| ASTM E285 | *Standard Test Method for Oxyacetylene Ablation Testing of Thermal Insulation Materials,* American Society for Testing and Materials, West Conshohocken, Pennsylvania. |
| AWS D1.1/D1.1M | *Structural Welding Code* – Steel, American Welding Society, Miami, Florida |
| AWS D1.6 | *Structural Welding Code* – Stainless Steel, American Welding Society, Miami, Florida. |
| AWS QC-1 | *Standard for AWS Certification of Welding Inspectors*, American Welding Society, Miami, Florida. |

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| HNF-2962 | *A List of EMI/EMC Requirements,* Rev. O, Numatec Hanford Corporation for Fluor Daniel Hanford, Inc. Richland, Washington. |
| HNF-SD-GN-ER-501 | *Natural Phenomena Hazards*, Hanford Site, Washington, Revision 1B, Westinghouse Hanford Company, Richland, Washington. |
| IEC 61000-4-2 | *Electromagnetic Compatibility (EMC) – Part 4-2: Testing and Measurement Techniques – Electrostatic Discharge Immunity Test,* International Engineering Consortium, Chicago, Illinois. |
| IEEE C62.41.1 | *IEEE Guide on the Surge Environment in Low-Voltage (1000 V and Less) AC Power Circuits,* Institute of Electrical and Electronics Engineers, New York, New York. |
| IEEE C62.41.2 | *IEEE Recommended Practice on Characterization of Surges in Low Voltage (1000 V and Less) AC Power Circuits,* Institute of Electrical and Electronics Engineers, New York, New York |
| IEEE C37.90.2 | *IEEE Standard for Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers,* Institute of Electrical and Electronics Engineers, New York, New York. |
| IEEE 141 | *IEEE Recommended Practice for Electric Power Distribution for Industrial Plants,* Institute of Electrical and Electronics Engineers, New York, New York. |
| IEEE 142 | *IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems,* Institute of Electrical and Electronics Engineers, New York, New York. |
| IEEE 242 | *IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems,* Institute of Electrical and Electronics Engineers, New York, New York. |
| IEEE 519 | *Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems,* Institute of Electrical and Electronics Engineers, New York, New York. |

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| IESNA HB-9 | *IESNA Lighting Handbook*, 9th Edition, Illuminating Engineering Society of North America, New York, New York. |
| IP-2 | The 2003 Hose Handbook, 7th Edition, Rubber Manufacturers of America, Washington, D.C. |
| ISO 668 | *Series 1 Freight Containers Classification, Dimensions and Ratings*, International Organization for Standardization, Geneva, Switzerland. |
| ISO 1161 | *Series 1 Freight Containers – Corner Fittings – Specification*, International Organization for Standardization, Geneva, Switzerland. |
| ISO 1496-2 | *Series 1 Freight Containers – Specification and Testing – Part 2: Thermal Containers*, International Organization for Standardization, Geneva, Switzerland. |
| MSS SP-72 | *Ball Valves with Flanged or Butt-Welding Ends for General Service*, Manufacturing Standardization Society of the Valve and Fittings Industry, Inc. Vienna, Virginia. |
| MSS SP-82 | *Valve Pressure Testing Methods*, Manufacturing Standardization Society of the Valve and Fittings Industry, Inc. Vienna, Virginia. |
| NEMA MG-1 | *Motors and Generators*, National Electrical Manufacturers Association, Rosslyn, Virginia. |
| NFPA 70 | *National Electrical Code*, 2002 Edition, National Fire Protection Association, Quincy, Massachusetts. |
| SAE J429 | *Mechanical and Material Requirements for Externally Threaded Fasteners*, Society of Automotive Engineers, Warrendale, Pennsylvania. |
| TFC-ENG-STD-21 | *Hose-in-Hose Transfer Lines*, CH@M Hill Hanford Group, Richland, Washington |
| TFC-ESHQ-QC-C-03, Rev. B | *Control of Suspect / Counterfeit Items.* |
| TFC-PLN-09, Rev. A-1 | *Human Factors Program.* |
| UBC, 1997 | *1997 Uniform Building Code*, International Conference of Building Officials, Whittier, California. |

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| UL-Listed | *Electrical Appliance and Utilization Equipment Directory*, Underwriters Laboratories, Inc., Northbrook, Illinois. |
| UL 142 | *Standard for Safety-Steel Aboveground Tanks for Flammable and Combustible Liquids*, Underwriters Laboratories, Inc., Northbrook, Illinois. |
| UL 508A | *Standard for Industrial Control Panels*, Underwriters Laboratories, Inc., Northbrook, Illinois. |
| WAC 173-303-640 | *Tank Systems*, Washington Administrative Code, as amended. |

# ATTACHMENT D

## SECONDARY WASTE SYSTEM

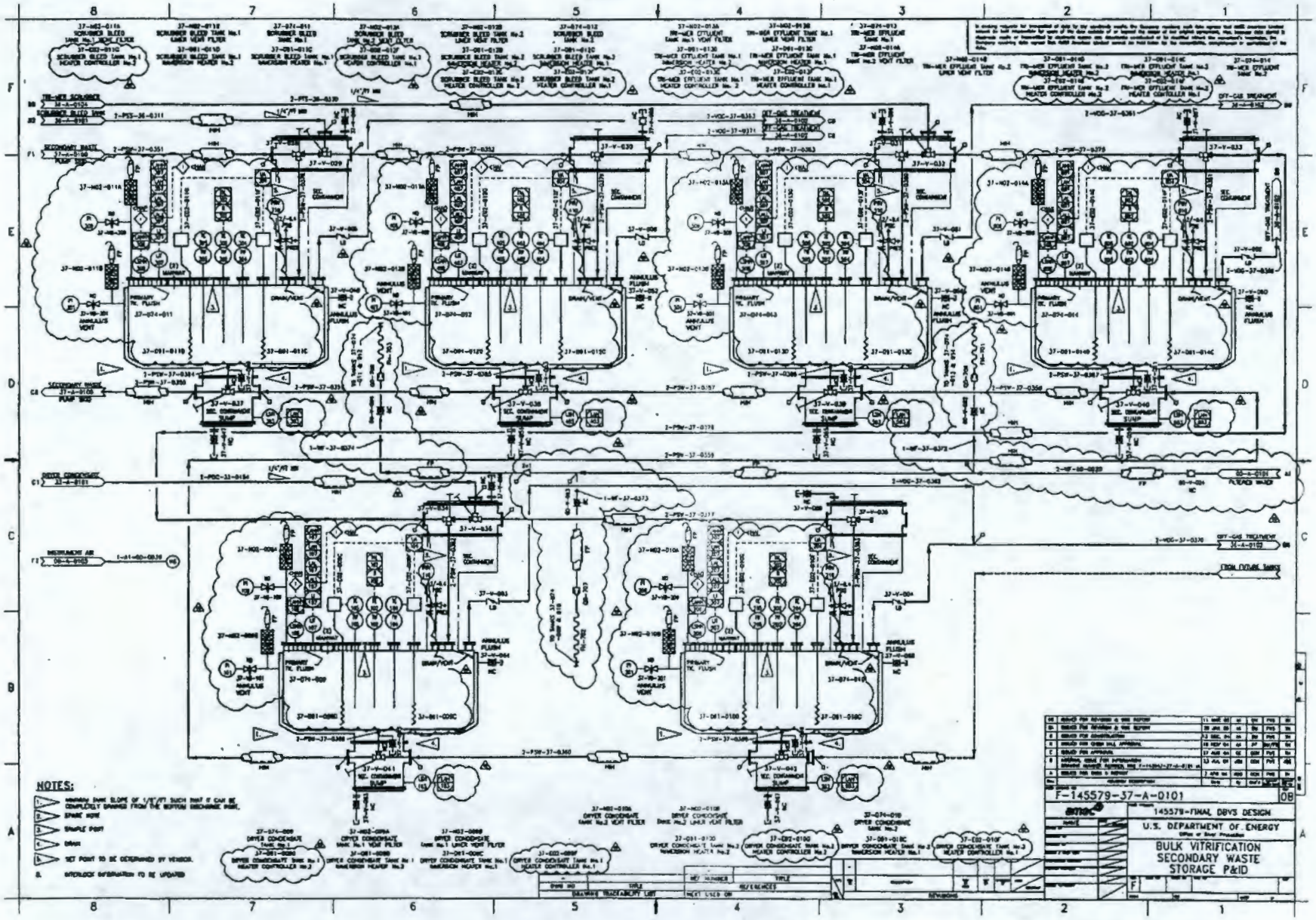
## PIPING AND INSTRUMENTATION DIAGRAMS

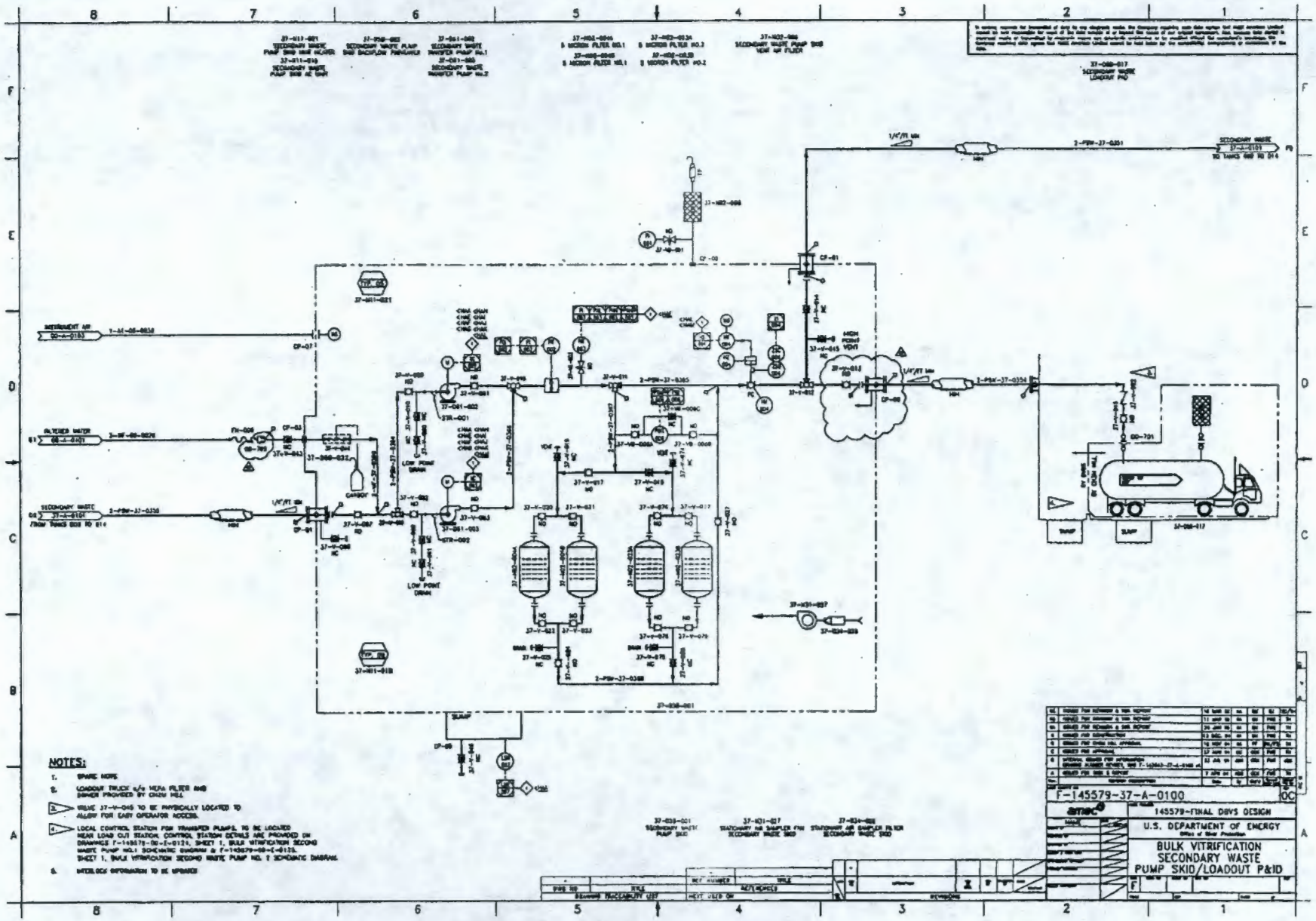
**Drawing F-145579-37-A-0101, Rev 0B**

**"Bulk Vitrification Secondary Waste Storage P&ID"**

**Drawing F-145579-37-A-0100, Rev 0C**

**"Bulk Vitrification Secondary Waste Pump Skid/Loadout P&ID"**


NOTES:
F-145579-37-A-0101
145579-FINAL DBVS DESIGN
U.S. DEPARTMENT OF ENERGY
BULK VITRIFICATION
SECONDARY WASTE
STORAGE P&ID


NOTES:
1. SPARE NOTE
2. LOADOUT TRUCK c/o HEPA FILTER AND SAMPLE PROVIDED BY CHZM HILL
3. VALVE 37-V-045 TO BE PHYSICALLY LOCATED TO ALLOW FOR EASY OPERATOR ACCESS.
4. LOCAL CONTROL STATION FOR TRANSFER PUMPS, TO BE LOCATED NEAR LOAD OUT STATION. CONTROL STATION DETAILS ARE PROVIDED ON DRAWINGS F-145579-00-E-0124, SHEET 1, BULK VITRIFICATION SECOND WASTE PUMP NO.1 SCHEMATIC DIAGRAM & F-145579-00-E-0125, SHEET 1, BULK VITRIFICATION SECOND WASTE PUMP NO. 2 SCHEMATIC DIAGRAM.
5. INTERLOCK INFORMATION TO BE UPDATED
F-145579-37-A-0100
145579-FINAL DWG DESIGN
U.S. DEPARTMENT OF ENERGY
BULK VITRIFICATION SECONDARY WASTE PUMP SKID/LOADOUT P&ID

# ATTACHMENT E

# ENGINEERING CORROSION REVIEW

**(Four Sheets)**

Northwest Corrosion Engineering

10995 Warfield Road, Sedro-Woolley, WA 98284
Phone: (360) 826-4570 Fax: (360) 826-6321

March 15, 2005

Mr. Robert Goodman, Jr., P.E.
TechnoGeneral Services Company
710 North 4th Avenue
Pasco, WA 99301

**SUBJECT: Corrosion Engineering Review – DBVS Secondary Waste System, Package 2.3 Revision B February 17, 2005**

Mr. Goodman,

The current Secondary Waste System, Rev. B dated 02/17/05 describes two effluent streams generated during normal operation, dryer condensate and off-gas scrubber solution bleed. In the event the selective catalytic reduction (SCR) wet scrubber system is not in operation, a proposed Tri-Mer Scrubber system will receive waste from the dryer condensate. The effluent properties of the Tri-Mer Scrubber outlined in Table 3-6 of technical specification SP-011 include a fluid pH of less than 1. The use of carbon steel and 300 series austenitic stainless steels for containment of this fluid would not be advised as these materials would experience significant general metal loss and corrosion related pitting damage.

Previous comments addressing the incompatibility of the Tri-Mer Scrubber effluent have resulted in a Disposition as outlined in the Review Comment Record, Secondary Waste System Revision B dated 03/01/05, Item 6. The Disposition states that the secondary waste streams will be operated to be caustic and that a change to technical specifications 010, 011, and 031 are forthcoming as will be a corrosion review of the changes.

As proposed changes have not been submitted as of the date of this review, comments concerning proposed containment materials of construction will be reserved until such time as specification changes are received.

The following comments concern specific portions of the 2.3 Design Package and related documents.

**1.0 Corrosion Review – Submitted by ChemMet, LTD, dated February 2, 2005.**

1.1 Secondary Waste Storage Tanks Specification (145579-D-SP-031 Rev 0)

Northwest Corrosion Engineering does not take any exceptions to the comments provided by Dr. Divine in his review of the Secondary Waste Storage Tanks (145579-D-SP-031 Rev 0). However, the comments made by Dr. Divine may be updated with the described revisions to the specifications.

1.2 Secondary Waste Pump Skid (145579-D-SP-011 Rev 0)

The actual specification number for this section is SP-011 and not SP-001. No other exceptions are taken with this section.

**2.0 The following additional comments concerning Technical Specifications 145579-D-SP-011 Rev 0 and 145579-D-SP-031 Rev 0 are being provided by Northwest Corrosion Engineering.**

2.1 145579-D-SP-011 Rev. 0 – Secondary Waste Pump Skid

a. Section 3.3.6 Protective Coatings requires that "Protective coating specifications shall be prepared by the Seller". Reliance has been placed upon the Seller to comply with manufacturer's recommendations for materials, surface preparation, application procedures, environmental controls, etc. As protective coatings are used as the first line of defense against corrosion, it would be prudent to provide the Seller with coating specifications specific to the items to be coated. This will require the Seller to recognize and prepare for a specific set of coating instructions.

b. Provisions should be made to perform 3rd party coating inspection at the application location.

c. Comments related to the proposed materials of construction to be in contact with the waste fluids will be reserved until updated specifications are provided. NOTE: Section 3.3.11.2.6 requires the Seller to determine appropriate corrosion allowances for all piping system calculations. The Seller should provide corrosion/erosion allowance data along with justification and assumptions to the Buyer for review prior to fabrication.

2.2 145579-D-SP-031 Rev. 0 – Secondary Waste Storage Tanks Specification

a. Section 3.3.6.1(a) Protective Coatings requires that "The procedures for preparing and coating the surfaces shall be submitted to the Buyer for review and approval". Reliance has been placed upon the Seller to comply with manufacturer's recommendations for materials, surface preparation, application procedures, environmental controls, etc. As protective coatings are used as the first line of defense against corrosion, it would be prudent to provide the Seller with coating specifications specific to the items to be coated. This will require the Seller to recognize and prepare for a specific set of coating instructions.

b. Section 3.3.13.2 requires appropriate training to personnel applying and performing testing of protective coatings. Application of coatings should be performed by individuals knowledgeable in the coating process. This requirement should extend to those individuals completing the surface preparation prior to coating.

c. Provisions should be made to perform 3rd party coating inspection at the application location.

**3.0 General Notes:**

a. Project specific coating specifications should be developed and issued with the design package. This will ensure that the protective coatings will be compatible with the materials and environments to which they are exposed. In addition, provisions should be made for 3rd party coating inspection to be completed. The inspection would take place at specific hold points as described in the coating specification.

The comments provided in this review are based upon the specific technical specifications as described at the 90% level of design.

Sincerely,
Northwest Corrosion Engineering

Jeremy A. Hailey, P.E.
NACE Corrosion Specialist, No. 5401

JEREMY ALLEN HAILEY
STATE OF WASHINGTON
37067
REGISTERED
PROFESSIONAL ENGINEER
EXPIRES 11-NOV-06

Northwest Corrosion Engineering
10995 Warfield Road, Sedro-Woolley, WA 98284
Phone: (360) 826-4570 Fax: (360) 826-6321

April 15, 2005

Mr. Robert Goodman, Jr., P.E.
TechnoGeneral Services Company
710 North 4th Avenue
Pasco, WA 99301

**SUBJECT: Corrosion Engineering Review – DBVS Secondary Waste System, Package 2.3 Revision C, Comment Dispositions Dated March 10, 2005**

Mr. Goodman,

Northwest Corrosion Engineering has completed a review of the Corrosion Control related comments for the subject DBVS Package. Previous review comments expressed concerns over the use of carbon and/or austenitic stainless steels in contact with the low pH solution associated with the Tri-mer Scrubber Secondary Waste process. These views were outlined in letters provided by ChemMet, LTD, PC (dated February 2, 2005) and Northwest Corrosion Engineering (dated March 15, 2005).

In response, DMJM Technology has provided a letter outlining that the scrubber discharge in both the normal and upset operating conditions will be maintained in a pH range of 7-8. This response along with the other Dispositions outlined in the subject letter are acceptable.

We appreciate the opportunity to be of assistance. If you have any questions or would like additional information, please do not hesitate to contact our office.

Sincerely,
Northwest Corrosion Engineering

Jeremy A. Hailey, P.E.
NACE Corrosion Specialist, No. 5401

JEREMY ALLEN HAILEY
STATE OF WASHINGTON
37087
REGISTERED PROFESSIONAL ENGINEER
EXPIRES 11-06-06

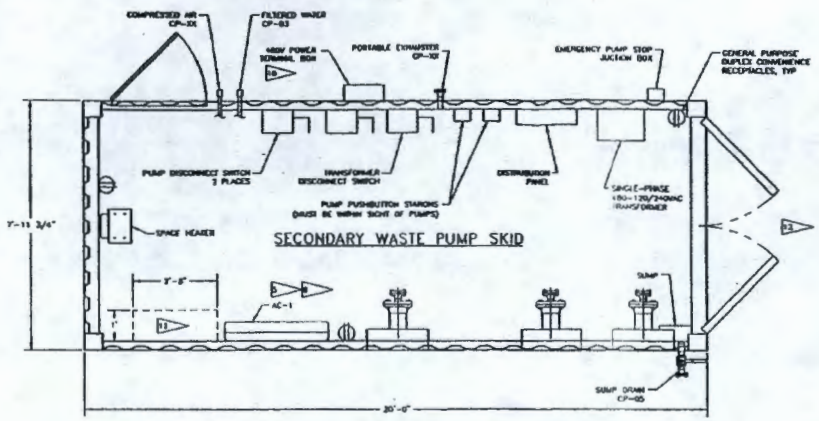
# Permit Attachment KK Tank Management

## Appendix 4 Secondary Waste System

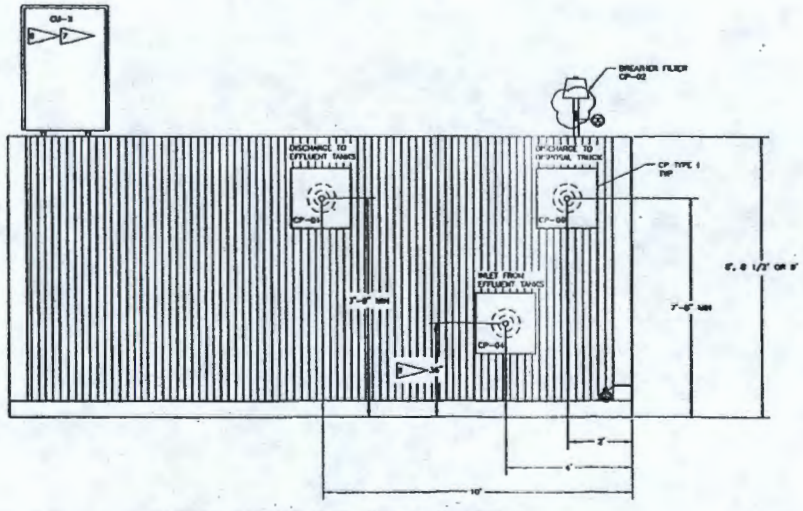
Section 3 Drawings

H-14-106789, Rev 1, BV Civil Site Improvements[a]
H-14-106794, Rev 0, BV Waste Receipt Area FDNs – Plans & Sections[a]
H-14-106796, Rev 0, Off-Gas Area Plans & Sections[a]
DBVS-SK-M001, Rev C, Secondary Waste Pump Skid Container Interfaces
F-145579-00-P-0008, Rev C, Bulk Vitrification Secondary Waste Storage Waste Piping Layout
F-145579-00-P-0013, Rev C, Bulk Vitrification Secondary Waste Storage Piping Sections
F-145579-36-V-0001, Rev B, Bulk Vitrification Off-Gas Handling Plot Plan
F-145579-36-V-0008, Rev C, Bulk Vitrification Off-Gas Treatment Secondary Waste Area Plan
F-145579-36-V-0035, Rev D, Bulk Vitrification Off-Gas Treatment Secondary Waste Area Section 'A'
F-145579-37-A-0100, Rev 0C, Bulk Vitrification Secondary Waste Pump Skid/Load-Out P&ID
F-145579-37-A-0101, Rev 0B, Bulk Vitrification Secondary Waste Storage P&ID
F-145579-37-D-0004, Rev C, Bulk Vitrification Secondary Waste Load-Out Details
F-145579-37-D-0005, Rev C, Bulk Vitrification Secondary Waste Load-Out GA
F-145579-37-D-0006, Rev C, Bulk Vitrification Secondary Containment Details

[a] Drawings H-14-106789, H-14-106794, and H-14-106796 are located in Permit Attachment KK, Appendix 1, Section 3.




PLAN VIEW (ROOF REMOVED)




SECONDARY WASTE PUMP SKID INTERFACES

SIDE VIEW

## GENERAL NOTES:

1. REFERENCE SPECIFICATION 145579-0-SP-011 FOR DESIGN, FABRICATION, TESTING AND INSPECTION REQUIREMENTS.
2. DO NOT SCALE. ALL DIMENSIONS ARE IN INCHES AND ARE REFERENCE ONLY UNLESS OTHERWISE SPECIFIED.
3. THIS ARRANGEMENT DRAWING IS PROVIDED TO ILLUSTRATE THE GENERAL REQUIRED CONFIGURATION. LOCATION OF SPECIFIC PIPING AND EQUIPMENT WILL BE PROVIDED BY THE SELLER ON FABRICATION DRAWINGS FOR BUYER APPROVAL. LOCATION OF SPECIFIC ITEMS MAY BY ADJUSTED TO ACCOMMODATE FABRICATION AND FUNCTIONAL REQUIREMENTS.
4. FOR SIMPLICITY AND CLARITY, INTERNAL AND EXTERNAL LIGHTING AND ASSOCIATED EQUIPMENT ARE NOT SHOWN (SEE SPECIFICATION FOR LIGHTING REQUIREMENTS).

A MOUNT UNIT PER MANUFACTURERS RECOMMENDATIONS.

B SEAL REFRIGERANT PIPING AND CONDUIT PENETRATIONS THROUGH CONTAINER WALL WITH RTV. INSULATE SUCTION LINE WITH 3/4" THICK CLOSED CELL FOAM PIPE INSULATION.

D MOUNT CONDUITS LINE ON UNISTRUT CHANNEL WELDED TO ROOF OF CONTAINER.

E WALL MOUNT AC-1 MINIMUM 6'-0" ABOVE FLOOR.

F CRITICAL DIMENSION.

10 LABEL OUTSIDE OF TERMINAL BOX COVER AS FOLLOWS: "CAUTION: THREE IONING SOURCES PRESENT."

11 AREA DESIGNATED FOR FIXED HOOD AIR SAMPLER TO BE INSTALLED BY OWNER. AREA SHALL SPAN FROM FLOOR TO 3'-0" ABOVE FLOOR MINIMUM.

12 DOUBLE DOORS MAY BE LOCATED ON EITHER END OF PUMP SKID. FILTERS SHALL BE LOCATED JUST INSIDE THE DOUBLE DOORS.

13. SEE DRAWING DBVS-SK-M003 FOR CP PENETRATION DETAIL.

DMJM Technology

amec

145579-FINAL DBVS DESIGN

U.S. DEPARTMENT OF ENERGY

SECONDARY WASTE PUMP SKID CONTAINER INTERFACES

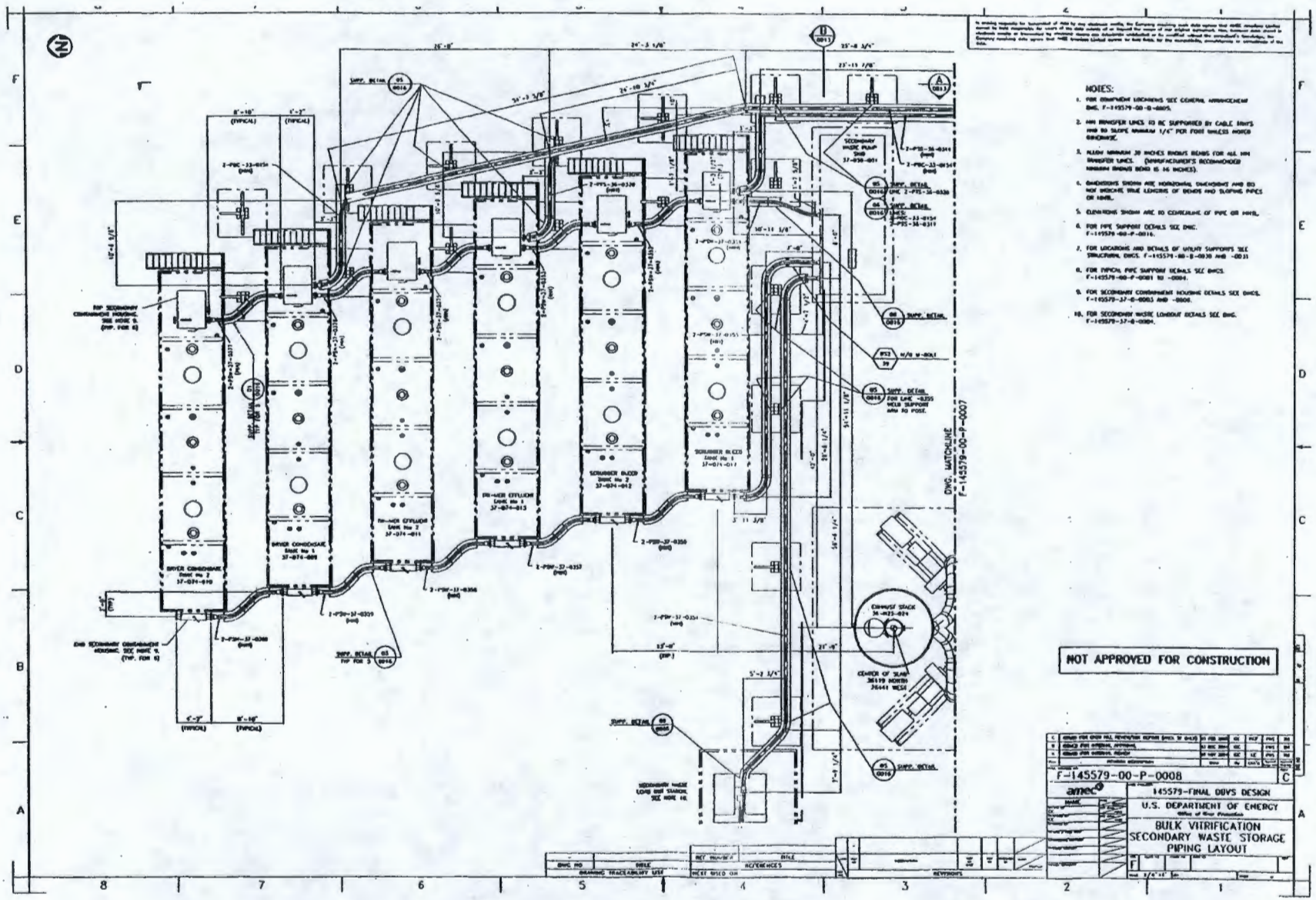
F 2H04 7100 DBVS-SK-M001 C

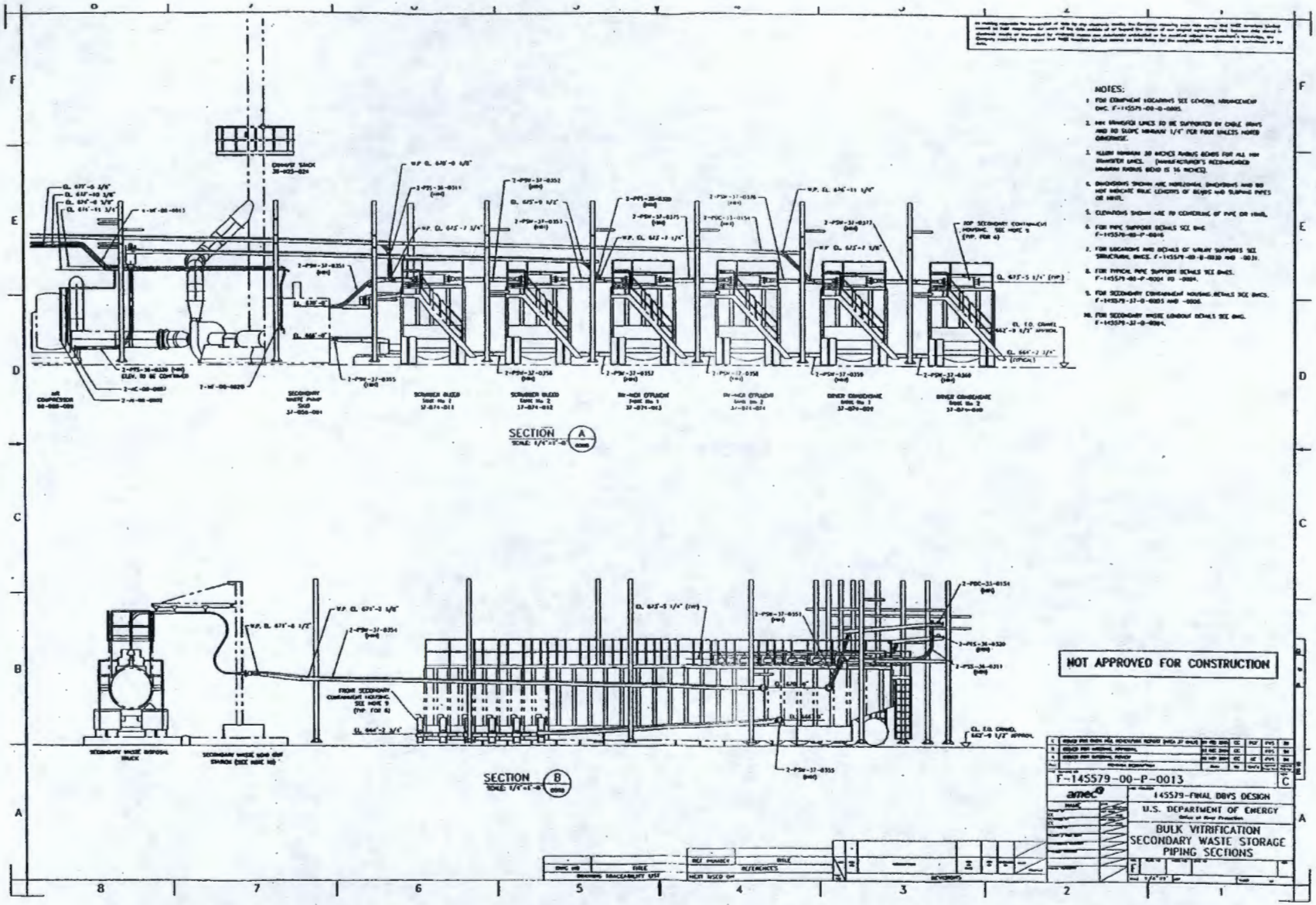
| REV | DATE | DESCRIPTION | BY | CHK | APP |
|---|---|---|---|---|---|
| C | | | | | |
| B | | RELEASED WITH SPECIFICATION 145579-0-SP-011 REV 0 | | | |
| A | | ISSUED FOR COMMENT | | | |

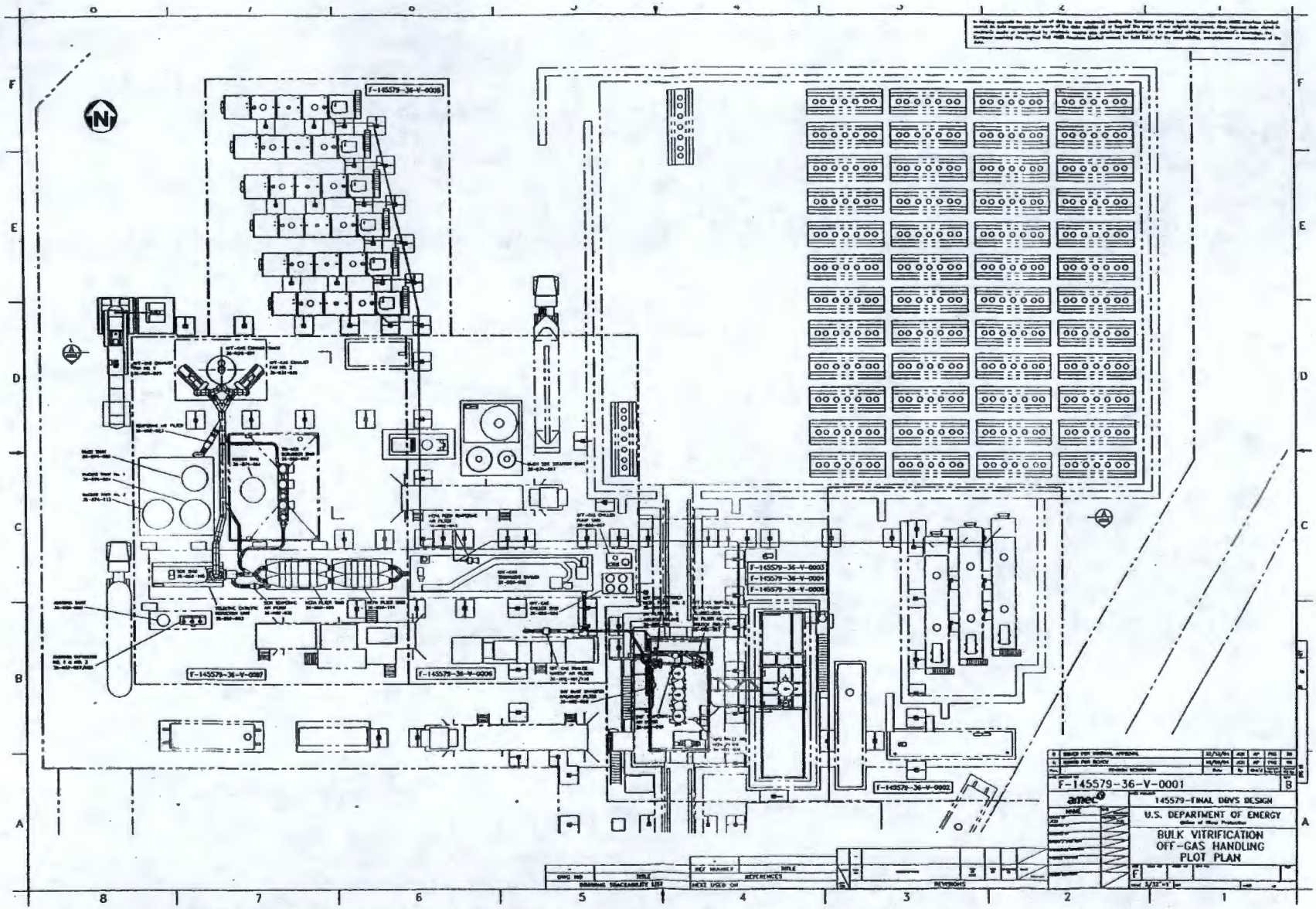
REVISIONS

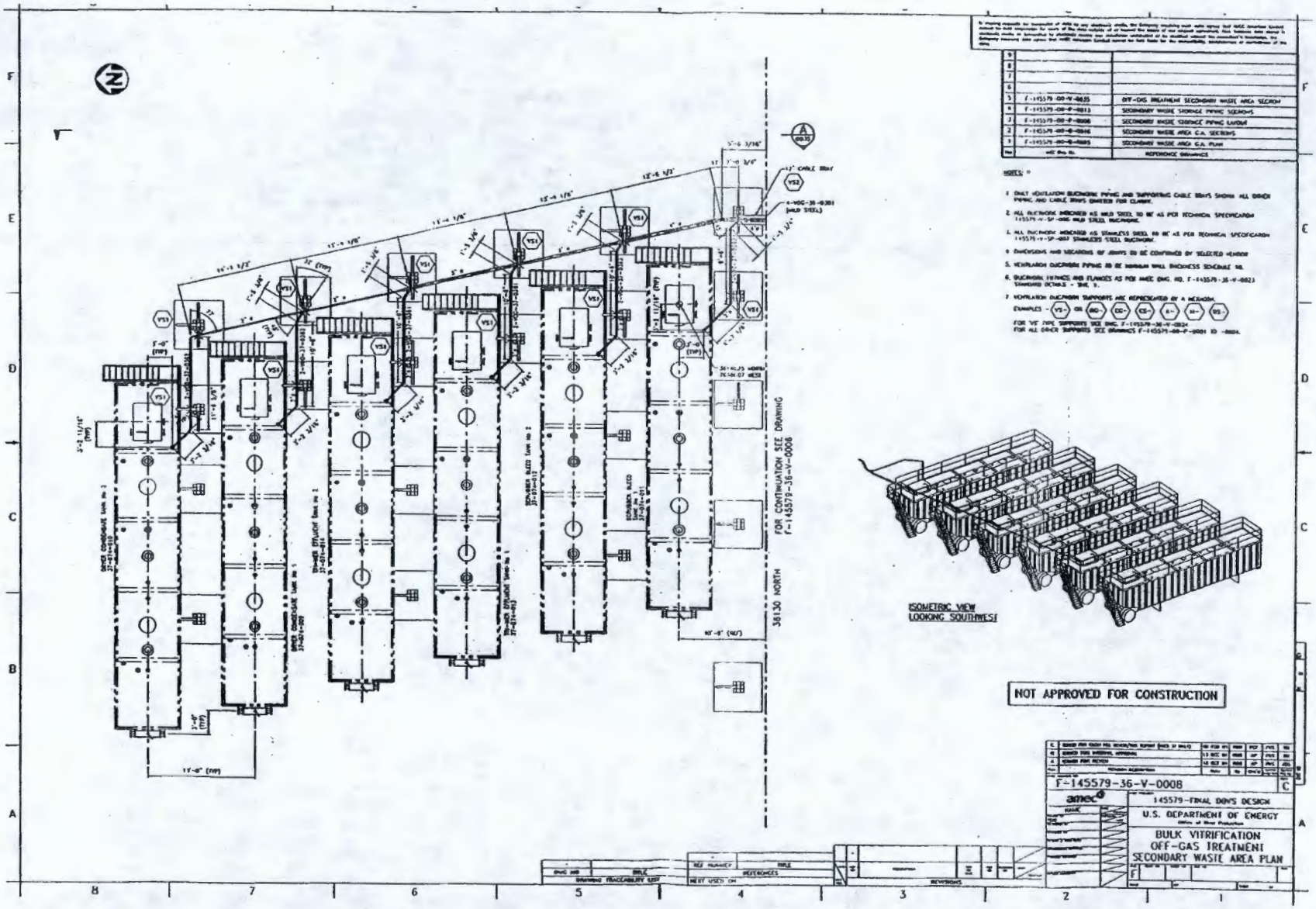
DWG NO | TITLE — DRAWING TRACEABILITY LIST

REF NUMBER | TITLE — REFERENCES — NEXT USED ON END ITEM


NOTES:
1. FOR COMPONENT LOCATIONS SEE GENERAL ARRANGEMENT DWG. F-145579-00-G-0005.
2. ALL TRANSFER LINES TO BE SUPPORTED BY CABLE TRAYS AND TO SLOPE MINIMUM 1/4" PER FOOT UNLESS NOTED OTHERWISE.
3. ALLOW MINIMUM 20 INCHES RADIUS BENDS FOR ALL HIH TRANSFER LINES. (MANUFACTURER'S RECOMMENDED MINIMUM RADIUS BEND IS 16 INCHES).
4. DIMENSIONS SHOWN ARE HORIZONTAL DIMENSIONS AND DO NOT INDICATE TRUE LENGTHS OF BENDS AND SLOPING PIPES OR TUBES.
5. ELEVATIONS SHOWN ARE TO CENTERLINE OF PIPE OR TUBE.
6. FOR PIPE SUPPORT DETAILS SEE DWG. F-145579-00-P-0016.
7. FOR LOCATIONS AND DETAILS OF UTILITY SUPPORTS SEE STRUCTURAL DWGS. F-145579-00-S-0030 AND -0031
8. FOR TYPICAL PIPE SUPPORT DETAILS SEE DWGS. F-145579-00-P-0001 TO -0004.
9. FOR SECONDARY CONTAINMENT HOUSING DETAILS SEE DWGS. F-145579-37-G-0001 AND -0006.
10. FOR SECONDARY WASTE LOADOUT DETAILS SEE DWG. F-145579-37-G-0004.
NOT APPROVED FOR CONSTRUCTION
F-145579-00-P-0008
145579-FINAL DDVS DESIGN
U.S. DEPARTMENT OF ENERGY
BULK VITRIFICATION
SECONDARY WASTE STORAGE
PIPING LAYOUT
DWG. MATCHLINE F-145579-00-P-0007

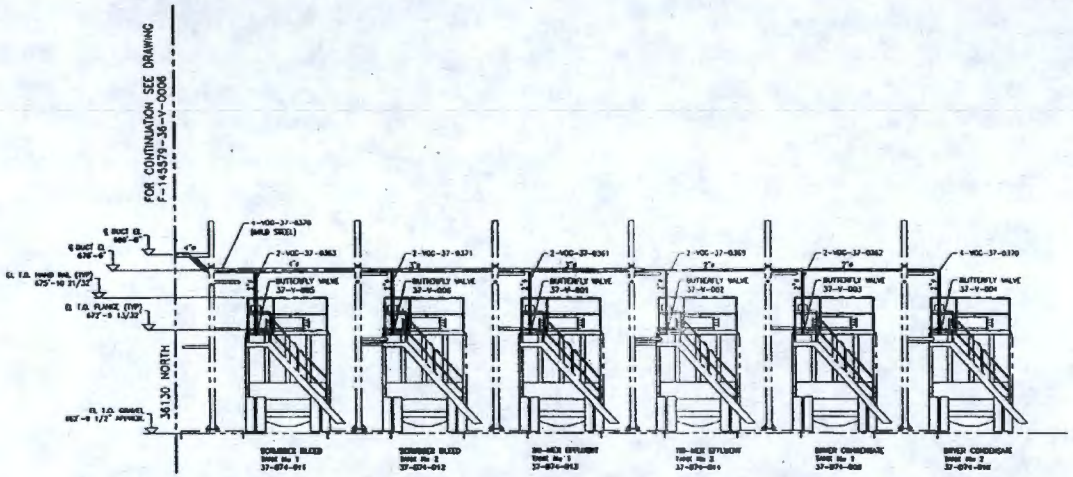

NOTES:
SECTION A
SCALE: 1/4"=1'-0"
SECTION B
SCALE: 1/4"=1'-0"
NOT APPROVED FOR CONSTRUCTION
F-145579-00-P-0013
C
145579-FINAL DBVS DESIGN
U.S. DEPARTMENT OF ENERGY
BULK VITRIFICATION
SECONDARY WASTE STORAGE
PIPING SECTIONS


F-145579-36-V-0001
145579-FINAL DRYS DESIGN
U.S. DEPARTMENT OF ENERGY
BULK VITRIFICATION
OFF-GAS HANDLING
PLOT PLAN


FOR CONTINUATION SEE DRAWING F-145579-36-V-0006
38150 NORTH
ISOMETRIC VIEW LOOKING SOUTHWEST
NOT APPROVED FOR CONSTRUCTION
F-145579-36-V-0008
145579-FINAL DON'S DESIGN
U.S. DEPARTMENT OF ENERGY
BULK VITRIFICATION OFF-GAS TREATMENT SECONDARY WASTE AREA PLAN

| No | WTC Dwg No. | REFERENCE DRAWINGS |
|---|---|---|
| 1 | F-145579-36-V-0008 | OFF-GAS TREATMENT – SECONDARY WASTE AREA PLAN |
| 2 | F-145579-00-0-0005 | SECONDARY WASTE AREA G.A. – PLAN |
| 3 | F-145579-00-0-0016 | SECONDARY WASTE AREA G.A. – SECTIONS |
| 4 | F-145579-00-P-0008 | SECONDARY WASTE STORAGE – PIPING LAYOUT |
| 5 | F-145579-00-P-0013 | SECONDARY WASTE STORAGE – PIPING SECTIONS |

NOTES:
SEE NOTES ON DRAWING F-145579-36-V-0008




SECTION A
1/4"=1'-0"

NOT APPROVED FOR CONSTRUCTION

F-145579-36-V-0035

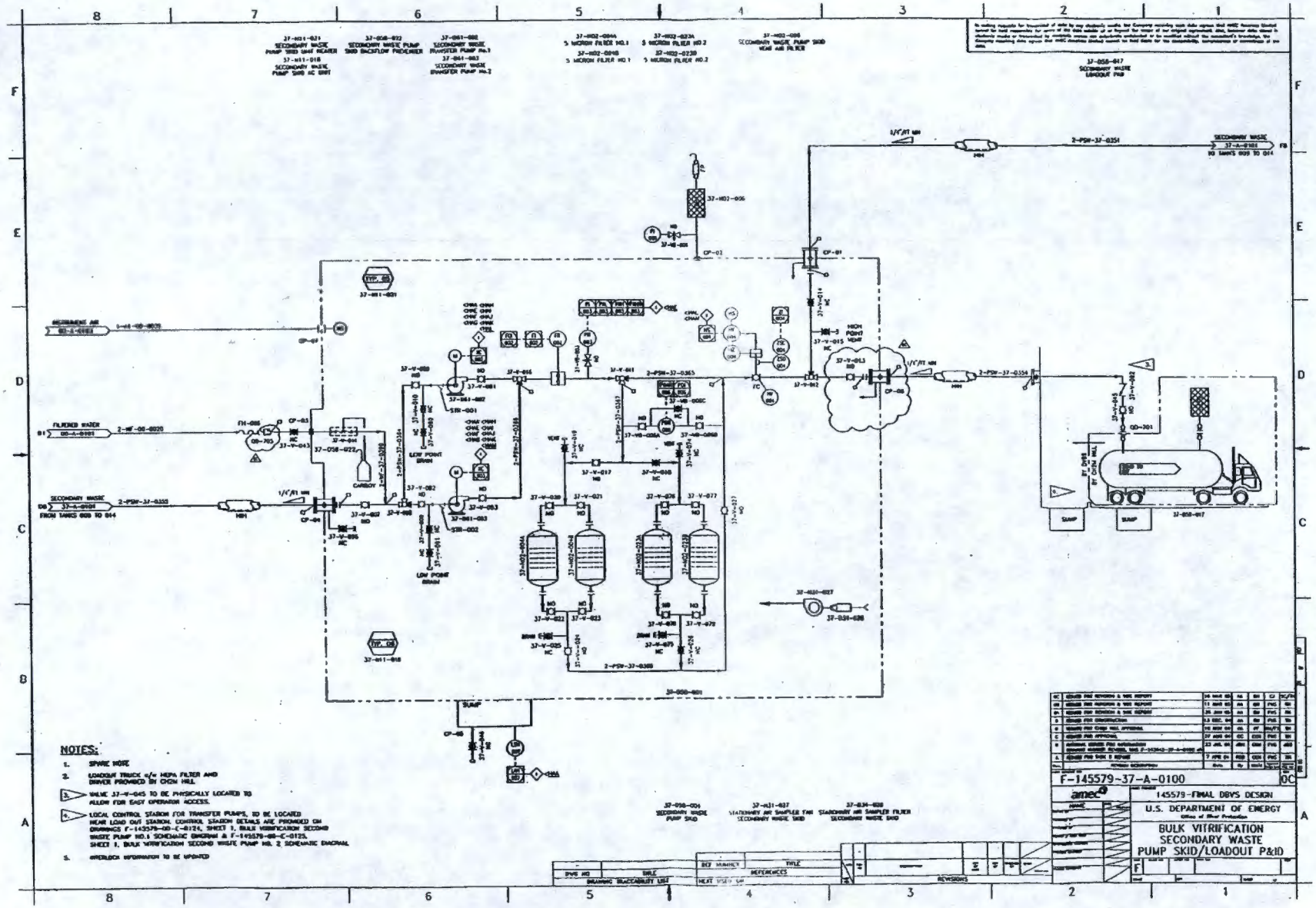
145579-FINAL DBVS DESIGN

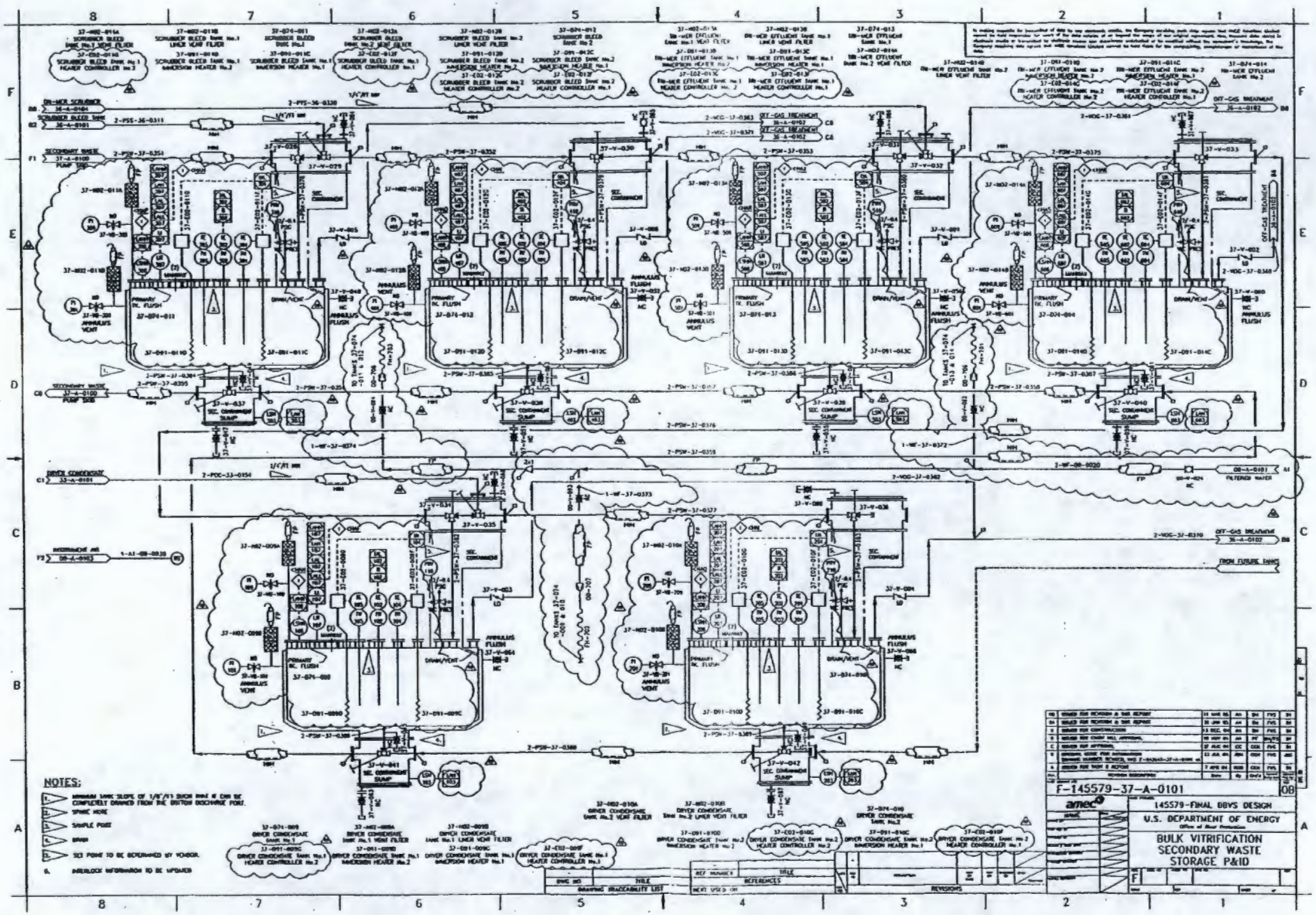
U.S. DEPARTMENT OF ENERGY

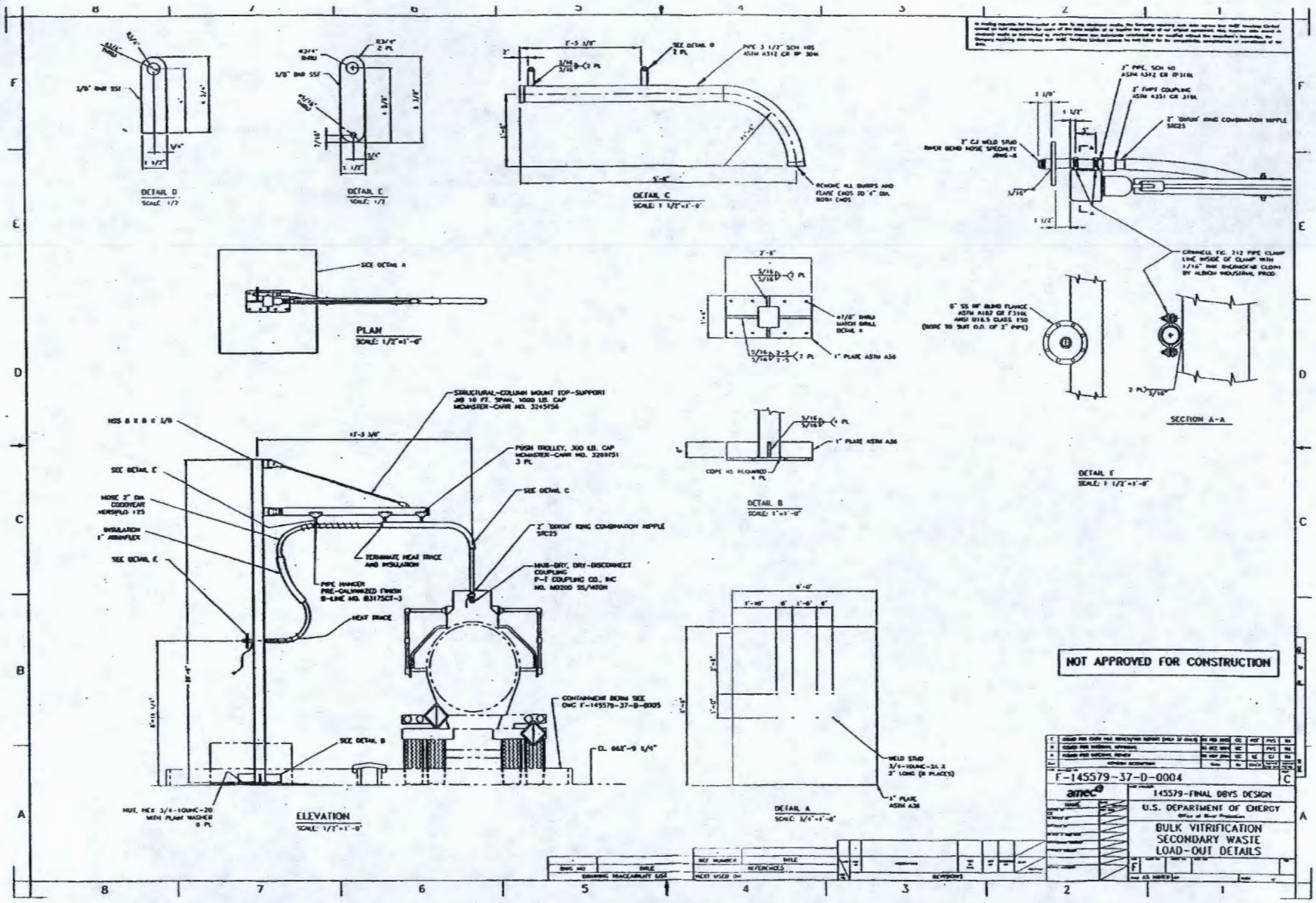
BULK VITRIFICATION
OFF-GAS TREATMENT
SECONDARY WASTE AREA SECTION 'A'

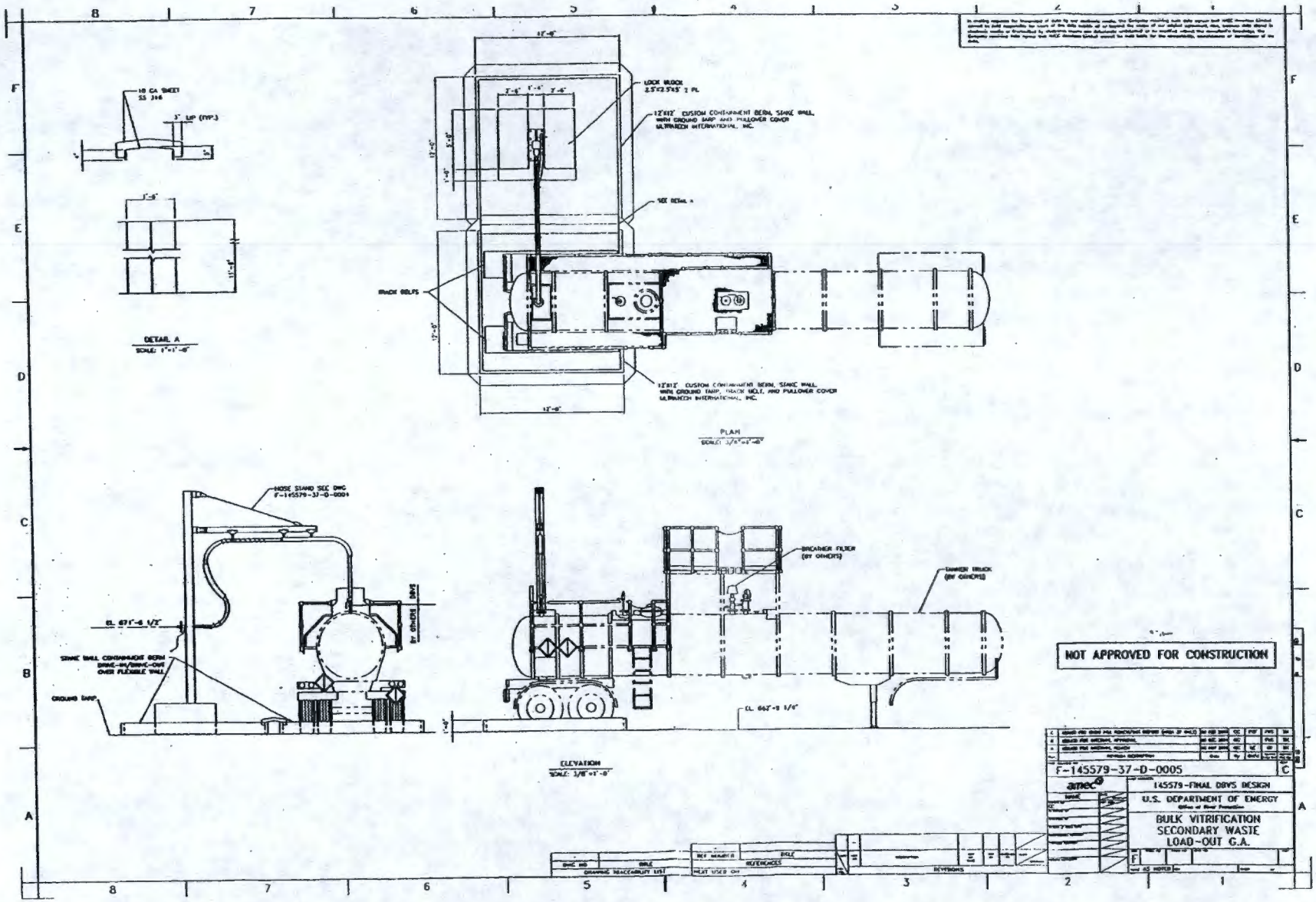
DRAWING TRACEABILITY LIST

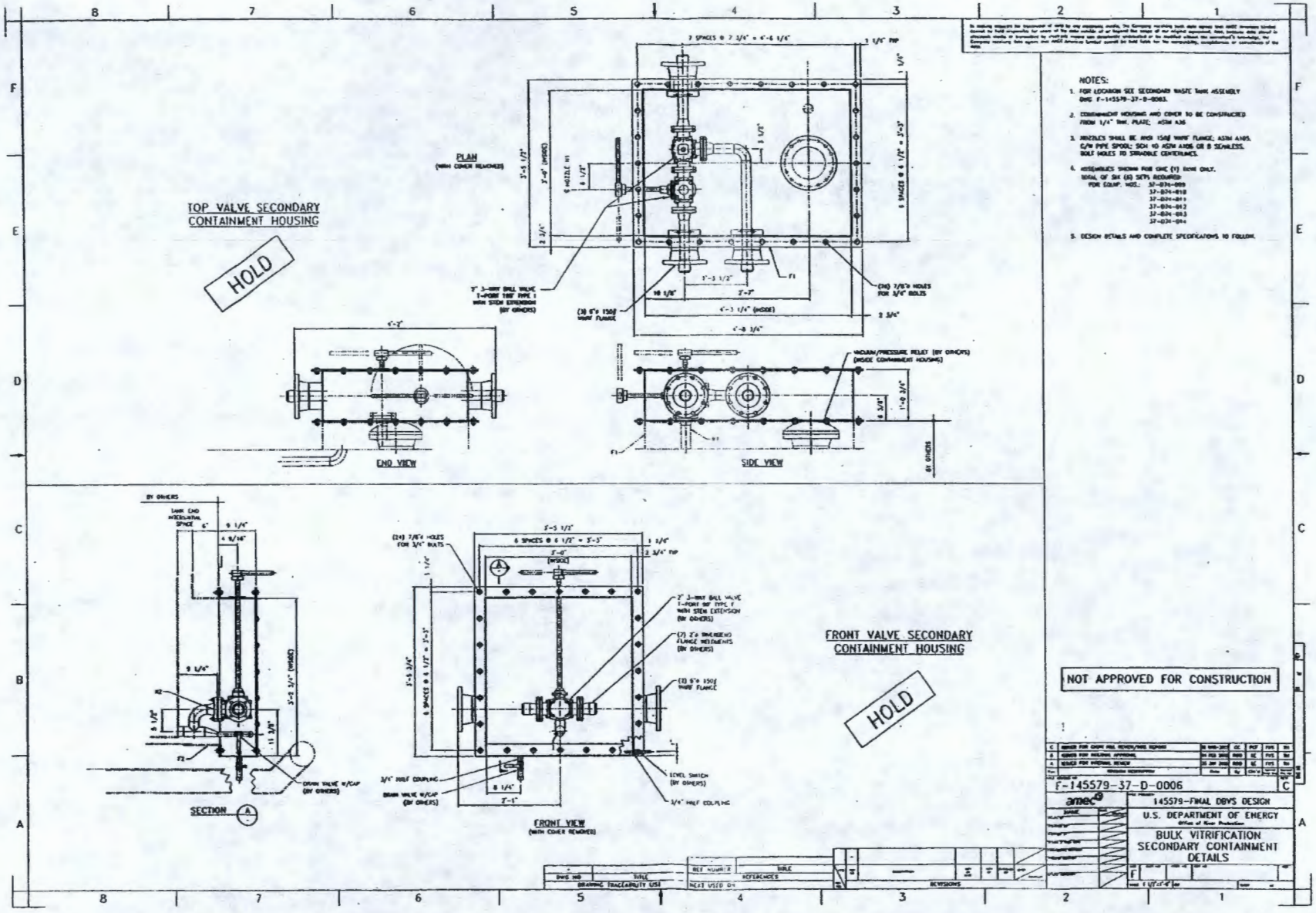
REVISIONS


NOTES:
1. SPARE NOZZ
2. LOADOUT TRUCK w/ HEPA FILTER AND DRIVER PROVIDED BY CHCH HILL
3. VALVE 37-V-045 TO BE PHYSICALLY LOCATED TO ALLOW FOR EASY OPERATOR ACCESS.
4. LOCAL CONTROL STATION FOR TRANSFER PUMPS, TO BE LOCATED NEAR LOAD OUT STATION. CONTROL STATION DETAILS ARE PROVIDED ON DRAWINGS F-145579-00-E-0124, SHEET 1, BULK VERIFICATION SECOND WASTE PUMP NO.1 SCHEMATIC DIAGRAM & F-145579-00-E-0125, SHEET 1, BULK VERIFICATION SECOND WASTE PUMP NO. 2 SCHEMATIC DIAGRAM.
5. INTERLOCK INFORMATION TO BE UPDATED
F-145579-37-A-0100
145579-FINAL DBVS DESIGN
U.S. DEPARTMENT OF ENERGY
BULK VITRIFICATION SECONDARY WASTE PUMP SKID/LOADOUT P&ID


NOTES:
F-145579-37-A-0101
145579-FINAL BBVS DESIGN
U.S. DEPARTMENT OF ENERGY
BULK VITRIFICATION
SECONDARY WASTE
STORAGE P&ID


DETAIL D
SCALE: 1/2
DETAIL C
SCALE: 1/2
DETAIL C
SCALE: 1 1/2"=1'-0"
REMOVE ALL BURRS AND FLARE ENDS TO 4" DIA. BOTH ENDS
PLAN
SCALE: 1/2"=1'-0"
DETAIL A
SCALE: 3/4"=1'-0"
1" PLATE ASTM A36
DETAIL B
SCALE: 1"=1'-0"
DETAIL E
SCALE: 1 1/2"=1'-0"
SECTION A-A
ELEVATION
SCALE: 1/2"=1'-0"
STRUCTURAL-COLUMN MOUNT TOP-SUPPORT
PUSH TROLLEY, 300 LB. CAP
SEE DETAIL C
2" 'DIXON' RING COMBINATION NIPPLE
TERMINATE HEAT TRACE AND INSULATION
HEAT TRACE
CONTAINMENT BORN SEE DWG F-145579-37-D-0005
SEE DETAIL B
NOT APPROVED FOR CONSTRUCTION
F-145579-37-D-0004
145579-FINAL DBYS DESIGN
U.S. DEPARTMENT OF ENERGY
BULK VITRIFICATION SECONDARY WASTE LOAD-OUT DETAILS


DETAIL A
PLAN
ELEVATION
NOT APPROVED FOR CONSTRUCTION
F-145579-37-D-0005
145579-FINAL DBVS DESIGN
U.S. DEPARTMENT OF ENERGY
BULK VITRIFICATION
SECONDARY WASTE
LOAD-OUT G.A.


TOP VALVE SECONDARY CONTAINMENT HOUSING
HOLD
PLAN (WITH COVER REMOVED)
END VIEW
SIDE VIEW
SECTION A
FRONT VIEW (WITH COVER REMOVED)
FRONT VALVE SECONDARY CONTAINMENT HOUSING
HOLD
NOTES:
1. FOR LOCATION SEE SECONDARY WASTE TANK ASSEMBLY DWG F-145579-37-D-0003.
2. CONTAINMENT HOUSING AND COVER TO BE CONSTRUCTED FROM 1/4" THK. PLATE, ASTM A36
3. NOZZLES SHALL BE ANSI 150# WNRF FLANGE, ASTM A105. C/W PIPE SPOOL; SCH 10 ASTM A106 GR B SEAMLESS. BOLT HOLES TO STRADDLE CENTERLINES.
4. ASSEMBLIES SHOWN FOR ONE (1) SIDE ONLY. TOTAL OF SIX (6) SETS REQUIRED FOR EQUIP. NOS.: 37-03A-009 37-03A-010 37-03A-011 37-03A-012 37-03A-013 37-03A-014
5. DESIGN DETAILS AND COMPLETE SPECIFICATIONS TO FOLLOW.
NOT APPROVED FOR CONSTRUCTION
F-145579-37-D-0006
C
amec
145579-FINAL DBVS DESIGN
U.S. DEPARTMENT OF ENERGY
BULK VITRIFICATION SECONDARY CONTAINMENT DETAILS