HLW-105-11

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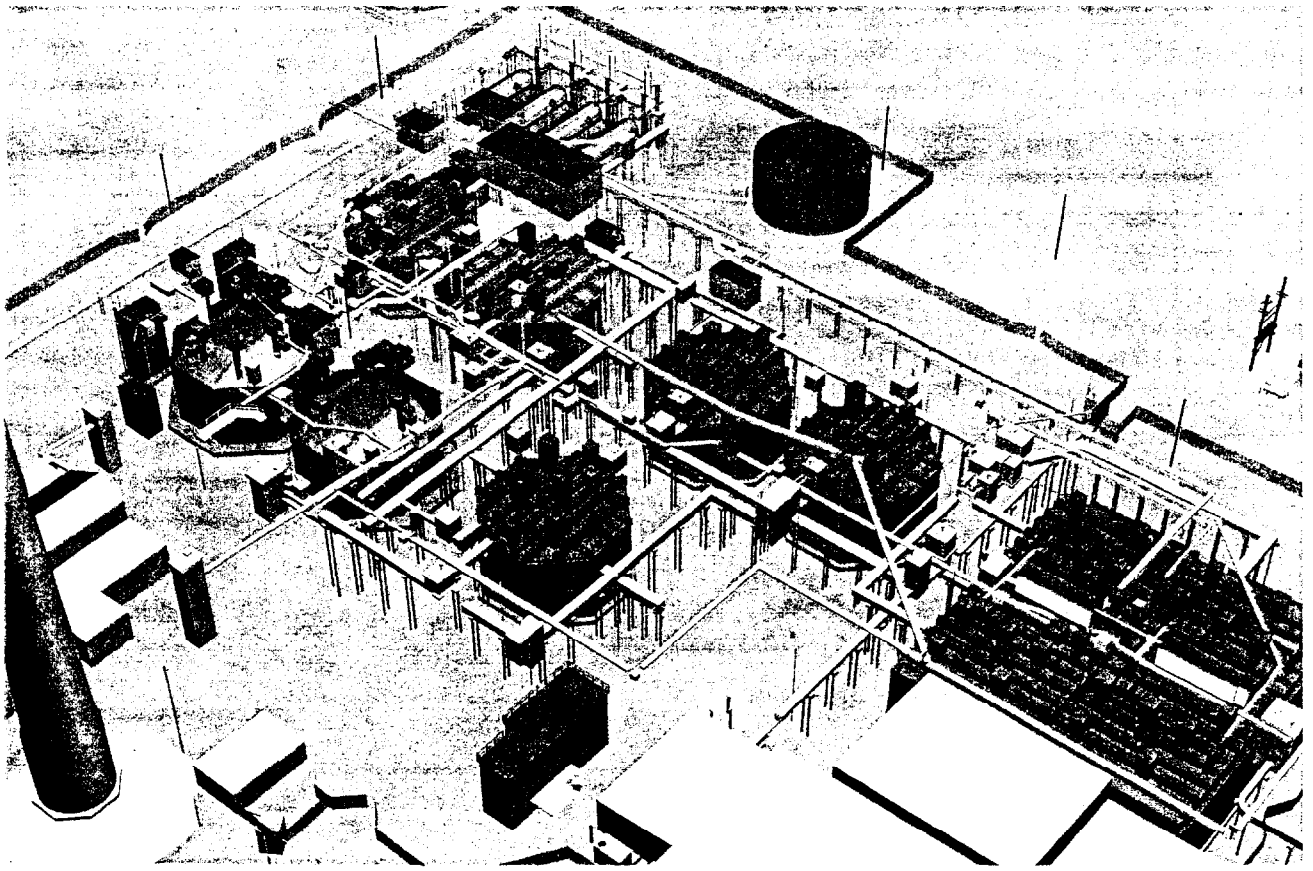
Revision: 0

Project File: 015722

CONCEPTUAL DESIGN REPORT

BOOK 1: GENERAL

Volume 1 of 2



INTEC TANK FARM FACILITY CLOSURE

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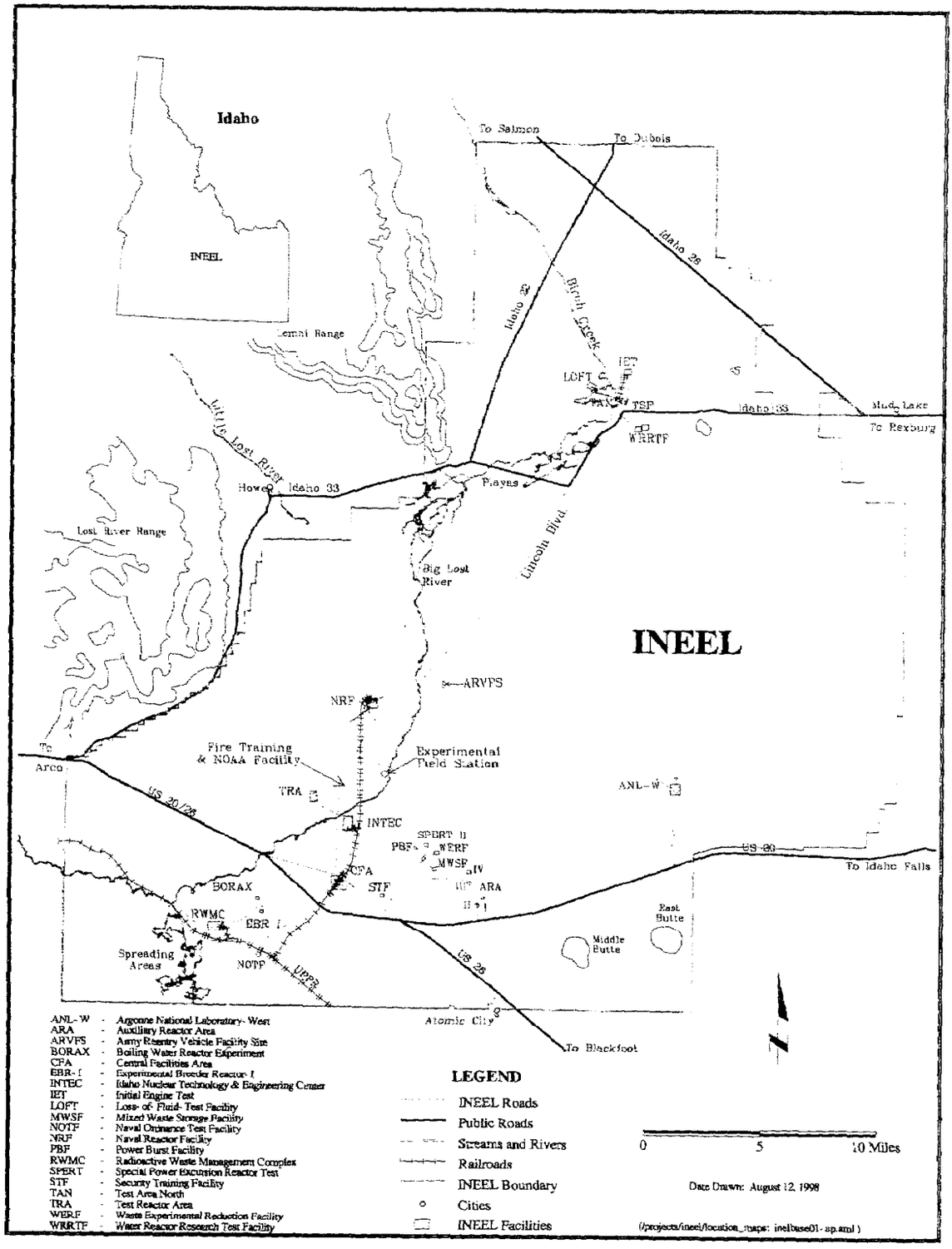
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INEEL
To Salmon
To Dubois
Idaho 28
Idaho 33
Birch Creek
Lemhi Range
LOFT
TSP
WRRTF
Mud Lake
To Rexburg
Little Lost River
Howe
Idaho 33
Playes
Lost River Range
Lincoln Blvd
Big Lost River
INEEL
ARVFS
NRF
Fire Training & NOAA Facility
Experimental Field Station
To Arco
US 20/26
TRA
INTEC
SPERT II
PBF
NERF
MWSF
CFA
STF
ARA
ANL-W
US 20
To Idaho Falls
BORAX
RWMC
EBR I
Spreading Areas
NOTF
UPPER
US 26
East Butte
Middle Butte
Atomic City
To Blackfoot
ANL-W - Argonne National Laboratory-West
ARA - Auxiliary Reactor Area
ARVFS - Army Reentry Vehicle Facility Site
BORAX - Boiling Water Reactor Experiment
CFA - Central Facilities Area
EBR-I - Experimental Breeder Reactor-I
INTEC - Idaho Nuclear Technology & Engineering Center
IET - Initial Engine Test
LOFT - Loss-of-Fluid-Test Facility
MWSF - Mixed Waste Storage Facility
NOTF - Naval Ordnance Test Facility
NRF - Naval Reactor Facility
PBF - Power Burst Facility
RWMC - Radioactive Waste Management Complex
SPERT - Special Power Excursion Reactor Test
STF - Security Training Facility
TAN - Test Area North
TRA - Test Reactor Area
WERF - Waste Experimental Reduction Facility
WRRTF - Water Reactor Research Test Facility
LEGEND
INEEL Roads
Public Roads
Streams and Rivers
Railroads
INEEL Boundary
Cities
INEEL Facilities
0
5
10 Miles
Date Drawn: August 12, 1998
(/projects/ineel/location_maps: ineltbase01-ap.aml)

ABSTRACT

This is the Conceptual Design Report for the Idaho Nuclear Technology and Engineering Center (INTEC) Tank Farm Facility (TFF) Closure Project. The INTEC TFF is located at the Idaho National Engineering and Environmental Laboratory (INEEL). The INTEC TFF system consists of eleven nominal 300,000-gallon below-ground stainless steel tanks contained within concrete vaults of various construction; four inactive 30,000-gallon stainless steel tanks; and valve boxes, encasements, and various process and instrumentation piping associated with the tanks. The INTEC TFF has been historically used for the storage of high-level mixed (radioactive and hazardous) waste from spent nuclear fuel reprocessing and other radioactive wastes derived from the INTEC mission operations.

Closure of the TFF will be initiated upon approval of the HWMC RCRA Closure Plan by the State of Idaho Division of Environmental Quality (IDEQ) and DOE Headquarters authorization to proceed. The TFF will be closed according to Hazardous Waste Management Act (HWMA)/Resource Conservation and Recovery Act (RCRA) closure standards and U.S. Department of Energy (DOE) Radioactive Waste Management 435.1 requirements. In addition, closure will be integrated with Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) environmental restoration risk management of contaminated soils surrounding TFF components.

CONCEPTUAL DESIGN

FOR THE

INTEC TANK FARM FACILITY CLOSURE

Project File No. 015722

Revision No. 0

September 29, 2000

APPROVED BY:

K. D. Quigley, Project Manager — Date 9/28/00

PREPARED BY:

E. C. Anderson, Technical Coordinator — Date 9/27/00

E. L. Baker, Mechanical Engineer — Date 9/27/00

J. L. Benson, Mechanical Engineer — Date 9/27/00

S. M. Berry, Remote Applications Engineering — Date 9/27/00

S. A. Jensen, Civil Engineer — Date 9/27/00

T. A. Langenwalter, Civil Engineer — Date 9/27/00

T. D. McIntire, Environmental Engineer — Date 9.28.00

A. P. Poloski, Chemical Engineer — Date 9/28/00

M. R. Wilcox, Chemical Engineer — Date 9/27/00

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HLW-105 - 11

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1.	**Document ID. Number And Rev:**	HLW-105 - 11
2.	**Document Date:**	09/29/2000
3.	**Document Title (or description):**	INTEC Tank Farm Facility Closure Conceptual Design Report, Project File No. 015722
4.	**Addressee Name and Organization:**	N/A
5.	**Author Name and Organization:**	Keith Quigley/BBWI
6.	**Key Words:**	TFFC, Book 1, Vol 1&2; General , Book 2: Process Justification Document, No copy Book 3: Modeling & Animations 2 Volumes, Book 4: Volume 1&2: Mock-ups, Book 5: Drawings, Book 6 Volume 1,2,3: EDFS, Book 7: Line Lists, Book 8: Photos , Book 1 Volume 1 of 2, Hard Copy Only found in file -

~~EDF-015422-021~~ B7/15/02

B7/15/02

7. **Uniform Filing Code:** 6153. 105 **Disposition Authority:** ☐ ENV1-k-1 ☐ RD1-A-2 ☒ ENV1-k-2-b ☐ RD1-B-9-b

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Engineering Design Files
Environmental Monitoring
Fax
Independent Hazard Review
Letter
Logbooks
Minutes
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Plan
Presentation
Procedure
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Report
Sampling Analysis
Sub-Contract Agreements
Training
Waste Characterization Data

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102 - Immobilization	105 - Closure and Stabilization	

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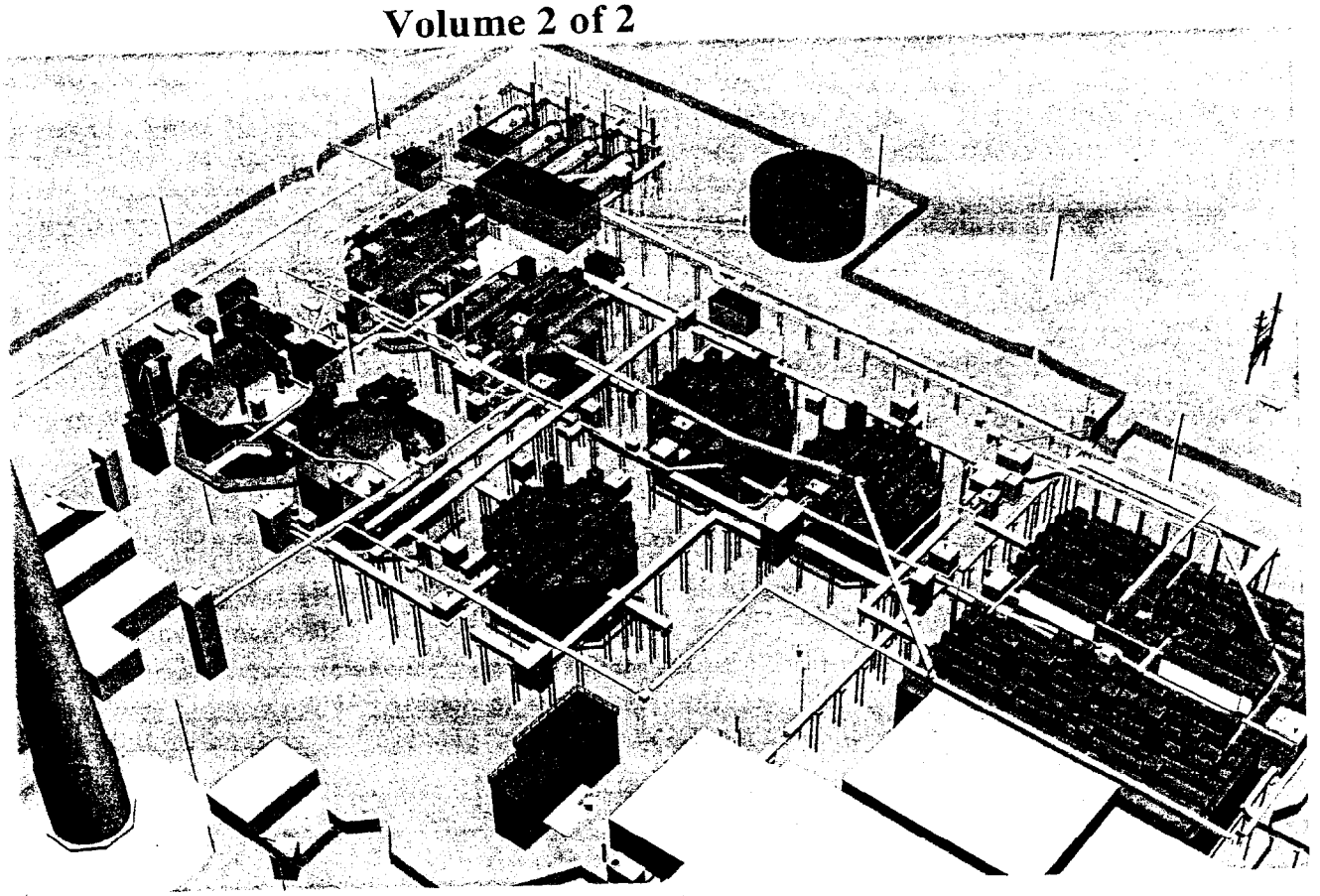
CONCEPTUAL DESIGN REPORT

BOOK 1: GENERAL

Volume 2 of 2



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3.	**Document Title (or description):**	INTEC Tank Farm Facility Closure Conceptual Design Report, Project File No. 015722
4.	**Addressee Name and Organization:**	N/A
5.	**Author Name and Organization:**	Keith Quigley/BBWI
6.	**Key Words:**	TFFC, Book 1, Volume 2 of 2, General, MDS-05-00; Estimate for Bounding Tank, MIL-03-00; WM-182 and WM-183 Tank Sampling Summary

7. **Uniform Filing Code:** 6153. 105 **Disposition Authority:** ☐ ENV1-k-1 ☐ RD1-A-2 ☒ ENV1-k-2-b ☐ RD1-B-9-b

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Budgets	*Miscellaneous Documents*
Construction Documents	*Plan*
Data Sheets	*Presentation*
Electronic Mail	*Procedure*
Engineering Design Files	*Reference Material*
Environmental Monitoring	*Report*
Fax	*Sampling Analysis*
Independent Hazard Review	*Sub-Contract Agreements*
Letter	*Training*
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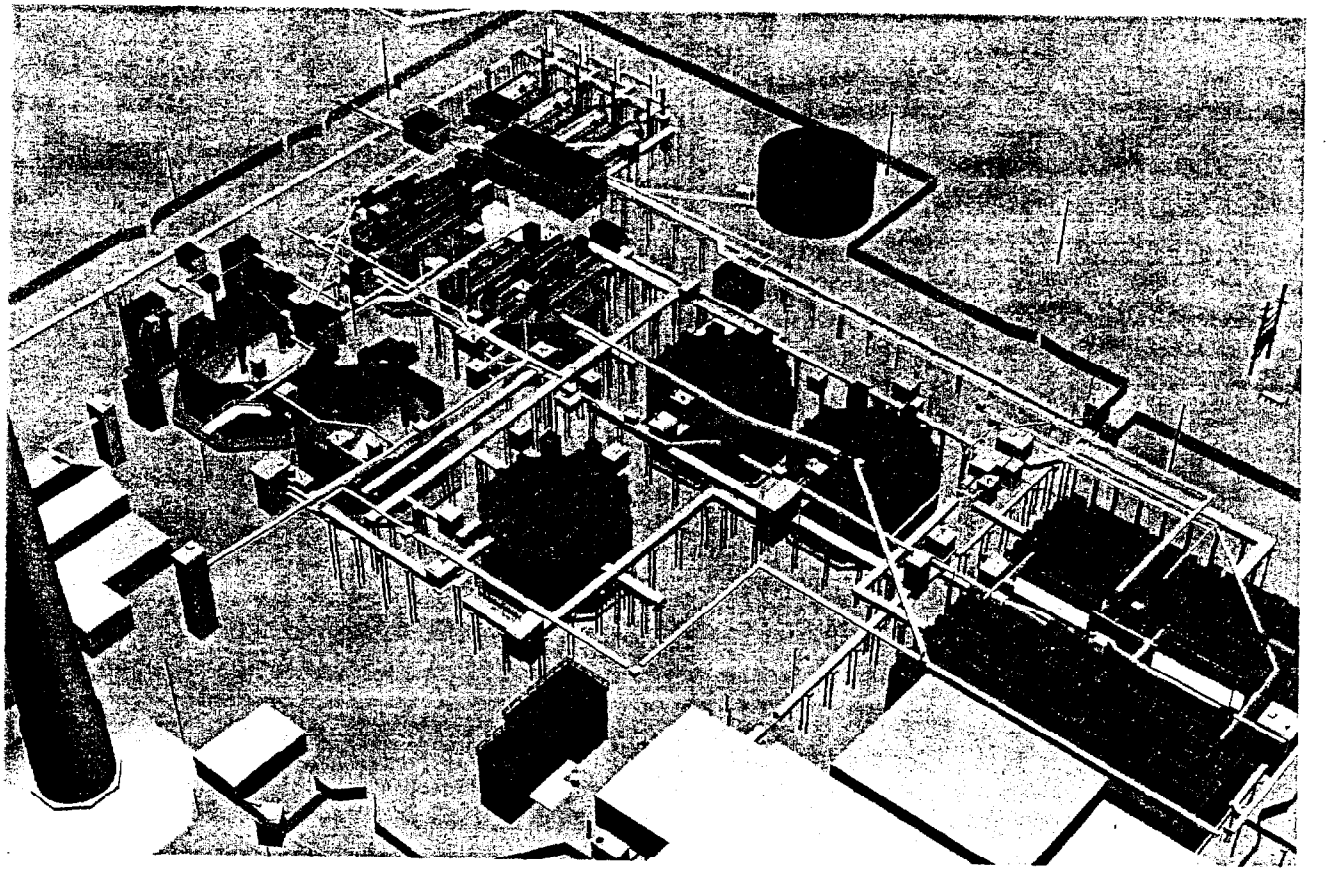
Project File: 015722

CONCEPTUAL DESIGN REPORT

BOOK 2: PROCESS JUSTIFICATION DOCUMENT



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2.	**Document Date:**	09/29/2000
3.	**Document Title (or description):**	INTEC Tank Farm Facility Closure Conceptual Design Report, Project File No. 015722
4.	**Addressee Name and Organization:**	N/A
5.	**Author Name and Organization:**	Keith Quigley/BBWI
6.	**Key Words:**	TFFC, Book 2, Process Justification Document, hard copy only found in file.

7. **Uniform Filing Code:** 6153. 105 **Disposition Authority:** ☐ ENV1-k-1 ☐ RD1-A-2 ☒ ENV1-k-2-b ☐ RD1-B-9-b

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Letter	*Training*
Logbooks	*Waste Characterization Data*

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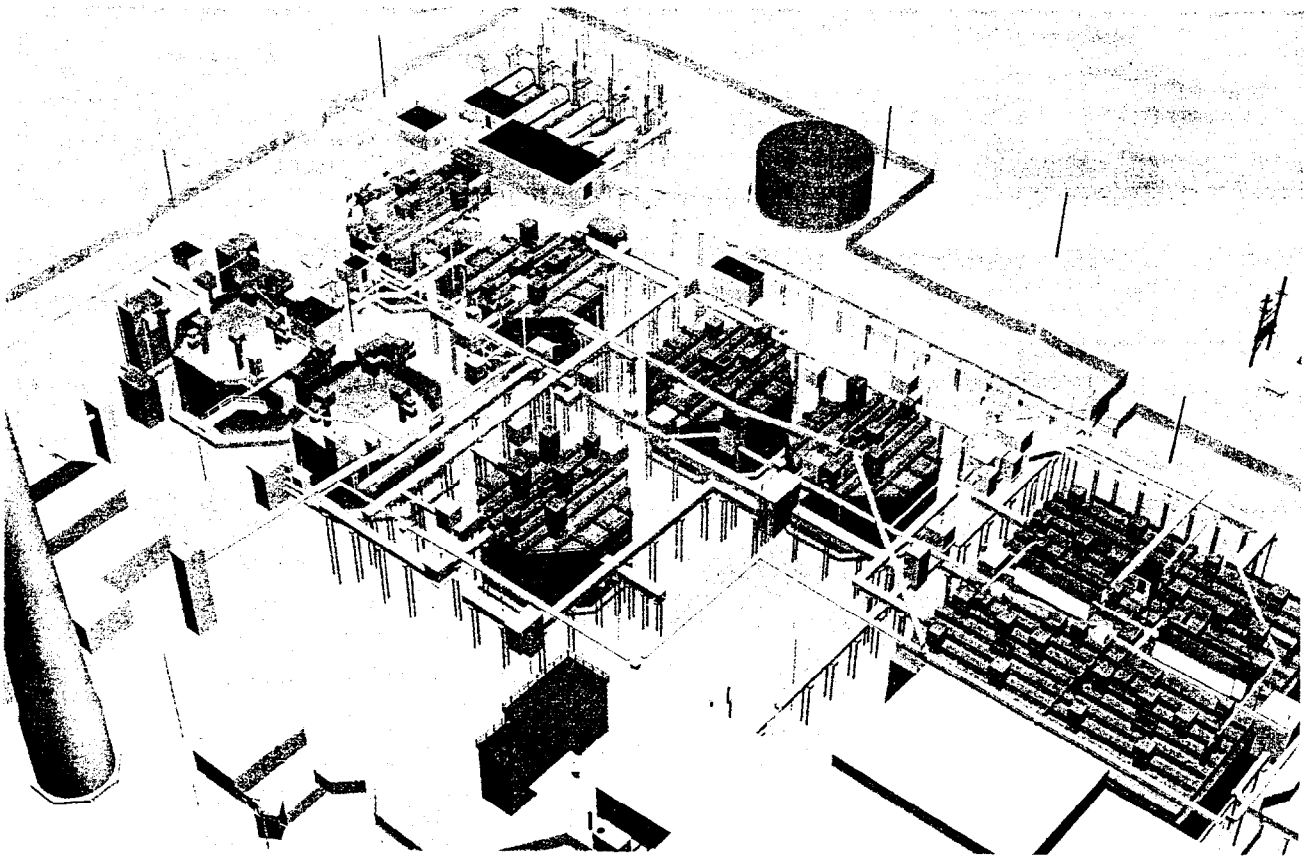
BOOK 4: MOCK-UPS

Volume 1 of 2



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5.	**Author Name and Organization:**	Keith Quigley/BBWI
6.	**Key Words:**	TFFC, Book 4 Volume 1of 2, Hard Copy Only found in file, MOCK-UPS, SPC-156, SPC-155

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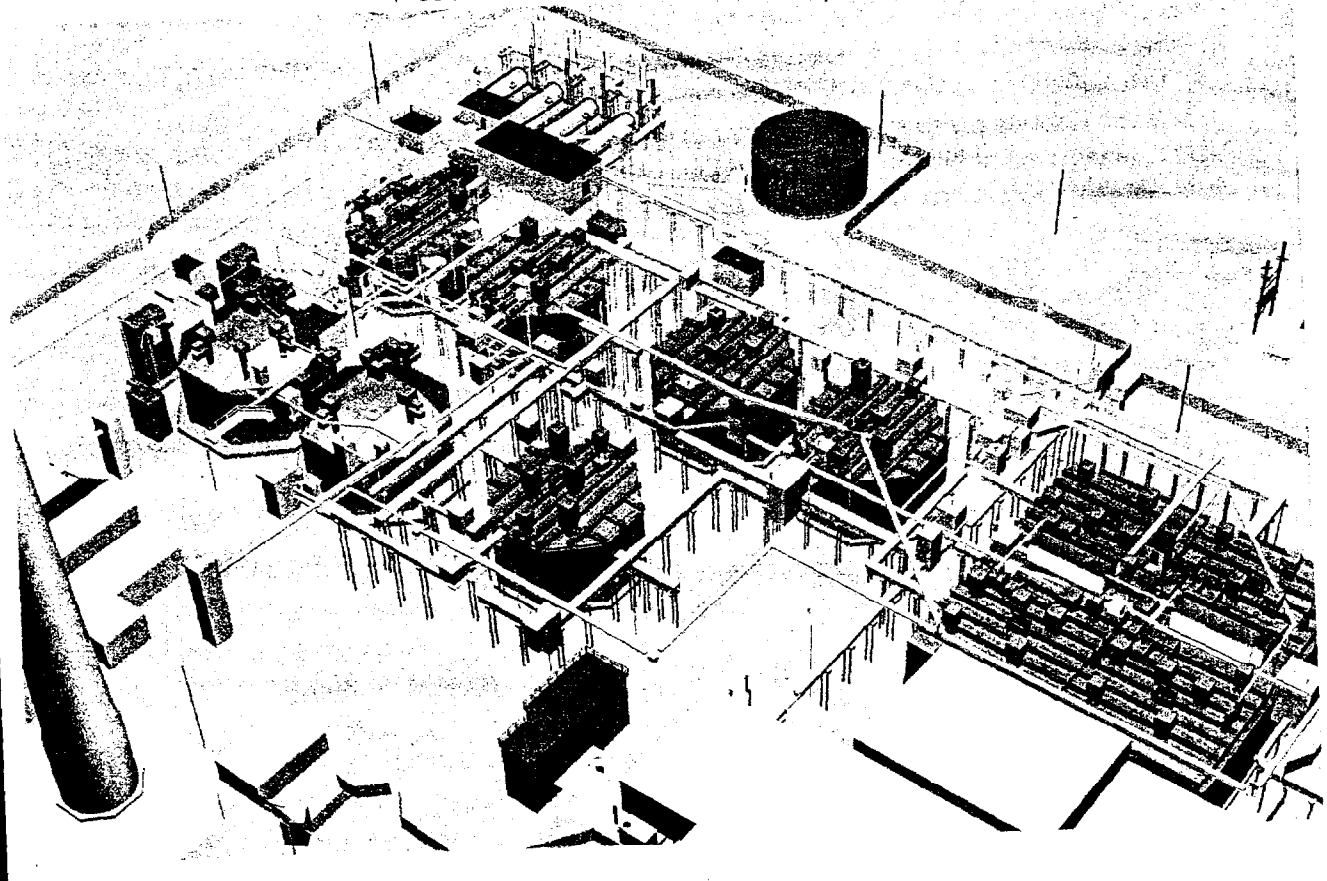
FY00 Test Plan

CONCEPTUAL DESIGN REPORT

BOOK 4: MOCK-UPS

Volume 2 of 2



INTEC TANK FARM FACILITY CLOSURE

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4.	**Addressee Name and Organization:**	N/A
5.	**Author Name and Organization:**	Keith Quigley/BBWI
6.	**Key Words:**	TFFC, Book 4 Volume 2of 2, Hard Copy Only found in file, MOCK-UPS, mock-up test plans outline, EDF-015722-35

7. **Uniform Filing Code:** 6153. 105 **Disposition Authority:** ☐ ENV1-k-1 ☐ RD1-A-2 ☒ ENV1-k-2-b ☐ RD1-B-9-b

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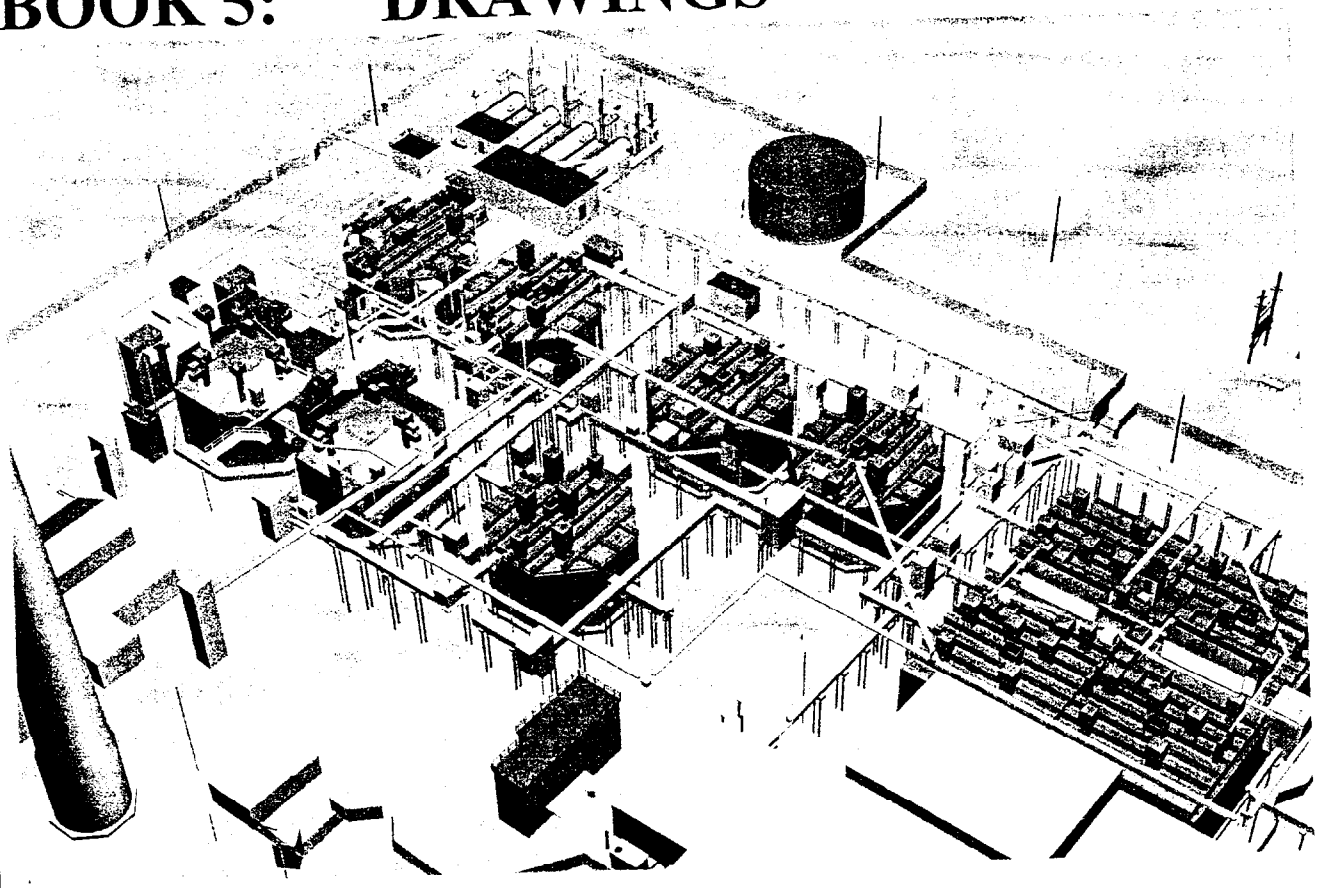
BOOK 5: DRAWINGS



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4.	**Addressee Name and Organization:**	N/A
5.	**Author Name and Organization:**	Keith Quigley/BBWI
6.	**Key Words:**	TFFC, Book 5, Drawings, hard copy only found in file.

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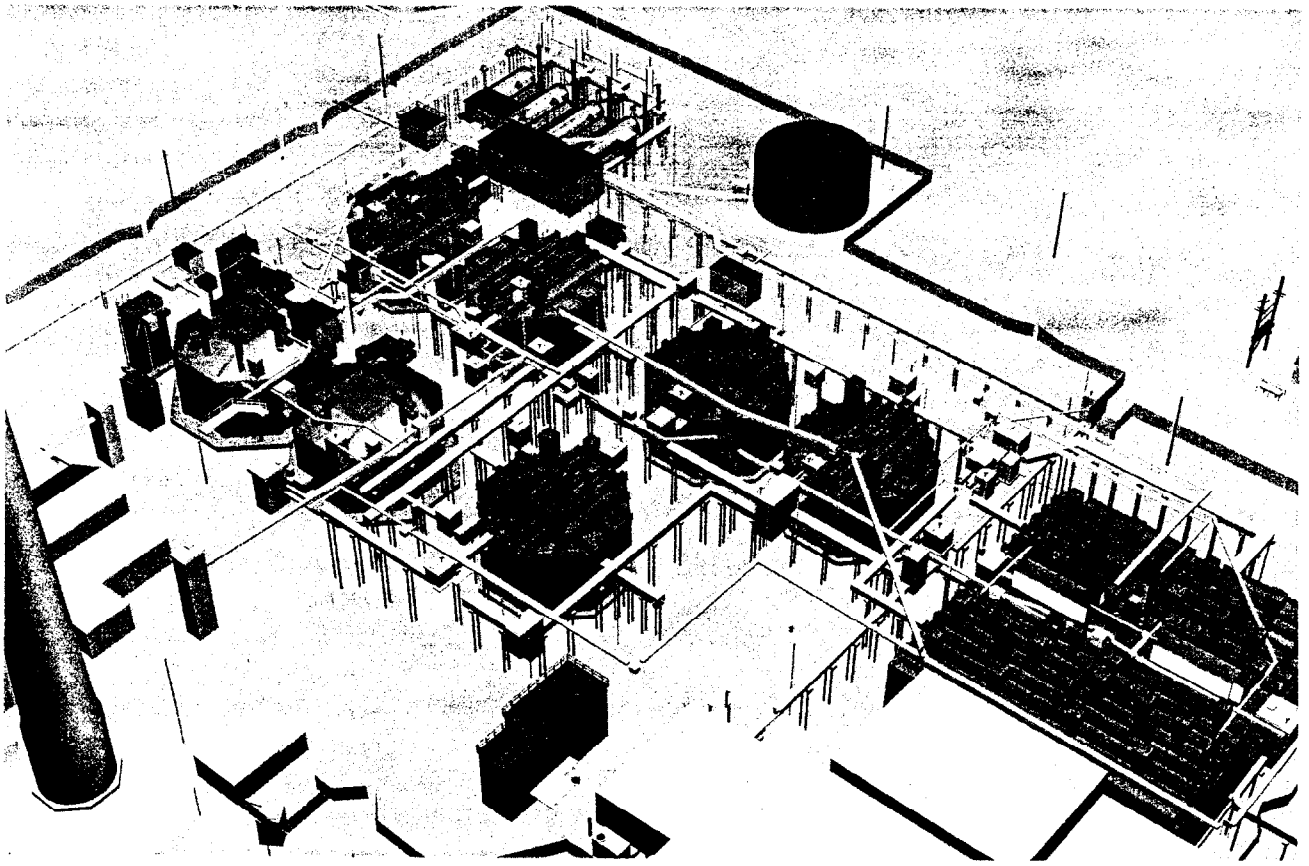
BOOK 6: EDFs

Volume 1 of 3



INTEC TANK FARM FACILITY CLOSURE

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INTEC TANK FARM CLOSURE CONCEPTUAL DESIGN REPORT

BOOK 1 GENERAL (Two Volumes)

Book 1 consists of design requirements, design descriptions, general project information, and summaries of EDFs. Book one provides an overall summary of the project and the approach to Tank Farm Closure. Where an EDF covers a subject in more detail, the EDF is referenced. EDFs reside in BOOK 6.

BOOK 2 JUSTIFICATION DOCUMENT

Book 2 provides the details and justification for the closure process selected for the INTEC Tank Farm. It includes an alternatives assessment and cost benefit analysis.

BOOK 3 MODELING AND ANIMATIONS (Two Volumes)

Book 3 consists of the 3D Model of the Tank Farm and various views of the model. In addition the closure sequence for WM-182 & WM-183 has been animated utilizing the 3D Model; and has been transferred to VHS tape. 3D views of each of the major closure steps are provided.

BOOK 4 MOCK-UPS (Two Volumes)

Book 4 provides details on the past, present, and future proof of process activities. Mock-up test plans, subcontracts, current data, and drawings are included.

BOOK 5 DRAWINGS

Book 5 contains the underground drawings, design drawings for equipment and systems, and four fully annotated 3D views of each of the Tanks.

BOOK 6 EDFS (Three Volumes)

Book 6 contains all of the EDFs developed under the Conceptual Design (FY 99 & 00). The EDFs are summarized throughout BOOK 1. EDFs developed prior to the Conceptual Design are not included, but are available upon request.

BOOK 7 LINE LISTS

Book 7 contains a complete set of underground drawings for the Tank Farm and a complete line list for all pipelines within the Tank Farm. The Line List is subdivided into sections referenced to the specific Tank to which the line is associated. In addition, abandoned line drawings and associated lines lists are provided.

BOOK 8 PHOTOS

Book 8 is a small subset of Tank Farm Photos and Mock-up Photos. An extensive photo library has been developed within the HLW Program and is available.

ENGINEERING DESIGN FILES
Volume 1 of 3

EDF-015722-021	WM-182 & WM-183 Closure Sequence	Bryon Spaulding	8/25/99
EDF-015722-022	Steam Jet vs Pump	E. L. Baker	4/15/99
EDF-015722-023	Tank and vault Seismic Analysis	B. D. Hawkes	5/26/99
EDF-015722-024	Tank Ventilation System	B. K. Grover	7/13/99
EDF-015722-025	Hazardous Waste Constituents	T.D. McIntire	6/24/99
EDF-015722-026	Releases to Trenches and Encasements	T.D. McIntire	6/20/99
EDF-015722-027	PCBs in the TFF	W. Becker	7/26/99
EDF-015722-028	Hazardous Waste Generation	T.D. McIntire	6/18/99
EDF-015722-029	Regulatory Drivers	W. Becker	6/2/99
EDF-015722-030	Utilities for INTEC Tank Farm Closure Project	B. G. Harris	8/25/99
EDF-015722-031	Feasibility of Using Existing Pipelines to Transfer CPP-603 Basin Water to INTEC Tank Farm for use as Wash Water for the Tank Farm Closure Project	B. G. Harris	8/25/99
EDF-015722-032	Procedure for Repairing the Tank Farm Below-Grade Membrane	B. G. Harris	8/25/99
EDF-015722-033	Conceptual Construction Sequence for Tank Farm Closure Project	B. G. Harris	8/25/99

EDF-015722-021

ENGINEERING DESIGN FILE

1. Project File No. 015722 2. Project/Task INTEC Tank Farm Facility Closure

3. Subtask WM-182 & WM-183 Closure Conceptual Design

4. Title: General Pipeline/Enclosure Closure Criteria and Associated Process Flow Development

5. Summary:

This Engineering Design File (EDF) summarizes and updates the criteria used to establish the tank, pipeline and encasement isolation and grouting criteria identified in Section 8, Section 10, Section 11, and Appendix D of the report "INTEC TFF Tanks WM-182 and WM-183 Closure Study" (INEEL/EXT-98-00913).

Attachment 1 of this EDF provides an updated version of the closure sequence provided in Appendix D of INEEL/EXT-98-00913. This updated version reflects more current information.

Attachment 2 of this EDF provides an updated version of the P&ID's (Figures 8-4 and 8-5) developed for INEEL/EXT-98-00913). These P&ID's show the lines (including line numbers) connected to the WM-182 and WM-183 tanks and are to be used in conjunction with Attachment 1 to help verify how each line is handled during the closure sequence.

Note: Color coding each operation will aid in establishing what happens to each line throughout the closure sequence.

This isolation and grouting criteria was based on information contained in EDF-015722-003 of the identified report. Additional information was obtained from the report "ICPP Tank Farm Closure Study" (INEEL/EXT-97-01204) as needed. This summarization is intended to aid the current closure design efforts.

6. Distribution (complete package): Project Files

Distribution (summary package only):

7. Review (R) and Approval (A) Signatures: (Minimum reviews and approvals are listed. Additional reviews/approvals may be added as necessary.)

	R/A	Printed Name	Signature	Date
Author	R	Bryan Spaulding	B. Spaulding	8/25/99
Independent Verification	R	Shayler Backlund	Shayler Backlund	8/25/99
Requestor	A	Ed Anderson	Edward C. Anderson	8/25/99

1 Discussion

This Engineering Design File (EDF) summarizes the criteria used to establish the tank isolation and grouting methods identified in Section 8, Section 10, Section 11, and Appendix D of the report "INTEC TFF Tanks WM-182 and WM-183 Closure Study (INEEL/EXT-98-00913) and updates this information to current project direction.

This isolation and grouting criteria was based on information contained in EDF-015722-003 of the identified report and current project direction. Additional information, as needed, was obtained from the report "ICPP Tank Farm Closure Study" (INEEL/EXT-97-01204). These criteria can be extrapolated to cover the remaining 300,000-gallon and 30,000-gallon Tank Farm Facility (TFF) tanks.

The first step in isolating tanks WM-182 and WM-183 from the rest of the TFF involved identifying all pipelines associated with these two tanks. A thorough review of all currently existing INTEC drawings, photographs, and interviews with TFF experts was conducted to gather this information. Using this information, a matrix (see Appendix A of INEEL/EXT-98-00913) was developed and includes the following information for each pipeline:

1. Item number
2. Identification number
3. Origin and termination points
4. Origin and termination elevations to determine whether the pipeline slopes into or out of the tank
5. Connections that will be used during the isolation process
6. Three-dimensional figures providing a graphic representation of each line.

Each identified line received a unique number[1]. This line number was used to identify the known pipeline information such as the INTEC pipe identification number, origin and termination points, known elevations, developed isolation information, etc. Three-dimensional figures were also developed to help tie the information to the task of isolation. Each identified line was evaluated to establish a point of isolation relative to each tank system. Some lines identified in Appendix A of INEEL/EXT-98-00913 do not have an associated Isolation Point (IP) number. Lines that did not receive an IP were those that:

1. Will be isolated through other lines
2. Do not require isolation since they will be contained within the tank system being closed[2]
3. Were isolated during previous INTEC activities.

[1] Some pipelines have more than one INTEC identification number. Providing a new number minimizes the chance of a misinterpretation of line information.
[2] For example, lines going from the vault to the tank will not be isolated since both ends of these lines will be encased in grout when the closure activities have been completed.

Appendix D of INEEL/EXT-98-00913 contains information on how each identified line will be isolated. This information is tied back to Appendix A of INEEL/EXT-98-00913 through the IP number. The isolation point usually corresponds to the first control point in the pipeline as it leaves the tank or vault to be isolated. This control point could be a valve, a flange, an existing cap, etc. Once the isolation point was identified, a method of isolation for each pipeline was determined based on slope (into or out of the tank or vault), the accessibility of the isolation point, and the required level of decontamination required[3].

1.1 General Criteria

1. The "as low as reasonably achievable" (ALARA) principal shall be used throughout the closure process.

   Basis: The most critical requirement relative to closure is ALARA. ALARA requires that radiation exposure to personnel is as low as reasonably achievable. The radiation fields should be reduced, through decontamination, shielding, and distance, to ensure the safety and health of workers. Equipment and pipeline re-contamination must be minimized to reduce secondary waste generation.

2. Any isolation activities being conducted on a tank shall minimize the interference with ongoing operations at the TFF, as liquid waste must still be transferred to, and out of, the active tanks.

   Basis: This ensures that ongoing tank farm operations are minimally affected by the closure activities.

3. Process waste transfer piping between valve boxes and leading into tanks can be decontaminated by flushing with an acidic solution (e.g., 0.5 molar aluminum nitrate), followed by two deionized or demineralized water flushes for lines that drain directly into a tank.

   Basis: Decontamination methods used for prior TFF projects. 40 CFR 261.7(b)(1) provides guidance for residues in containers. While not directly related to tanks, it has been used as a performance standard in Closure Plans and should be acceptable for pipe flushing. This guidance coupled with the hazardous debris standard should allow for hazardous waste contaminated pipe washing in this manner. See also, EDF-TFC-034, "ICPP Tank Farm Closure Study (INEEL/EXT-97-01204).

4. Process waste piping that penetrates the tank wall and cannot be isolated from the tank can be decontaminated by pumping grout through the pipes into the tanks and then permanently capping[4].

   Basis: Engineering judgement. This is consistent with the WCF Closure Plan approved by the State of Idaho for the lines outside the WCF cap. (INEEL-96/0189 Rev 2, June 97)

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[3] The level of required decontamination is based on either reducing radiation fields to minimize exposure or to meet RCRA requirements for closure.

[4] Such lines are currently flushed with decontamination fluids. Grouting occurs later to minimize potential water infiltration.

5. Process waste piping that lies outside of the footprint of a closure cap can be decontaminated by pumping grout through the pipes into the tanks or vessels, and then the pipes will be permanently capped[5].

   Basis: Engineering judgement. This is consistent with the WCF Closure Plan approved by the State of Idaho for the lines outside the WCF cap.

6. Process waste piping that can be isolated from the tank will be considered a yard line and, as such will be decontaminated but will not require grouting.

   Basis: Engineering judgement. Such lines once decontaminated do not pose a threat to human health or the environment and do not provide a method for liquid to enter a closed tank.

7. Utility and instrumentation lines that are not open to the tank will be cut, capped, and left in place regardless of slope.

   Basis: Engineering judgement. Such lines do not have an open end inside a tank and, as such, will not accept any type of fill material and does not present a credible failure mode.

8. Instrumentation lines that are open to the tank will be filled with grout/epoxy when possible and then permanently capped.

   Basis: TFF process knowledge. Some instrumentation lines are currently plugged at the tank inlet side. These lines are ¼" in diameter. As such, attempts to unplug those lines would not be practical and would result in additional exposure to personnel without commensurate benefit.

[5] Such lines are currently flushed with decontamination fluids then permanently capped. No grouting of these lines occurs.

9. Tank isolation issues associated with WM-183 were analyzed to provide a closure baseline in report INEEL/EXT-97-01204 and various isolation methods were developed for closing this tank. The preferred method identified in this report is provided below since some tank closures may require this method.

NOTE: Parts of this method may still be required on some tank closures where the cartridge style ball valves were not installed on the process waste lines.

The following method is:

Flush process waste lines to decontaminate, then purge using compressed air. Cut and grout the process waste transfer piping lines from inside one valve box to another connecting valve box. Lines other than waste transfer piping that slope away from the tank will be cut and capped in associated buildings. Lines sloping toward the tank will be cut, grouted, and capped, with the exception of ¼-inch instrumentation lines. One-quarter in. instrumentation lines will be cut and capped regardless of slope. It will be necessary to grout valve boxes to prevent water collection in the valve box sumps.

NOTE: Additional isolation requirements must be developed for each tank and should be done as part of the design phase for each tank closure.

Basis: This tank isolation method was used because excavation is not required to gain access to process waste piping. Excavation would require removing the last few feet of potentially contaminated soil by hand to prevent damage to the pipe trench and piping. Excavation would be costly, time consuming, and increase personnel radiation exposure. Prior TTF projects used valve boxes to cut and cap waste transfer lines with success. Using this tank isolation method translates into lower labor and equipment costs and personnel radiation exposure, and reduced waste generation.

1.1.1 Generalized Tank Isolation Method Steps

The following main steps outline the recommended tank isolation method for piping associated with a TFF waste storage tank. These tanks will be isolated, to the maximum extent possible, before other closure activities begin.

The isolation activities identified were:

1. Flushing the process waste lines used to fill and empty the tanks.[6]

2. Decontaminating the valve boxes.

3. Isolating all the process waste lines previously flushed except for one line going to each tank.

[6] It is anticipated that INTEC operations will decontaminate the process waste lines before the tanks are turned over for closure and that the closure project will perform the line isolation. These decontamination activities will be properly documented in the RCRA closure records.

4. Isolating the existing Vessel Off-Gas (VOG) system from each tank and installing a temporary VOG system.

5. Pumping the remaining heel down to remove as much heel as practicable[7] and transferring the fluid to the operational tanks within the TFF.

6. Washing the interior wall of each tank while simultaneously removing the heel and wash fluid and sending the mixture to the HLLW evaporator for processing.

7. Washing the tank, as required, to adjust the heel for grouting.[8]

8. Measuring the heel pH.[9]

9. Isolating the valve boxes, non-process waste lines[10] such as cooling coils, instrumentation lines (except for the nitric acid lines), and steam jets[11] associated with the tank being closed.

10. Isolating piping associated with vault once the piping is no longer required.

Several considerations must be taken into account when determining the methodology (order) in which a tank will be isolated from the rest of the TFF. Each component making up the individual tank being closed must be identified and actions described that will isolate that tank from the rest of the operational TFF.

1.2 Isolation Methodology

Tanks WM-182 and WM-183 systems were identified within report INEEL/EXT-98-00913. These tanks require isolation from the rest of the operating TFF as part of closure. Each system isolation and applicable grouting and/or capping criteria is discussed within the sections that follow.

Note: The order in which each piping system is presented in this EDF does not represent the actual isolation sequence required to close a tank. The isolation sequence for WM-182 and WM-183 is provided in Attachment 1 of this EDF.

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[7] Pumping the heel down to the indicated level is dependent upon the solid concentrations in each tank. A tank found with high solid concentrations may require first washing and then pumping down. This step will be verified once heel characterization activities have been conducted.

[8] Additional water will be added to the tanks if the pH is not in an acceptable range to grout. This wash and remove process will continue until the heel has been adjusted sufficiently for grouting.

[9] pH will be used to establish the relative amount of SBW remaining in the heel. The SBW concentration must be reduced to a point that will allow the remaining heel to be grouted.

[10] Some non-process waste lines such as the nitric acid lines running into the tanks will require flushing before isolation. For instance, the nitric acid lines will be flushed with water to reduce the acidity in the lines before grouting.

[11] The steam jets consist of a steam line and a process waste line. All but one process waste line per tank will be isolated from the rest of the TFF at this time. Each process waste line will be flushed before isolation.

1.2.1 Process Waste Lines

Process waste lines are defined in report INEEL/EXT-98-00913, as lines that transfer waste into and out of a tank.

The process waste lines will be isolated first, since:

1. These lines contain higher levels of radiation contamination than any other lines ancillary to the tanks being closed, resulting in a higher radiation exposure risk to personnel, and

2. These lines are directly tied to the operational portion of the TFF and could allow additional waste into the tank system being closed.

Standard INTEC operating procedures will be used to flush the process waste lines[12] to remove as much of the mixed waste residue from the lines as practical and reduce the valve box radiation fields. The flushing process is currently defined as:

1. Flushing once with an acidic decontamination fluid[13]

2. Flushing twice with deionized water.

The decontamination fluid will flow through the decontamination stubs, process waste lines and valves. This will entrain the contamination as the fluid is transferred to a predetermined waste storage tank.[14]

Note: The vault liquid removal lines running from valve box DVB-WM-PW-C6 to vaults CPP-782 and CPP-783 will be flushed at a separate time, as will the lines that transfer liquid from the vault sumps to the tanks.

[12] Process waste lines will be flushed through the decontamination stubs located in valve boxes DVB-WM-PW-A5, DVB-WM-PW-A6, and DVB-WM-PW-C1 through DVB-WM-PW-C7.
[13] Other fluids will be used and will be selected based on what provides the maximum cleaning effect for that given situation.
[14] Decontamination flushes used to clean the process waste lines may flow into an active tank, tank being closed, or the PEWE.

1.2.1.1 Process Waste Valves

After the lines have been flushed, the top-loading ball valve mechanism used to control process waste flow will be remotely replaced with a split-flow cartridge mechanism (see Figure 1-1). This cartridge will isolate the process waste line leading from the valve to the tank being closed from the rest of the TFF system. Two pipes will extend from each cartridge and terminate at an elevation just below the existing valve box lid. The split-flow cartridge allows grouting of the line connected to the tank, while allowing future decontamination and grouting (if required) of the line connected to the operational portion of the TFF.[15] In this way, the process waste lines running into, or out of, the tank can be grouted without compromising ongoing waste operations. These lines will not be grouted until after the heel has been managed (see Figure 8 of Attachment 1).

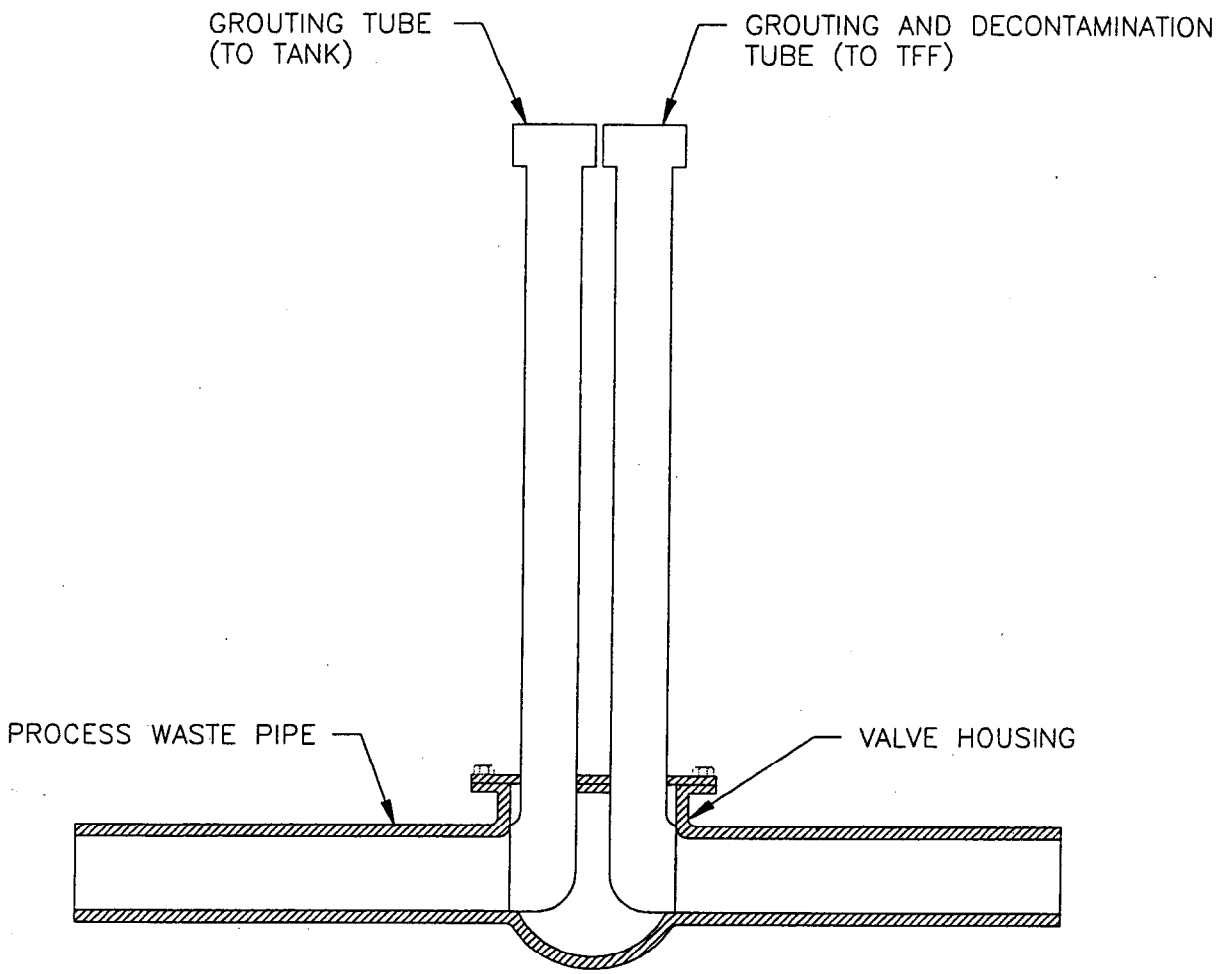

Figure 1-1. Split-Flow Cartridge

[15] This operational line will be closed at a later date and will be identified in the appropriate phase of the entire TFF closure plan.

1.2.1.2 Line Grouting

Each process waste removal line identified for grouting (see Figure 10 of Attachment 1) will be grouted by:

1. Calculating the grout volume required ensuring the pipe will be filled.
2. Attaching a grout source to the correct side of the split flow cartridge.
3. Grouting each line with the predetermined grout volume.
4. Permanently capping the line once grouted.

Note: Process waste lines used to fill the tanks will be physically disconnected from the tank and, as such, become yard lines and do not require grouting.

1.2.2 Liquid Removal Lines

Liquid removal lines are defined in report INEEL/EXT-98-00913 as, process waste lines that transfer moisture accumulation potentially containing small amounts of process waste.

Once the tank heel has been managed, any liquids remaining in the vault from moisture infiltration or decontamination activities will be removed using the liquid removal lines. Removing these fluids will also serve to decontaminate these lines.

The liquid removal and steam lines entering and exiting the vault through the vault risers must be removed to access the vault for grouting activities. This includes disconnecting these lines attached to the steam jet in the south sump. Both lines will be disconnected inside the access way to the vault riser. The steam jets will be left in the vault, where they will be encased in grout.

Note: The lines contained within the vault risers may require partial removal and disassembly to ensure that the pipes do not block access. The pipe sections will be left inside the vault.

The liquid removal and steam lines running from DVB-WM-PW-C6 to the associated jet pumps just removed will be isolated and permanently capped inside the vault riser box. These lines will then be abandoned in place, as they no longer provide a pathway for moisture into the vault or tank.

The liquid removal lines running run from the vault to tank (two per tank) start inside the vault sumps, run upward, and end inside the tank. As such, these lines slope away from the tank. These lines will be reactivated and flushed with decontamination fluid prior to grouting. These lines cannot be accessed without excavating the vault. This requires that line isolation occur when the vault and tank are grouted. Plugging and encasing each line with grout minimizes the chance of water infiltration into a tank.

1.2.2.1 Line Grouting

The liquid removal lines that allow liquid accumulated inside the vault to be pumped to the Process Equipment Waste Evaporator (PEWE) will not be grouted since these lines are disconnected from the vault and, as such, become yard lines. The liquid removal lines that run from the vault to tank (two per tank) will be plugged and encased with grout during the vault void grouting operations. Each liquid removal line connected to each tank will be plugged by:

1. Calculating the grout volume required ensuring the pipe will be filled.
2. Attaching a grout source to the correct steam line inside valve box C1.
3. Grouting each line with the predetermined grout volume.
4. Permanently capping the grouted steam line inside valve box C1.

1.2.3 Cooling Coils

Before cooling coil isolation, the lines will be purged of cooling water contained within the coils. To purge and flush the lines:

1. The main cooling water supply and return headers for tanks WM-182 and WM-183 will be isolated from the rest of the cooling coil system in CPP-628.
2. Clean water will be connected to the supply header and a line connecting the return header to the PEWE[16,i] will be installed.
3. The valves on the individual cooling coil lines (supply and return) will be opened and the lines flushed with a predetermined water volume.
4. A compressed air source will be attached to the supply header and the cooling coil lines will be purged of water using the compressed air.
5. Once empty, the individual cooling coils will be isolated from the supply and return headers at the union connection located on each line in CPP-628.
6. The lines will be temporarily capped at the stainless steel to carbon steel transition point[17] to allow future line grouting.

[16] The cooling water will be sent to the PEWE since the water contains low but measurable quantities of Cs-137 and, as such, is radioactively contaminated.
[17] The temporary cap will be removed during the grouting process, the lines grouted, and permanent cap installed on each line.

1.2.3.1 Line Grouting

Each line will be grouted by:

1. Connecting the grout line to the inlet side of the line.
2. Connecting a line to the outlet shut-off valve and run line to an appropriate location, such as the vault riser access boxes, drum, or other container.
3. Grouting each line until grout has emerged from the flexible line or until the line no longer accepts grout.
4. Disconnecting the grout line and allowing the grout to solidify.
5. Capping both ends of the grouted line.

1.2.4 VOG System

The VOG lines currently connected to tanks WM-182 and WM-183 will be isolated from the rest of the existing TFF VOG system before the temporary VOG system will be connected to the existing tank VOG lines. Each tank has two 10-inch VOG lines connected from the man-way to the condenser pit (see Figure 1-2 and Figure 1-3). One of the two VOG lines connected to each tank vents gas to the stack.[18] The other 10-inch VOG line is connected to the pressure/vacuum relief system. This system provides protection to each tank against an over- or under-pressure condition.

1.2.4.1 WM-182 VOG Lines. Both WM-182 10-inch lines will be isolated inside condenser pit CPP-721. The 10-inch VOG line connected to the condenser will be cut, flanged, and temporarily capped (see Figure 1-4).[19] The pressure/vacuum relief line (10"-VGA-603, Line 109) will be cut, flanged, and then connected to the temporary VOG system. The temporary VOG system will be operational during most of the closure activities. Both 10-inch VOG lines connected to the tank will be filled with clean grout when no longer needed.

In addition to the 10-inch lines, there is a single 4-inch line connecting the condenser tank in CPP-721 to the INTEC stack via the existing VOG system and the Atmospheric Protection System. This line is still connected to the operational portion of the TFF and, as such, the line will be cut, the active line side temporarily capped, and closed during a later closure phase.

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[18] Any gas released to the stack goes through an atmospheric protection system.
[19] Lines will be stubbed up and capped. Caps used on lines that are still active will be designed to allow flushing and/or grouting operations to occur at a later date.

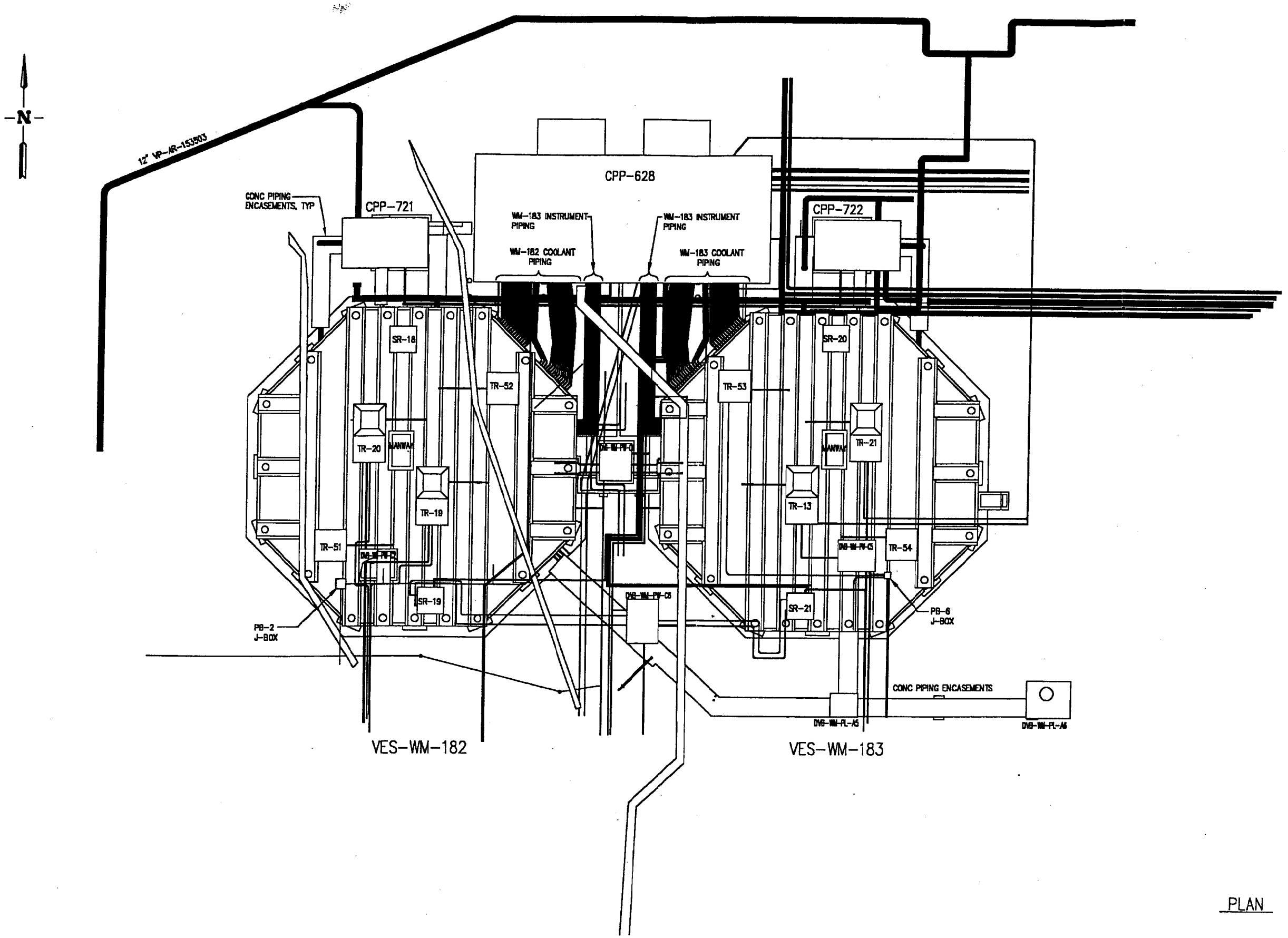

Figure 1-2. WM-182 and WM-183 Plan View

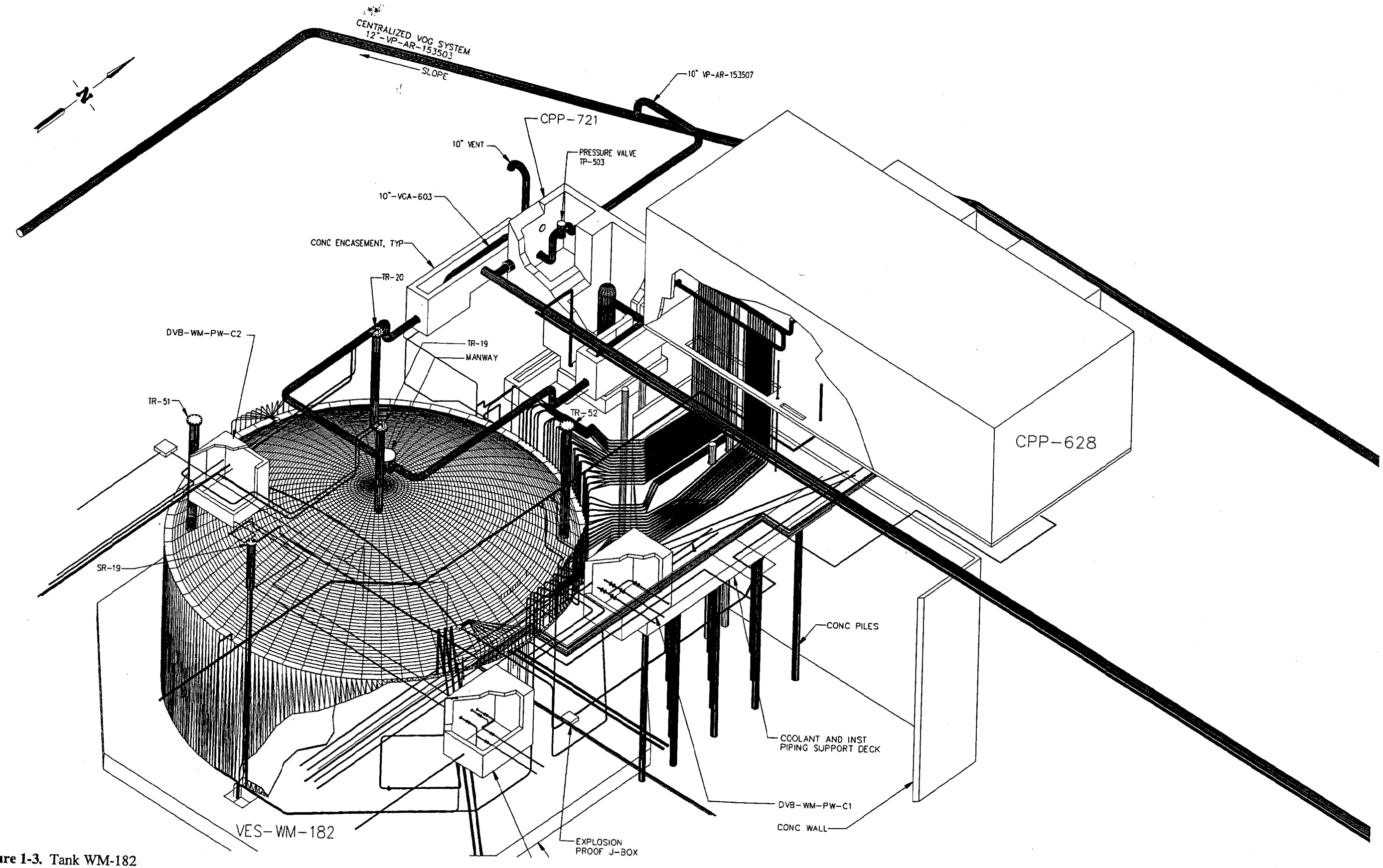

Figure 1-3. Tank WM-182

1.2.4.2 WM-183 VOG Lines. The 10-inch pressure/vacuum relief VOG line will be isolated inside condenser pit CPP-722, east room. The end connected to the operational portion of the existing TFF VOG system and the end connected to the tank will be connected to the temporary VOG system.

The 10-inch vent VOG line also connects to WM-185 before terminating inside CPP-722 and, as such cannot be isolated inside CPP-722. Excavation will be required to isolate this line. It is assumed that the excavation will occur just south of CPP-722 just before the pipe enters the vault.[20] No high-contamination areas were found in this area during the 1993 to 1995 Tank Farm Valve Box Upgrade project and minimal personnel exposures are expected.

The vent VOG line will be cut at the point where the line exits the vault. The tank and active side of the VOG line will be routed to a point above grade level and temporally capped. The excavation will then be back-filled with the excavated soils (see Figure 4 of Attachment 1).

1.2.4.3 Line Grouting

Both tanks WM-182 and WM-183 have two VOG lines that are connected to the man-way located on top of each tank. These VOG lines will be grouted and capped when these lines are no longer required for the remaining closure activities.

These lines will be used to fill the remaining tank void, since the lines tie directly into the tank man-way. Forcing grout into the tank man-way will fill the loop seal, or "U" trap (see Figure 1-3) made where the VOG line runs under the vault ring beam and the associated drain line that runs from the "U" trap to the tank. The tank side of the line will then be permanently capped and the active side will be temporarily capped at the above grade location.

[20] Additional study is required to establish the best location to excavate. Excavation just north of CPP-722 is also an option and may be less expensive.

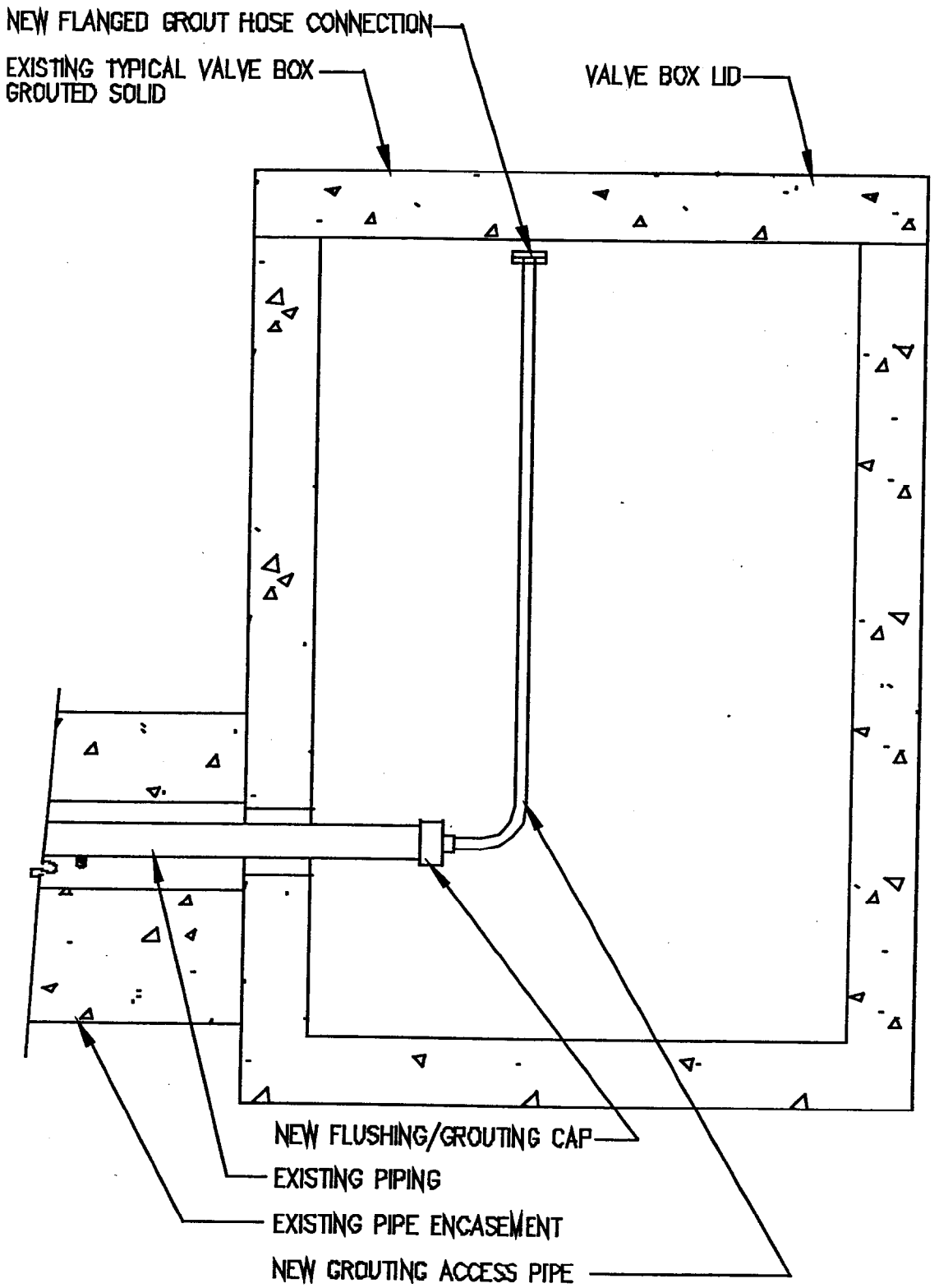

Figure 1-4. Typical Line Additions Used on Lines Requiring Future Flushing or Grouting.

1.2.5 Nitric Acid Lines and Tank Risers

The nitric acid lines consist of pipe stubs, located above-grade near the vaults, tanks, and condenser pits. A hose attachment is connected to each stub. Lines that have been used will be flushed with water to reduce the acidity level in the pipes at a point in closure that allows the decontamination fluid to be removed from the tank being closed. Once decontaminated, the hose connection will be removed and replaced with a temporary cap. The nitric acid lines will be filled with grout following tank void filling.

1.2.5.1 Line Grouting

The nitric acid lines connected to the tank risers will be grouted at the same time as the tank risers. The following sequence will be used on each nitric acid line after tank void filling has been completed:

1. Connect a grout source to the nitric acid line and grout until the tank riser has filled.
2. Fill any remaining space in the tank riser with grout, as applicable.
3. Permanently cap the tank riser and nitric acid line.
4. Fill the tank riser access box full of grout.

1.2.6 Steam Lines

The steam jet supply lines running from CPP-628 into the tanks and vaults were contaminated during past waste transfer operations. The steam lines came in contact with process waste when the main steam line valve in CPP-628 was shut, but the valves in the individual tank steam supply lines were not closed. A siphoning effect was created as the steam lines cooled and liquid waste was pulled through these lines into CPP-628.[21] Following this incident, operations ensured that the steam lines could not be re-contaminated by installing a siphon break in CPP-628.[ii,22] The siphon break and requiring that steam line valves be closed and chained after waste transfers has prevented further contamination incidents from occurring.

Since this incident, the steam supply lines have been flushed with high-pressure steam every time a waste transfer, to and from, the tank being closed has occurred. Taking into account these steam flushes and engineering controls to prevent recontamination, the steam supply lines will be considered decontaminated, with no further decontamination required. Each steam line will be cut and permanently capped inside CPP-628, valve box DVB-WM-PW-C1, or –C6 when no longer needed.

1.2.6.1 Line Grouting

The steam lines running from DVB-WM-PW-C1 to the associated vault will be cut, grouted, and capped to plug the liquid removal line going into the tank and to prevent moisture from entering the vault region. All other steam lines will be cut and permanently capped.

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[21] The contamination from this incident is mainly located in the stainless-steel section of pipe downstream from the CPP-628 block valve.
[22] This siphon break vents to the vessel off-gas or air purge systems.

1.2.7 Instrumentation and Thermocouple Conduit

The lines supplying air to the tank instrumentation lines will be cut and capped in CPP-628 to allow instrumentation line isolation. The isolation point for the instrumentation lines will be the globe valves located in CPP-628. These valves, as well as the pipe sections upstream of the valves, will be removed. The instrumentation lines that run into the tank will be temporarily capped.

The 2-inch thermocouple conduit will be cut in CPP-628 and permanently capped since this line slopes away from the tank.

1.2.7.1 Line Grouting

Instrumentation lines will be filled with an appropriate material such a grout or epoxy. Some of these lines are known to be plugged and are not expected to accept much, if any, fill material[23]. Filling each line will be attempted by:

1. Connecting the fill line to the accessible end of the line.

2. Filling each line with a predetermined amount of fill material or until the line no longer accepts the material.

3. Permanently capping the accessible end of the filled line.

1.2.8 Drain Lines

Drain lines associated with each tank system will be decontaminated as part of the closure activities. Decontamination of the systems associated with a drain line will also decontaminate the drain line.

Drain lines are not directly accessible and will be sealed at both ends once the associated systems are filled with grout. As such, no isolation of these lines will be conducted.

1.2.8.1 Grouting

Each end of a drain line will be grouted when the associated system is grouted.

For example:

> The end of a drain line associated with a pipe encasement will be grouted when the encasement is grouted. The other end will be grouted when the vault is grouted which effectively plugs both pipe ends.

[23] Grout may not be an acceptable material for the intended use. The actual fill material selection will occur during Title Design.

1.3 Associated Tank Structures

Each tank system has various associated structures. Some structures, such as CPP-628 and CPP-722, are used by more than just one tank. Each associated tank structure must be evaluated to establish how and with what tank the structure will be closed.

1.3.1 Condenser Pits

The condenser pits associated with each tank will be grouted once the VOG lines have been capped and are no longer needed for ongoing closure activities. CPP-721 can be grouted during the WM-182 tank closure and CPP-722 will be grouted during the WM-185 closure phase, since this pit is still required to support tank WM-185 operations.

1.3.2 Vaults

Once the tank heel has been managed, any liquids remaining in a vault will be removed and the vault isolated.

Vault isolation involves:

1. Verifying that the liquid removal lines[24] and associated structures including drain lines have been flushed.

2. Transferring any liquids from the various decontamination activities remaining in the vaults to the PEWE or identified tank.

3. Isolating the steam and liquid removal lines associated with the vault at the appropriate valve.

4. Lines entering and exiting the vault through the vault risers will be removed to access the vault for grouting activities. Both lines will be disconnected external to the vault riser to ensure maximum access into the vault.

   Note: The lines contained within the vault risers may require partial removal and disassembly to ensure that the pipes do not block access. The pipe sections will be left inside the vault.

5. Installing a temporary Vault VOG System.

   Note: The vaults may contain radioactive contamination and are not currently exhausted to the atmosphere. Air displaced during vault grouting operations will be HEPA filtered to protect the environment. This requires that the VOG system connection to the vault riser be designed to allow ventilation during vault-grouting activities. The other vault riser will also be opened to allow air into the vault. This air movement will also aid in evaporating any moisture accumulating inside the vaults.

[24] Includes the lines going from the vault into the tank.

1.3.2.1 Grouting

Each tank vault will be filled with grout to:

1. Minimize subsidence issues associated with tanks WM-182 and WM-183[25]
2. Minimize water infiltration
3. Provide a temporary cap around the tank which allows leaving the tank void empty for future use
4. Encapsulate the tank between the newly poured grout and the vault floor.[26]

A vault filling sequence was developed in report INEEL/EXT-98-00913 and was based on issues associated with the structural vault integrity, pipe encasements, and the valve boxes connected to these vaults. Vault filling activities are assumed to occur together as this would minimize personnel down time. The pipe encasements will be filled first, then the valve boxes, and then finally the vaults[27] as sequenced in the flow sheets contained in Attachment 1.

1.3.2.1.1 Vault Filling Sequence

It is assumed that filling equipment will be placed to allow pouring of more than one vault from a single location. The vaults will be filled through both vault risers. Each vault would receive a predetermined grout volume as identified in Table 1-1, and then the flow would be switched to fill the other vault to the same lift height as the first vault. A pig[28] would be used to clean the grout piping. Each lift would be allowed to cure for a minimum of 7 days to allow the heat generated from the hydration process to dissipate before another pour would occur.

Table 1-1. **Sequential Vault Lift Depths[29] (inches)**

Lift #	1	2	3	4	5	6	7	8	9	10	11
Lift Depth (inches)	18	48	48	48	48	42	48	46	48	18	21[a, b]

a. The last lift height is estimated. The actual lift height will be whatever is required to fill the vault to the maximum extent possible.

b. Grout can be placed into the vault through the tank access riser boxes. The maximum grout line size is 3" in outside diameter[iii]

Each south vault riser access box[30] associated with a vault will also be grouted at this time.

Note: This vault filling activity also encases the liquid removal lines that run from the south and north sumps into each tank.

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[25] Minimizing subsidence issues will also allow easier access for future CERCLA related activities be allowing heaver equipment inside the TFF and minimize maintenance of the final RCRA/CERCLA cap.
[26] This also encases the sand under each tank and aids in minimizing potential future releases.
[27] This assumes that the tank void will be filled after tank closure has been completed.
[28] A pig is a device placed inside the pipe and run through to remove the remaining grout from the fill lines.
[29] Calculated lifts provide a safety factor of 4 against tank buckling.
[30] SR-19 for WM-182 and SR-21 for WM183.

1.3.3 Pipe Encasements

The concrete and stainless steel encasements will be accessed via the valve boxes once the valve boxes have been decontaminated. Covers will be installed to seal the rectangular and circular encasements from the valve box to allow decontamination and grouting (see Figure 1-5 and Figure 1-6). A decontamination hose will be attached to each encasement grouting stub. A decontamination fluid will then be used to flush contaminants from the encasement bottoms. This fluid will also decontaminate drain lines connected to each encasement. These lines also drain into the associated tank vault sumps or valve box C12.

Water accumulating in the vault sumps from encasement decontamination activities will be used to flush the liquid removal lines running from the south vault sump to the PEWE.

Some pipe encasements are open to the associated valve boxes and the encasement ends next to the vaults are sealed from the vaults. Each encasement is sloped to allow drainage to occur and will be flushed during the tank isolation activities.

Some encasements, such as those for the VOG lines are sealed at both ends, difficult to access (requires excavation), and would be very clean because of the current use and sealed conditions. It is assumed that these types of encasements will be abandoned as is.

1.3.3.1 Grouting

The grout pumped into an encasement will run or be pushed to the end of the encasement and fill up as more grout is added until grout exits the vent hole placed in the isolation cover.[31]

The grout used for encasement filling will be the same used to fill the vaults.

[31] Work performed on the WCF closure showed that pumping the grout from the lower to higher elevation worked best. The actual grouting method should be established to maximize encasement filling while minimizing issues associated with grouting operation failures. Such failures prevented continued encasement grouting.

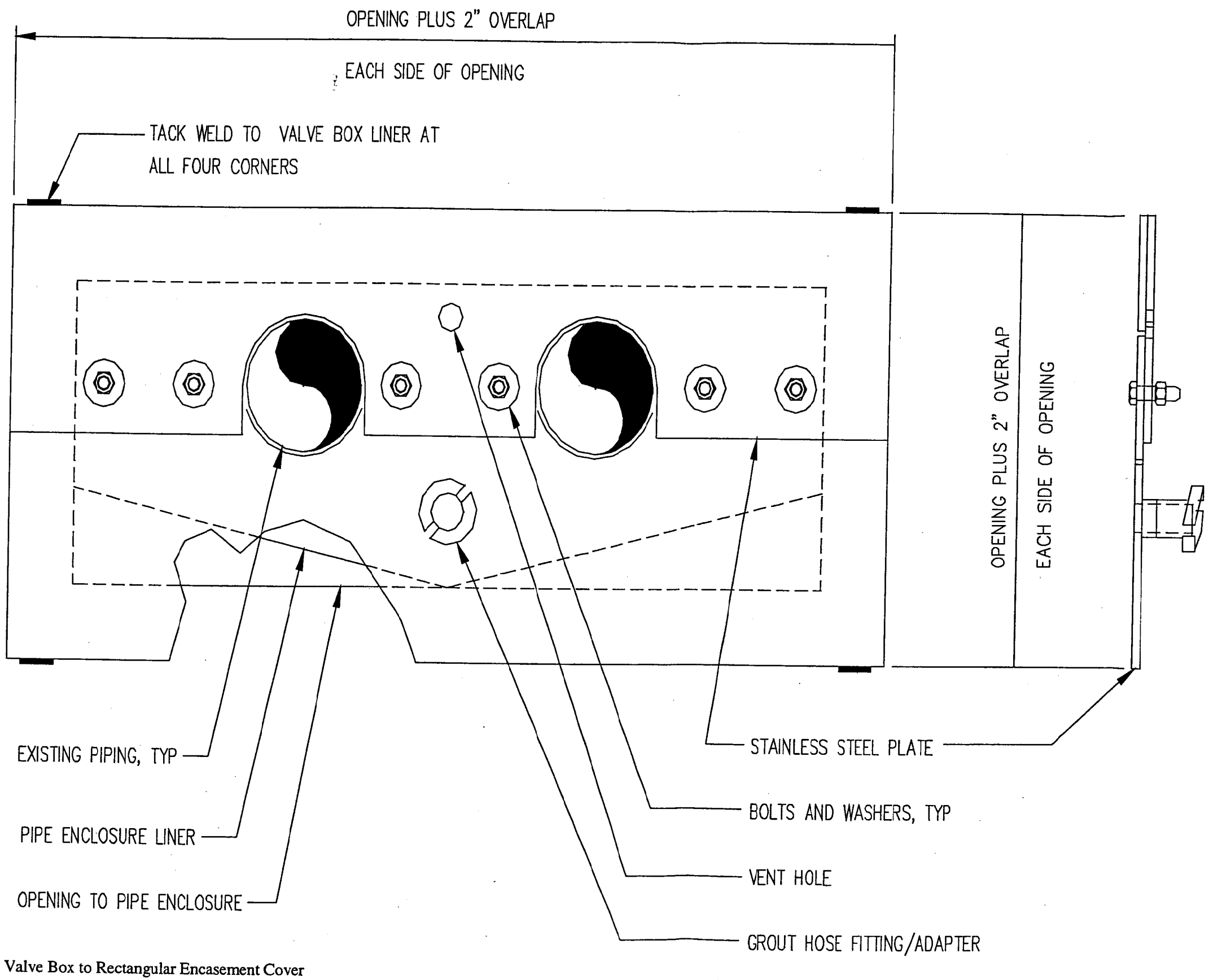

Figure 1-5 Typical Valve Box to Rectangular Encasement Cover

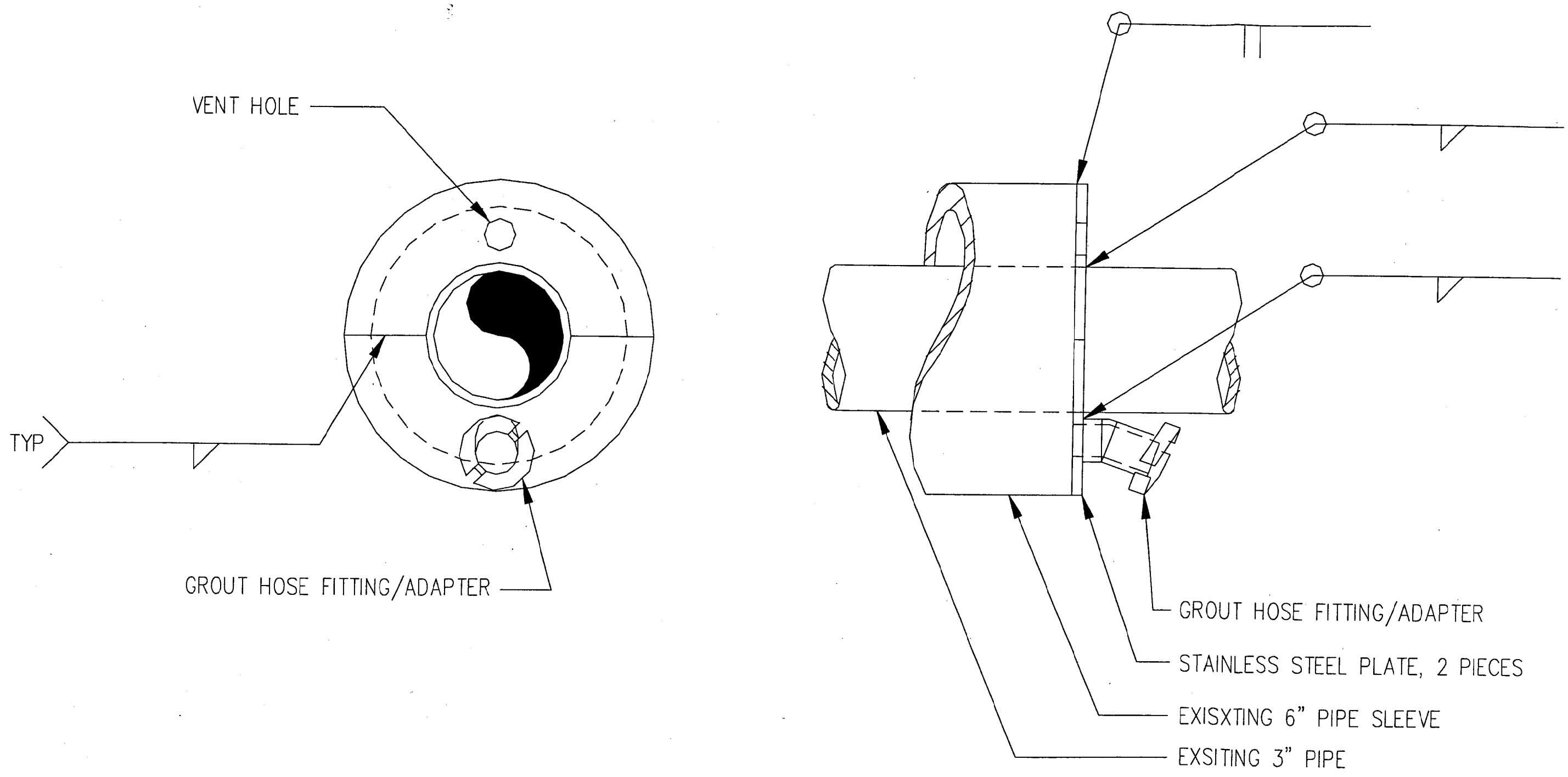

Figure 1-6 Typical Valve Box to Circular Encasement Cover

1.3.4 Valve Boxes

Following process waste line isolation, those valve boxes requiring access to perform closure activities will be sampled[32] and, if necessary, decontaminated[33] sufficiently to allow entry (see Figure 1-7) and shielding added.

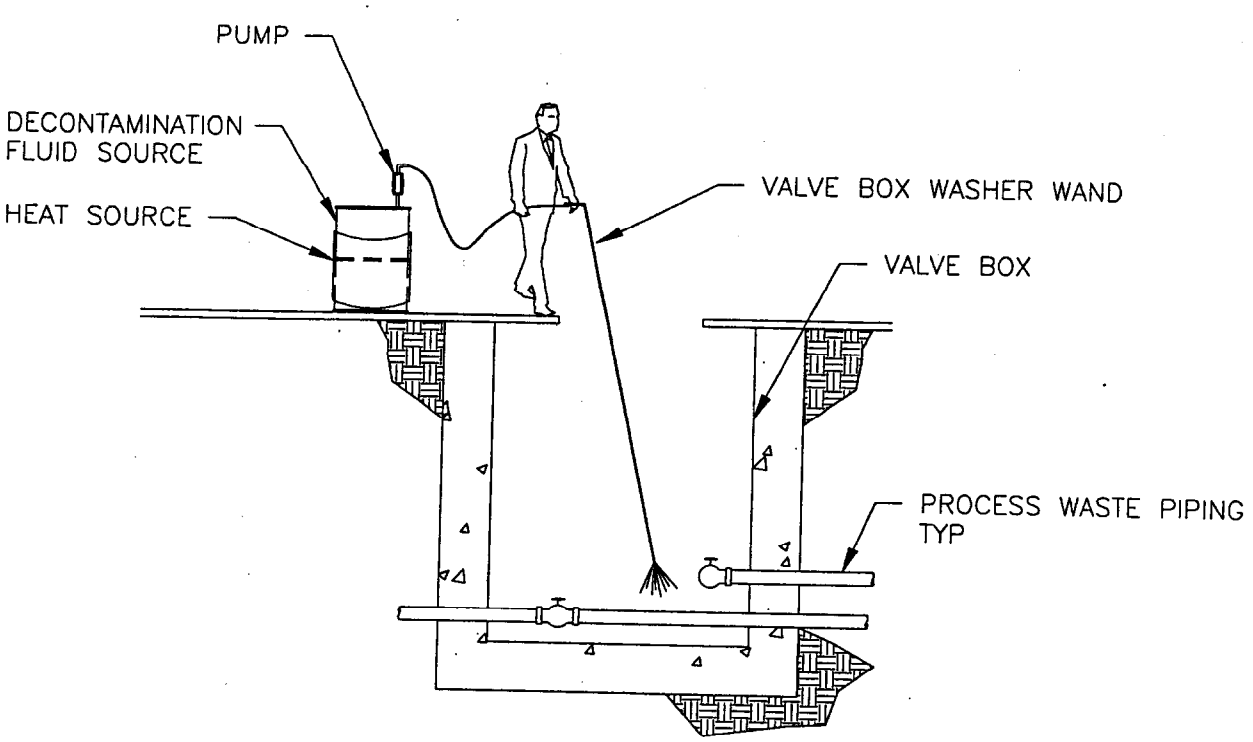

Figure 1-7. Valve Box Washing System

A low-volume spray nozzle, designed to enter the valve box through the access hatch, will be used to decontaminate the stainless steel liner contained within each valve box. The nozzle design will minimize any undesired nozzle movement within the valve box during decontamination activities. The decontamination fluid spray will be directed downward at an angle to maximize the surface area coming in direct contact with the full force of the spray. This decontamination fluid will then drain from the valve box to the associated vault sump. This draining action will also decontaminate these valve box drain lines.

[32] Sampling will include radioactive and hazardous constituents.
[33] Recent valve box entries have found radiation fields as high as 100 R/hour in both DVB-WM-PW-A5 and DVB-WM-PW-A6 valve boxes. These high radiation fields were caused by past leaks into the surrounding soils outside the valve boxes and waste inside the pipes and are not caused by internal box contamination. Past decontamination efforts have brought the radiation levels down to 1 R/hour.

Note: Low-strength acid could be used as a decontamination fluid. High-strength acid will not be used, as the acid mist formed during spraying operations could contact the concrete walls of the valve boxes and damage the interior wall surfaces. See Figure 1-8. Damaging the wall material could plug the drain line. Plugging the line at this point would not allow the decontamination fluid to drain and the flow of grout into the drain line during grouting activities.

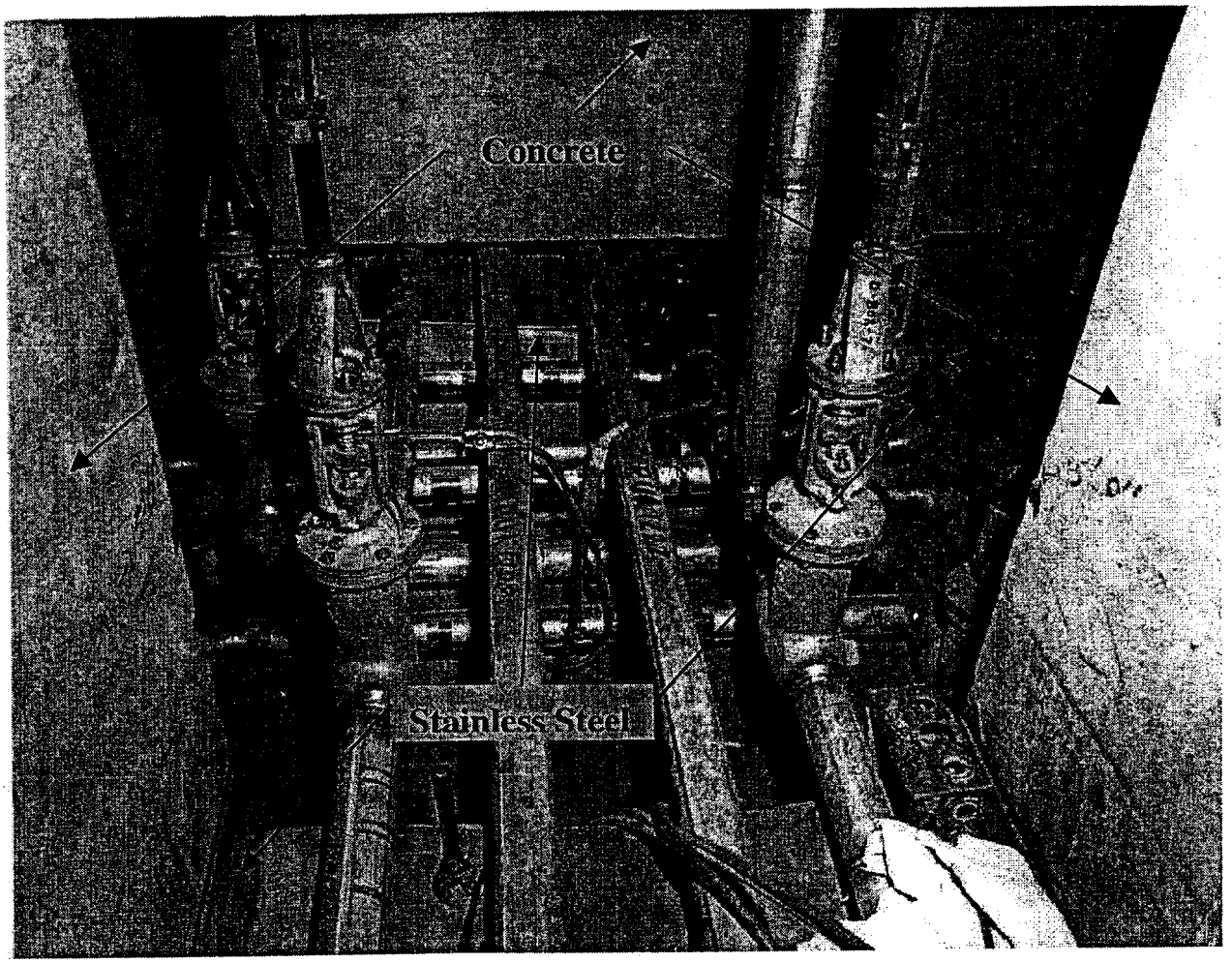

Figure 1-8. **Typical Valve Box**

Liquid accumulating in the vault sumps from valve box decontamination activities will be jetted out of the vault sumps before vault isolation. As the steam jets are activated, the liquid removal lines running from the north and south vault sumps to the tanks[34, 35, 36] will be decontaminated.

Note: The liquid used to decontaminate the liquid removal lines going from the vault sumps to the tank will be removed during the tank washing activities.

1.3.4.1 Valve Box Paint

The exposed concrete in the C series valve boxes was painted with an epoxy paint. This paint was intended to aid in decontamination efforts. The paint, however, may contain RCRA hazardous components, such as PCBs. This paint type could require removal. No Material Safety Data Sheets have been found, to date, that establish the chemical composition of the paints that were used during the original construction. Additional investigation will be required to provide adequate documentation on the chemical constituents of these paints. The investigation may require analyzing a paint sample from each valve box.

1.3.4.2 Valve Box Grouting

The valve boxes can be filled with grout once the encasements are filled. The valve boxes will be filled to just below the split valve decontamination and grouting tube access points. Access will be left to these tubes until all lines in the associated valve box has been decontaminated and filled with grout. Each tube will be permanently capped when no longer needed.

The small space remaining between the existing valve box ceiling and the decontamination and grouting tubes will be left ungrouted to allow access to the lines that are still active. The remaining volume should be small and not present a subsidence problem for the final cap.

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[34] The steam jet in the north sump of each vault will be reactivated to flush the associated liquid removal lines.
[35] The lines which transfer liquid from the sumps to the tanks will be flushed as best management practice. These lines will be completely encased in grout during vault void management and do not require flushing from a regulatory standpoint.
[36] Due to the location of the steam jet(s) in the sump(s), approximately 2-½-inches of water will remain in the vault sumps following these flushing operations. It is assumed that this small liquid amount will be absorbed into the grout mix.

References:

[i] G. C. McCoy, *Radiological Control Assessment of the Chromate Solution used in the ICPP Tank Farm*, EDF CPP-017, Functional File Number # 1000-15, December 4, 1995.

[ii] INTEC Drawing 106181, Zone A-4, 5.

[iii] R. Ochoa, *Tank Riser Dimension Verification*, EDF-015722-009, September 1998.

ATTACHMENT 1

HLW TANK FARM FACILITY CLOSURE SEQUENCE DESCRIPTION

The HLW Tank Farm Facility (TFF) Closure Sequence consists of 11 flowchart figures. The figures describe the sequential activities required for closure. Figure 1 begins with Phase 1[1] Closure and continues through all 6 phases until the facility is turned over to CERCLA for final cap placement and monitoring. Figure 1 provides a high level sequence of activities. Activities in Figure 1 requiring more detailed descriptions refer to the other figures contained in this attachment. The reader is referred back to figure 1 once the activity has been adequately described. Figures 2 through 11 have been developed for Phase 1. Attachment 2 of this EDF (Figures 12 and 13) provides an updated version of the P&ID's (Figures 8-4 and 8-5) of INEEL/EXT-98-00913. These P&ID's show the lines (including line numbers) connected to the WM-182 and WM-183 tanks and are to be used in conjunction with Attachment 1 to help verify how each line is handled during the closure sequence. Each closure phase will require modifying figures 1 through 11 and generating new figures 12 and 13 to adequately describe the closure sequence for that phase. Each box shape describes the associated box function as identified below.

Trapezoids represent a lower level task that contains several steps. The boxes that follow the trapezoid are parts of the sequence that must be performed to complete the task.

Rectangular boxes describe a specific task.

Diamond boxes contain questions related to the sequence.

Parallelograms signify the beginning or ending of a high level task.

Ovals provide comments.

[1] INEEL/EXT-98-01198, Idaho Nation Engineering and Environmental Laboratory, "Idaho Nuclear T... E... Center Tank Farm Facility Conceptual HWMA/RCRA Closure Approach", December '98.

Pentagons indicate where a task continues from one figure to another figure.

Box border thickness also aids in reading the flow sheets. Rectangular boxes with a thicker border are described in greater detail either in the flowchart or another document. Parallelograms, trapezoids, and diamonds are given thick borders to help them stand out and make them recognizable as higher order functions.

The activities described in the flow sheets are based on the WM-182 and WM-183 Closure Study[2]. Assumptions were made in the flowchart that can not be traced to the referenced report. These assumptions along with their basis are described below.

- Radiation shielding may be installed to allow access to valve boxes.

  Basis: ALARA and engineering judgment. Some valve boxes have contaminated soils outside of the box that could present an unacceptable amount of exposure to workers even after the valve boxes have been decontaminated.

- The soil grade will be adjusted near CPP-721 and CPP-722 previous to installing large area containment tents in the area.

  Basis: Visual inspection. The sloping grade will need to be adjusted to ensure a stable base with a uniform elevation for the containment tents.

- The 4" water lines in CPP-721 will be cut and capped in CPP-721.

  Basis: All active lines must be deactivated to complete closure.

- Existing steam jets may be modified for use during heel removal.

  Basis: Engineering judgement. This is a feasible option. Further study needs to be performed to establish risk and economics associated with this option.

- Carbon steel piping sections connected to the stainless steel cooling coil lines will be removed.

  Basis: Engineering judgement. The carbon steel pipe sections attached to the stainless steel cooling coils corrode at an increased rate. Liquids could enter the cooling coils and eventually the tank through corroded pipe sections.

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[2] INEEL/EXT-98-00913, Idaho National Engineering and Environmental Laboratory, "INTEC TFF Tanks WM-182 and WM-183 Closure Study, September '98.

- Fluids that collect in the liquid catches will be sampled to determine proper disposal method.

  Basis: Current regulations require that data be collected on potential wastes so that a Hazardous Waste Determination may be performed and the substance correctly managed.

- Video equipment will be installed in vault risers during vault void filling.

  Basis: Engineering judgement. This provides visual verification during vault void filling.

- Tank instrumentation lines will be grouted/epoxied to the maximum extent practicable previous to heel management.

  Basis: Engineering judgement. Some instrumentation lines extend almost to the bottom of the tanks. Some of these lines have become plugged inside the tank. A line that opens into a tank requires filling before the grout poured into the tank plugs the instrumentation line ends.

- Vault instrumentation lines will be grouted/epoxied previous to vault void filling.

  Basis: Engineering judgement. These lines extend into the vault sumps. They need to be filled before the grout poured into the vault plugs the instrumentation line ends.

- The pipe encasements will be grouted before the vault voids.

  Basis: Engineering judgement. The encasements drain lines end in the vaults. These lines are filled with grout when the encasements are grouted. The encasements need to be grouted before the grout poured into the vault plugs the drain line ends.

- The valve boxes will be grouted before the vault voids.

  Basis: Engineering judgement. The valve box drain lines are grouted when the valve boxes are grouted. Some of these lines run to the vaults. The valve boxes need to be grouted before the grout poured into the vault plugs the drain line ends.

- Vault steam lines that are left in place will be grouted.

  Basis: Engineering judgement. These lines present a potential route for liquids to enter the vaults and eventually the tanks. The steam and associated liquid removal lines connect directly to the steam jets. Grouting the steam lines will also plug the ends of the liquid removal lines and minimize chances for liquid to enter the associated tank.

- The VOG lines will be used to grout the top of the tank voids.

  Basis: Engineering judgement. The VOG lines penetrate the tank manway, which is at the highest point on the tank. Grouting with the VOG lines ensures that maximum tank void filling occurs.

- VOG lines that have not been decontaminated previously will be decontaminated when grout is pumped through them to fill the tank voids.

  Basis: The line being used with the temporary VOG system cannot be decontaminated using a liquid flush without introducing additional liquids into the tank being closed. Using grout will minimize the introduction of free liquids into the tank.

Some processes that appear in the flowcharts require further clarification. These processes are defined below:

- Decontamination - For the purpose of this discussion, decontamination is defined as flushing a line with 3 volumes of decontamination fluid. For valve boxes, concrete encasements, some 10" VOG lines[3], and tank voids, 3 volumes of decontamination fluid would create significant amounts of waste. Therefore, decontaminating the surfaces of these items will be accomplished by washing with a low volume spray system. In most cases, samples will not be taken because of the inability to access the decontamination fluid once it has been used to decontaminate the different systems.

- Sampling of Collected Liquids - Liquids that are accessible once removed from the Tank Farm system may be sampled. Waste Generator Services determine whether sampling is required to make a hazardous waste determination. This will define the proper disposal method for the liquids.

- Temporary Cap - A cap on an active line that can be removed at a later date to allow flushing and/or grouting operations to occur at the time that the line is being closed.

- Permanent Cap - A cap designed to permanently seal the closed line from liquid infiltration.

- Stub up - An extension added to the end of a line that brings the line to an accessible location. There are various situations when these are needed; lines in valve boxes, lines in condenser pits and an encasement cover in valve box A6. Some lines in the valve boxes and condenser pits need to be accessible after the boxes and pits are grouted. Therefore, the pipe ends will be extended up just below the bottom of the valve box lids. This will allow the lines to be accessed once valve boxes and condenser pits are grouted and leave room for the lids to be put on these structures. The grout hose fitting/adapter on an encasement cover in valve box A6 will be stubbed up similar to the stubbed up lines.

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[3] Other 10" VOG lines can not be decontaminated until after heel management. Washing would introduce free liquids into the tank after grout has been placed. Grout pumped through the VOG lines to fill the tank voids will be used as the decontamination fluid for these lines.

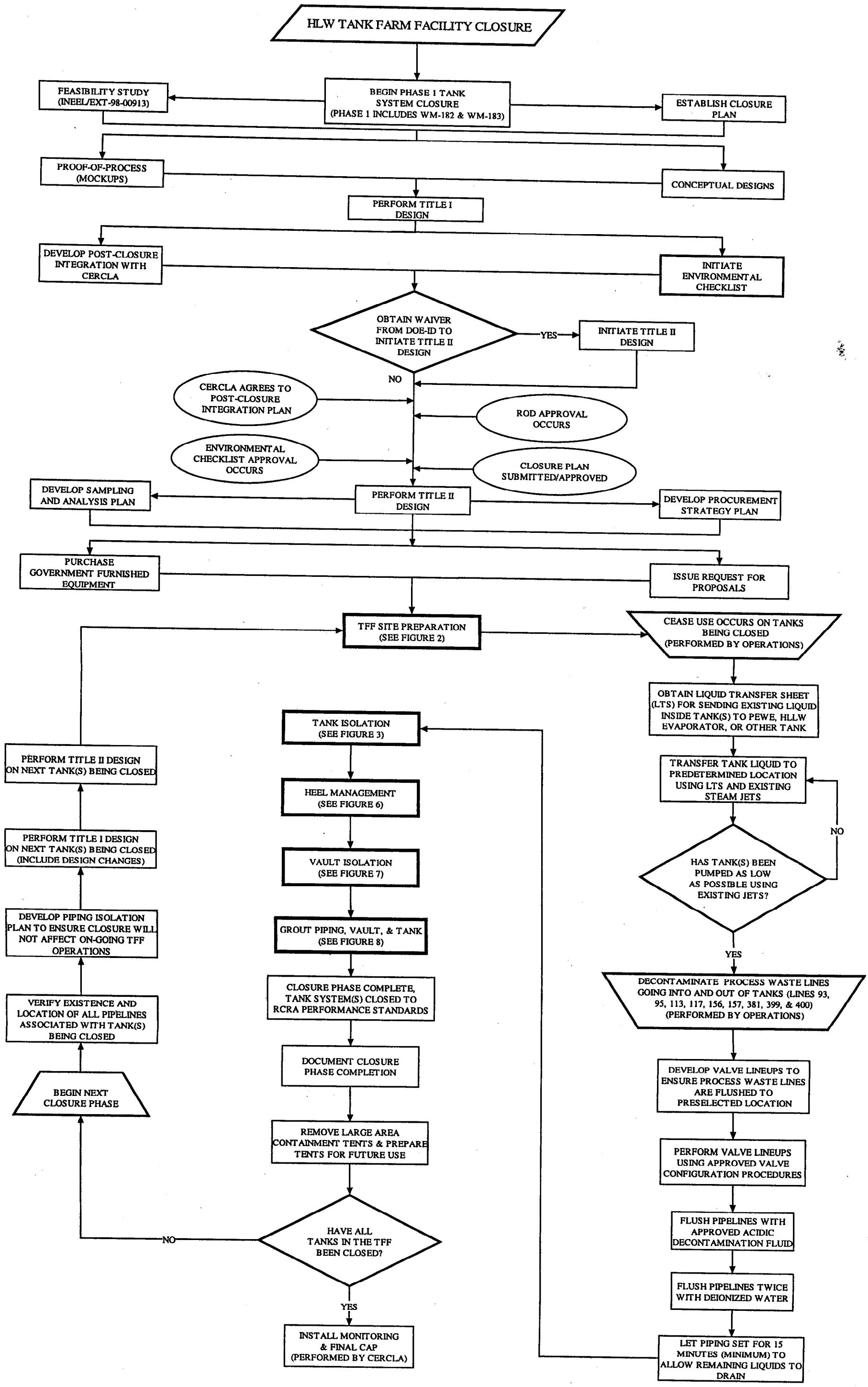
HLW TANK FARM FACILITY CLOSURE
BEGIN PHASE 1 TANK SYSTEM CLOSURE (PHASE 1 INCLUDES WM-182 & WM-183)
FEASIBILITY STUDY (INEEL/EXT-98-00913)
ESTABLISH CLOSURE PLAN
PROOF-OF-PROCESS (MOCKUPS)
CONCEPTUAL DESIGNS
PERFORM TITLE I DESIGN
DEVELOP POST-CLOSURE INTEGRATION WITH CERCLA
INITIATE ENVIRONMENTAL CHECKLIST
OBTAIN WAIVER FROM DOE-ID TO INITIATE TITLE II DESIGN
YES
INITIATE TITLE II DESIGN
NO
CERCLA AGREES TO POST-CLOSURE INTEGRATION PLAN
ROD APPROVAL OCCURS
ENVIRONMENTAL CHECKLIST APPROVAL OCCURS
CLOSURE PLAN SUBMITTED/APPROVED
DEVELOP SAMPLING AND ANALYSIS PLAN
PERFORM TITLE II DESIGN
DEVELOP PROCUREMENT STRATEGY PLAN
PURCHASE GOVERNMENT FURNISHED EQUIPMENT
ISSUE REQUEST FOR PROPOSALS
TFF SITE PREPARATION (SEE FIGURE 2)
CEASE USE OCCURS ON TANKS BEING CLOSED (PERFORMED BY OPERATIONS)
OBTAIN LIQUID TRANSFER SHEET (LTS) FOR SENDING EXISTING LIQUID INSIDE TANK(S) TO PEWE, HLLW EVAPORATOR, OR OTHER TANK
TRANSFER TANK LIQUID TO PREDETERMINED LOCATION USING LTS AND EXISTING STEAM JETS
HAS TANK(S) BEEN PUMPED AS LOW AS POSSIBLE USING EXISTING JETS?
NO
YES
DECONTAMINATE PROCESS WASTE LINES GOING INTO AND OUT OF TANKS (LINES 93, 95, 113, 117, 156, 157, 381, 399, & 400) (PERFORMED BY OPERATIONS)
DEVELOP VALVE LINEUPS TO ENSURE PROCESS WASTE LINES ARE FLUSHED TO PRESELECTED LOCATION
PERFORM VALVE LINEUPS USING APPROVED VALVE CONFIGURATION PROCEDURES
FLUSH PIPELINES WITH APPROVED ACIDIC DECONTAMINATION FLUID
FLUSH PIPELINES TWICE WITH DEIONIZED WATER
LET PIPING SET FOR 15 MINUTES (MINIMUM) TO ALLOW REMAINING LIQUIDS TO DRAIN
TANK ISOLATION (SEE FIGURE 3)
HEEL MANAGEMENT (SEE FIGURE 6)
VAULT ISOLATION (SEE FIGURE 7)
GROUT PIPING, VAULT, & TANK (SEE FIGURE 8)
CLOSURE PHASE COMPLETE, TANK SYSTEM(S) CLOSED TO RCRA PERFORMANCE STANDARDS
DOCUMENT CLOSURE PHASE COMPLETION
REMOVE LARGE AREA CONTAINMENT TENTS & PREPARE TENTS FOR FUTURE USE
HAVE ALL TANKS IN THE TFF BEEN CLOSED?
NO
YES
INSTALL MONITORING & FINAL CAP (PERFORMED BY CERCLA)
BEGIN NEXT CLOSURE PHASE
VERIFY EXISTENCE AND LOCATION OF ALL PIPELINES ASSOCIATED WITH TANK(S) BEING CLOSED
DEVELOP PIPING ISOLATION PLAN TO ENSURE CLOSURE WILL NOT AFFECT ON-GOING TFF OPERATIONS
PERFORM TITLE I DESIGN ON NEXT TANK(S) BEING CLOSED (INCLUDE DESIGN CHANGES)
PERFORM TITLE II DESIGN ON NEXT TANK(S) BEING CLOSED

FIGURE 1

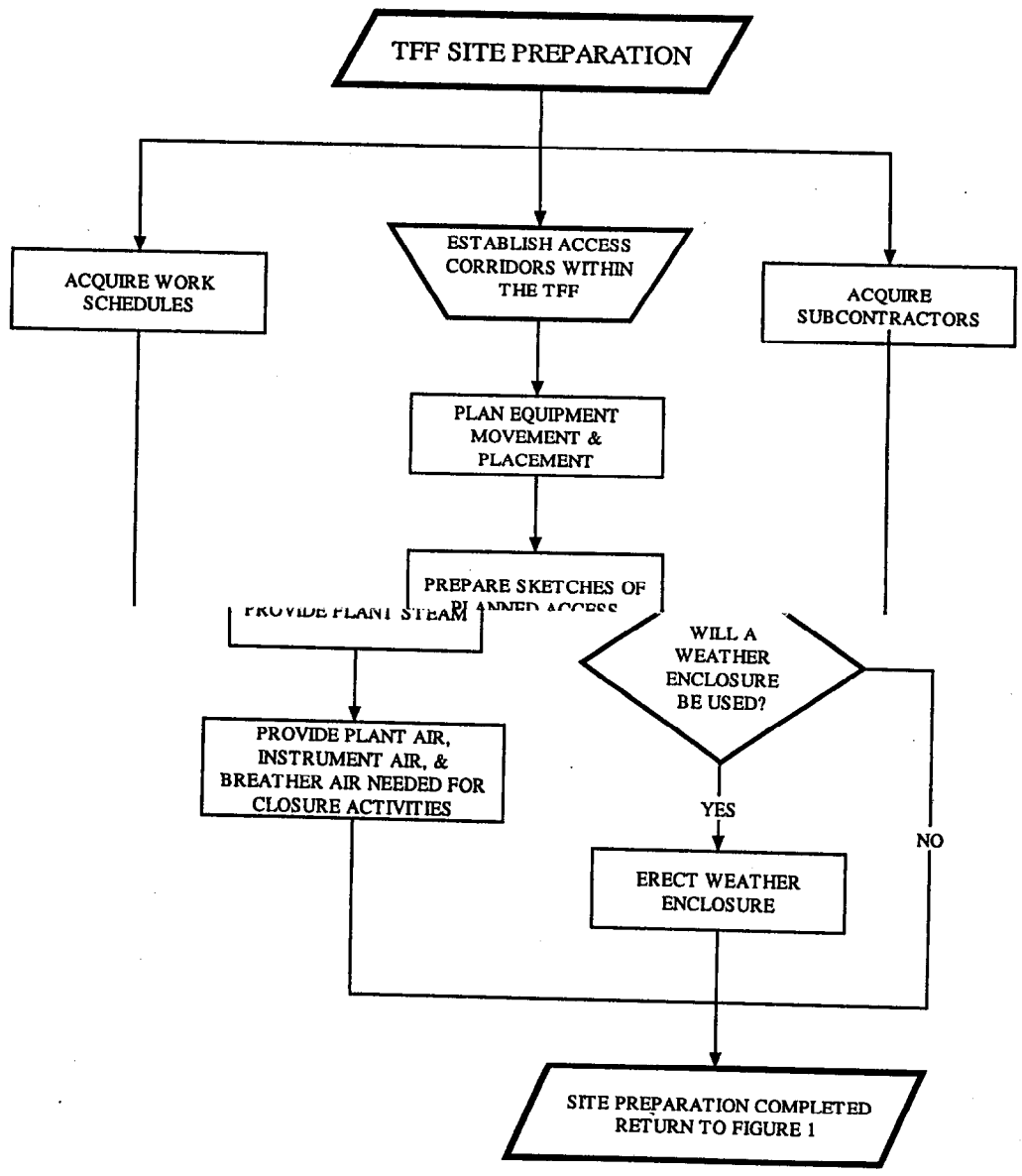
TFF SITE PREPARATION
ACQUIRE WORK SCHEDULES
ESTABLISH ACCESS CORRIDORS WITHIN THE TFF
ACQUIRE SUBCONTRACTORS
PLAN EQUIPMENT MOVEMENT & PLACEMENT
PREPARE SKETCHES OF PLANNED ACCESS
PROVIDE PLANT STEAM
WILL A WEATHER ENCLOSURE BE USED?
PROVIDE PLANT AIR, INSTRUMENT AIR, & BREATHER AIR NEEDED FOR CLOSURE ACTIVITIES
YES
NO
ERECT WEATHER ENCLOSURE
SITE PREPARATION COMPLETED RETURN TO FIGURE 1

FIGURE 2

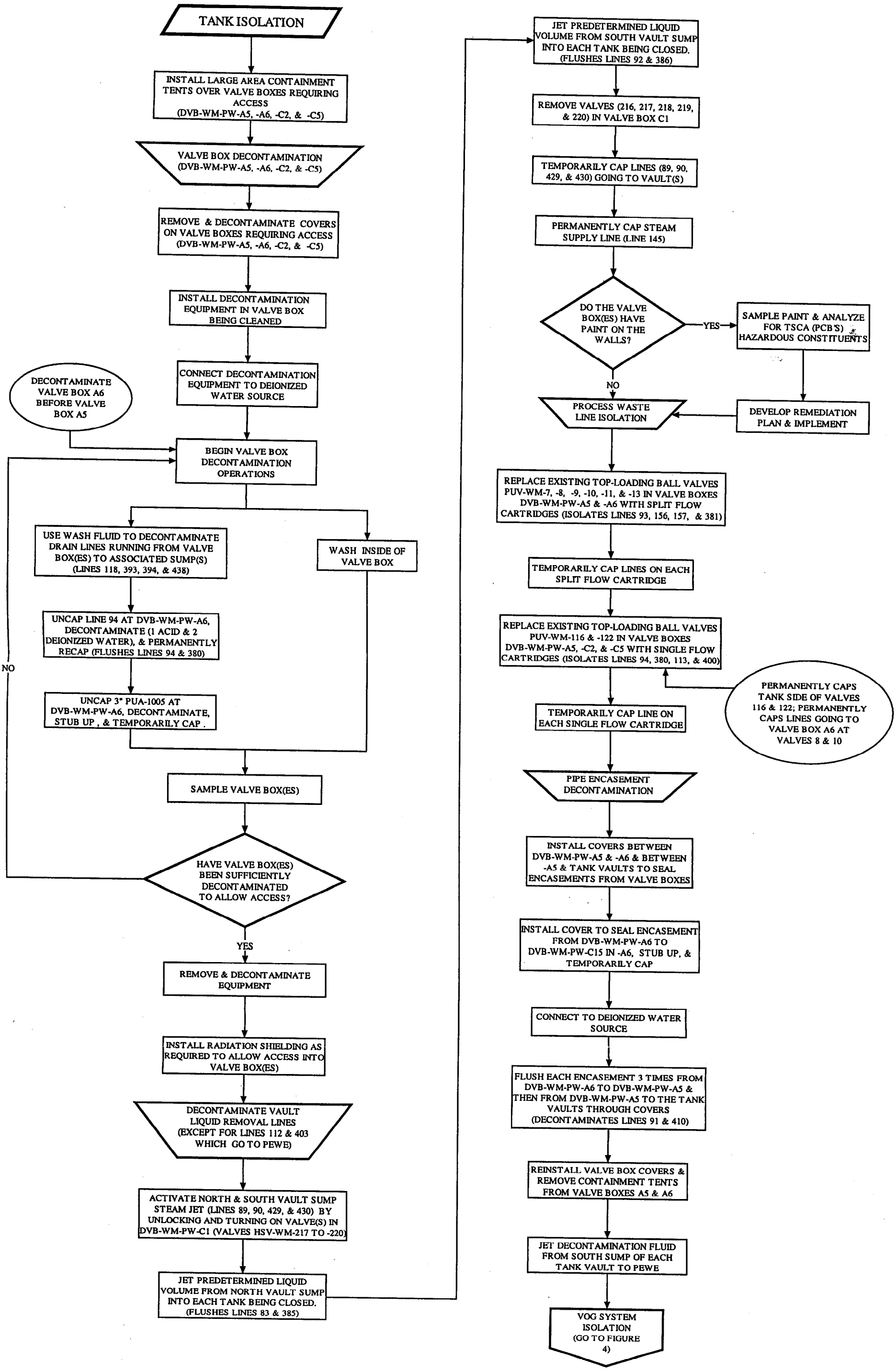
TANK ISOLATION
INSTALL LARGE AREA CONTAINMENT TENTS OVER VALVE BOXES REQUIRING ACCESS (DVB-WM-PW-A5, -A6, -C2, & -C5)
VALVE BOX DECONTAMINATION (DVB-WM-PW-A5, -A6, -C2, & -C5)
REMOVE & DECONTAMINATE COVERS ON VALVE BOXES REQUIRING ACCESS (DVB-WM-PW-A5, -A6, -C2, & -C5)
INSTALL DECONTAMINATION EQUIPMENT IN VALVE BOX BEING CLEANED
CONNECT DECONTAMINATION EQUIPMENT TO DEIONIZED WATER SOURCE
DECONTAMINATE VALVE BOX A6 BEFORE VALVE BOX A5
BEGIN VALVE BOX DECONTAMINATION OPERATIONS
USE WASH FLUID TO DECONTAMINATE DRAIN LINES RUNNING FROM VALVE BOX(ES) TO ASSOCIATED SUMP(S) (LINES 118, 393, 394, & 438)
WASH INSIDE OF VALVE BOX
UNCAP LINE 94 AT DVB-WM-PW-A6, DECONTAMINATE (1 ACID & 2 DEIONIZED WATER), & PERMANENTLY RECAP (FLUSHES LINES 94 & 380)
UNCAP 3" PUA-1005 AT DVB-WM-PW-A6, DECONTAMINATE, STUB UP , & TEMPORARILY CAP .
SAMPLE VALVE BOX(ES)
HAVE VALVE BOX(ES) BEEN SUFFICIENTLY DECONTAMINATED TO ALLOW ACCESS?
NO
YES
REMOVE & DECONTAMINATE EQUIPMENT
INSTALL RADIATION SHIELDING AS REQUIRED TO ALLOW ACCESS INTO VALVE BOX(ES)
DECONTAMINATE VAULT LIQUID REMOVAL LINES (EXCEPT FOR LINES 112 & 403 WHICH GO TO PEWE)
ACTIVATE NORTH & SOUTH VAULT SUMP STEAM JET (LINES 89, 90, 429, & 430) BY UNLOCKING AND TURNING ON VALVE(S) IN DVB-WM-PW-C1 (VALVES HSV-WM-217 TO -220)
JET PREDETERMINED LIQUID VOLUME FROM NORTH VAULT SUMP INTO EACH TANK BEING CLOSED. (FLUSHES LINES 83 & 385)
JET PREDETERMINED LIQUID VOLUME FROM SOUTH VAULT SUMP INTO EACH TANK BEING CLOSED. (FLUSHES LINES 92 & 386)
REMOVE VALVES (216, 217, 218, 219, & 220) IN VALVE BOX C1
TEMPORARILY CAP LINES (89, 90, 429, & 430) GOING TO VAULT(S)
PERMANENTLY CAP STEAM SUPPLY LINE (LINE 145)
DO THE VALVE BOX(ES) HAVE PAINT ON THE WALLS?
YES
SAMPLE PAINT & ANALYZE FOR TSCA (PCB'S) & HAZARDOUS CONSTITUENTS
DEVELOP REMEDIATION PLAN & IMPLEMENT
NO
PROCESS WASTE LINE ISOLATION
REPLACE EXISTING TOP-LOADING BALL VALVES PUV-WM-7, -8, -9, -10, -11, & -13 IN VALVE BOXES DVB-WM-PW-A5 & -A6 WITH SPLIT FLOW CARTRIDGES (ISOLATES LINES 93, 156, 157, & 381)
TEMPORARILY CAP LINES ON EACH SPLIT FLOW CARTRIDGE
REPLACE EXISTING TOP-LOADING BALL VALVES PUV-WM-116 & -122 IN VALVE BOXES DVB-WM-PW-A5, -C2, & -C5 WITH SINGLE FLOW CARTRIDGES (ISOLATES LINES 94, 380, 113, & 400)
PERMANENTLY CAPS TANK SIDE OF VALVES 116 & 122; PERMANENTLY CAPS LINES GOING TO VALVE BOX A6 AT VALVES 8 & 10
TEMPORARILY CAP LINE ON EACH SINGLE FLOW CARTRIDGE
PIPE ENCASEMENT DECONTAMINATION
INSTALL COVERS BETWEEN DVB-WM-PW-A5 & -A6 & BETWEEN -A5 & TANK VAULTS TO SEAL ENCASEMENTS FROM VALVE BOXES
INSTALL COVER TO SEAL ENCASEMENT FROM DVB-WM-PW-A6 TO DVB-WM-PW-C15 IN -A6, STUB UP, & TEMPORARILY CAP
CONNECT TO DEIONIZED WATER SOURCE
FLUSH EACH ENCASEMENT 3 TIMES FROM DVB-WM-PW-A6 TO DVB-WM-PW-A5 & THEN FROM DVB-WM-PW-A5 TO THE TANK VAULTS THROUGH COVERS (DECONTAMINATES LINES 91 & 410)
REINSTALL VALVE BOX COVERS & REMOVE CONTAINMENT TENTS FROM VALVE BOXES A5 & A6
JET DECONTAMINATION FLUID FROM SOUTH SUMP OF EACH TANK VAULT TO PEWE
VOG SYSTEM ISOLATION (GO TO FIGURE 4)

FIGURE 3

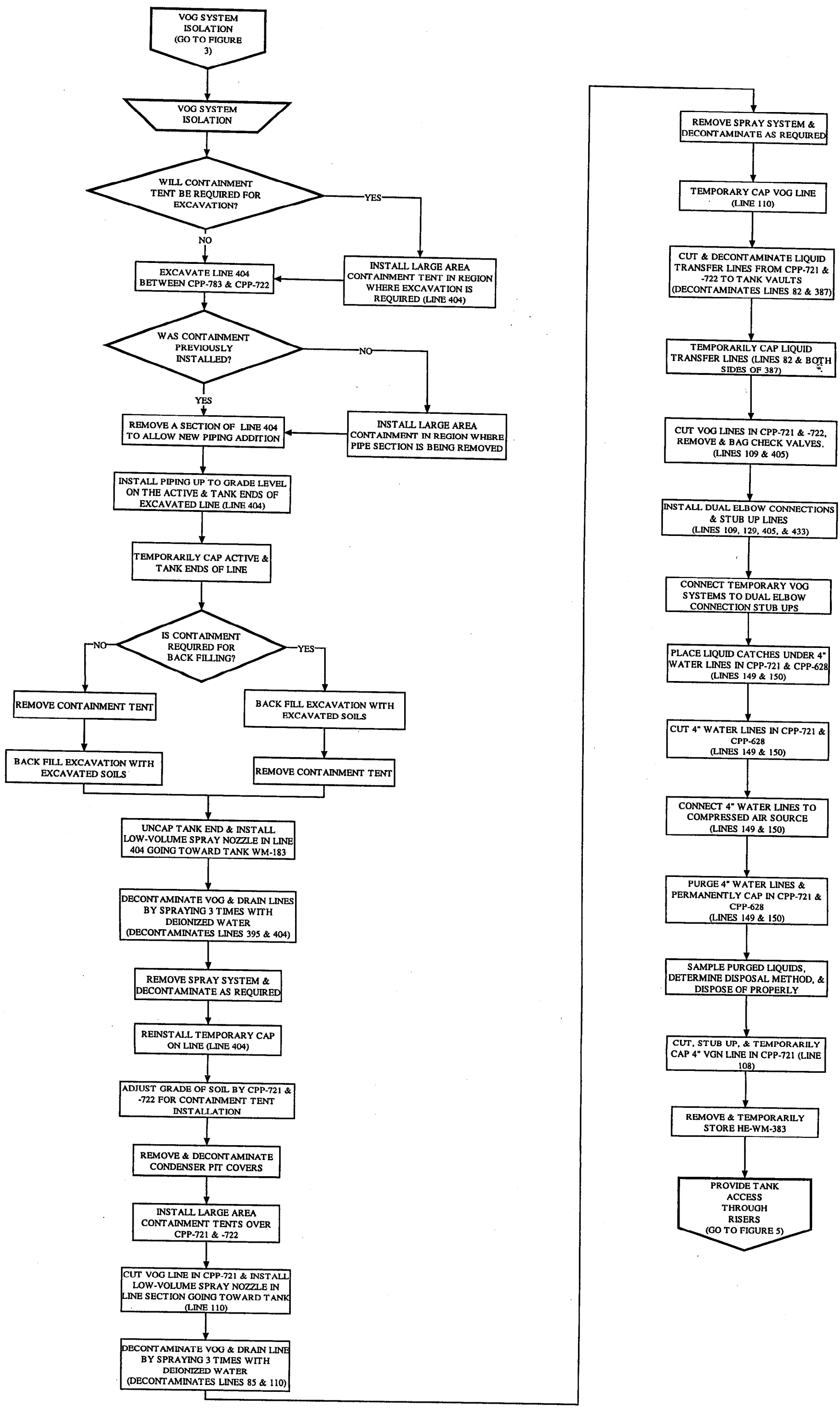
VOG SYSTEM ISOLATION (GO TO FIGURE 3)
VOG SYSTEM ISOLATION
WILL CONTAINMENT TENT BE REQUIRED FOR EXCAVATION?
YES
NO
INSTALL LARGE AREA CONTAINMENT TENT IN REGION WHERE EXCAVATION IS REQUIRED (LINE 404)
EXCAVATE LINE 404 BETWEEN CPP-783 & CPP-722
WAS CONTAINMENT PREVIOUSLY INSTALLED?
NO
YES
INSTALL LARGE AREA CONTAINMENT IN REGION WHERE PIPE SECTION IS BEING REMOVED
REMOVE A SECTION OF LINE 404 TO ALLOW NEW PIPING ADDITION
INSTALL PIPING UP TO GRADE LEVEL ON THE ACTIVE & TANK ENDS OF EXCAVATED LINE (LINE 404)
TEMPORARILY CAP ACTIVE & TANK ENDS OF LINE
IS CONTAINMENT REQUIRED FOR BACK FILLING?
NO
YES
REMOVE CONTAINMENT TENT
BACK FILL EXCAVATION WITH EXCAVATED SOILS
BACK FILL EXCAVATION WITH EXCAVATED SOILS
REMOVE CONTAINMENT TENT
UNCAP TANK END & INSTALL LOW-VOLUME SPRAY NOZZLE IN LINE 404 GOING TOWARD TANK WM-183
DECONTAMINATE VOG & DRAIN LINES BY SPRAYING 3 TIMES WITH DEIONIZED WATER (DECONTAMINATES LINES 395 & 404)
REMOVE SPRAY SYSTEM & DECONTAMINATE AS REQUIRED
REINSTALL TEMPORARY CAP ON LINE (LINE 404)
ADJUST GRADE OF SOIL BY CPP-721 & -722 FOR CONTAINMENT TENT INSTALLATION
REMOVE & DECONTAMINATE CONDENSER PIT COVERS
INSTALL LARGE AREA CONTAINMENT TENTS OVER CPP-721 & -722
CUT VOG LINE IN CPP-721 & INSTALL LOW-VOLUME SPRAY NOZZLE IN LINE SECTION GOING TOWARD TANK (LINE 110)
DECONTAMINATE VOG & DRAIN LINE BY SPRAYING 3 TIMES WITH DEIONIZED WATER (DECONTAMINATES LINES 85 & 110)
REMOVE SPRAY SYSTEM & DECONTAMINATE AS REQUIRED
TEMPORARY CAP VOG LINE (LINE 110)
CUT & DECONTAMINATE LIQUID TRANSFER LINES FROM CPP-721 & -722 TO TANK VAULTS (DECONTAMINATES LINES 82 & 387)
TEMPORARILY CAP LIQUID TRANSFER LINES (LINES 82 & BOTH SIDES OF 387)
CUT VOG LINES IN CPP-721 & -722, REMOVE & BAG CHECK VALVES. (LINES 109 & 405)
INSTALL DUAL ELBOW CONNECTIONS & STUB UP LINES (LINES 109, 129, 405, & 433)
CONNECT TEMPORARY VOG SYSTEMS TO DUAL ELBOW CONNECTION STUB UPS
PLACE LIQUID CATCHES UNDER 4" WATER LINES IN CPP-721 & CPP-628 (LINES 149 & 150)
CUT 4" WATER LINES IN CPP-721 & CPP-628 (LINES 149 & 150)
CONNECT 4" WATER LINES TO COMPRESSED AIR SOURCE (LINES 149 & 150)
PURGE 4" WATER LINES & PERMANENTLY CAP IN CPP-721 & CPP-628 (LINES 149 & 150)
SAMPLE PURGED LIQUIDS, DETERMINE DISPOSAL METHOD, & DISPOSE OF PROPERLY
CUT, STUB UP, & TEMPORARILY CAP 4" VGN LINE IN CPP-721 (LINE 108)
REMOVE & TEMPORARILY STORE HE-WM-383
PROVIDE TANK ACCESS THROUGH RISERS (GO TO FIGURE 5)

FIGURE 4

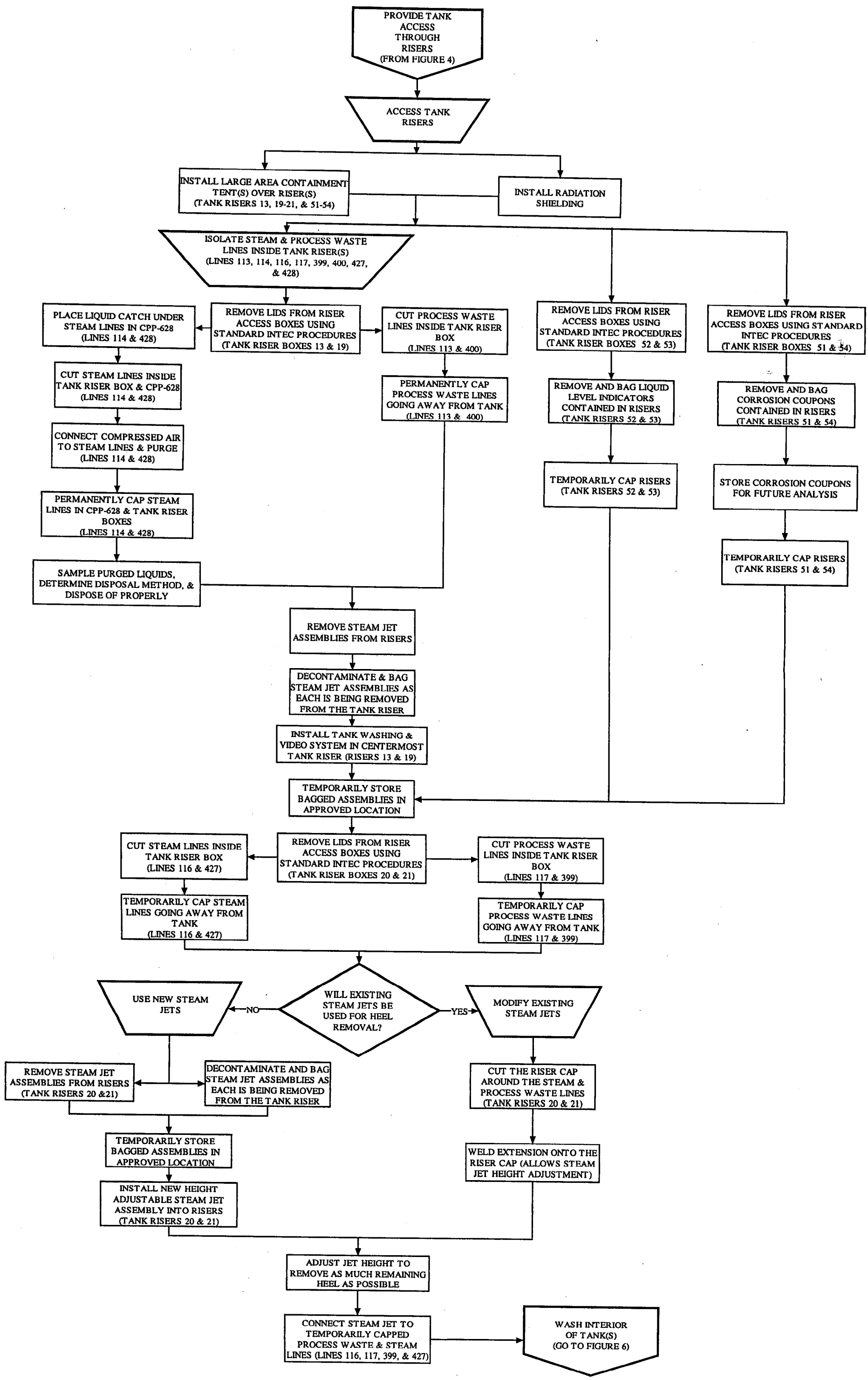
PROVIDE TANK ACCESS THROUGH RISERS (FROM FIGURE 4)
ACCESS TANK RISERS
INSTALL LARGE AREA CONTAINMENT TENT(S) OVER RISER(S) (TANK RISERS 13, 19-21, & 51-54)
INSTALL RADIATION SHIELDING
ISOLATE STEAM & PROCESS WASTE LINES INSIDE TANK RISER(S) (LINES 113, 114, 116, 117, 399, 400, 427, & 428)
PLACE LIQUID CATCH UNDER STEAM LINES IN CPP-628 (LINES 114 & 428)
REMOVE LIDS FROM RISER ACCESS BOXES USING STANDARD INTEC PROCEDURES (TANK RISER BOXES 13 & 19)
CUT PROCESS WASTE LINES INSIDE TANK RISER BOX (LINES 113 & 400)
REMOVE LIDS FROM RISER ACCESS BOXES USING STANDARD INTEC PROCEDURES (TANK RISER BOXES 52 & 53)
REMOVE LIDS FROM RISER ACCESS BOXES USING STANDARD INTEC PROCEDURES (TANK RISER BOXES 51 & 54)
CUT STEAM LINES INSIDE TANK RISER BOX & CPP-628 (LINES 114 & 428)
PERMANENTLY CAP PROCESS WASTE LINES GOING AWAY FROM TANK (LINES 113 & 400)
REMOVE AND BAG LIQUID LEVEL INDICATORS CONTAINED IN RISERS (TANK RISERS 52 & 53)
REMOVE AND BAG CORROSION COUPONS CONTAINED IN RISERS (TANK RISERS 51 & 54)
CONNECT COMPRESSED AIR TO STEAM LINES & PURGE (LINES 114 & 428)
TEMPORARILY CAP RISERS (TANK RISERS 52 & 53)
STORE CORROSION COUPONS FOR FUTURE ANALYSIS
PERMANENTLY CAP STEAM LINES IN CPP-628 & TANK RISER BOXES (LINES 114 & 428)
TEMPORARILY CAP RISERS (TANK RISERS 51 & 54)
SAMPLE PURGED LIQUIDS, DETERMINE DISPOSAL METHOD, & DISPOSE OF PROPERLY
REMOVE STEAM JET ASSEMBLIES FROM RISERS
DECONTAMINATE & BAG STEAM JET ASSEMBLIES AS EACH IS BEING REMOVED FROM THE TANK RISER
INSTALL TANK WASHING & VIDEO SYSTEM IN CENTERMOST TANK RISER (RISERS 13 & 19)
TEMPORARILY STORE BAGGED ASSEMBLIES IN APPROVED LOCATION
CUT STEAM LINES INSIDE TANK RISER BOX (LINES 116 & 427)
REMOVE LIDS FROM RISER ACCESS BOXES USING STANDARD INTEC PROCEDURES (TANK RISER BOXES 20 & 21)
CUT PROCESS WASTE LINES INSIDE TANK RISER BOX (LINES 117 & 399)
TEMPORARILY CAP STEAM LINES GOING AWAY FROM TANK (LINES 116 & 427)
TEMPORARILY CAP PROCESS WASTE LINES GOING AWAY FROM TANK (LINES 117 & 399)
USE NEW STEAM JETS
NO
WILL EXISTING STEAM JETS BE USED FOR HEEL REMOVAL?
YES
MODIFY EXISTING STEAM JETS
REMOVE STEAM JET ASSEMBLIES FROM RISERS (TANK RISERS 20 &21)
DECONTAMINATE AND BAG STEAM JET ASSEMBLIES AS EACH IS BEING REMOVED FROM THE TANK RISER
CUT THE RISER CAP AROUND THE STEAM & PROCESS WASTE LINES (TANK RISERS 20 & 21)
TEMPORARILY STORE BAGGED ASSEMBLIES IN APPROVED LOCATION
WELD EXTENSION ONTO THE RISER CAP (ALLOWS STEAM JET HEIGHT ADJUSTMENT)
INSTALL NEW HEIGHT ADJUSTABLE STEAM JET ASSEMBLY INTO RISERS (TANK RISERS 20 & 21)
ADJUST JET HEIGHT TO REMOVE AS MUCH REMAINING HEEL AS POSSIBLE
CONNECT STEAM JET TO TEMPORARILY CAPPED PROCESS WASTE & STEAM LINES (LINES 116, 117, 399, & 427)
WASH INTERIOR OF TANK(S) (GO TO FIGURE 6)

FIGURE 5

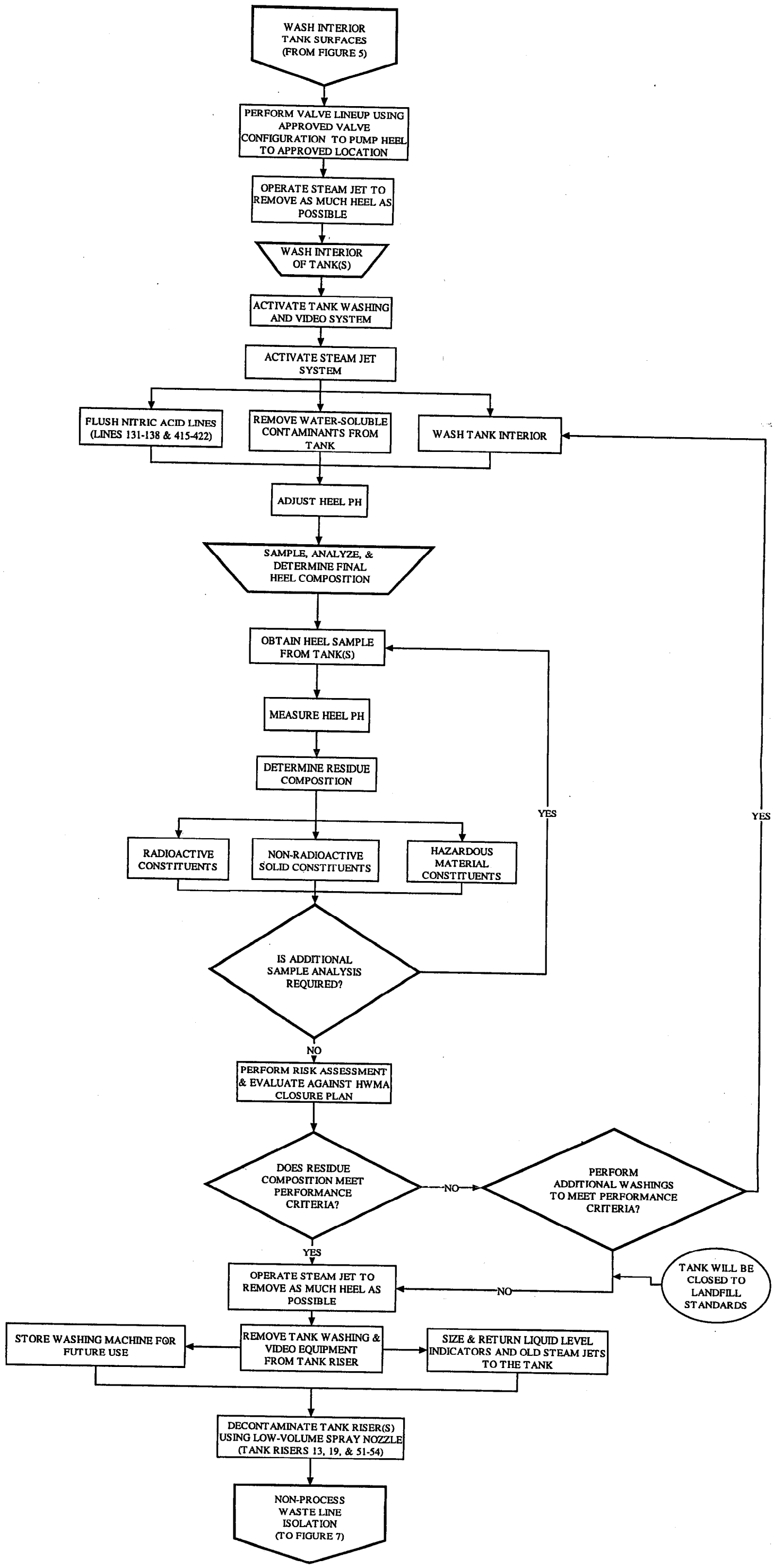
WASH INTERIOR TANK SURFACES (FROM FIGURE 5)
PERFORM VALVE LINEUP USING APPROVED VALVE CONFIGURATION TO PUMP HEEL TO APPROVED LOCATION
OPERATE STEAM JET TO REMOVE AS MUCH HEEL AS POSSIBLE
WASH INTERIOR OF TANK(S)
ACTIVATE TANK WASHING AND VIDEO SYSTEM
ACTIVATE STEAM JET SYSTEM
FLUSH NITRIC ACID LINES (LINES 131-138 & 415-422)
REMOVE WATER-SOLUBLE CONTAMINANTS FROM TANK
WASH TANK INTERIOR
ADJUST HEEL PH
SAMPLE, ANALYZE, & DETERMINE FINAL HEEL COMPOSITION
OBTAIN HEEL SAMPLE FROM TANK(S)
MEASURE HEEL PH
DETERMINE RESIDUE COMPOSITION
RADIOACTIVE CONSTITUENTS
NON-RADIOACTIVE SOLID CONSTITUENTS
HAZARDOUS MATERIAL CONSTITUENTS
IS ADDITIONAL SAMPLE ANALYSIS REQUIRED?
YES
NO
PERFORM RISK ASSESSMENT & EVALUATE AGAINST HWMA CLOSURE PLAN
DOES RESIDUE COMPOSITION MEET PERFORMANCE CRITERIA?
NO
PERFORM ADDITIONAL WASHINGS TO MEET PERFORMANCE CRITERIA?
YES
YES
TANK WILL BE CLOSED TO LANDFILL STANDARDS
NO
OPERATE STEAM JET TO REMOVE AS MUCH HEEL AS POSSIBLE
STORE WASHING MACHINE FOR FUTURE USE
REMOVE TANK WASHING & VIDEO EQUIPMENT FROM TANK RISER
SIZE & RETURN LIQUID LEVEL INDICATORS AND OLD STEAM JETS TO THE TANK
DECONTAMINATE TANK RISER(S) USING LOW-VOLUME SPRAY NOZZLE (TANK RISERS 13, 19, & 51-54)
NON-PROCESS WASTE LINE ISOLATION (TO FIGURE 7)

FIGURE 6

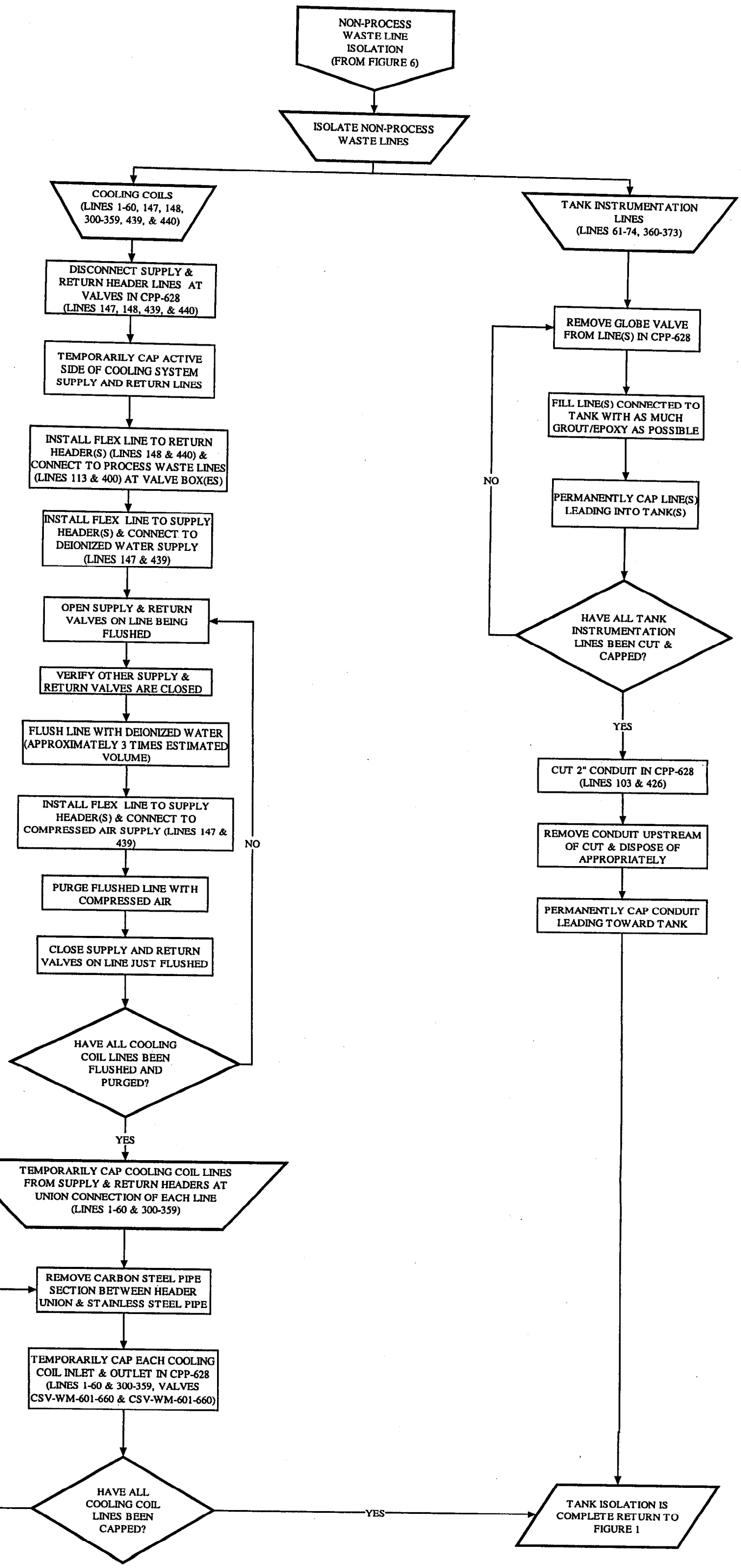
NON-PROCESS WASTE LINE ISOLATION (FROM FIGURE 6)
ISOLATE NON-PROCESS WASTE LINES
COOLING COILS (LINES 1-60, 147, 148, 300-359, 439, & 440)
TANK INSTRUMENTATION LINES (LINES 61-74, 360-373)
DISCONNECT SUPPLY & RETURN HEADER LINES AT VALVES IN CPP-628 (LINES 147, 148, 439, & 440)
TEMPORARILY CAP ACTIVE SIDE OF COOLING SYSTEM SUPPLY AND RETURN LINES
INSTALL FLEX LINE TO RETURN HEADER(S) (LINES 148 & 440) & CONNECT TO PROCESS WASTE LINES (LINES 113 & 400) AT VALVE BOX(ES)
INSTALL FLEX LINE TO SUPPLY HEADER(S) & CONNECT TO DEIONIZED WATER SUPPLY (LINES 147 & 439)
OPEN SUPPLY & RETURN VALVES ON LINE BEING FLUSHED
VERIFY OTHER SUPPLY & RETURN VALVES ARE CLOSED
FLUSH LINE WITH DEIONIZED WATER (APPROXIMATELY 3 TIMES ESTIMATED VOLUME)
INSTALL FLEX LINE TO SUPPLY HEADER(S) & CONNECT TO COMPRESSED AIR SUPPLY (LINES 147 & 439)
PURGE FLUSHED LINE WITH COMPRESSED AIR
CLOSE SUPPLY AND RETURN VALVES ON LINE JUST FLUSHED
HAVE ALL COOLING COIL LINES BEEN FLUSHED AND PURGED?
NO
YES
TEMPORARILY CAP COOLING COIL LINES FROM SUPPLY & RETURN HEADERS AT UNION CONNECTION OF EACH LINE (LINES 1-60 & 300-359)
REMOVE CARBON STEEL PIPE SECTION BETWEEN HEADER UNION & STAINLESS STEEL PIPE
TEMPORARILY CAP EACH COOLING COIL INLET & OUTLET IN CPP-628 (LINES 1-60 & 300-359, VALVES CSV-WM-601-660 & CSV-WM-601-660)
HAVE ALL COOLING COIL LINES BEEN CAPPED?
NO
YES
REMOVE GLOBE VALVE FROM LINE(S) IN CPP-628
FILL LINE(S) CONNECTED TO TANK WITH AS MUCH GROUT/EPOXY AS POSSIBLE
PERMANENTLY CAP LINE(S) LEADING INTO TANK(S)
HAVE ALL TANK INSTRUMENTATION LINES BEEN CUT & CAPPED?
NO
YES
CUT 2" CONDUIT IN CPP-628 (LINES 103 & 426)
REMOVE CONDUIT UPSTREAM OF CUT & DISPOSE OF APPROPRIATELY
PERMANENTLY CAP CONDUIT LEADING TOWARD TANK
TANK ISOLATION IS COMPLETE RETURN TO FIGURE 1

FIGURE 7

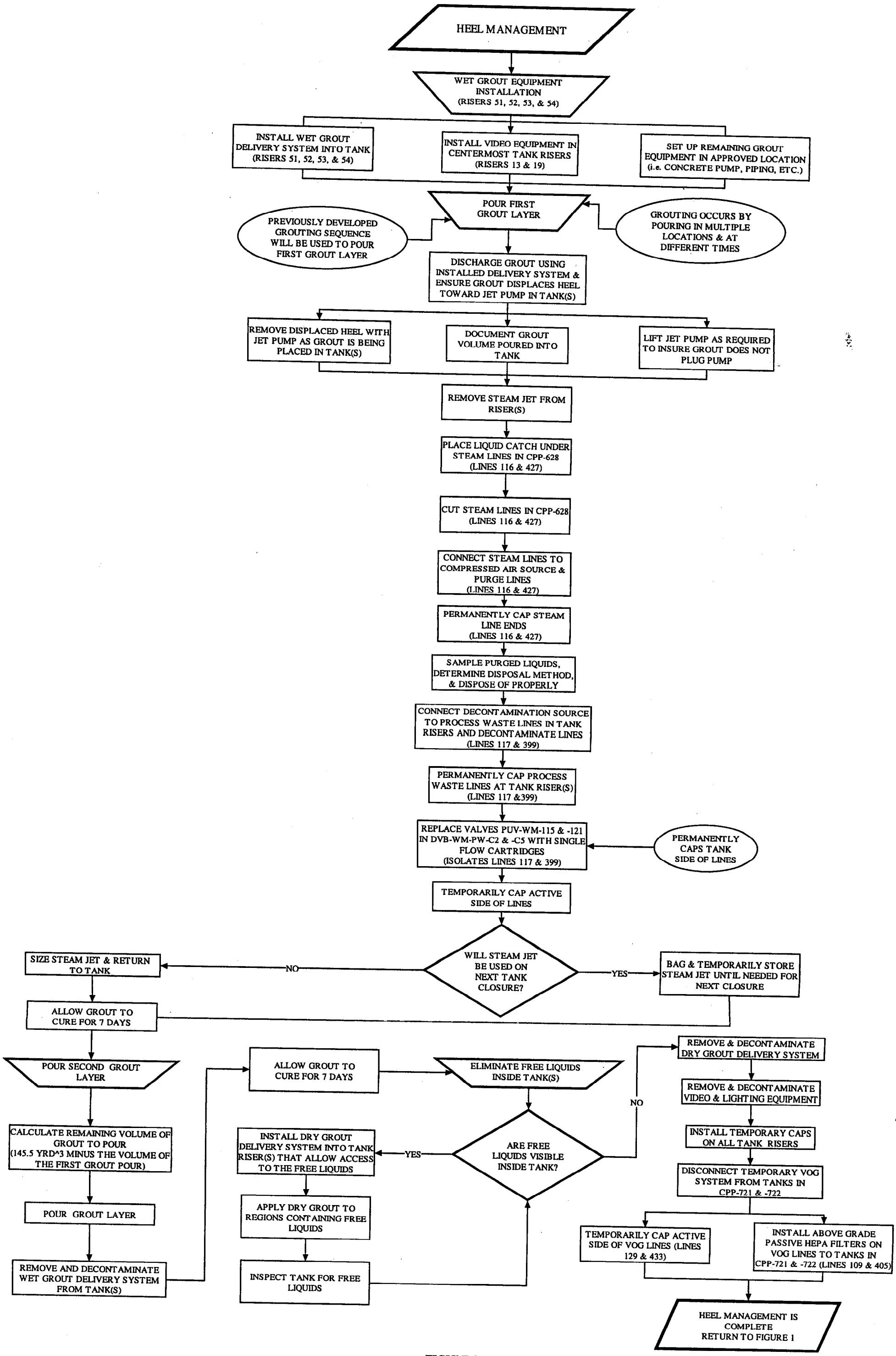
HEEL MANAGEMENT
WET GROUT EQUIPMENT INSTALLATION (RISERS 51, 52, 53, & 54)
INSTALL WET GROUT DELIVERY SYSTEM INTO TANK (RISERS 51, 52, 53, & 54)
INSTALL VIDEO EQUIPMENT IN CENTERMOST TANK RISERS (RISERS 13 & 19)
SET UP REMAINING GROUT EQUIPMENT IN APPROVED LOCATION (i.e. CONCRETE PUMP, PIPING, ETC.)
POUR FIRST GROUT LAYER
PREVIOUSLY DEVELOPED GROUTING SEQUENCE WILL BE USED TO POUR FIRST GROUT LAYER
GROUTING OCCURS BY POURING IN MULTIPLE LOCATIONS & AT DIFFERENT TIMES
DISCHARGE GROUT USING INSTALLED DELIVERY SYSTEM & ENSURE GROUT DISPLACES HEEL TOWARD JET PUMP IN TANK(S)
REMOVE DISPLACED HEEL WITH JET PUMP AS GROUT IS BEING PLACED IN TANK(S)
DOCUMENT GROUT VOLUME POURED INTO TANK
LIFT JET PUMP AS REQUIRED TO INSURE GROUT DOES NOT PLUG PUMP
REMOVE STEAM JET FROM RISER(S)
PLACE LIQUID CATCH UNDER STEAM LINES IN CPP-628 (LINES 116 & 427)
CUT STEAM LINES IN CPP-628 (LINES 116 & 427)
CONNECT STEAM LINES TO COMPRESSED AIR SOURCE & PURGE LINES (LINES 116 & 427)
PERMANENTLY CAP STEAM LINE ENDS (LINES 116 & 427)
SAMPLE PURGED LIQUIDS, DETERMINE DISPOSAL METHOD, & DISPOSE OF PROPERLY
CONNECT DECONTAMINATION SOURCE TO PROCESS WASTE LINES IN TANK RISERS AND DECONTAMINATE LINES (LINES 117 & 399)
PERMANENTLY CAP PROCESS WASTE LINES AT TANK RISER(S) (LINES 117 &399)
REPLACE VALVES PUV-WM-115 & -121 IN DVB-WM-PW-C2 & -C5 WITH SINGLE FLOW CARTRIDGES (ISOLATES LINES 117 & 399)
PERMANENTLY CAPS TANK SIDE OF LINES
TEMPORARILY CAP ACTIVE SIDE OF LINES
WILL STEAM JET BE USED ON NEXT TANK CLOSURE?
NO
YES
SIZE STEAM JET & RETURN TO TANK
BAG & TEMPORARILY STORE STEAM JET UNTIL NEEDED FOR NEXT CLOSURE
ALLOW GROUT TO CURE FOR 7 DAYS
POUR SECOND GROUT LAYER
CALCULATE REMAINING VOLUME OF GROUT TO POUR (145.5 YRD^3 MINUS THE VOLUME OF THE FIRST GROUT POUR)
POUR GROUT LAYER
REMOVE AND DECONTAMINATE WET GROUT DELIVERY SYSTEM FROM TANK(S)
ALLOW GROUT TO CURE FOR 7 DAYS
ELIMINATE FREE LIQUIDS INSIDE TANK(S)
ARE FREE LIQUIDS VISIBLE INSIDE TANK?
YES
NO
INSTALL DRY GROUT DELIVERY SYSTEM INTO TANK RISER(S) THAT ALLOW ACCESS TO THE FREE LIQUIDS
APPLY DRY GROUT TO REGIONS CONTAINING FREE LIQUIDS
INSPECT TANK FOR FREE LIQUIDS
REMOVE & DECONTAMINATE DRY GROUT DELIVERY SYSTEM
REMOVE & DECONTAMINATE VIDEO & LIGHTING EQUIPMENT
INSTALL TEMPORARY CAPS ON ALL TANK RISERS
DISCONNECT TEMPORARY VOG SYSTEM FROM TANKS IN CPP-721 & -722
TEMPORARILY CAP ACTIVE SIDE OF VOG LINES (LINES 129 & 433)
INSTALL ABOVE GRADE PASSIVE HEPA FILTERS ON VOG LINES TO TANKS IN CPP-721 & -722 (LINES 109 & 405)
HEEL MANAGEMENT IS COMPLETE RETURN TO FIGURE 1

FIGURE 8

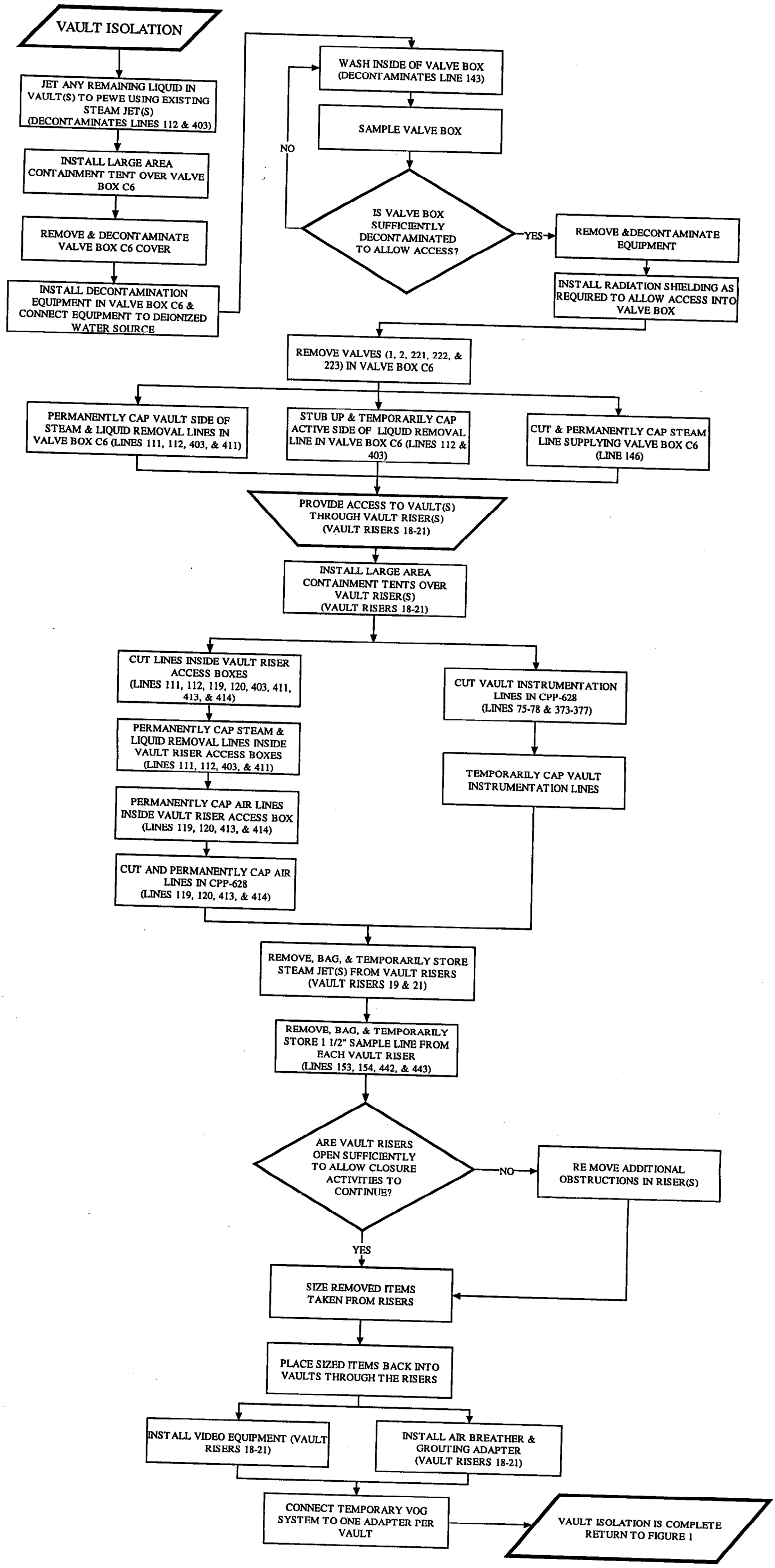
VAULT ISOLATION
JET ANY REMAINING LIQUID IN VAULT(S) TO PEWE USING EXISTING STEAM JET(S) (DECONTAMINATES LINES 112 & 403)
INSTALL LARGE AREA CONTAINMENT TENT OVER VALVE BOX C6
REMOVE & DECONTAMINATE VALVE BOX C6 COVER
INSTALL DECONTAMINATION EQUIPMENT IN VALVE BOX C6 & CONNECT EQUIPMENT TO DEIONIZED WATER SOURCE
WASH INSIDE OF VALVE BOX (DECONTAMINATES LINE 143)
SAMPLE VALVE BOX
IS VALVE BOX SUFFICIENTLY DECONTAMINATED TO ALLOW ACCESS?
NO
YES
REMOVE &DECONTAMINATE EQUIPMENT
INSTALL RADIATION SHIELDING AS REQUIRED TO ALLOW ACCESS INTO VALVE BOX
REMOVE VALVES (1, 2, 221, 222, & 223) IN VALVE BOX C6
PERMANENTLY CAP VAULT SIDE OF STEAM & LIQUID REMOVAL LINES IN VALVE BOX C6 (LINES 111, 112, 403, & 411)
STUB UP & TEMPORARILY CAP ACTIVE SIDE OF LIQUID REMOVAL LINE IN VALVE BOX C6 (LINES 112 & 403)
CUT & PERMANENTLY CAP STEAM LINE SUPPLYING VALVE BOX C6 (LINE 146)
PROVIDE ACCESS TO VAULT(S) THROUGH VAULT RISER(S) (VAULT RISERS 18-21)
INSTALL LARGE AREA CONTAINMENT TENTS OVER VAULT RISER(S) (VAULT RISERS 18-21)
CUT LINES INSIDE VAULT RISER ACCESS BOXES (LINES 111, 112, 119, 120, 403, 411, 413, & 414)
PERMANENTLY CAP STEAM & LIQUID REMOVAL LINES INSIDE VAULT RISER ACCESS BOXES (LINES 111, 112, 403, & 411)
PERMANENTLY CAP AIR LINES INSIDE VAULT RISER ACCESS BOX (LINES 119, 120, 413, & 414)
CUT AND PERMANENTLY CAP AIR LINES IN CPP-628 (LINES 119, 120, 413, & 414)
CUT VAULT INSTRUMENTATION LINES IN CPP-628 (LINES 75-78 & 373-377)
TEMPORARILY CAP VAULT INSTRUMENTATION LINES
REMOVE, BAG, & TEMPORARILY STORE STEAM JET(S) FROM VAULT RISERS (VAULT RISERS 19 & 21)
REMOVE, BAG, & TEMPORARILY STORE 1 1/2" SAMPLE LINE FROM EACH VAULT RISER (LINES 153, 154, 442, & 443)
ARE VAULT RISERS OPEN SUFFICIENTLY TO ALLOW CLOSURE ACTIVITIES TO CONTINUE?
NO
RE MOVE ADDITIONAL OBSTRUCTIONS IN RISER(S)
YES
SIZE REMOVED ITEMS TAKEN FROM RISERS
PLACE SIZED ITEMS BACK INTO VAULTS THROUGH THE RISERS
INSTALL VIDEO EQUIPMENT (VAULT RISERS 18-21)
INSTALL AIR BREATHER & GROUTING ADAPTER (VAULT RISERS 18-21)
CONNECT TEMPORARY VOG SYSTEM TO ONE ADAPTER PER VAULT
VAULT ISOLATION IS COMPLETE RETURN TO FIGURE 1

FIGURE 9

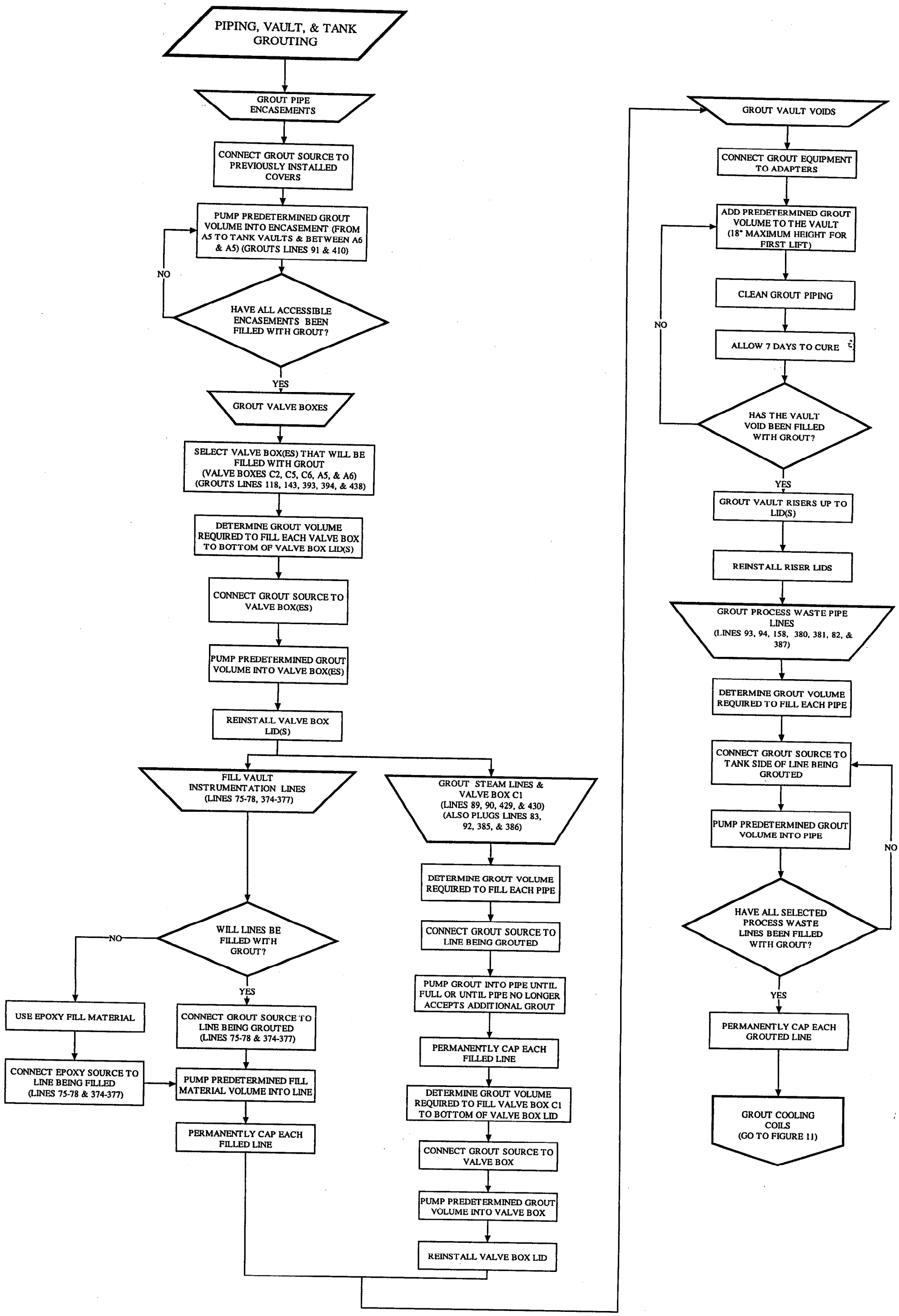
PIPING, VAULT, & TANK GROUTING
GROUT PIPE ENCASEMENTS
CONNECT GROUT SOURCE TO PREVIOUSLY INSTALLED COVERS
PUMP PREDETERMINED GROUT VOLUME INTO ENCASEMENT (FROM A5 TO TANK VAULTS & BETWEEN A6 & A5) (GROUTS LINES 91 & 410)
NO
HAVE ALL ACCESSIBLE ENCASEMENTS BEEN FILLED WITH GROUT?
YES
GROUT VALVE BOXES
SELECT VALVE BOX(ES) THAT WILL BE FILLED WITH GROUT (VALVE BOXES C2, C5, C6, A5, & A6) (GROUTS LINES 118, 143, 393, 394, & 438)
DETERMINE GROUT VOLUME REQUIRED TO FILL EACH VALVE BOX TO BOTTOM OF VALVE BOX LID(S)
CONNECT GROUT SOURCE TO VALVE BOX(ES)
PUMP PREDETERMINED GROUT VOLUME INTO VALVE BOX(ES)
REINSTALL VALVE BOX LID(S)
FILL VAULT INSTRUMENTATION LINES (LINES 75-78, 374-377)
WILL LINES BE FILLED WITH GROUT?
NO
USE EPOXY FILL MATERIAL
CONNECT EPOXY SOURCE TO LINE BEING FILLED (LINES 75-78 & 374-377)
YES
CONNECT GROUT SOURCE TO LINE BEING GROUTED (LINES 75-78 & 374-377)
PUMP PREDETERMINED FILL MATERIAL VOLUME INTO LINE
PERMANENTLY CAP EACH FILLED LINE
GROUT STEAM LINES & VALVE BOX C1 (LINES 89, 90, 429, & 430) (ALSO PLUGS LINES 83, 92, 385, & 386)
DETERMINE GROUT VOLUME REQUIRED TO FILL EACH PIPE
CONNECT GROUT SOURCE TO LINE BEING GROUTED
PUMP GROUT INTO PIPE UNTIL FULL OR UNTIL PIPE NO LONGER ACCEPTS ADDITIONAL GROUT
PERMANENTLY CAP EACH FILLED LINE
DETERMINE GROUT VOLUME REQUIRED TO FILL VALVE BOX C1 TO BOTTOM OF VALVE BOX LID
CONNECT GROUT SOURCE TO VALVE BOX
PUMP PREDETERMINED GROUT VOLUME INTO VALVE BOX
REINSTALL VALVE BOX LID
GROUT VAULT VOIDS
CONNECT GROUT EQUIPMENT TO ADAPTERS
ADD PREDETERMINED GROUT VOLUME TO THE VAULT (18" MAXIMUM HEIGHT FOR FIRST LIFT)
CLEAN GROUT PIPING
ALLOW 7 DAYS TO CURE
NO
HAS THE VAULT VOID BEEN FILLED WITH GROUT?
YES
GROUT VAULT RISERS UP TO LID(S)
REINSTALL RISER LIDS
GROUT PROCESS WASTE PIPE LINES (LINES 93, 94, 158, 380, 381, 82, & 387)
DETERMINE GROUT VOLUME REQUIRED TO FILL EACH PIPE
CONNECT GROUT SOURCE TO TANK SIDE OF LINE BEING GROUTED
PUMP PREDETERMINED GROUT VOLUME INTO PIPE
NO
HAVE ALL SELECTED PROCESS WASTE LINES BEEN FILLED WITH GROUT?
YES
PERMANENTLY CAP EACH GROUTED LINE
GROUT COOLING COILS (GO TO FIGURE 11)

FIGURE 10

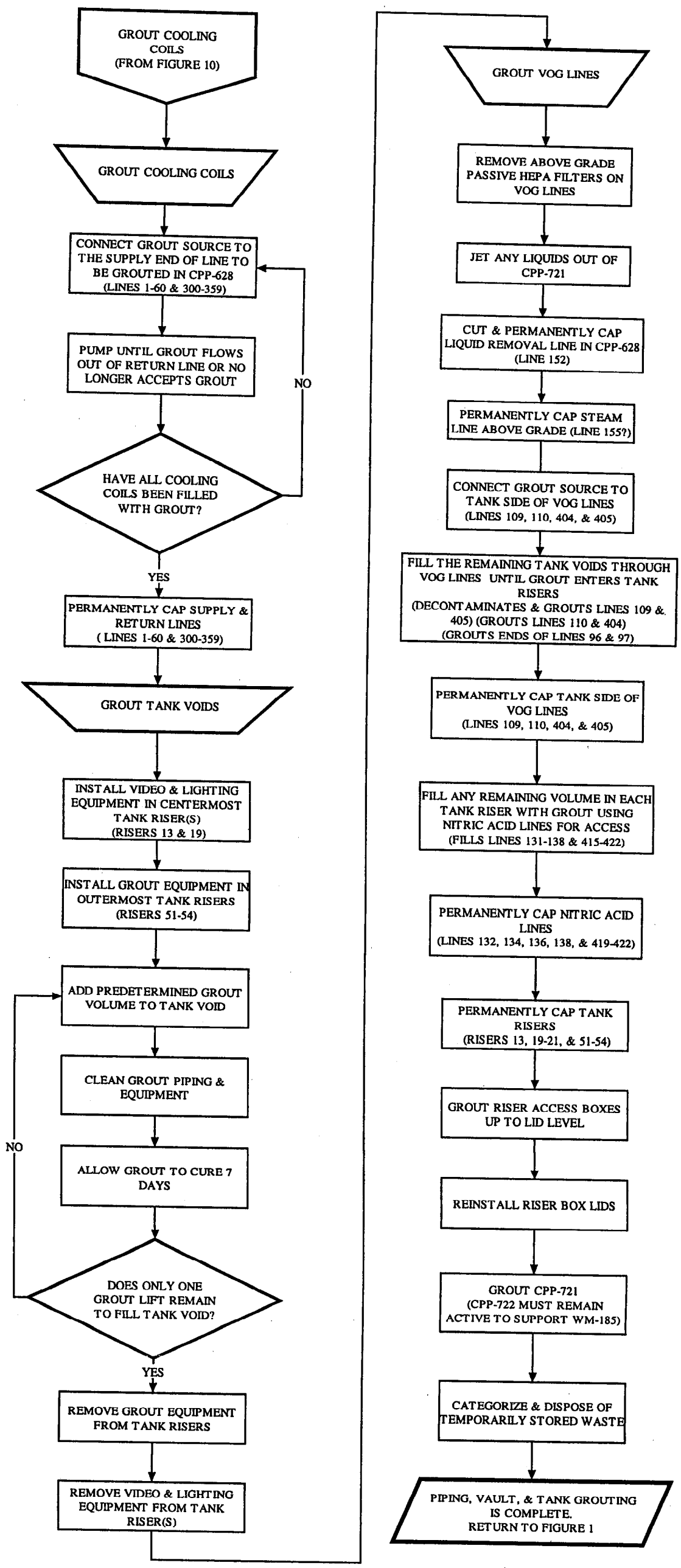
GROUT COOLING COILS (FROM FIGURE 10)
GROUT COOLING COILS
CONNECT GROUT SOURCE TO THE SUPPLY END OF LINE TO BE GROUTED IN CPP-628 (LINES 1-60 & 300-359)
PUMP UNTIL GROUT FLOWS OUT OF RETURN LINE OR NO LONGER ACCEPTS GROUT
HAVE ALL COOLING COILS BEEN FILLED WITH GROUT?
NO
YES
PERMANENTLY CAP SUPPLY & RETURN LINES (LINES 1-60 & 300-359)
GROUT TANK VOIDS
INSTALL VIDEO & LIGHTING EQUIPMENT IN CENTERMOST TANK RISER(S) (RISERS 13 & 19)
INSTALL GROUT EQUIPMENT IN OUTERMOST TANK RISERS (RISERS 51-54)
ADD PREDETERMINED GROUT VOLUME TO TANK VOID
CLEAN GROUT PIPING & EQUIPMENT
ALLOW GROUT TO CURE 7 DAYS
NO
DOES ONLY ONE GROUT LIFT REMAIN TO FILL TANK VOID?
YES
REMOVE GROUT EQUIPMENT FROM TANK RISERS
REMOVE VIDEO & LIGHTING EQUIPMENT FROM TANK RISER(S)
GROUT VOG LINES
REMOVE ABOVE GRADE PASSIVE HEPA FILTERS ON VOG LINES
JET ANY LIQUIDS OUT OF CPP-721
CUT & PERMANENTLY CAP LIQUID REMOVAL LINE IN CPP-628 (LINE 152)
PERMANENTLY CAP STEAM LINE ABOVE GRADE (LINE 155?)
CONNECT GROUT SOURCE TO TANK SIDE OF VOG LINES (LINES 109, 110, 404, & 405)
FILL THE REMAINING TANK VOIDS THROUGH VOG LINES UNTIL GROUT ENTERS TANK RISERS (DECONTAMINATES & GROUTS LINES 109 & 405) (GROUTS LINES 110 & 404) (GROUTS ENDS OF LINES 96 & 97)
PERMANENTLY CAP TANK SIDE OF VOG LINES (LINES 109, 110, 404, & 405)
FILL ANY REMAINING VOLUME IN EACH TANK RISER WITH GROUT USING NITRIC ACID LINES FOR ACCESS (FILLS LINES 131-138 & 415-422)
PERMANENTLY CAP NITRIC ACID LINES (LINES 132, 134, 136, 138, & 419-422)
PERMANENTLY CAP TANK RISERS (RISERS 13, 19-21, & 51-54)
GROUT RISER ACCESS BOXES UP TO LID LEVEL
REINSTALL RISER BOX LIDS
GROUT CPP-721 (CPP-722 MUST REMAIN ACTIVE TO SUPPORT WM-185)
CATEGORIZE & DISPOSE OF TEMPORARILY STORED WASTE
PIPING, VAULT, & TANK GROUTING IS COMPLETE. RETURN TO FIGURE 1

FIGURE 11

ATTACHMENT 2

HLW TANK FARM FACILITY P&ID DESCRIPTION

Figures 12 and 13 included in this attachment provide an updated version of the P&ID's (Figures 8-4 and 8-5) developed for INEEL/EXT-98-00913). These P&ID's show the lines (including line numbers) connected to the WM-182 and WM-183 tanks and are to be used in conjunction with Attachment 1 to help verify how each line is handled during the closure sequence. Piping Identification tables[1] are also contained in the attachments of the referenced report. These tables can be used to help understand the function of the pipe in question.

The method used to verify the final state of each line was to develop a color-coding scheme. The scheme used was as follows:

Green = Line Cut

Orange = Grouted

Blue = Temporarily Capped

Pink = Permanently Capped

Red = Flushed

Yellow = Encasement Covers Installed

This scheme is provided to allow other parties to perform independent verification of the flow sheets and state of each component during and after closure and communicate any findings or questions to the closure design team.

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[1] These tables are being revised at this time and will be added to this EDF once complete. Questions on the figures or tables should be referred to the design team technical lead for clarification.

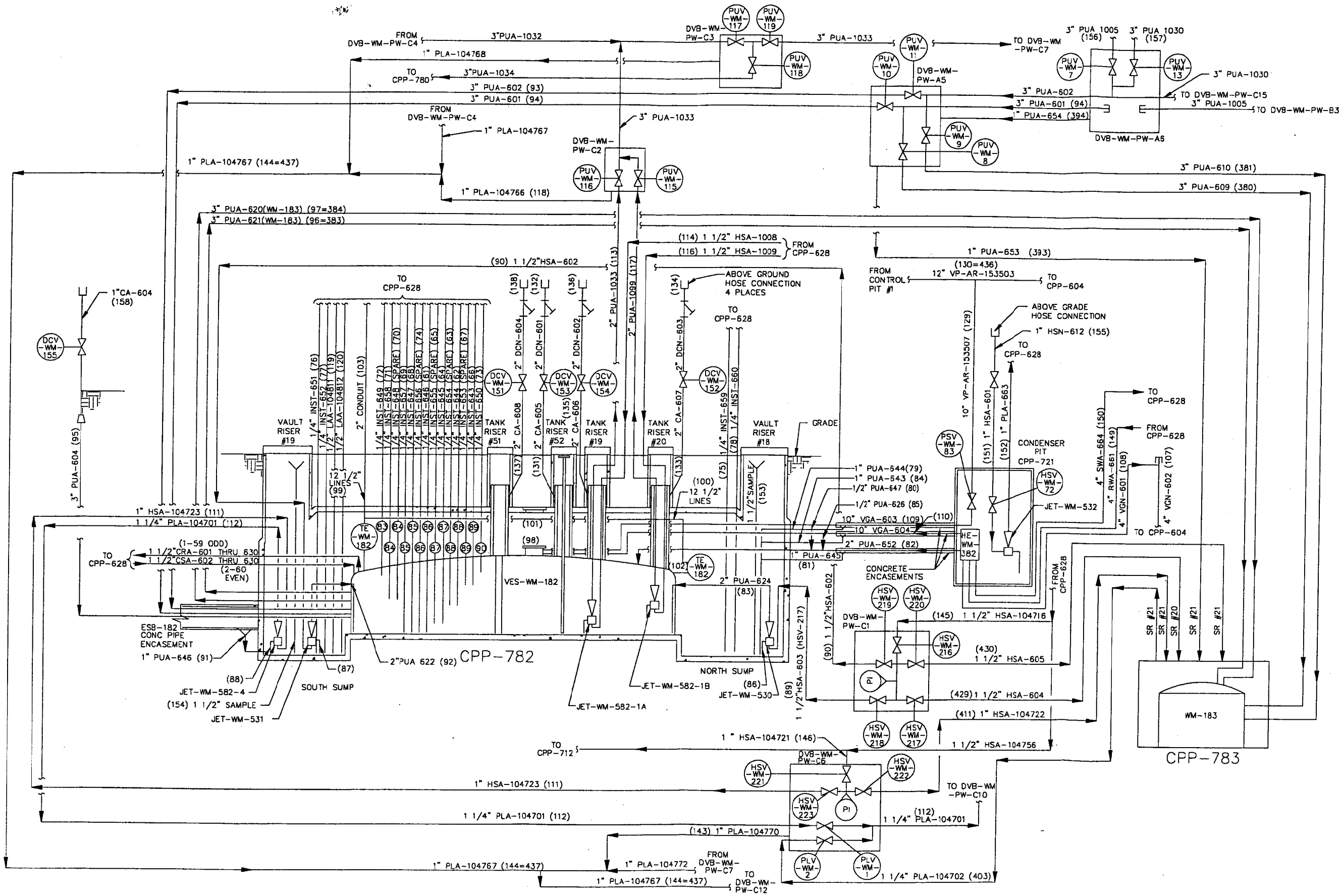

Figure 12 WM-182 Closure P&ID

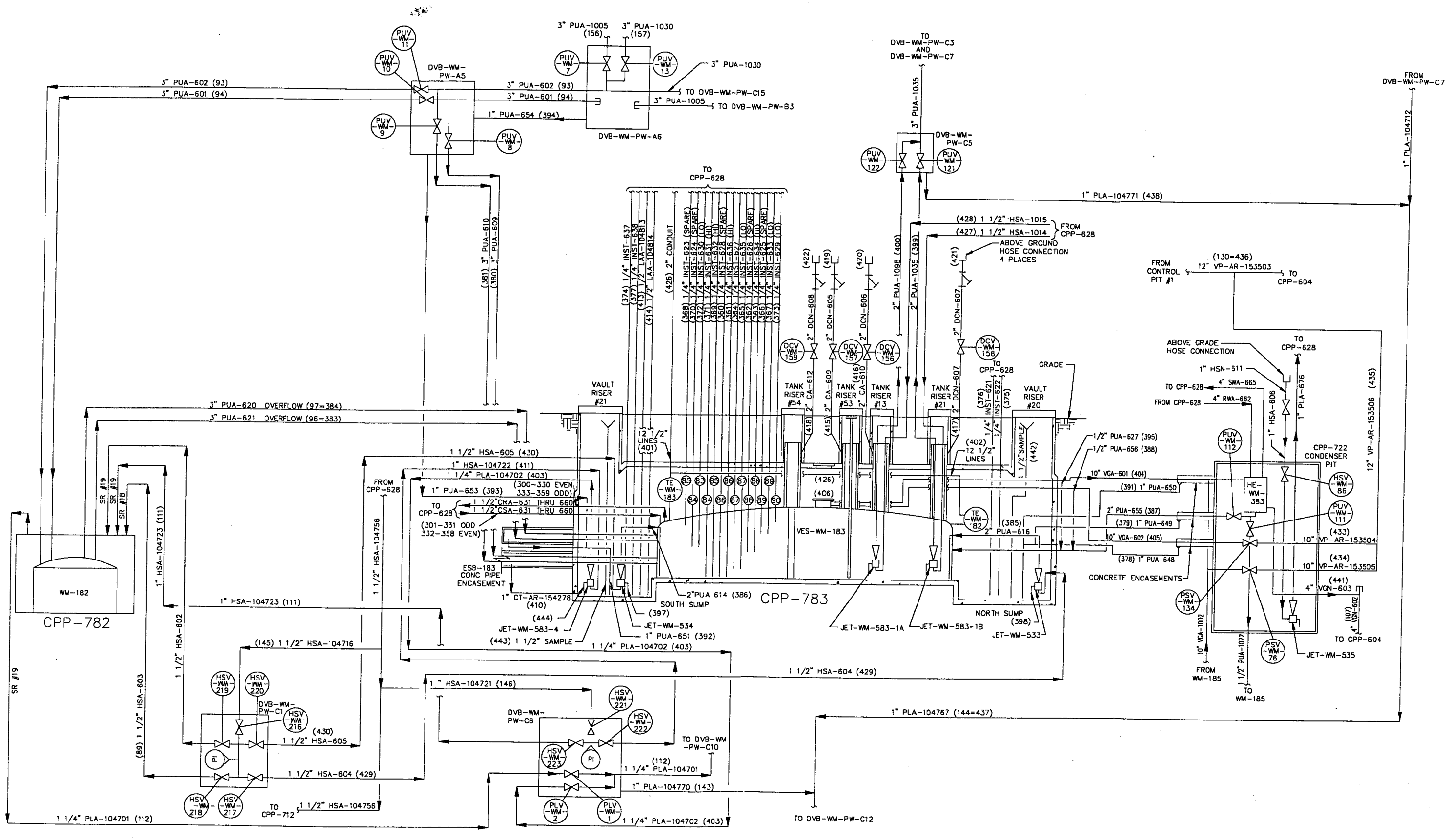

Figure 13 WM-183 Closure P&ID

EDF-015722-022

ENGINEERING DESIGN FILE

1. Project File No. _____ 2. Project/Task INTEC TFF Closure Project

3. Subtask Removal of Suspended Solids and Liquids

4. Title: Existing Steam Jet vs New Pump

5. Summary:

Activity: There are eleven large liquid waste storage tanks (approximately 300,000 gallon each) located in the Tank Farm Facility (TTF) within the Idaho Nuclear Technology and Engineering Center (INTEC) at the Idaho National Engineering and Environmental Laboratory (INEEL). The TFF will be closed in phases over the next fifteen years. The first phase of TFF closure will include tanks WM-182 and WM-183. Part of the waste removal is to remove as much as feasible all remaining liquids and suspended solids from the bottom of the tanks. An earlier study, "INTEC TFF WM-182 and WM-183 Closure Study"[1], suggested using a submersible pump to remove this remaining waste. The new submersible pump was to be placed in another tank riser closer to the side of the tank. This submersible pump was to be used to pump the liquid and solid constituents to above grade levels.
Analysis: The use of existing steam jets to pump the suspended solids instead of a new submersible pump was analyzed. The existing steam jets have demonstrated the capability to pump suspended solids in the past and a means of lowering the existing steam jets has been developed. The steam jets are presently attached to underground piping connected to other locations in the TFF, thus the suspended solids can be pumped to other tanks easily rather than to an above ground location. Steam jets can operate with a mixture of liquid and air in the suction. Steam jets can also be back-flushed to remotely unplug a steam jet if it becomes plugged.
Conclusion: Use the existing steam jets to pump the remaining suspended solids and liquids. Modify the attachment at the top of the steam jets so they can be lowered or raised during operation from their present position. The connection on top of the steam jets riser shall be modified to provide back-flushing capability

6. Distribution (complete package):

Distribution (summary package only): BAKER

7. Review (R) and Approval (A) Signatures: (Minimum reviews and approvals are listed. Additional reviews/approvals may be added as necessary.)

	R/A	Printed Name	Signature	Date
Author	R	E. L. Baker		
Independent Verification	R			
Requestor	A			

Discussion

There are eleven large liquid waste storage tanks (approximately 300,000 gallon each) located in the Tank Farm Facility (TTF) within INTEC at the INEEL. These waste tanks currently use steam powered eductors (steam jets) for removing and/or transferring liquids from the tanks. The inlets of these steam jets are located near the bottom of the tanks (approximately 3" from the bottom of the tank on most of the tanks, and at approximately 9 ½" on the rest). These steam jets are capable of moving approximately 40 to 60 gpm of liquid (with a specific density of about 1.2), depending on the positive pressure suction head on the inlet of the steam jet and the pressure head on the outlet piping of the jet.

The steam jets were installed when the tanks and vaults were constructed, approximately 45 years ago. The motive power for these steam jets is 100 psi steam from a centralized steam source. The steam piping is routed along with the discharge piping down through a 12" riser in the tank, to the steam jet located near the bottom of the tank. The inlet to the steam jet is approximately 45 feet below the top flange of the riser, which is approximately ground level.

The present steam jets are connected to piping that is currently routed underground (shielded by the soil above and the concrete risers from the vault) to other tanks in the tank farm area and to process buildings throughout the INTEC plant. The jets have been used since they were installed in the 50's and have operated with only minor problems. The steam jets have demonstrated that they can pump suspended solids.

There are only two known problems that have been mentioned in operating the steam jets over the years. In a discussion with Frank Ward and Dave Machovek, one time a steam jet pulled some solids from the bottom of the one of the tanks, got lodged in a valve downstream of the pump, and the steam jet stopped pumping. It was later found that this valve was only partially open, the valve was plugged, not the steam jet. The other problem occurs when the steam jet is operating and then stopped when the level of the liquid in the tank is very low. The steam jet sometimes can not be re-started again immediately, have to wait some time before it will pump again. It is theorized this is due to condensate getting into the steam upstream of the jet.

There was a proposal in an earlier conceptual design to replace these steam jets with an electric pump during the final removal of liquids plus suspended solids from the tanks. If new pumps were to be installed in different tank risers within the tank, then the lines would have to be routed above grade to the existing underground piping. The new electric pumps would be installed in risers which currently do not have any pumps installed and are located close to the outside of the tank (approximately 3' from the edge of the tank). The reasoning for placing the submersible pump close to the outside of the tank was to place grout in the riser on the opposite side of the tank to force the suspended solids and liquids towards this pump. In a mock-up of the pouring of grout in a simulated tank this past summer, it was demonstrated that the solids could be moved towards the existing steam jet. The demonstration showed that the remaining liquids would be less using the steam jet than using the submersible pump.

Advantage of Steam jets

Steam jets have many advantages over mechanical pumps in severe conditions. The steam jets have no moving parts to wear out. The steam jets can pump air as well as liquid, thus they can pump to a much lower liquid levels than mechanical pumps. They have demonstrated by past history to be capable of pumping suspended solids. Loss of suction will not damage a steam jet. The steam jets are already connected to shielded discharge waste piping for the transfer of liquids to other locations within INTEC.

Modifications Required to Steam Jets

The existing steam jets are mounted to the top flange on the tank riser. This steam jet mounting bracket will be modified to allow the steam jet to be adjusted to a height from 1" to 9" above the bottom of the tank. The new mounting bracket will also be capable of horizontally moving the steam jets to avoid the piping in the bottom of the tank. The reason some of the steam jets were installed at 9" was that the cooling piping was located directly under the steam jets, so they could not be lowered to the bottom of the tank.

The steam supply piping and waste piping connection to the steam jet will have to be modified to allow for the movement of the jets, and to allow for the jets to be easily back-flushed using steam. This will required some extra valves to be installed on top of the tank riser between the steam jet and the existing steam supply line.

Supporting Data on steam jets

The following study[2] was completed by Stearns Roger in November, 1989 on the decontamination of five of the 300,000 gallon waste storage tanks.

The following statements are quoted directly from this study report.

From Page 3 Executive Summary

"The purpose of this special study is to identify and investigate possible options for decontaminating five 300,000 gallon waste storage tanks (WM-182, WM-183, WM-184, WM-185, and M-186) at the ICPP at INEL. Decontamination will consist of:

Removal of remaining sludge and liquid residue
Washing, chemical cleaning and rinsing of the inside of the tanks
Heel removal and drying"

From Page 3 Executive Summary)

"The preferred method for heel removal is the steam jet."

From Page 32, Section 5.3.1 and 5.3.2

"5.3.1 Pumps

Transfer or heel removal pumps can be provided that fit through a 12-inch riser, pump liquid at 250 gpm, and pump down to within one inch of the tank bottom. A long shaft is required between the motor at the top of the riser and the pump at the tank bottom. Such pumps are inferior for this service to the jet pumps described in the next section because:

Moving parts that wear (bearings and seals, for example) introduce a significantly higher risk of equipment failure.

The combination of flow requirements, small size, and long shaft is unusual. Proven technologies exist to address aspects of this design, but have apparently not been used in combination before. Using a custom type pump implies an additional element of risk.

As liquid level drops, a loss of suction may damage a centrifugal pump but not a jet pump.

Fresh water leakage from bearings and seals increases the volume of contaminated liquid to be removed from the tank.

5.3.2 Steam Jets

A steam jet can be used for final draw down to a minimum level regardless of what sludge removal method is used. advantage of the steam jet is its ability to remove liquid from a flat bottom tank to within one inch depth or less. The steam jet will operate with a mixture of liquid and air in the suction line with no difficulty. The quantity of liquid remaining is only dependent upon how flat the tank bottom is and the length of time used. In most sludge removal options the steam jet will be already in place. No new equipment is needed."

Ejectors (Venturi Jets) are "used for handling radioactive or toxic materials, where pump failure is unacceptable." Quote from Fox Valve Development Corp.

Reference

1. INTEC TFF Tanks WM-182 and WM-183 Closure study INEEL/EXT-98-00913, September 1998, B. C. Spaulding, M. m. Chadwick, K. D. McAllister, L. C. Tuott, S. K. Rvans

2. "SPECIAL STUDY FOR DECONTAMINATION OF EXISTING TANKS, November, 1989 Task 89-03, DOE-ID Contract No. DE-AC07-89ID12679, Stearns-Roger Project No. 9354026"

EDF-015722-023

Lockheed Martin Idaho Technologies Company

Document ID: EDF-015722-023
Revision: 0

IDAHO NATIONAL ENGINEERING & ENVIRONMENTAL LABORATORY

Engineering Design File

for

INTEC TFF Closure
Tank and Vault Seismic Analysis

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(08-96 - Rev. #00)

DOCUMENT MANAGEMENT CONTROL SYSTEM (DMCS)
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Title: INTEC TFF Closure - Tank and Vault Seismic Analysis

Author: B. D. Hawkes and G. K. Miller

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Phone: 526-1572

REVIEW CONCURRENCE AND APPROVAL SIGNATURES
Denote R for review concurrence, A for approval, as appropriate

Type or printed name / Signature	R/A	Date	Organization Discipline	Mailing Address
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A. G. Ware A. G. Ware /DKM	A	5/26/99	41A0	MS 3760

ENGINEERING DESIGN FILE

1. Project File No. 15722 2. Project/Task INTEC TFF Closure

3. Subtask Tank and Vault Seismic Analysis

4. Title: Tank and Vault Seismic Analysis

5. Summary: This summary briefly defines the problem or activity to be addressed in the EDF, gives a summary of the activities performed in addressing the problem and states the conclusions, recommendations, or results arrived at from this task.

Results of the calculations performed in the attached calculation format show that both the tank and vault structures, when filled with grout as specified, meet the acceptance criteria for PC-2 seismic loading.

6. Distribution (complete package): E. C. Anderson, MS 3650 (2 copies); S. A. Jensen, MS 3650; K. D. Quigley, MS 3211 (2 copies); B. D. Hawkes, MS 3760; G. K. Miller, MS 3760; AMG File
Distribution (summary package only): A. G. Ware, MS 3760

7. Review (R) and Approval (A) Signatures: (Minimum reviews and approvals are listed. Additional reviews/approvals may be added as necessary.)

	R/A	Printed Name	Signature	Date
Author	R	B. D. Hawkes	B. D. Hawkes	5/26/99
Author	R	G. K. Miller	G. K. Miller by BDH	5/26/99
Review	R	R. G. RAHL	R. G. Rahl / DKLM	5/26/99
Approval	A	A. G. WARE	A. G. Ware / DKLM	5/26/99
Independent Review	R	S. A. Jensen	S. A. Jensen	6/15/99
Requestor	A	K. D. QUIGLEY	Kurt D. Quigley	6/23/99

Calculation Cover Sheet

Project: INTEC TFF Closure	**Calculation Number:** EDF-015722-023

Calculation Title: Tank and Vault Seismic Analysis

Summary of Calculation Purpose and Objective:

Perform a PC-2 seismic evaluation of the WM-183 tank vault as a representative vault for the tank farm. The vaults will be filled with grout while the tanks will be empty except for a 24-inch layer of grout in the bottom. Verify that a seismic event will not cause a failure of the tank or vault.

Quality Level (MCP-540 Definitions): ☐ 1 ☒ 2 ☐ 3 ☐ Other (Project Defined)

Level of Checking: (Mark all that apply)
☐ Random Check
☒ Detailed Document Review
☐ Independent Calculations

Performance Category (DOE-STD-1020-94): ☐ PC-4 ☐ PC-3 ☒ PC-2 ☐ PC-1 ☐ PC-0 ☐ N/A

Independent Peer Review Required (required by DOE-STD-1020 for PC-2 or higher)? ☒ Yes ☐ No

Summary of Conclusions and Recommendations:

Results of the calculations performed show that both the tank and vault structures, when filled with grout as specified, meet the acceptance criteria for PC-2 seismic loading.

Revision Information and Signatures/Approvals(sign and date below typed or printed names)

Checker - Note pages checked next to signature. The checker's signature signifies that the pages noted have been checked at the level indicated above and using the methods indicated above. Thus, the checker's initials or signature is not required to appear on every page checked.

Rev. No.	Date	Description	Affected Pages
0		Initial issue	All

Originator Signature	Checker Signature	Group Lead/Supervisor Approval
B. D. Hawkes	R G Rahl 5-25-99 p 1-8, A1, B1-34, C1-7	A.G. WARE A G Ware / DKW 5/26/99
G K Miller	D1-13	

Calculation Sheet

Project: INTEC TFF Closure **Calc. No.:** EDF-015722-023 **Rev.:** 0

Calc. Title: Tank and Vault Seismic Analysis

Originator: B. D. Hawkes and G. K. Miller **Date:** 05/26/99 **Checked By:** R. G. Rahl **Date:** 05/26/99

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Project: INTEC TFF Closure **Calc. No.:** EDF-015722-023 **Rev.:** 0
Calc. Title: Tank and Vault Seismic Analysis
Originator: B. D. Hawkes and G. K. Miller **Date:** 05/26/99 **Checked By:** R. G. Rahl **Date:** 05/26/99

Purpose

Perform a PC-2 seismic evaluation of a representative vault for the tank farm. The vaults will be filled with grout while the tanks will be empty except for a 24-inch layer of grout in the bottom. Verify that a seismic event will not cause a failure of the tank or vault.

Scope

This seismic evaluation is focused on the WM-183 tank vault as a representative vault for the tank farm.

Quality Level

This project has been assigned a Quality Level 2.

Natural Phenomena Hazards (NPH) Performance Category (PC)

The seismic loading for this facility is designated as Performance Category 2 (PC-2).

Structure, System, or Component (SSC) Description

The tank vault is an underground reinforced concrete structure that rests on bedrock. It is composed of a thick slab (~30 in.) that rests on bedrock, walls that consist of concrete panels attached to columns, and a roof consisting of beams and slabs. The vault is approximately 39 ft high, the top of which is under 10 ft of soil. The vault encloses a 300,000-gallon stainless steel storage tank.

Materials

The vault structure is fabricated of reinforced concrete. The concrete in the facility dates back to the 1960 timeframe. Since the specifications for the concrete in these vault structures are not available, it is assumed that all of the concrete has a nominal compressive strength of 3000 psi. The steel reinforcement in concrete of this vintage is expected to have a yield strength of 40,000 psi. The storage tank is fabricated from 304L stainless steel, which has a minimum yield stress of 25,000 psi.

The material properties used in the analysis are summarized in the tables below.

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Material Property Nomenclature:

Metals -

$E \equiv$ Modulus of elasticity (psi)
$\rho \equiv$ Density (lb/ft^3)
$f_y \equiv$ Yield stress (ksi)

Reinforced Concrete -

$w_c \equiv$ Unit weight (density) (lb/ft^3)
$f_c' \equiv$ Concrete compressive strength (psi)
$7.5(f_c')^{0.5} \equiv$ Concrete tensile strength (Modulus of rupture) (psi)
$E_c \equiv$ Modulus of elasticity of concrete (psi), (determined using ACI Code equation, $E=57000(f_c')^{0.5}$)
$m \equiv$ Poisson's ratio
$f_y \equiv$ Yield strength of nonprestressed reinforcement bars (psi)

Table 1. Material properties - metals.

Material	Temp. (°F)	E (10^6 psi)	ρ (lb./in^3)	f_y (ksi)		Data Reference
304L stainless steel	70	28.3	0.29	25.0		Ref. 1

Table 2. Material properties - concrete

w_c (lb./ft^3)	f_c' (psi)	$7.5(f_c')^{0.5}$ (psi)	E_c (10^6 psi)	m	f_y (psi)	Material
150	3000	411	3.12	0.2	40000	Reinforced Concrete
135	3000	411	3.12	0.2		Grout

Loads

The loads considered in this evaluation include the weight of the vault, grout, and storage tank; vertical soil pressure on the roof of the vault; static soil pressure on the walls of the vault; dynamic soil pressure on the walls of the vault; and PC-2 level seismic loading. The magnitude of the PC-2 loading was determined from the 1997 Uniform Building Code (UBC), Ref 2. The properties of the soil were obtained from Ref. 3. All of these loadings were applied in a static analysis of the tank and vault. Load combinations were in accordance with the ACI-318 Code (Ref. 4). Details of the loadings applied are as follows:

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The weight loadings were incorporated in the analysis by applying a 1 g downward vertical acceleration to all the masses in the structure.

The vertical soil pressure applied to the roof of the vault corresponded to a 10-ft. soil depth above the roof. The soil was assumed to have a density of 125 pcf in accordance with Ref. 3. This gave a vertical soil pressure at the roof level of

$$p = \gamma h = 125(10) = 1250 \ psf$$

To this was added a 35 psf snow load (Ref. 5) to give a total pressure on the roof of

$$p = 1250 + 35 = 1285 \ psf$$

A static soil pressure was applied around the circumference of the vault wall. The magnitude of this pressure varies with depth based on a lateral earth pressure of 50 pcf (Ref. 3, for a wet soil). The top of the vault walls is at a depth of 14.25 ft., giving a lateral pressure of

$$p_{top} = 50(14.25) = 712.5 \ psf$$

The base of the vault walls is at a depth of 46.25 ft, giving a lateral pressure of

$$p_{base} = 50(46.25) = 2312.5 \ psf$$

The soil pressure was varied linearly between these values through the height of the walls.

The dynamic soil pressure is induced by the seismic loads, and was applied in the analysis along one side of the vault structure. The pressure was applied in the form of a resultant force determined in accordance with Ref. 6, Section 3.5.4 (p. 38):

$$F_r = \alpha_H C_v \gamma H^2$$

where,

α_H = horizontal earthquake acceleration (g) = 0.194 (as determined below)

C_v = coefficient as a function of Poisson's ratio = 0.94 (for ν=0.3, per Ref. 3)

γ = soil unit weight = 125 pcf

H = embedment height = 32 ft (height of vault walls)

On substitution,

$$F_r = 23342 \ lbf / ft$$

Per Ref. 6, this resultant force was applied at a height of 0.6H, or 19.2 ft, above the base of the vault walls. It was applied as a line load along one side of the vault structure in the direction of the earthquake loading.

The magnitude of the PC-2 seismic load was determined in accordance with UBC criteria (Ref. 2), as follows:

Per Eqn. (30-4) of Ref. 2, the total design base shear in a given direction is

$$V = \left(\frac{C_v I}{RT}\right) W$$

where.

C_v = seismic coefficient per Table 16-R = 0.4 (for seismic zone Z = 2 and a stiff soil S_D)

I = importance factor per Table 16-K = 1.25 (for a hazardous facility)

R = numerical coefficient per Table 16-N = 4.5 (for a concrete structure with shear walls)

T = fundamental period of vibration = $C_t(h_n)^{3/4}$

C_t = 0.02 (per 1630.2.2 of UBC)

h_n = overall height of vault structure = 39 ft.

On substitution,

$$V = 0.356W$$

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According to Eqn. (30-5), however, the base shear need not exceed

$$V = \left(\frac{2.5C_a I}{R}\right)W$$

where, Ca = seismic coefficient per Table 16-Q = 0.28

Thus, the base shear need not exceed

$$V = 0.194W$$

This value was used in the analysis as a base shear load. In the analysis, it was distributed over the height of the structure in accordance with Eqn. (30-15) of Ref. 2. Because of the very small period *T* for the structure, the force F_t in this equation was zero. Included in the weight W for this base shear was the weight of 25% of the soil column above the vault roof. The mass of this quantity of soil was assumed to move with the roof during the earthquake. The specifics of this earthquake load application are shown in the calculations of Appendix B. All of the base shear loading was assumed to be reacted at the base of the vault structure (i.e., no passive soil pressure was assumed).

Because the vault is a concrete structure, the loads were combined and factored in accordance with the requirements of Ref. 4, Eq. (9-2), which gives the following:

$$U = 0.75(1.4D + 1.7H + 1.7(1.1E))$$

or

$$U = 1.05D + 1.28H + 1.40E$$

where *D*, *H* and *E* represent the weight, soil pressure, and earthquake loads, respectively. The dynamic soil pressure was treated as part of the earthquake load *E* in the analysis. Orthogonal effects of earthquake loading were considered in accordance with Ref. 2, 1633.1, by applying the full earthquake loading in one direction simultaneously with 30% of the full load in the perpendicular direction. The sign of the 30% load was reversed in a separate load case to assure that the worst load combination was considered.

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Assumptions

The assumptions used in the analysis are as follows:

The grout in the void between the vault and the tank has cured to its 28-day strength of 3000 psi.

There is no void between the roof of the vault and the grout above the tank.

The bottom of the tank has a 24-in. layer of grout.

Acceptance Criteria

The reinforced concrete is acceptable if the calculated loadings are within its strength as determined according to Ref. 4. Stresses in the tank are considered to be acceptable if they lie within the yield strength of the tank material. These acceptance criteria are as specified in Ref 7.

Calculations

The calculations performed are contained in Appendices B and C.

Conclusions

Results of the analyses performed show that the vault and tank structures, when filled with grout as described above, meet the acceptance criteria for PC-2 seismic loading.

References

1. American Society of Mechanical Engineers, ASME Boiler and Pressure Vessel Code, Section II, Part D, 1998.

2. International Conference of Building Officials, 1997 Uniform Building Code, Volume 2, Structural Engineering Design Provisions, April 1997.

3. Golder Associates, Inc., High Level Waste Tank Farm Replacement Project Geotechnical Investigation for Westinghouse Idaho Nuclear Company, November 16, 1992.

4. American Concrete Institute, Building Code Requirements for Structural Concrete (ACI 318-95) and Commentary (ACI 318R-95), October 1996.

5. DOE-ID Architectural Engineering Standards, Revision 25, December 1998.

6. American Society of Civil Engineers, Seismic Analysis of Safety-Related Nuclear Structures and Commentary on Standard for Seismic Analysis of Safety Related Nuclear Structures, ASCE 4-86, September 1986.

7. Lockheed Martin Idaho Technologies Co., Facility Engineering Work Agreement for INTEC TFF Closure, Project File No. 15722, February 9, 1999.

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Appendix A - Computer Code Verification Information

Project: INTEC TFF Closure **Calc. No.:** **Rev.:** 0
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Table A1. Computer code verification information.

Program	Version	Module	Computer	Model	V&V Reference
ABAQUS	5.8-1	Standard & Explicit	Medusa	Sun Enterprise 5000	See list below - item 1

1. Hawkes, B. D., "Verification of HKS ABAQUS 5.8-1 for Sun Enterprise 5000 (Medusa) Compute Server-BDH-01-99," LMITCO Interdepartmental Communication, February 15,1999.

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Appendix B – Verification of Adequacy of Members in Vault Structure

Member Capacities and Loadings

The calculations below determine load capacities for the essential concrete members of the vault structure, and compare these capacities to the calculated loadings for the members. The loadings in members of the vault roof are determined in the calculations below. Loadings in all other members of the vault and tank structures were determined in a separate finite element analysis (using the ABAQUS program), which is discussed in Appendix C. ABAQUS results that are used in the calculations below are attached to this Appendix, and correspond to the worst case analyzed.

Roof Beam RB2

The bending capacity of the roof beams designated RB2 is determined below according to the ultimate strength theory of the ACI-318 Code (Ref. 1).

Per the drawings (Ref. 2), the RB2 beams have three rows of nine #11 bars plus four #8 bars for tension reinforcement. This gives a steel area of

$$A_s := (27\cdot(1.56) + 4\cdot(.79))\cdot in^2$$

$$A_s = 45.28\cdot in^2$$

The average depth to this bottom reinforcement is

$$d := (51 - 7)\cdot in$$

$$d = 44\cdot in$$

The beam width is

$$b := 30\cdot in$$

The yield strength for the reinforcement is

$$f_y := 40000\cdot\frac{lbf}{in^2}$$

The compressive strength for the concrete is

$$f_c := 3000\cdot\frac{lbf}{in^2}$$

The ACI-318 strength reduction factor for flexure is

$$\phi := 0.9$$

The equation for ultimate moment capacity for a beam is

$$M_u := \phi \cdot A_s \cdot f_y \cdot d \cdot \left(1 - .59 \cdot \frac{f_y}{f_c} \cdot \frac{A_s}{b \cdot d}\right)$$

On substitution, this becomes

$$M_u = 5.237 \cdot 10^7 \cdot in \cdot lbf$$

Vertical Soil Pressure:

Per Ref. 3, the design unit weight for the soil is 125 pcf. For a 10-ft column of soil over the vault roof, this translates to a vertical soil pressure of (conservatively assuming a cohensionless soil):

$$p_v := 125 \cdot 10 \cdot \frac{lbf}{ft^2}$$

$$p_v = 1.25 \cdot 10^3 \cdot \frac{lbf}{ft^2}$$

Adding in the effect of a 35-psf snow load this becomes

$$p_v := p_v + 35 \cdot \left(\frac{lbf}{ft^2}\right)$$

$$p_v = 1.285 \cdot 10^3 \cdot \frac{lbf}{ft^2}$$

Per the drawings (Ref. 2), a typical RB2 roof beam is responsible for a 60 x 6-ft area of soil pressure. This translates to a uniform load (per unit length) on the beam of

$$w := p_v \cdot (6) \cdot ft$$

$$w = 7.71 \cdot 10^3 \cdot \frac{lbf}{ft}$$

This is amplified by the ACI-318 Code factor of 1.28 for soil loading

$$w := 1.28 \cdot w$$

$$w = 9.869 \cdot 10^3 \cdot \frac{lbf}{ft}$$

To this is added the weight of the beam and supported roof slabs. As shown in the calculation for the weight of the roof, a 1-ft length of beam weighs:

$$w_b := 1681 \cdot \frac{lbf}{ft}$$

The 6-in. thick roof slabs weigh 75 psf (per calculations below). This translates to a uniform load on the beam of

$$w_s := 75 \cdot 6 \cdot \frac{lbf}{ft} \qquad w_s = 450 \cdot \frac{lbf}{ft}$$

Applying an ACI-318 Code factor of 1.05 to the deadweight loading, the total beam load becomes

$$w := w + 1.05 \cdot (w_b + w_s)$$

$$w = 1.211 \cdot 10^4 \cdot \frac{lbf}{ft}$$

Assuming simply supported ends for the beam, this loading results in a maximum bending moment of (for the 60-ft beam length):

$$l := 60 \cdot ft$$

$$M_{max} := \frac{w \cdot l^2}{8}$$

$$M_{max} = 6.537 \cdot 10^7 \cdot in \cdot lbf$$

This moment exceeds the calculated moment capacity by 25%. However, the vault roof receives support from the grout immediately below, which will relieve this overstress. In the finite element analyses performed using ABAQUS, it was shown that the vault roof on its own would deflect more than the grout beneath it. This shows that the roof contacts the grout, thereby receiving support from it. Because of the support from the grout, the shear loadings on these roof beams are expected to be insignificant.

Roof Beam B1

The capacity for the RB1 roof beams is calculated similarly to that above. These have tension reinforcement consisting of two rows of eight #11 bars plus four #8 bars, giving a steel area of

$$A_s := (16\cdot(1.56) + 4\cdot(.79))\cdot in^2$$

$$A_s = 28.12\cdot in^2$$

The depth to reinforcement, beam width, and ultimate capacity are:

$$d := (51 - 3.5)\cdot in$$

$$d = 47.5\cdot in$$

$$b := 30\cdot in$$

$$M_u := \phi\cdot A_s\cdot f_y\cdot d\cdot\left(1 - .59\cdot\frac{f_y}{f_c}\cdot\frac{A_s}{b\cdot d}\right)$$

$$M_u = 4.062\cdot 10^7\cdot in\cdot lbf$$

A typical R1 roof beam is responsible for a 41.83 x 9.08-ft area of vertical soil pressure. This gives a uniform load along its length of:

$$w := p_v\cdot(9.08)\cdot ft$$

$$w = 1.167\cdot 10^4\cdot\frac{lbf}{ft}$$

Amplifying this soil load by 1.28,

$$w := 1.28 \cdot w$$

$$w = 1.493 \cdot 10^4 \cdot \frac{lbf}{ft}$$

To this is added the weight of the beam and supported roof slabs. As shown in the calculation for the weight of the roof, a 1-ft length of beam weighs:

$$w_b := 1681 \cdot \frac{lbf}{ft}$$

The 6-in. thick roof slabs weigh 75 psf. This translates to uniform load on the beam of

$$w_s := 75 \cdot (9.08) \cdot \frac{lbf}{ft} \qquad w_s = 681 \cdot \frac{lbf}{ft}$$

Applying an ACI-318 Code factor of 1.05 to the deadweight loading, the total beam load becomes

$$w := w + 1.05 \cdot (w_b + w_s)$$

$$w = 1.741 \cdot 10^4 \cdot \frac{lbf}{ft}$$

For a beam length of 41.83 ft, this gives a maximum bending moment in the beam of:

$$l := 41.83 \cdot ft$$

$$M_{max} := \frac{w \cdot l^2}{8}$$

$$M_{max} = 4.571 \cdot 10^7 \cdot in \cdot lbf$$

This moment exceeds the calculated moment capacity by 12.5%. However, the vault roof receives support from the grout immediately below, which will relieve this overstress. Because of the support from the grout, the shear loadings on these roof beams are expected to be insignificant.

RB3, RB4

The RB3 beams support load applied by the RB2 beams, so should be more heavily loaded than the RB4 beams. Per the drawings (Ref. 2), the RB3 beams have one row of eight #11 bars for tension reinforcement. This gives a steel area of

$$A_s := (8 \cdot 1.56) \cdot in^2$$

$$A_s = 12.48 \cdot in^2$$

The depth to this bottom reinforcement is

$$d := (36 - 3) \cdot in$$

$$d = 33 \cdot in$$

The beam width is

$$b := 30 \cdot in$$

The equation for ultimate moment capacity for a beam is

$$M_u := \phi \cdot A_s \cdot f_y \cdot d \cdot \left(1 - .59 \cdot \frac{f_y}{f_c} \cdot \frac{A_s}{b \cdot d}\right)$$

On substitution, this becomes

$$M_u = 1.336 \cdot 10^7 \cdot in \cdot lbf$$

The RB3 beams support load applied by the RB2 roof beams. The loading on the RB2 beams was

$$w := 1.211 \cdot 10^4 \cdot \frac{lbf}{ft}$$

An RB2 beam is 60 ft long. An RB3 beam would carry the loading from a 30-ft length of an RB2 beam. This gives a force of

$F := (30 \cdot ft) \cdot w$

$F = 3.633 \cdot 10^5 \cdot lbf$

which is applied midspan to an RB3 beam. An RB3 beam spans 8.3 ft, giving a moment of

$M := \frac{F \cdot (8.3 \cdot ft)}{4}$ $\qquad M = 9.046 \cdot 10^6 \cdot in \cdot lbf$

This is much less than the capacity calculated above. As would be expected, this moment is substantially higher than what was calculated in the finite element analysis. Therefore, the maximum moment was determined to be (per Fig. B19):

$M_{max} := 3.10 \cdot 10^4 \cdot in \cdot lbf$

This value reflects the support that the roof beams RB1 and RB2 receive from the grout. The maximum shear force for either an RB3 or RB4 beam as calculated by the finite element analysis is (see Figs. B21 and B22):

$V := 4.71 \cdot 10^3 \cdot lbf$

$\tau := \frac{V}{2 \cdot (30) \cdot (36) \cdot in^2}$ $\qquad \tau = 2.181 \cdot \frac{lbf}{in^2}$

Using Eq. (11-3) of the ACI Code, the shear stress shall not exceed

$\tau_a := 2 \cdot \phi \cdot \sqrt{f_c} \cdot \frac{lbf^{.5}}{in}$

where ϕ is a strength reduction factor, which is set equal to 0.85 for shear loading per 9.3.2.3 of the ACI Code. Thus,

$\phi := 0.85$

$\tau_a = 98.59 \cdot \frac{lbf}{in^2}$

The shear stresses in these beams are acceptable.

Roof Slab Bending

The slab is reinforced with #6 bars at a 7-in. spacing. On average, the reinforcement in a 1-ft width of the slab is

$$A_s := .44 \cdot \frac{12}{7} \cdot in^2$$

$$A_s = 0.754 \cdot in^2$$

$$b := 12 \cdot in$$

$$d := 4.5 \cdot in$$

$$M_u := \phi \cdot A_s \cdot f_y \cdot d \cdot \left(1 - .59 \cdot \frac{f_y}{f_c} \cdot \frac{A_s}{b \cdot d}\right)$$

$$M_u = 1.027 \cdot 10^5 \cdot in \cdot lbf$$

The loading on a 5.85 x 1-ft span of roof slab caused by the vertical soil pressure is

$$w := p_v \cdot (1) \cdot ft$$ over the 5.85-ft span

$$w = 1.285 \cdot 10^3 \cdot \frac{lbf}{ft}$$

Amplifying by a factor of 1.28,

$$w := 1.28 \cdot w$$

$$w = 1.645 \cdot 10^3 \cdot \frac{lbf}{ft}$$

To this is added the weight of the roof slab itself. The slab weight of 75 psf translates to a uniform load of:

$$w_s := 75 \cdot (1) \cdot \frac{lbf}{ft}$$

Applying a factor of 1.05 to this deadweight loading, the total beam load becomes

$w := w + 1.05 \cdot w_s$

$w = 1.724 \cdot 10^3 \cdot \frac{lbf}{ft}$

This gives a maximum moment in the 5.85-ft span of

$l := 5.85 \cdot ft$

$M_{max} := \frac{w \cdot l^2}{8}$

$M_{max} = 8.848 \cdot 10^4 \cdot in \cdot lbf$

The roof slab has ample capacity to carry the load without taking credit for support from the grout below. Calculations below verify that the slabs are also adequate for shear loading.

Shear Stress in Lip of Roof Beam

The lips on the roof beams (RB1 and RB2) must sustain the shear loading imposed by the roof slabs. The slabs span 5.85 ft between the beams. Attributing half the loading carried by the floor slab to one lip, the loading on the lip per unit length of the beam is

$w := p_v \cdot 2.93 \cdot ft$

$w = 3.765 \cdot 10^3 \cdot \frac{lbf}{ft}$

Amplifying this by the Code factor of 1.28 for soil load,

$w := 1.28 \cdot w$

$w = 4.819 \cdot 10^3 \cdot \frac{lbf}{ft}$

To this is added the weight of the roof slab itself. The slab weight of 75 psf translates to a uniform load of:

$$w_s := 75 \cdot (2.93) \cdot \frac{lbf}{ft}$$

Applying a factor of 1.05 to this deadweight loading, the total beam load becomes

$$w := w + 1.05 \cdot w_s$$

$$w = 5.05 \cdot 10^3 \cdot \frac{lbf}{ft}$$

This translates to a bearing stress on the concrete in the lip of

$$\sigma_{bear} := \frac{w}{6 \cdot in}$$

$$\sigma_{bear} = 70.139 \cdot \frac{lbf}{in^2}$$ which is insignificant

The lips are 7 in. deep. Therefore, the shear area in a 1-ft length of beam is

$$A_s := 12 \cdot (7) \cdot \frac{in^2}{ft}$$

$$A_s = 84 \cdot \frac{in^2}{ft}$$

This gives an average shear stress of

$$\tau := \frac{w}{A_s}$$

$$\tau = 60.119 \cdot \frac{lbf}{in^2}$$

Using Eq. (11-3) of the ACI Code, the shear stress shall not exceed

$$\tau_a := 2 \cdot \phi \cdot \sqrt{f_c} \cdot \frac{lbf^{.5}}{in}$$

where ϕ is a strength reduction factor, which is set equal to 0.85 for shear loading per 9.3.2.3 of the ACI Code. Thus,

$\phi := 0.85$

$\tau_a = 93.113 \cdot \frac{lbf}{in^2}$

Thus, the calculated shear stress is acceptable.

Because these 7-in. thick lips are adequate for the shear loading, it is evident that the 6-in. thick roof slabs will also adequately carry the shear loading. These results do not rely on the presence of the grout beneath the roof slabs.

The lip also sees a small bending moment, which could be as high as

$M := (6 \cdot in) \cdot w$

$M = 3.03 \cdot 10^4 \cdot \frac{in \cdot lbf}{ft}$

The resisting moment of inertia in a 1-ft length is

$I := \frac{12 \cdot 7^3}{12} \cdot \frac{in^4}{ft}$ $\qquad$ $I = 343 \cdot \frac{in^4}{ft}$

This would give a tensile stress in the concrete of

$\sigma := \frac{M \cdot (3.5 \cdot in)}{I}$

$\sigma = 309.184 \cdot \frac{lbf}{in^2}$

This is less than the modulus of rupture for the material (411 psi), indicating that the concrete will not fail. The presence of rebar ties in the lip region enhances the strength of the lip. The presence of the grout beneath the roof slabs should also reduce the loading on these lips. Therefore, they are acceptable for the applied loads.

Wall Panel Capacity

The wall panels are designated P1 on the drawings (Ref. 2), and have a 6-in. thickness. They have horizontal and vertical reinforcement on the outside face. These consist of #7 bars at 6-in. spacing and #4 bars at 1-ft. spacing, respectively. The moment capacities for these panels are as follows:

Considering capacity for the horizontal direction per unit height of a panel,

$$A_s := .6 \cdot \left(\frac{12}{6}\right) \cdot in^2$$

$$A_s = 1.2 \cdot in^2$$

$$d := 4.5 \cdot in$$

$$b := 12 \cdot in$$

$$M_u := \phi \cdot A_s \cdot f_y \cdot d \cdot \left(1 - .59 \cdot \frac{f_y}{f_c} \cdot \frac{A_s}{b \cdot d}\right)$$

$$M_u = 1.515 \cdot 10^5 \cdot in \cdot lbf$$

The maximum calculated moment in this direction from the finite element analysis was (per Fig. B-2):

$$M_{max} := 1.34 \cdot 10^3 \cdot in \cdot lbf$$

This lies well within the moment capacity.

Considering capacity for the vertical direction per unit length of a panel,

$$A_s := 0.2 \cdot in^2$$

$$d := (4.5 - .4375 - .25) \cdot in$$

$$d = 3.813 \cdot in$$

$$M_u := \phi \cdot A_s \cdot f_y \cdot d \cdot \left(1 - .59 \cdot \frac{f_y}{f_c} \cdot \frac{A_s}{b \cdot d}\right)$$

$$M_u = 2.503 \cdot 10^4 \cdot in \cdot lbf$$

The maximum calculated moment in this direction from the finite element analysis was (per Fig. B-1):

$$M_{max} := 4.15 \cdot 10^2 \cdot in \cdot lbf$$

Again, this is well within the bending capacity of the panels.

The maximum calculated transverse shear force for the wall panels was (per Figs. B-6 and B-7):

$$F_t := 1.56 \cdot 10^2 \cdot \frac{lbf}{ft}$$

The corresponding shear area for the 6-in. thick panels is

$$A := 6 \cdot (12) \cdot \frac{in^2}{ft}$$

$$A = 72 \cdot \frac{in^2}{ft}$$

The resulting shear stress is

$$\tau := \frac{F_t}{A} \qquad \tau = 2.167 \cdot \frac{lbf}{in^2}$$

This is obviously acceptable.

Columns

The vault structure has two types of columns having cross-sections as shown on the attached sketches. Listed with the sketches are the cross-sectional areas and moments of inertia for the columns as calculated by the I-DEAS program. The basic axial load capacities for these members are as follows:

Corner Columns:

$$A_1 := 1886.93 \cdot in^2$$

This member has a total of nineteen #11 bars having a total steel area of

$$A_{s1} := 19 \cdot (1.56) \cdot in^2$$

The axial capacity is

$$P_0 := \phi \cdot \left(.85 \cdot f_c \cdot A_1 + f_y \cdot A_{s1}\right) \qquad \phi := 0.70$$

(strength reduction factor for axial loading)

$P_0 = 5.098 \cdot 10^6 \cdot lbf$

Mid-side Columns:

For the second beam section (columns at the mid-sides):

$A_2 := 1236.0 \cdot in^2$

This member has a total of twenty #11 bars having a total steel area of

$A_{s2} := 20 \cdot (1.56) \cdot in^2$ $\qquad$ $A_{s2} = 31.2 \cdot in^2$

The axial capacity becomes

$P_0 := \phi \cdot (.85 \cdot f_c \cdot A_2 + f_y \cdot A_{s2})$

$P_0 = 3.08 \cdot 10^6 \cdot lbf$

Results:

The maximum calculated axial force for a <u>corner</u> column was (per Fig. B-10):

$P_{max} := 2.85 \cdot 10^5 \cdot lbf$

This is much less than the axial load capacity determined above.

The maximum bending moments about the strong and weak axes of this section, respectively, were calculated to be (per Figs. B8 and B9):

$M_s := 4.0 \cdot 10^5 \cdot in \cdot lbf$ $\qquad$ $M_w := 6.94 \cdot 10^5 \cdot in \cdot lbf$

These cause bending stresses in the section of:

$\sigma_s := \dfrac{M_s \cdot 21.37 \cdot in}{328269 \cdot in^4}$ $\qquad$ $\sigma_w := \dfrac{M_w \cdot 25.87 \cdot in}{251192 \cdot in^4}$

$\sigma_s = 26.04 \cdot \dfrac{lbf}{in^2}$ $\qquad$ $\sigma_w = 71.474 \cdot \dfrac{lbf}{in^2}$

These small bending stresses are well within the modulus of rupture for the concrete (which doesn't even account for the presence of the rebar.) Since the axial force and bending stresses are each much smaller than capacity, these members are acceptable for axial loads and bending.

The maximum components of shear force for any these columns are (per Figs. B11 and B12):

$V_1 := 1.79 \cdot 10^4 \cdot lbf$ $\qquad$ $V_2 := 2.73 \cdot 10^4 \cdot lbf$

Conservatively combining these components into a resultant gives

$R := \sqrt{V_1^2 + V_2^2}$ $\qquad$ $R = 3.265 \cdot 10^4 \cdot lbf$

This gives an average shear stress in the section of

$\tau := \frac{R}{A_1}$ $\qquad$ $\tau = 17.301 \cdot \frac{lbf}{in^2}$

This lies within the shear capacity of the concrete.

The maximum calculated axial force for a <u>mid-side</u> column was (per Fig. B15):

$P_{max} := 1.51 \cdot 10^5 \cdot lbf$

This is well within the axial load capacity determined above.

The maximum bending moments about the strong and weak axes of this section, respectively, were calculated to be (per Figs. B13 and B14):

$M_s := 3.02 \cdot 10^5 \cdot in \cdot lbf$ $\qquad$ $M_w := 5.43 \cdot 10^5 \cdot in \cdot lbf$

These cause bending stresses in the section of

$\sigma_s := \frac{M_s \cdot 18.73 \cdot in}{125633 \cdot in^4}$ $\qquad$ $\sigma_w := \frac{M_w \cdot 18 \cdot in}{125428 \cdot in^4}$

$\sigma_s = 45.024 \cdot \frac{lbf}{in^2}$ $\sigma_w = 77.925 \cdot \frac{lbf}{in^2}$

These small bending stresses are again well within the modulus of rupture for the concrete (which doesn't even account for the presence of the rebar.) Since the axial force and bending stresses are each much smaller than capacity, these members are acceptable for axial loads and bending.

This confirms that the maximum calculated moment is well within the moment capacity for the column.

The maximum components of shear force for any these columns are (per Figs. B16 and B17):

$V_1 := 1.6 \cdot 10^4 \cdot lbf$ $V_2 := 3.02 \cdot 10^4 \cdot lbf$

Conservatively combining these components into a resultant gives

$R := \sqrt{V_1^2 + V_2^2}$ $R = 3.418 \cdot 10^4 \cdot lbf$

This gives an average shear stress in the section of

$\tau := \frac{R}{A_1}$ $\tau = 18.112 \cdot \frac{lbf}{in^2}$

This lies within the shear capacity of the concrete.

Weight of Vault Roof

The following calculations determine a total weight for the vault roof, which is needed for the application of earthquake loading in the analysis of the vault structure. The weight of the vault roof is broken into components as follows. Dimensions and member sizes were obtained from the drawings (Ref. 2):

Length of beams RB1, RB2, and RB5 are as follows:

$l_1 := 2\cdot(41.82)\cdot ft$ $\qquad l_1 = 83.64\cdot ft$

$l_2 := 5\cdot(60)\cdot ft$ $\qquad l_2 = 300\cdot ft$

$l_5 := 6\cdot(8.60)\cdot ft$ $\qquad l_5 = 51.6\cdot ft$

The areas of 6-in. thick slab are

$a_1 := 4\cdot(3.734)\cdot(60)\cdot ft^2$ $\qquad a_1 = 896.16\cdot ft^2$

$a_2 := 2\cdot(5.849)\cdot(50.91)\cdot ft^2$ $\qquad a_2 = 595.545\cdot ft^2$

$a_3 := 4\cdot(9.302)\cdot(8.599)\cdot ft^2$ $\qquad a_3 = 319.952\cdot ft^2$

$a_4 := 4\cdot(.5)\cdot(8.5)^2\cdot ft^2$ $\qquad a_4 = 144.5\cdot ft^2$

The total area of roof slab is

$A := a_1 + a_2 + a_3 + a_4$

The weights per unit length for the roof beams are

RB1

$w_1 := (2.5\cdot(3.667) + 3.5\cdot(.583))\cdot(1)\cdot(150)\cdot\frac{lbf}{ft}$ $\qquad w_1 = 1.681\cdot 10^3\cdot\frac{lbf}{ft}$

RB2

$w_2 := w_1$ $\qquad w_2 = 1.681\cdot 10^3\cdot\frac{lbf}{ft}$

RB5

$w_5 := (2.5\cdot(3) + 3.5\cdot(.583))\cdot(1)\cdot(150)\cdot\frac{lbf}{ft}$ $\qquad w_5 = 1.431\cdot10^3\cdot\frac{lbf}{ft}$

The slab weight per square foot is

$w_s := (1)\cdot(1)\cdot(.5)\cdot(150)\cdot\frac{lbf}{ft^2}$ $\qquad w_s = 75\cdot\frac{lbf}{ft^2}$

This gives a total weight for the roof of

$W := l_1\cdot w_1 + l_2\cdot w_2 + l_5\cdot w_5 + A\cdot w_s$

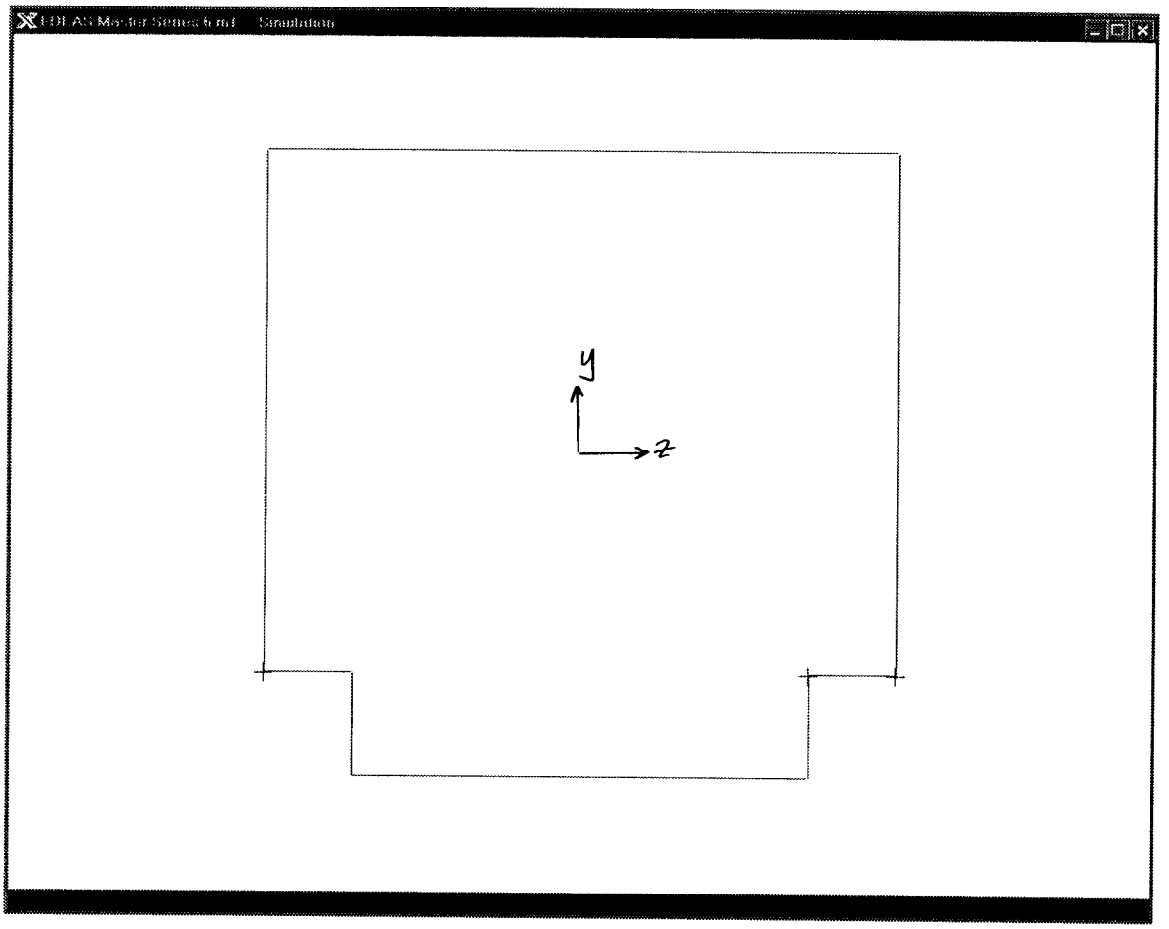
$W = 8.655\cdot10^5\cdot lbf$

References

1. American Concrete Institute, Building Code Requirements for Structural Concrete (ACI 318-95) and Commentary (ACI 318R-95), October 1996.

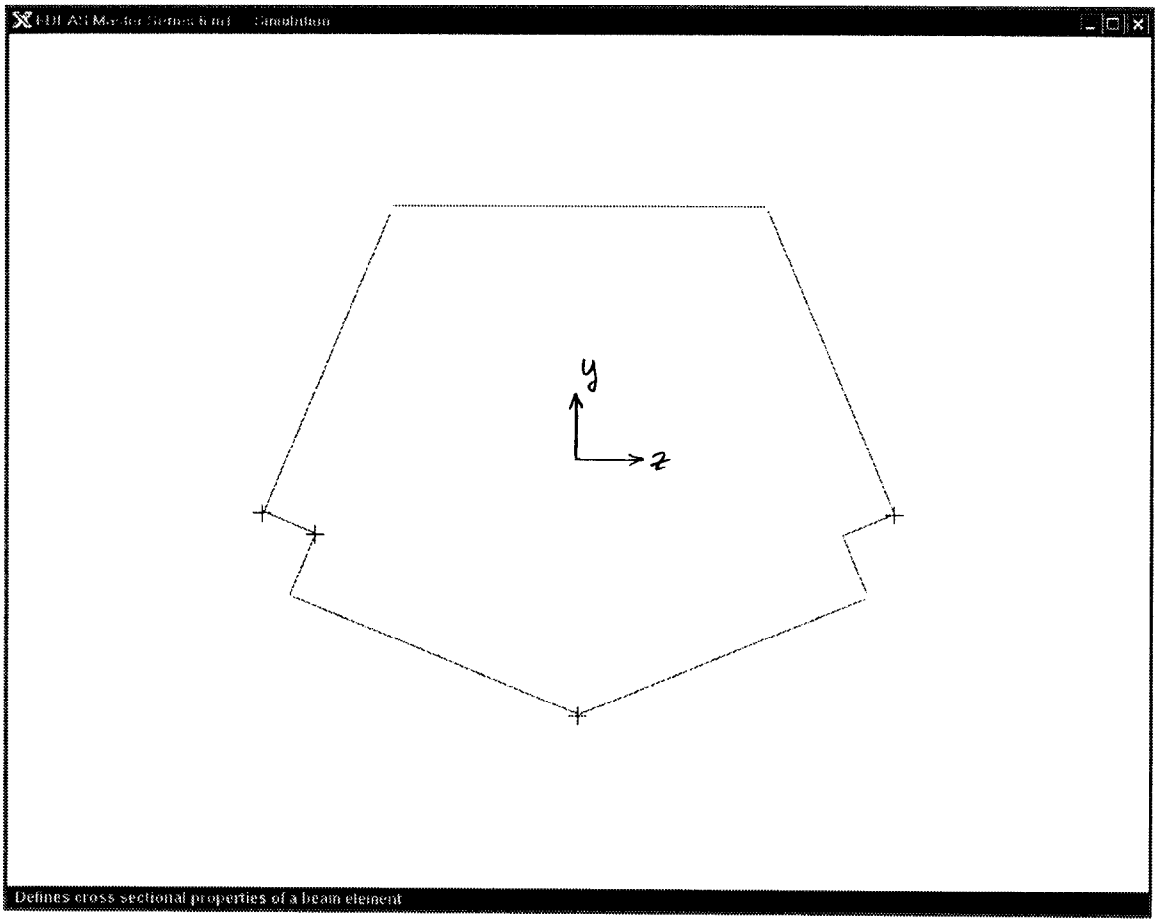
2. Blaw-Knox Company, Drawing Nos. 4272-81-106 through -109, Index Nos. 105587-105590, August 26, 1954.

3. Golder Associates, Inc., High Level Waste Tank Farm Replacement Project Geotechnical Investigation for Westinghouse Idaho Nuclear Company, November 16, 1992.




```
Area                        :   1236.0
 Prin. moment of inertia Y  :   125428.0
 Prin. moment of inertia Z  :   125632.7
 Shear ratio Y              :   1.157
 Shear ratio Z              :   1.164
 Torsional constant         :   220424.2
 Warping constant           :   174127.3
 Warping restraint factor   :   0.5
 Eccentricity Y             :   0.3198765
 Eccentricity Z             : -0.007858711

 X centroid location        : -4.098128E-11
 Y centroid location        : -2.271845 (+ 15 inches = 17.27 inches from
top)
 X shear center location    :   0.00785871
 Y shear center location    : -2.59172
```




```
Area                        :   1886.93
 Prin. moment of inertia Y  :  328269.4
 Prin. moment of inertia Z  :  251192.1
 Shear ratio Y              :  1.158
 Shear ratio Z              :  1.133
 Torsional constant         :  531050.3
 Warping constant           :  669235.0
 Warping restraint factor   :  0.5
 Eccentricity Y             : -0.06449481
 Eccentricity Z             :  0.0

 X centroid location        :  1.337738E-07
 Y centroid location        : -6.730518 (+ 15 inches = 21.73 inches from
top)
 X shear center location    :  0.0005548042
 Y shear center location    : -6.666023
```

Postprocessing results from ABAQUS input file tank_vault3.inp.

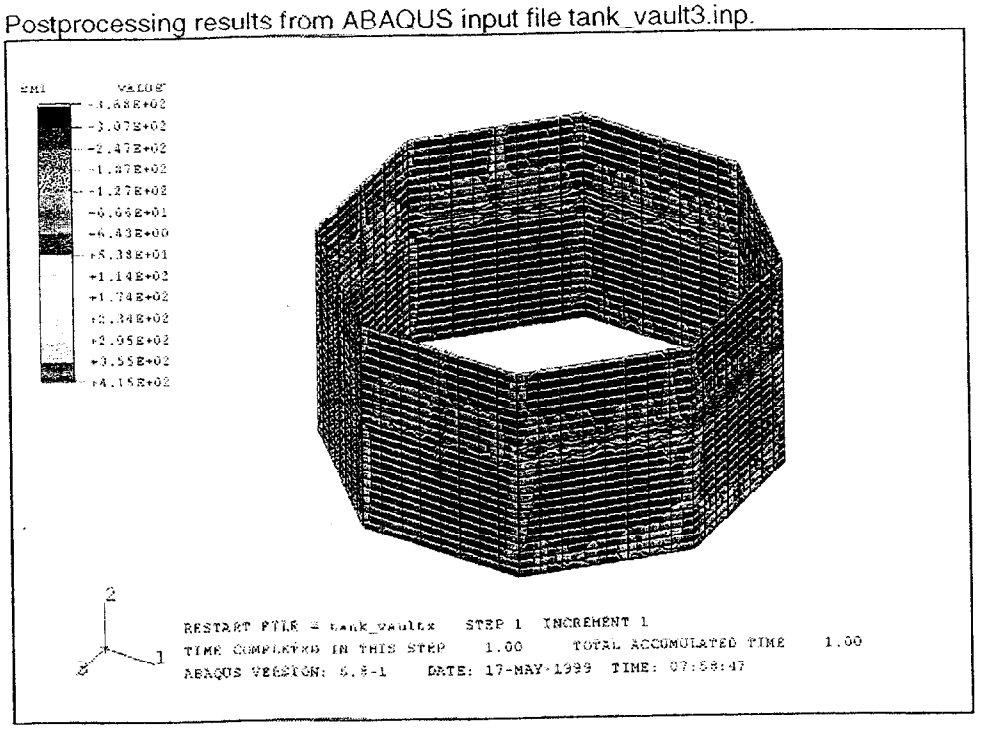


Figure B 1 - Vault panels - SM1 (bending moment force per unit width about the local 1-axis).

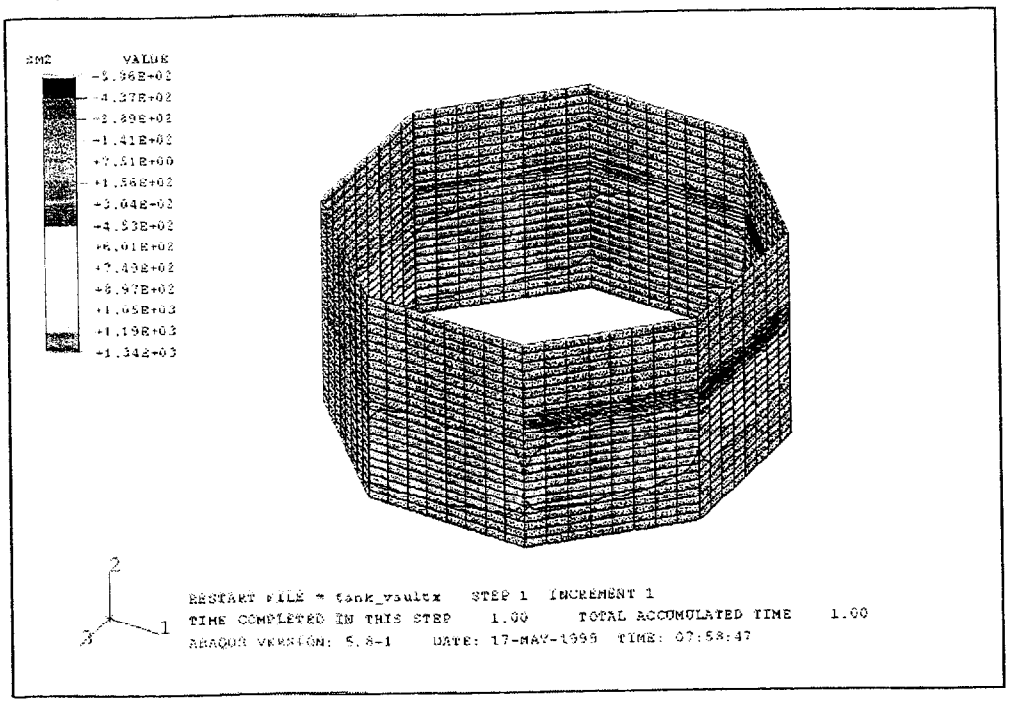


Figure B 2 - Vault panels - SM2 (bending moment force per unit width about the local 2-axis).

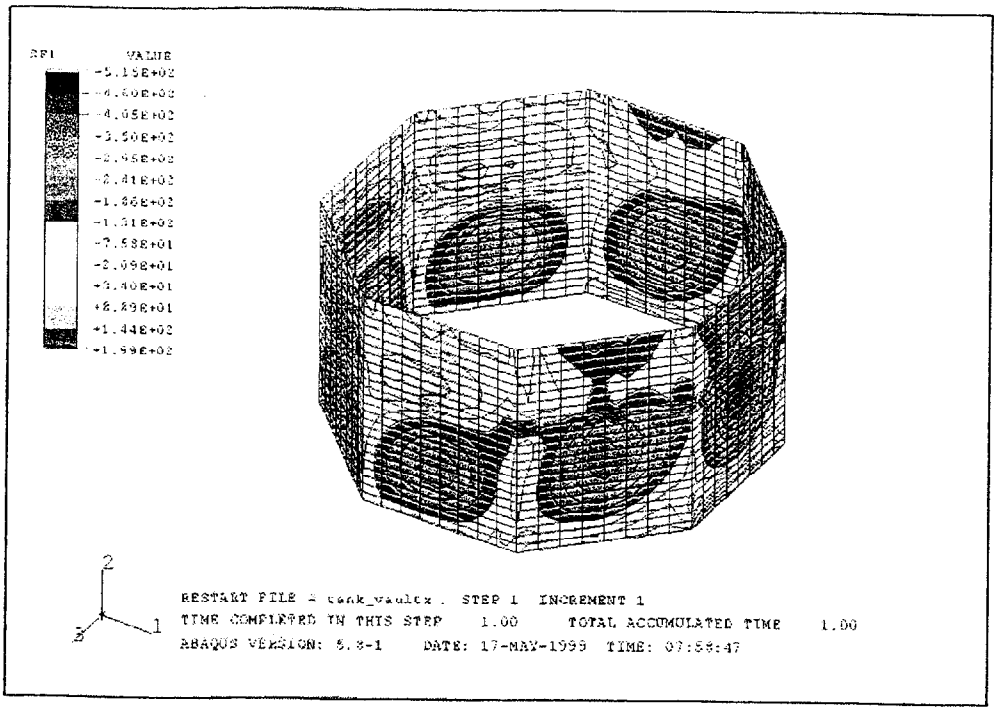


Figure B 3 - Vault panels - SF1 (direct membrane force per unit width in local 1-direction).

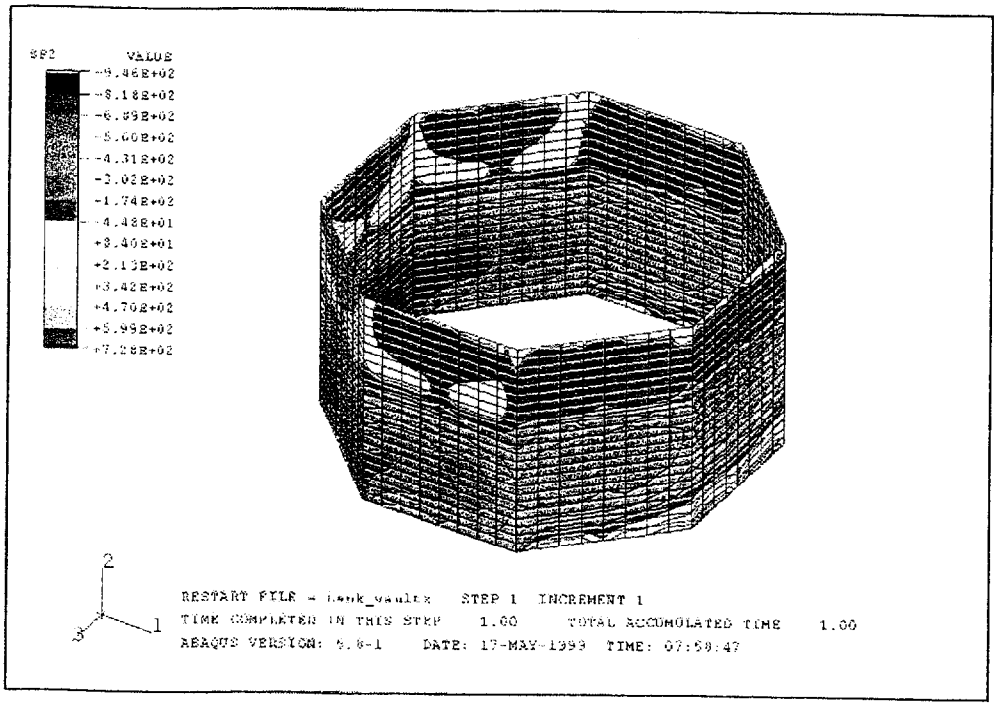


Figure B 4 - Vault panels - SF2 (direct membrane force pre unit width in local 2-direction).

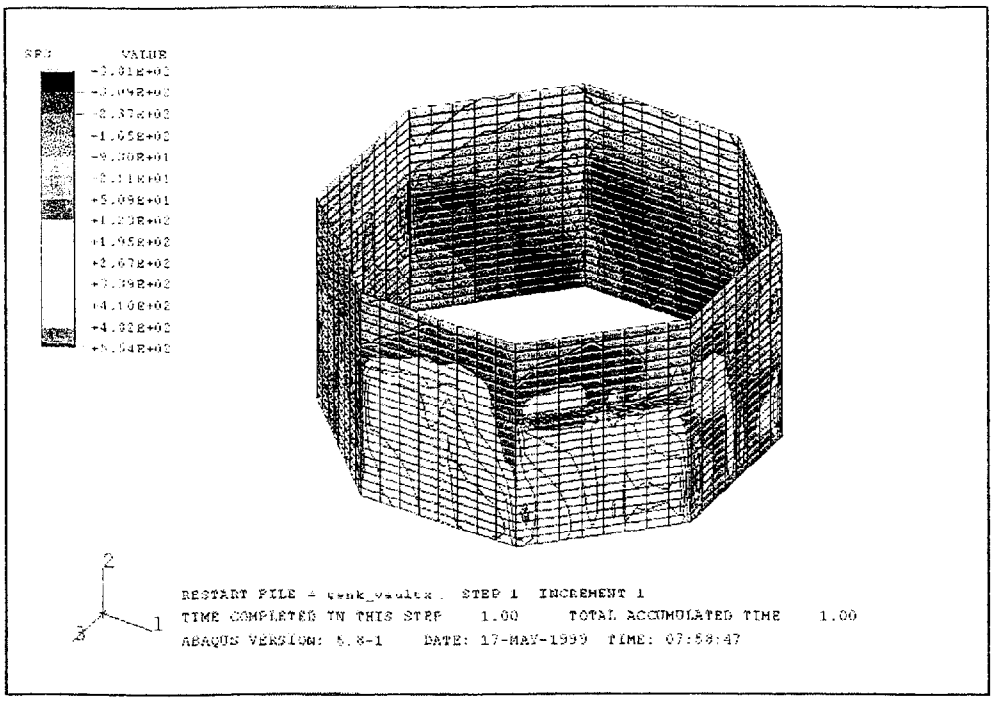


Figure B 5 - Vault panels - SF3 (shear membrane force per unit width in local 1-2 plane).

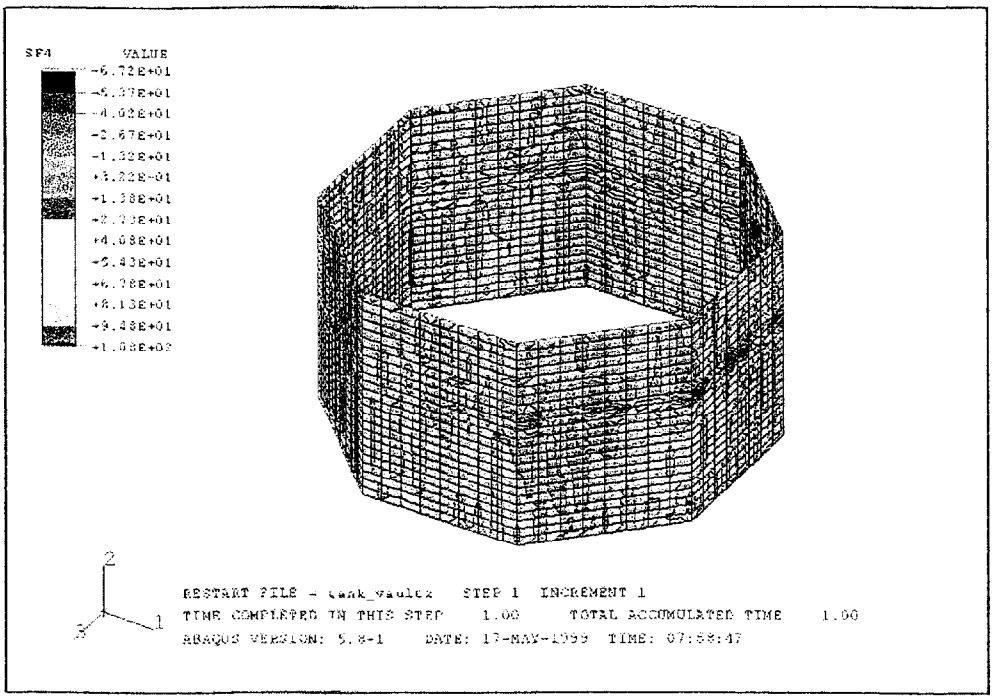


Figure B 6 - Vault panels - SF4 (transverse shear force per unit width in local 1-direction).

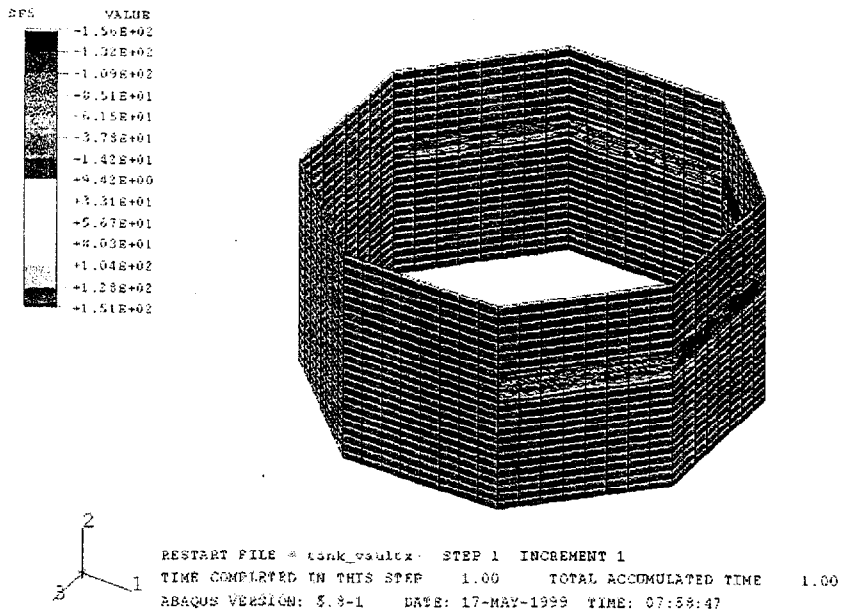


Figure B 7 - Vault panels - SF5 (transverse shear force per unit width in local 2-direction).

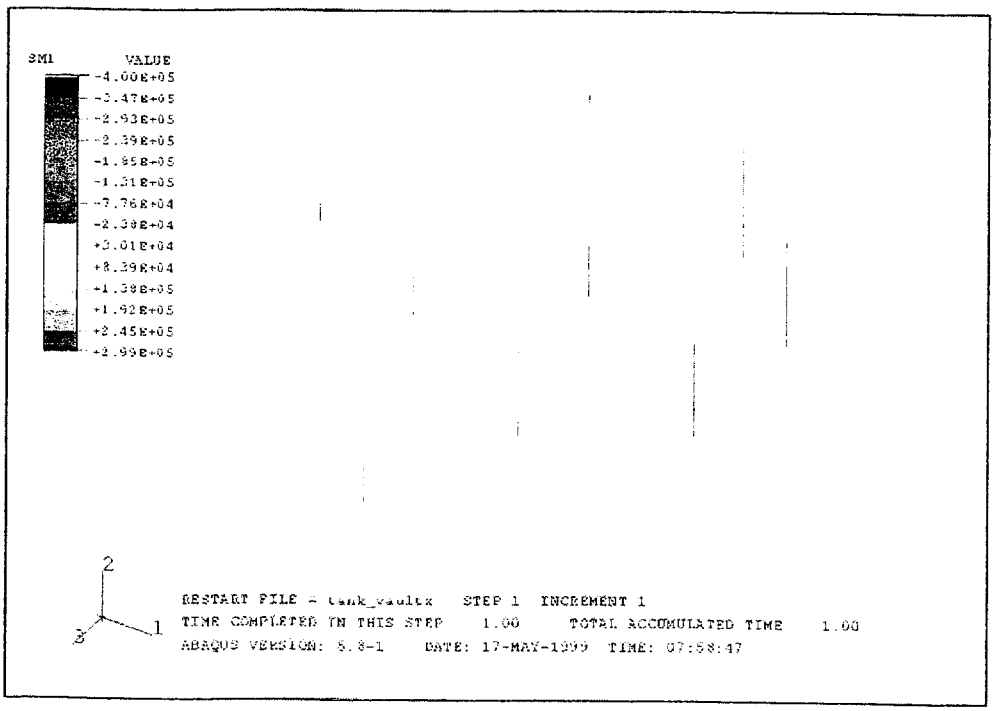


Figure B 8 - Corner columns - SM1.

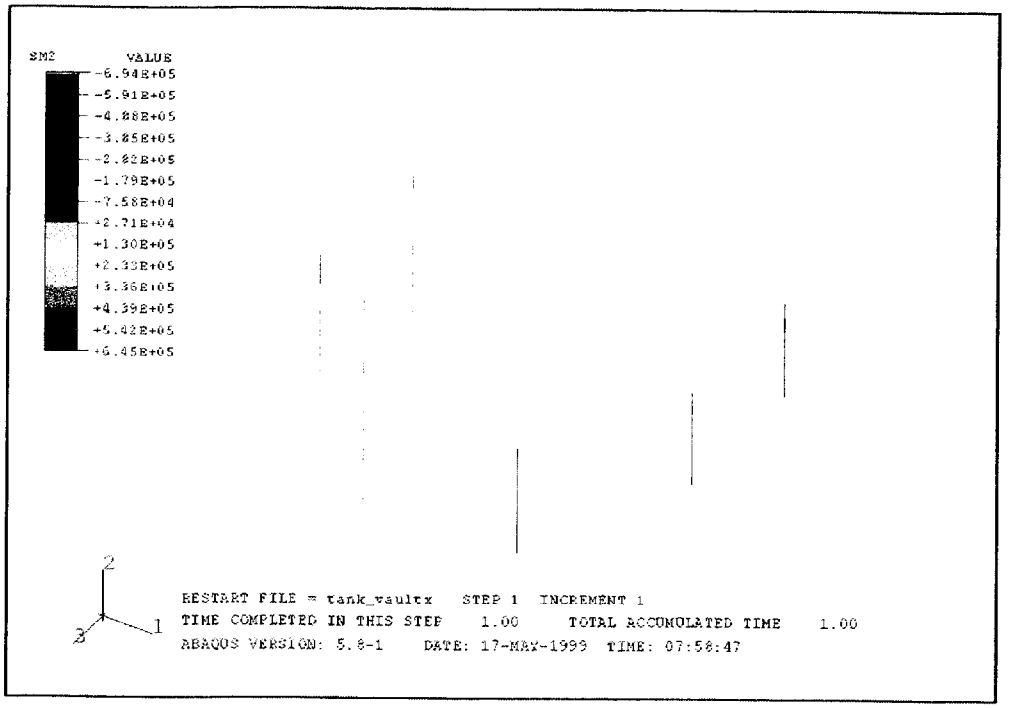


Figure B 9 - Corner columns - SM2.

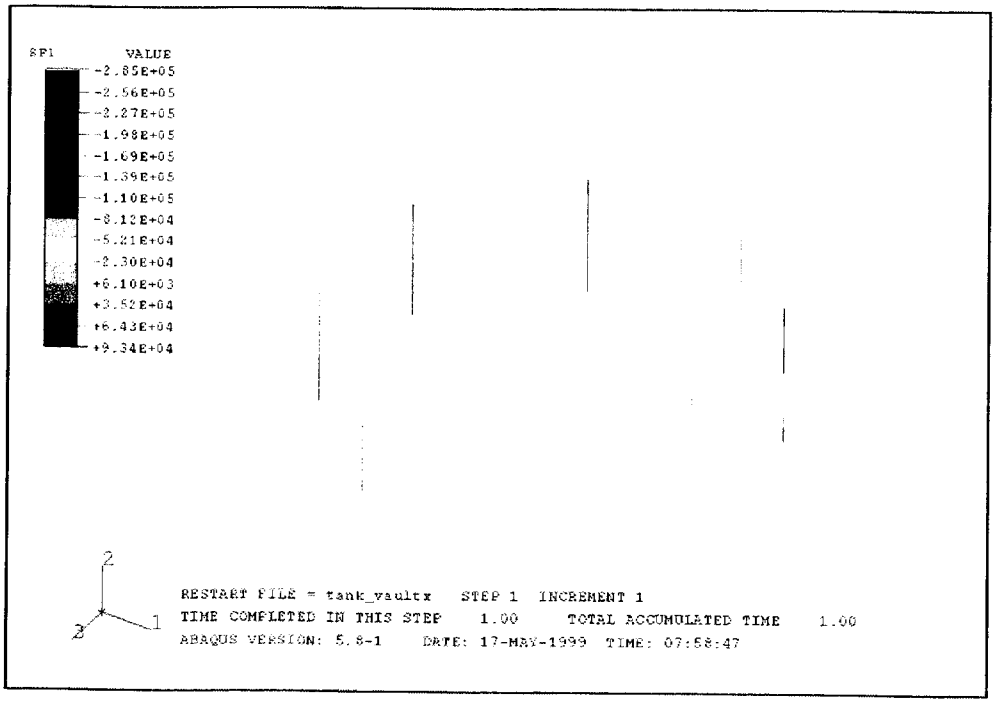


Figure B 10 - Corner columns - SF1.

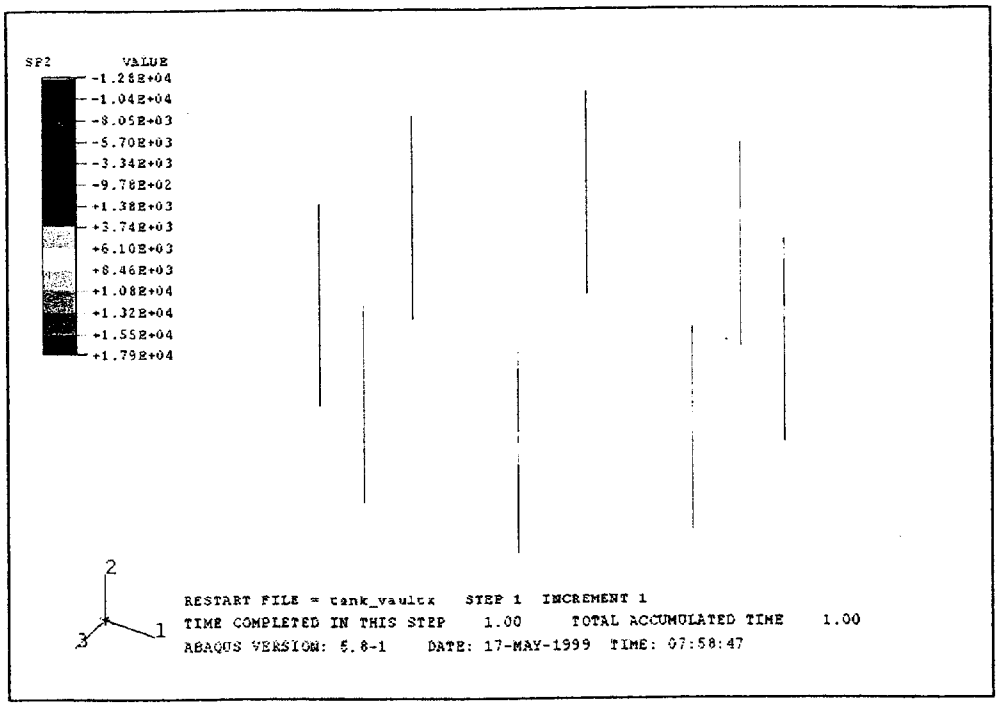


Figure B 11 - Corner columns - SF2.

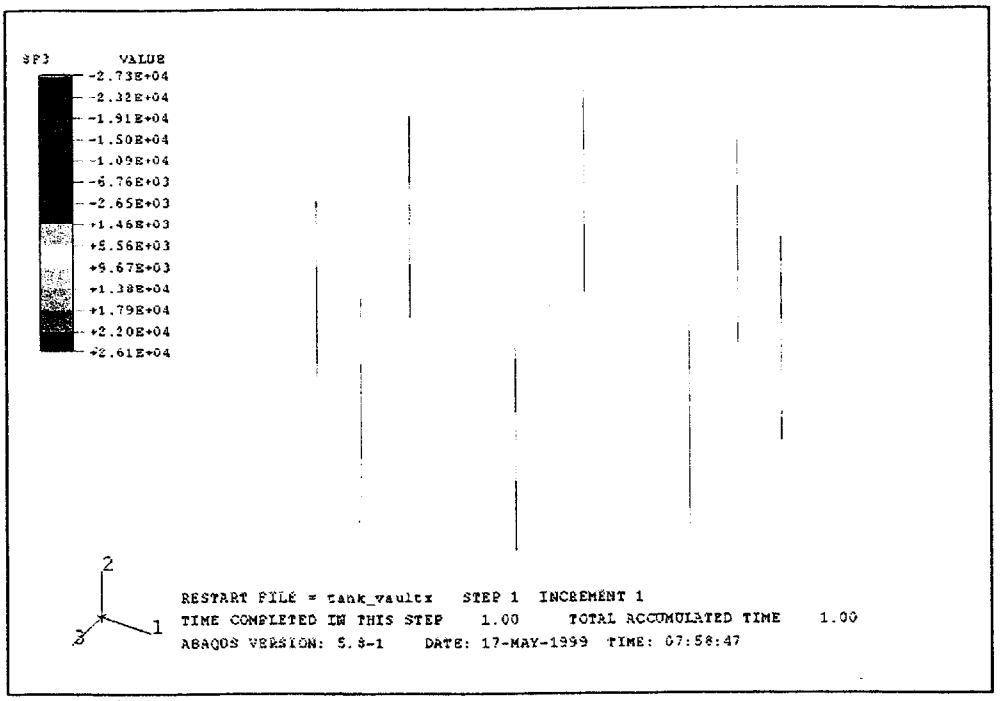


Figure B 12 - Corner columns - SF3.

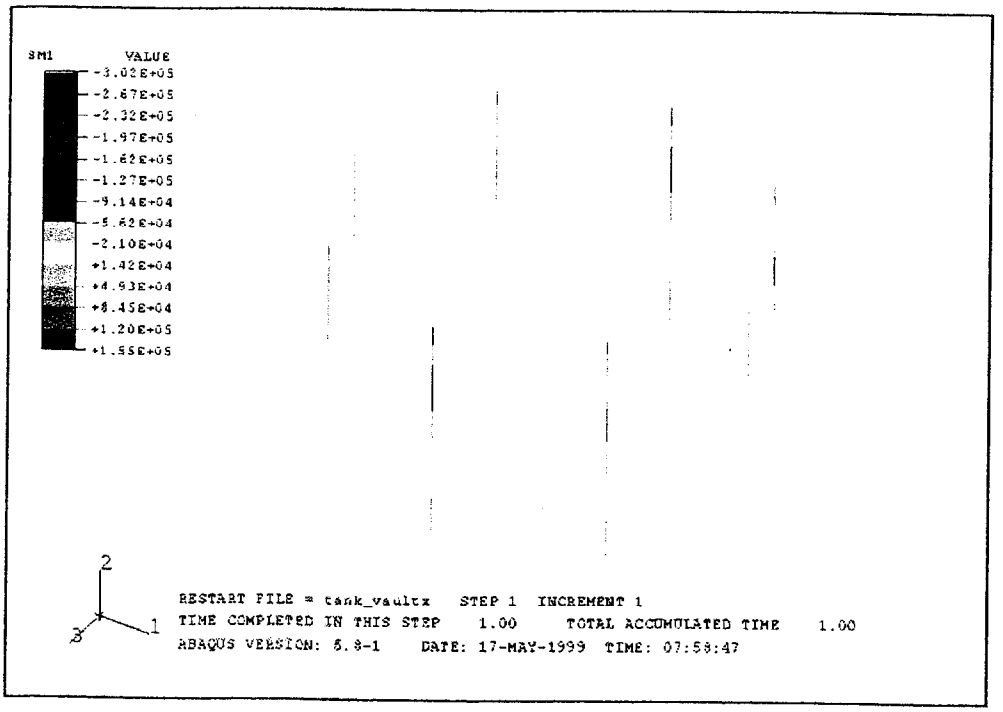


Figure B 13 - Mid-side columns - SM1.

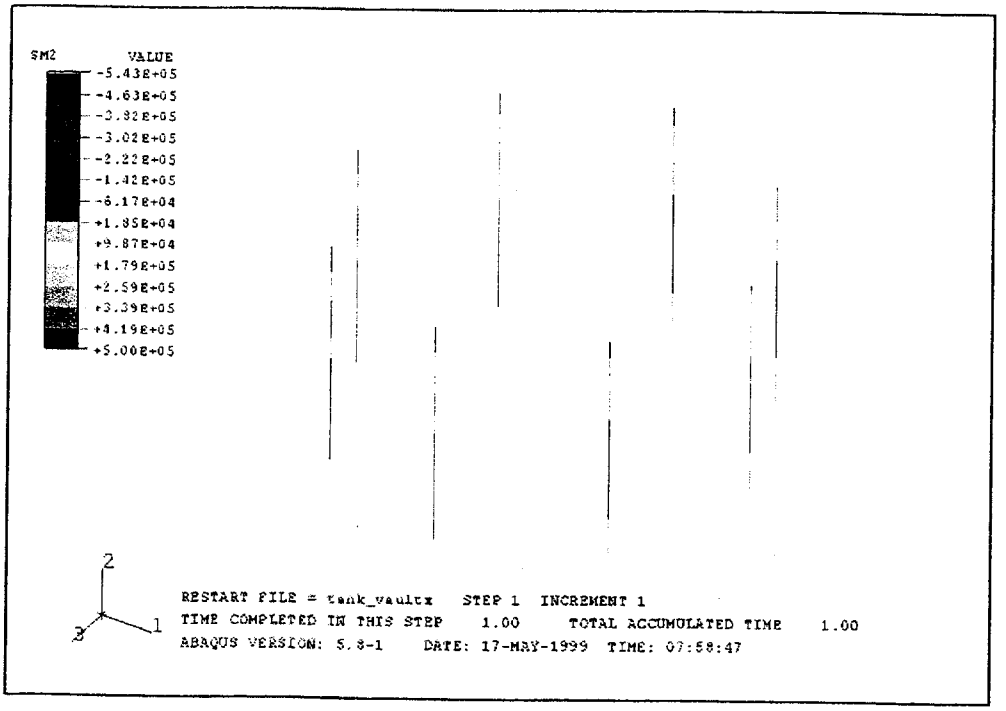


Figure B 14 - Mid-side columns - SM2.

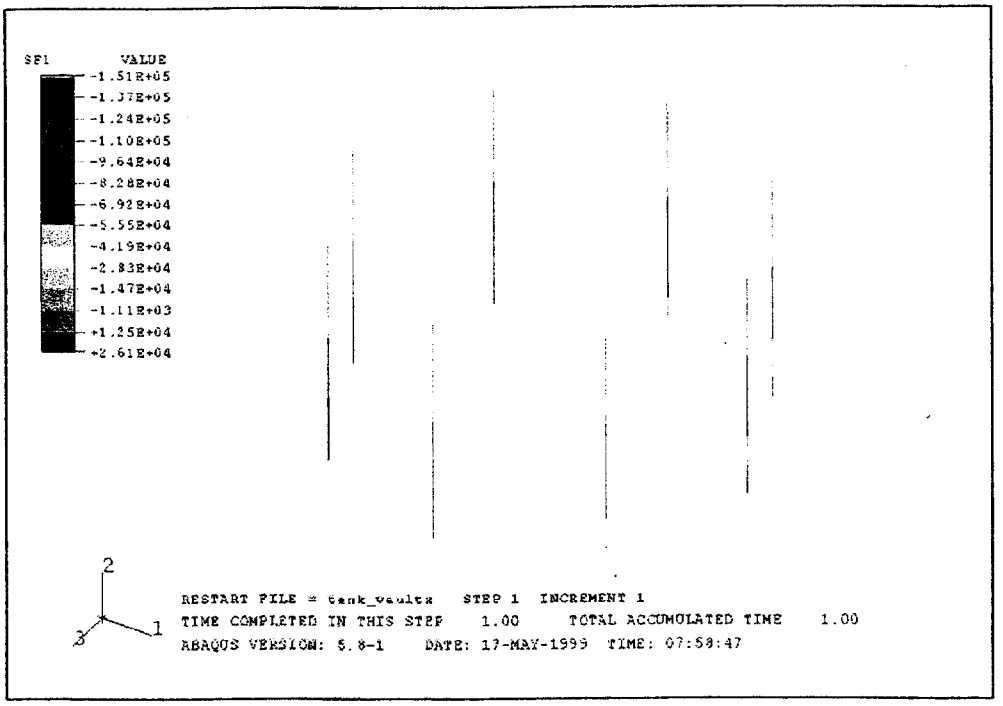


Figure B 15 - Mid-side columns - SF1.

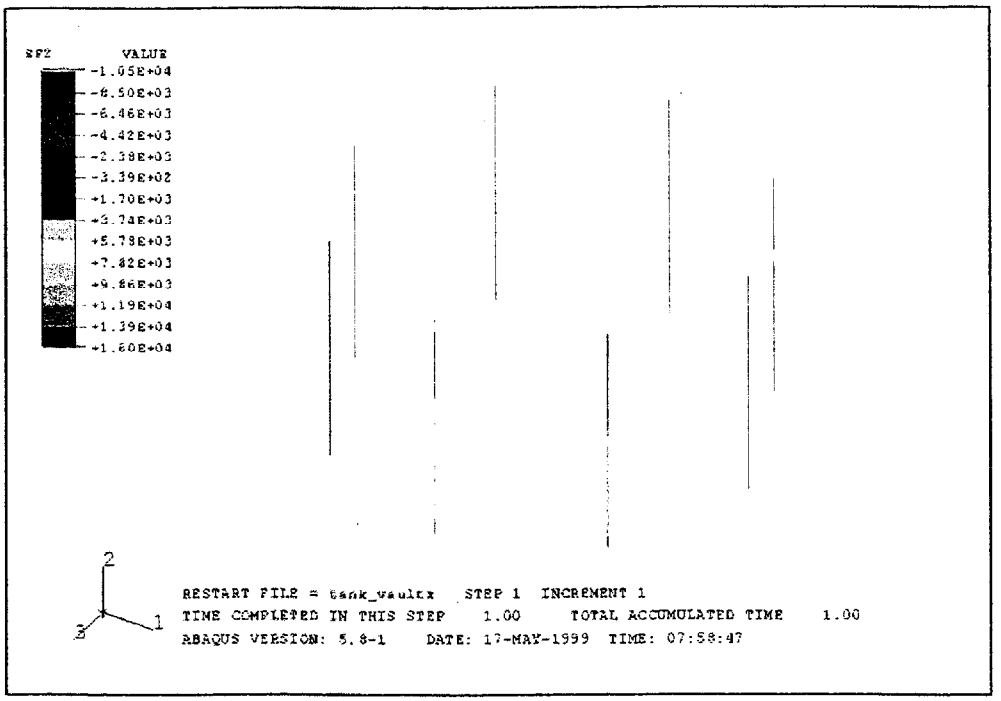


Figure B 16 - Mid-side columns - SF2.

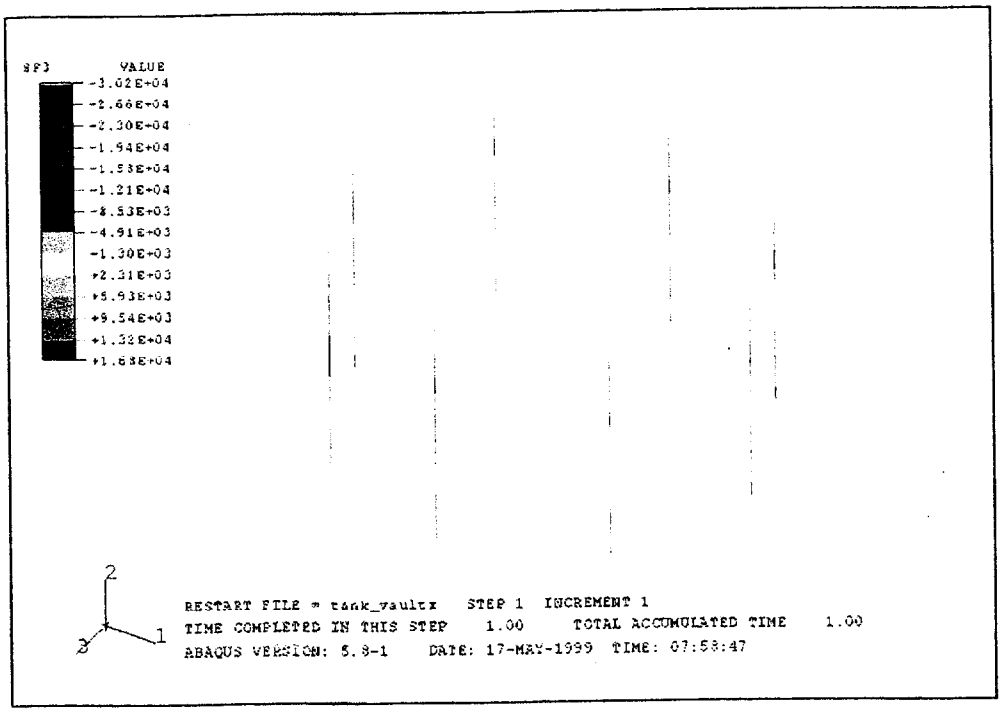


Figure B 17 - Mid-side columns - SF3.

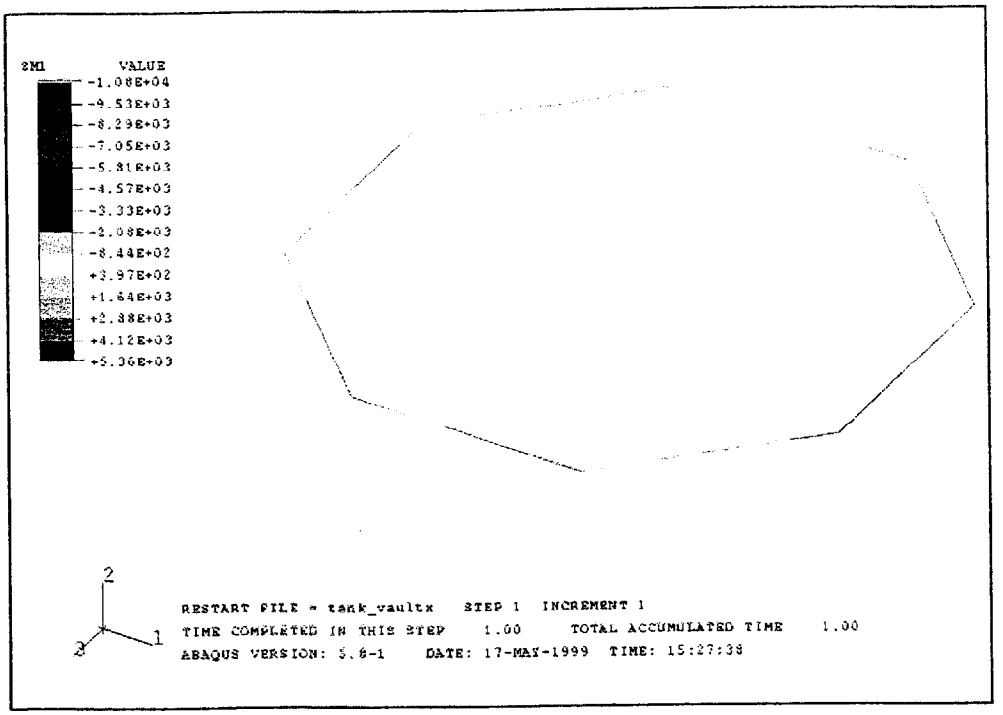


Figure B 18 - RB3 & 4 SM1.

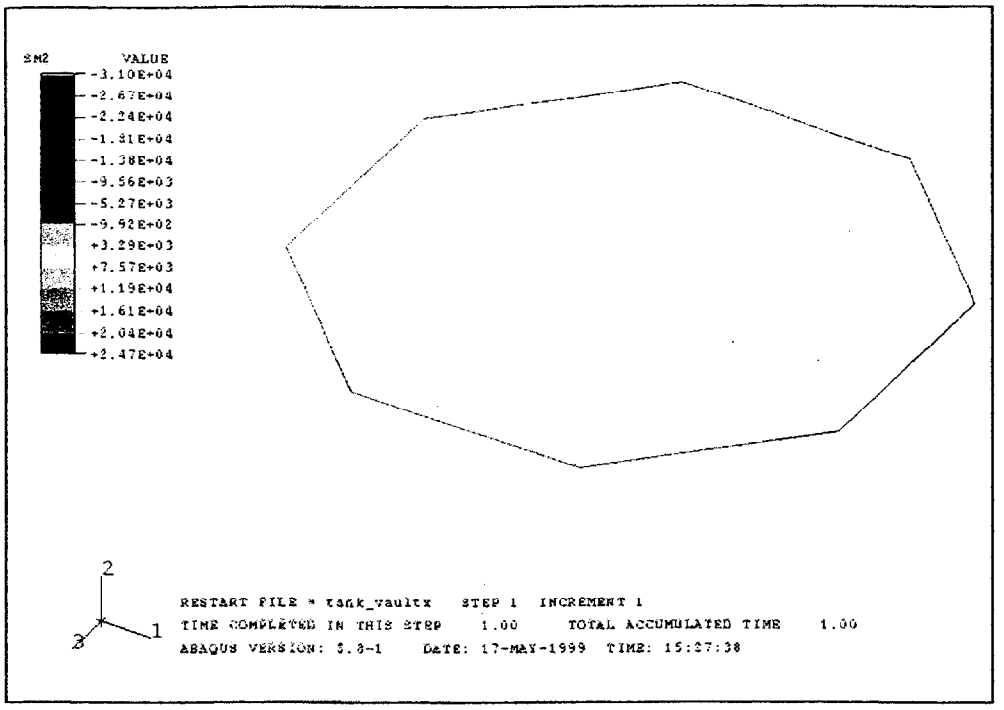


Figure B 19 - RB3 & 4 - SM2.

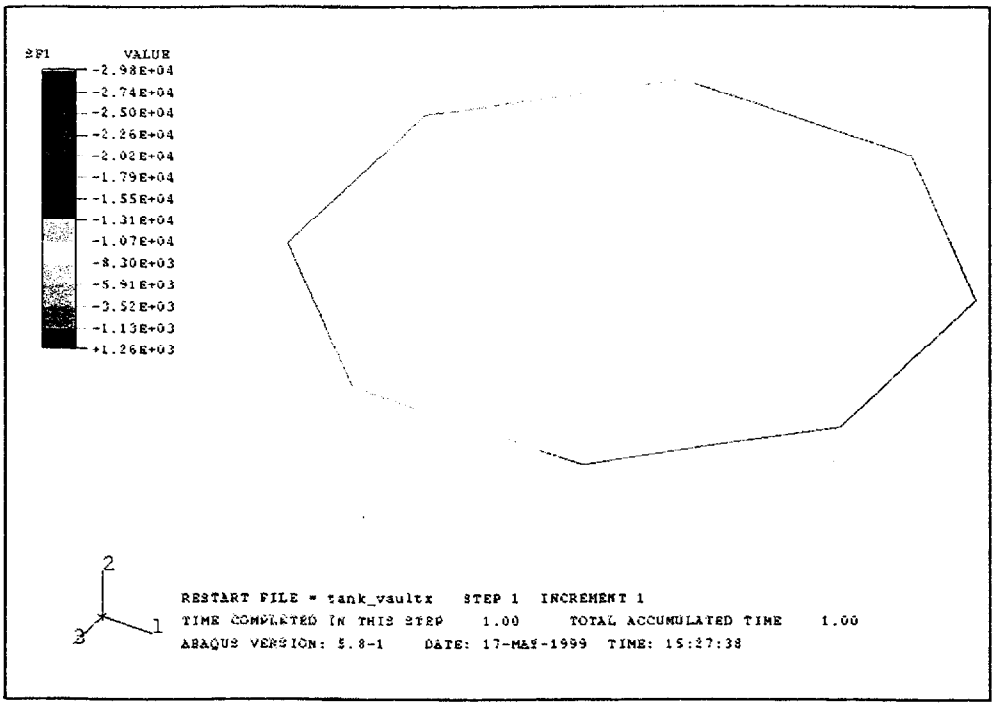


Figure B 20 - RB3 & 4 - SF1.

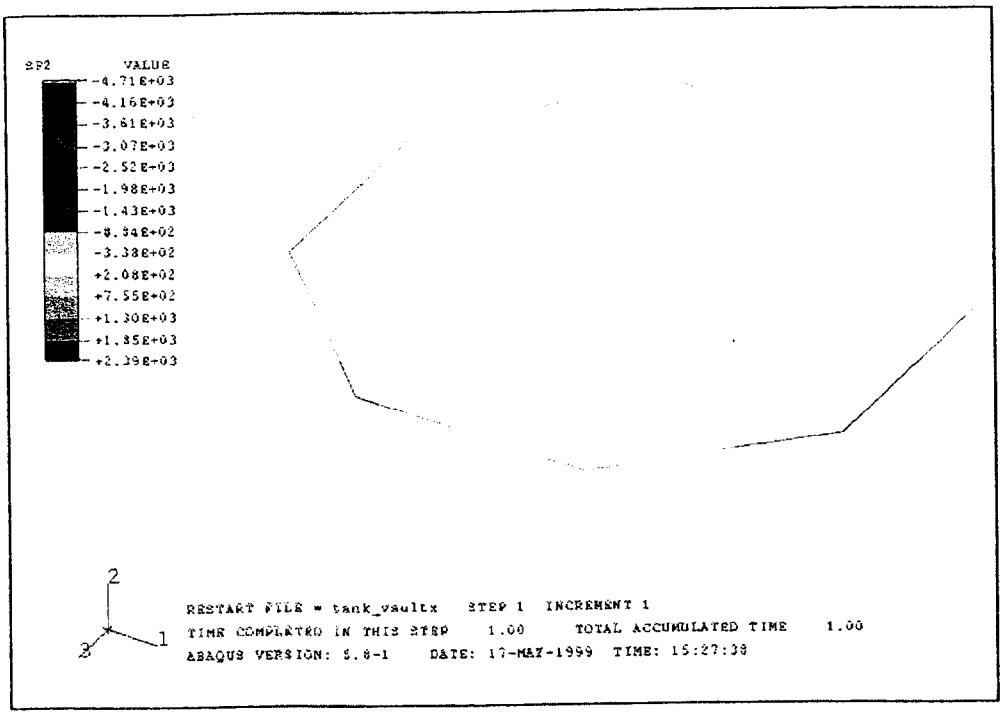


Figure B 21 - RB3 & 4 - SF2.

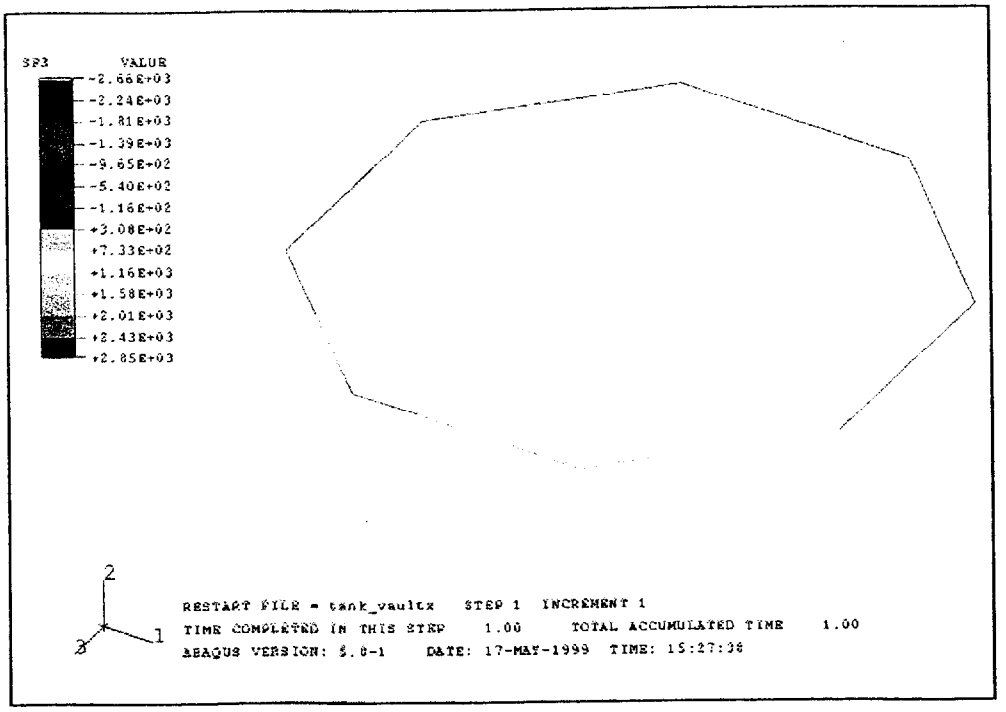


Figure B 22 - RB3 & 4 - SF3.

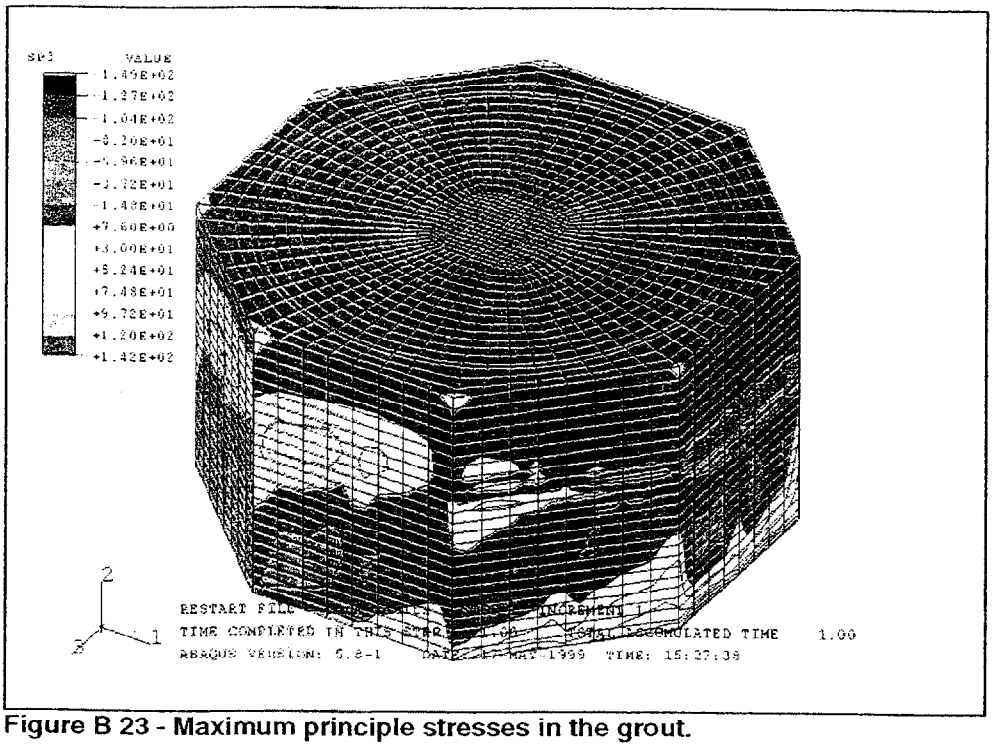


Figure B 23 - Maximum principle stresses in the grout.

Calculate the vertical distribution of force from UBC 97 equation 30 - 13 and 30 - 15 (p. 2-15). There is no concentrated force F_t at the top of the structure. The tank structure was divided into 4 discrete quarters and the roof to calculate the weights and heights in the I-DEAS finite element model. It was estimated that 25% of the soil supported by the roof would respond to the seismic forces.

$$V := \sum_{i=1}^{n} F_i$$

UBC 97 equation 30-13

$$F_x := \frac{V \cdot w_x \cdot h_x}{\sum_{i=1}^{n} w_i \cdot h_i}$$

UBC 97 equation 30-15

$w_{roof} := 865356 \cdot lbf$

Weight of the roof and 25% of the supported soil (125 lbf/ft^3).

$w_{soil} := 945469 \cdot lbf$

$grav := 386.4 \cdot \frac{in}{sec^2} \cdot 1.05$

Gravity in in/sec^2 with a 1.05 factor (from ACI)

$i := 0, 1 .. 5$

$grav = 405.72 \cdot \frac{in}{sec^2}$

$$w := \begin{bmatrix} 1793282 \cdot lbf \\ 936247 \cdot lbf \\ 1650700 \cdot lbf \\ 2901091 \cdot lbf \\ w_{roof} + w_{soil} \\ 0 \cdot lbf \end{bmatrix} \qquad h := \begin{bmatrix} 42.05 \cdot in \\ 148.8 \cdot in \\ 253.6 \cdot in \\ 351.9 \cdot in \\ 391.5 \cdot in \\ 391.5 \cdot in \end{bmatrix}$$

Weights and Heights (from I-DEAS model)
Bottom quarter
Second quarter
Third quarter
Top quarter (minus the roof)
Roof + 25% of soil above roof

$$tot := \sum_{i=0}^{5} w_i \cdot h_i \qquad tot = 2.363 \cdot 10^9 \cdot in \cdot lbf$$

$$W := \sum_{i=0}^{5} w_i$$

Total weight of the structure

$W = 9.092 \cdot 10^6 \cdot lbf$

$$F := 0.194 \cdot 1.4 \cdot W \cdot \frac{\overrightarrow{(w \cdot h)}}{tot}$$

The factor of 1.4 is from ACI.

$$bforce := \overrightarrow{\left(386.4 \cdot \frac{F}{w} \cdot \frac{in}{sec^2}\right)}$$

The body force (acceleration) applied to each section of the structure.

Component in -X direction

$$bforce = \begin{bmatrix} 16.979 \\ 60.082 \\ 102.397 \\ 142.088 \\ 158.077 \\ 0 \end{bmatrix} \cdot \frac{in}{sec^2}$$

Z Component

$$0.3 \cdot bforce = \begin{bmatrix} 5.094 \\ 18.024 \\ 30.719 \\ 42.626 \\ 47.423 \\ 0 \end{bmatrix} \cdot \frac{in}{sec^2}$$

Y Component = 0

(Use only first 4 - the roof acceleration is calculated below to account for 25% of the mass of the supported soil.)

$$bf\_mag := \overrightarrow{\sqrt{(bforce)^2 + (0.3 \cdot bforce)^2}}$$

Magnitude

$$bf\_mag = \begin{bmatrix} 17.726 \\ 62.727 \\ 106.906 \\ 148.344 \\ 165.038 \\ 0 \end{bmatrix} \cdot \frac{in}{sec^2}$$

The pressure of the supported soil is applied to the roof of the vault. The mass of the soil is added to the mass of the roof to calculate the correct force, but a higher acceleration must be applied to the roof since the mass of the soil is not included in the finite element model.

$$a_a := \frac{w_4 \cdot bforce_4}{w_{roof}}$$

Equivalent acceleration of the mass of the roof.

$$a_a = 330.789 \cdot \frac{in}{sec^2}$$

Roof -X component

$$0.3 \cdot a_a = 99.237 \cdot \frac{in}{sec^2}$$

Roof Z component

Project: INTEC TFF Closure **Calc. No.:** **Rev.:** 0
Calc. Title: Tank and Vault Seismic Analysis
Originator: G. K. Miller **Date:** 05/24/99 **Checked By:** R. G. Rahl **Date:** 05/24/99

Appendix C – Tank and Vault Finite Element Model

Project: INTEC TFF Closure **Calc. No.:** EDF-015722-023 **Rev.:** 0
Calc. Title: Tank and Vault Seismic Analysis
Originator: B. D. Hawkes **Date:** 05/26/99 **Checked By:** R. G. Rahl **Date:** 05/26/99

Finite Element Model of Tank and Vault

The finite element model of the tank, vault and grout was generated in I-DEAS Master Series 6 (Ref. C1) and solved using ABAQUS version 5.8 (Ref. C2).

The tank has a radius of 25 feet and the distance from the center of the tank to the flat side of the octagon vault was modeled at 28.5 feet. The centroids of the columns were lined up at this distance. The top of the grout is 37' 7-1/2" above the base and is 37-1/2 inches thick directly above the center of the tank.

Description

The precast concrete vault was modeled with shell and beam elements. All concrete components were modeled with concrete material properties without rebar. The concrete beams and columns were created with cross sections called out on the drawings and oriented as shown in Figure 1. The 6-inch thick panels between the columns were created with shell elements. The roof was modeled with shell elements having an element thickness of 25.72 inches, which matched the calculated weight of the roof (864,456 lbs.) using 150 lbf/ft^3 concrete. The roof was modeled as a uniform slab to simplify the model. The components of the roof were analyzed separately in Appendix B.

The grout was modeled with solid elements using material properties for 3000-psi strength grout at 135 lbf/ft^3 (see Figure 2).

The stainless steel tank was modeled with shell elements. These elements are 5/16-inch thick at the bottom ¼-inch thick on the sides and 3/16-inch thick on top. Gusset supports between the roof and the walls were modeled with triangular elements 3/8-inch thick.

The grout was considered bonded to the tank walls and the vault walls to simplify the analysis. Preliminary analyses showed that the vault roof deflects more than the grout beneath it. Therefore, the model was also simplified by allowing the roof to bond with the top of the grout.

The beams were modeled with 2-node linear beam elements. The interior grout is modeled with 8-node linear brick elements. All other solid and shell elements are parabolic.

Materials

The following material properties were used in this model:

Material Name	Young's Modulus	Poisson's Ratio	Density	Reference
304L Stainless Steel	28.3 x 10^6 psi	0.29	.29 lbs/in^3	ASME B&PV Section II Part D
3000 psi strength Grout	3.122 x 10^6 psi $(57000 * \sqrt{f'_c})$	0.2	135 lbf/ft^3	S. A. Jensen, Project Civil Engineer

Calculation Sheet

Project: INTEC TFF Closure **Calc. No.:** **Rev.:** 0
Calc. Title: Tank and Vault Seismic Analysis
Originator: B. D. Hawkes **Date:** 05/25/99 **Checked By:** R. G. Rahl **Date:** 05/25/99

3000 psi strength Concrete	3.122×10^6 psi $(57000 * \sqrt{f'_c})$	0.2	150 lbf/ft^3	Estimated

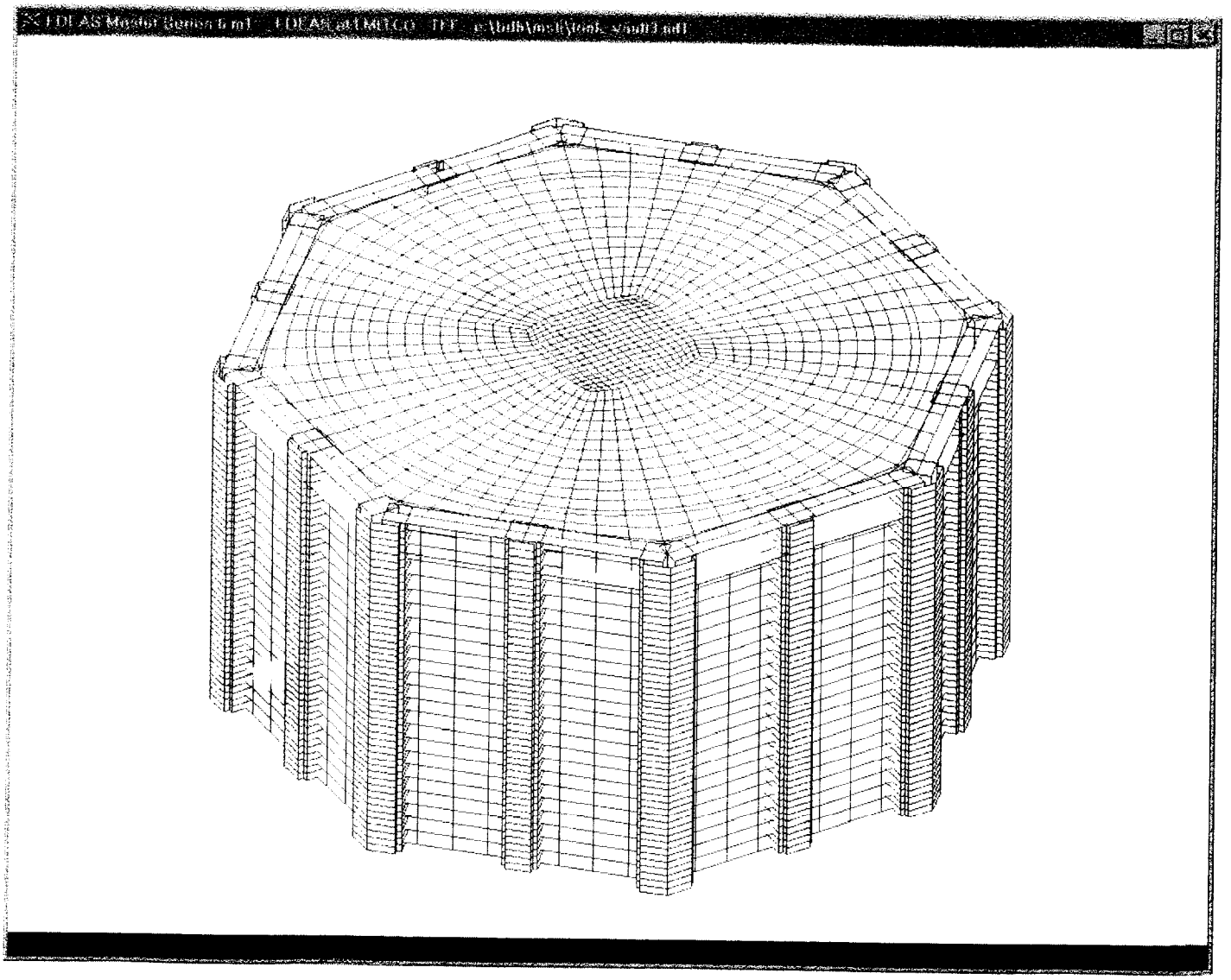


Figure 1 - Vault columns, panels and roof elements.

Project: INTEC TFF Closure **Calc. No.:** **Rev.:** 0
Calc. Title: Tank and Vault Seismic Analysis
Originator: B. D. Hawkes **Date:** 05/25/99 **Checked By:** R. G. Rahl **Date:** 05/25/99

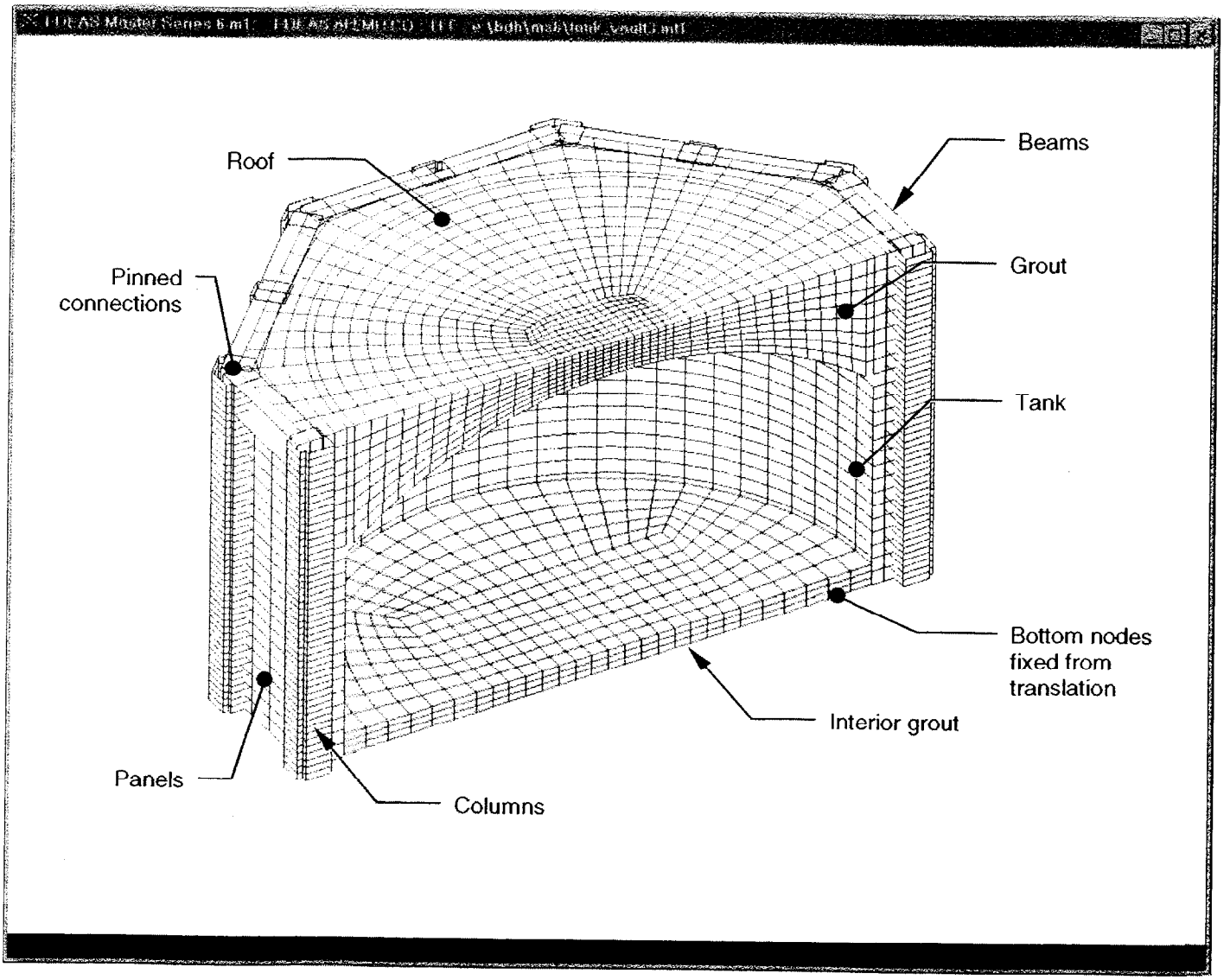


Figure 2 - Cutaway view of the finite element model.

Restraints

All nodes at the bottom of the model were restrained from translation in any direction.

Static Loads

Three static loads were placed on the model.

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Originator: B. D. Hawkes **Date:** 05/25/99 **Checked By:** R. G. Rahl **Date:** 05/25/99

1. Vertical soil pressure on the roof. There is 10 ft. of soil on top of the roof of the vault, weighing 125 lbs/ft^3 plus a 35 lbs/ft^2 snow load. This results in a static pressure of 1285 lbs/ft^2 on the vault roof.

2. Hydrostatic soil pressure on the sides of the vault. This increases linearly from 712.5 lbf/ft^2 at a depth of 14.25 feet to 2312.5 lbf/ft^2 at a depth of 46.25 feet (bottom of the vault).

3. Gravity load acting downward.

Seismic Loads

Two dynamic loads were placed on the model:

1. A horizontal line load of 23,342 lbs/ft acting in the negative X direction located 230.4 inches (0.6*tank height) up from the bottom of the vault panels. This accounts for dynamic soil pressure on the vault

2. Lateral seismic forces as described under "Loads" in this calculation package.

Load Factors

The following load factors were applied to these loads (converted to pounds and inches) per the ACI Code:

1. 1.05 for gravity load = 405.72 in/sec^2

2. 1.28 for static soil pressures

   - 11.422 psi roof load
   - 6.33 psi hydrostatic soil load at the top of the vault
   - 20.55 psi hydrostatic soil load at the bottom of the vault.

3. 1.4 for dynamic soil pressure = 2723 lbf/in horizontal line load at 0.6*vault height above the base.

4. 1.4 for lateral seismic forces.

Load Cases

The static loads were placed on the entire model. The seismic loads were applied in the following combinations (per UBC 97) (load case 1):

- Seismic loads in the negative X direction
- 0.3 times the seismic loads in the positive Z direction

The 0.3 load was then reversed and applied in the negative Z direction in combination with the negative X direction load for load case 2.

Project: INTEC TFF Closure **Calc. No.:** EDF-015722-023 **Rev.:** 0
Calc. Title: Tank and Vault Seismic Analysis
Originator: B. D. Hawkes **Date:** 05/26/99 **Checked By:** R. G. Rahl **Date:** 05/26/99

Roof Stiffness Considerations

Another run was made using tank_vault3.inp with the roof thickness changed from 25.72 inches to 10 inches and the density was increased to keep the weight of the roof the same. This model showed that the stresses in the roof were increased, as expected, but the stresses in the tank did not increase dramatically and did not exceed the yield strength of the stainless steel. This indicates that the thinner roof does not cause the tank to fail and that a roof with less stiffness does not result in failure of the tank.

Results

The results from ABAQUS show that the stresses in the tank were slightly higher for load case 1 than load case 2 and will be used in the display of results.

The maximum Von Mises stresses in the tank of 2.56 ksi are far below the yield strength of 25 ksi as shown in Figure 3. The highest stresses occur just above the interior grout in the wall of the tank.

Buckling of the tank wall was not considered to be a problem since the maximum displacement of the tank is about 0.025 inches in the direction of the seismic body forces (see Figure 4) and the tank wall is also supported on one side by the grout outside the tank.

Buckling of the tank roof was also not considered to be a problem since the stresses are very low, and the vertical deflection of the roof is about 0.02 inches over the 50-ft. span.

Precast concrete members are shown in Appendix B to have ample capacity to carry the calculated seismic loads.

The grout is not expected to fail since the maximum principal stress is 142 psi, which is much lower than the rupture modulus of 411 psi.

Conclusions

The tank and the vault can sustain the PC-2 seismic loadings.

References

1. Structural Dynamics Research Corporation, Milford, Ohio, I-DEAS Master Series 6, 1998
2. Hibbet, Karlson & Sorensen, Pawtucket, RI, ABAQUS Version 5.8, 1998

Project: INTEC TFF Closure **Calc. No.:** **Rev.:** 0
Calc. Title: Tank and Vault Seismic Analysis
Originator: B. D. Hawkes **Date:** 05/25/99 **Checked By:** R. G. Rahl **Date:** 05/25/99

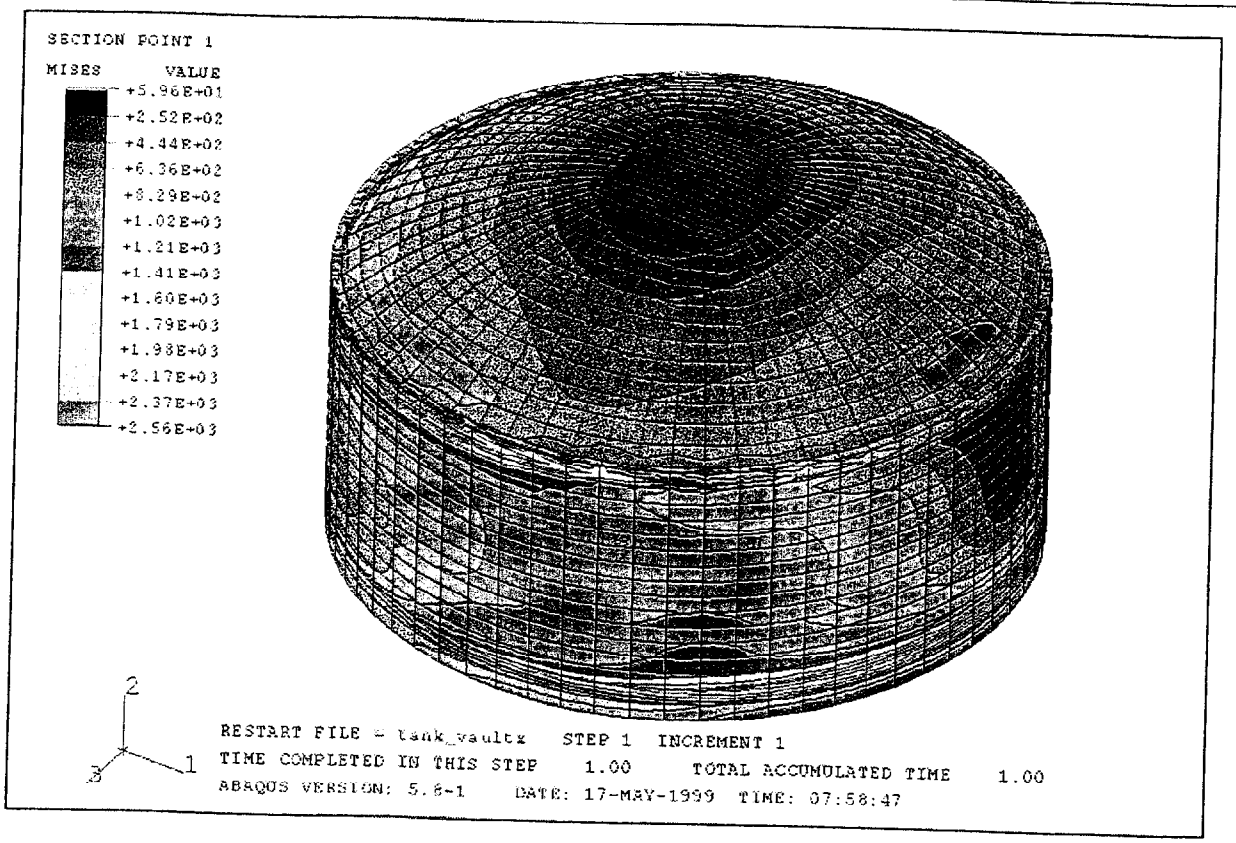

Figure 3 - Von Mises stresses in the tank.

Project: INTEC TFF Closure **Calc. No.:** **Rev.:** 0
Calc. Title: Tank and Vault Seismic Analysis
Originator: B. D. Hawkes **Date:** 05/25/99 **Checked By:** R. G. Rahl **Date:** 05/25/99

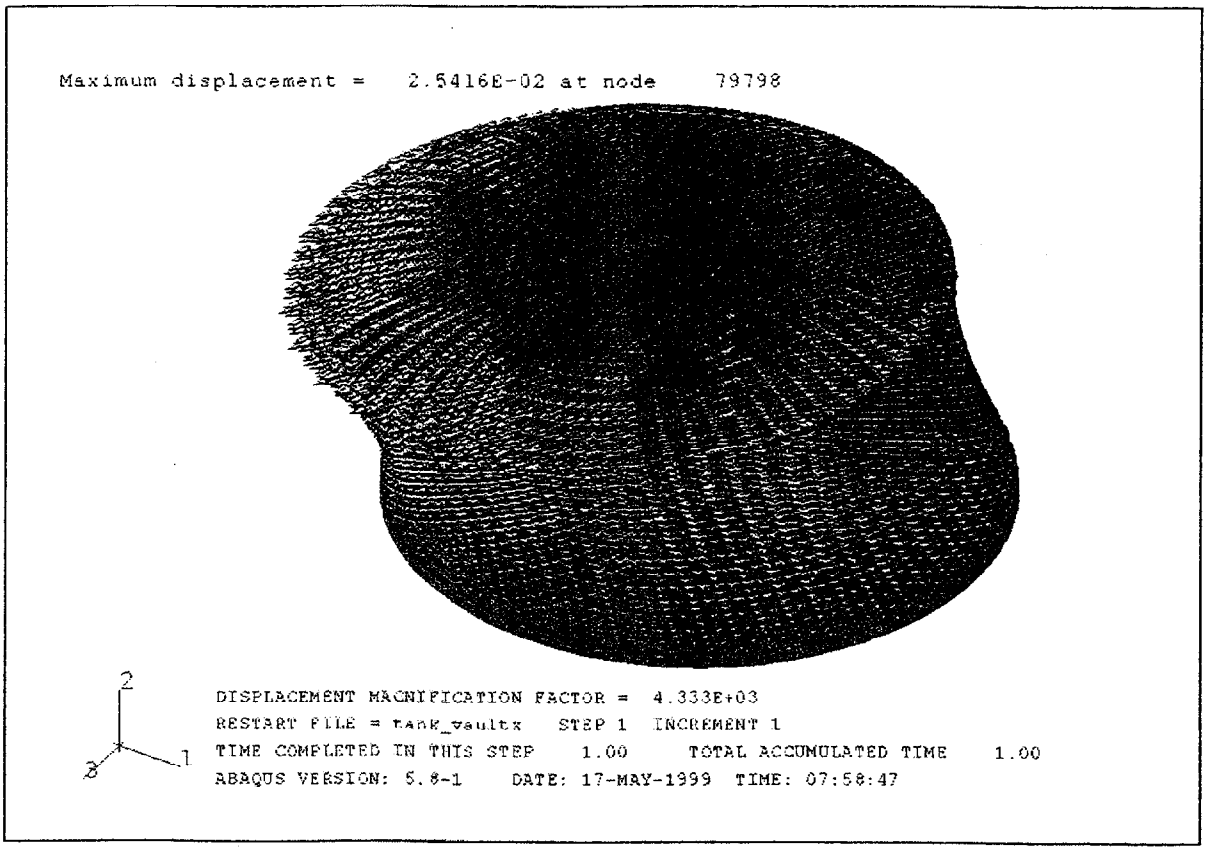

Figure 4 Tank displaced shape.

Project: INTEC TFF Closure **Calc. No.:** **Rev.:** 0
Calc. Title: Tank and Vault Seismic Analysis
Originator: G. K. Miller **Date:** 05/24/99 **Checked By:** R. G. Rahl **Date:** 05/24/99

Appendix D – Abbreviated ABAQUS Input and Journal Files

Project: INTEC TFF Closure **Calc. No.:** **Rev.:** 0
Calc. Title: Tank and Vault Seismic Analysis
Originator: B. D. Hawkes **Date:** 05/25/99 **Checked By:** R. G. Rahl **Date:** 05/25/99

Abbreviated ABAQUS Input file

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** tank and vault modeled without contact between grout and roof.
** no beam releases between roof and vault columns
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Project: INTEC TFF Closure **Calc. No.:** **Rev.:** 0
Calc. Title: Tank and Vault Seismic Analysis
Originator: B. D. Hawkes **Date:** 05/25/99 **Checked By:** R. G. Rahl **Date:** 05/25/99

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Project: INTEC TFF Closure **Calc. No.:** **Rev.:** 0
Calc. Title: Tank and Vault Seismic Analysis
Originator: B. D. Hawkes **Date:** 05/25/99 **Checked By:** R. G. Rahl **Date:** 05/25/99

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Post Processing Journal File

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ENGINEERING DESIGN FILE

1. Project File No. 015722 2. Project/Task INTEC Tank Farm Facility Closure

3. Subtask Conceptual Design

4. Title: Tank and Vault Ventilation Criteria

5. Summary:

This Engineering Design File (EDF) summarizes the criteria used to establish the tank and vault ventilation systems.

The information used was based on typical design parameters and existing piping in place in the Tank Farm Facility. Additional information was obtained from the report "ICPP Tank Farm Closure Study" (INEEL/EXT-97-01204) as needed. This summarization is intended to aid the current closure design efforts.

6. Distribution (complete package): Project Files

Distribution (summary package only):

7. Review (R) and Approval (A) Signatures: (Minimum reviews and approvals are listed. Additional reviews/approvals may be added as necessary.)

	R/A	Printed Name	Signature	Date
Author	R	Blair Grover	Blair Grover	7/12/99
Independent Verification	R	Ed Baker	E. J. Baker	7/12/99
Requestor	A	Ed Anderson	Edward Anderson	7/13/99

1 Discussion

The ventilation systems for the tank closures must provide a means of ventilation for the Enclosures used over the tank risers for cleaning the tank interior and for the tank themselves. By integrating together these two systems and using a once through scheme to existing systems, a simplified airflow pattern and system can be accomplished. Ventilation of the temporary Enclosures must be considered for two possible scenarios. The ventilation air for the 4 Enclosures can be used for the tank ventilation. By accomplishing this task, fewer systems must run during the closures and will provide a simpler system. Additionally, the Enclosures must have the capability of self-ventilation when the tank riser is sealed off from the respective Enclosure.

1.1 General Criteria

The ventilation systems for the Enclosures must provide a negative to their exterior. The Enclosures are assumed to be a containment space. The primary confinement space is assumed to be the interior of the tanks. Using this scheme, airflow must be from the Enclosures to the inside of the tank that is being closed. Maximum allowable negative static pressure the tanks can sustain is 0.8 inches water column. This value is used due to the pressure/vacuum relief valves rating protecting the tanks.

Ventilation rates for the tanks were examined to determine minimum requirements. The following items were examined to determine air changes required: Volatile Organic Compounds (VOC's) in the tank, Airflow velocities through piping systems to minimize moisture entrapment, existing piping pressure losses, and temporary Enclosure ventilation rates. See attachments for consideration calculations and supporting data.

1.1.1 Generalized Method

The two system flow diagrams, drawings P-1 and P-2, show the proposed airflow patterns for tanks WM-182 and WM-183. Air will pass through the Temporary Enclosures and into the tanks, though the existing pressure/vacuum relief system piping, through a skid mounted ventilation system, and into the exiting pressure relief piping loop routed around the Tank Farm Facility. Once the air has passed into the pressure relief system for the Tank Farm Facility, it will be discharged out of the main stack from the blowers in CPP-605. This provides filtration requirements and stack requirements without building new systems to facilitate the closure. The two drawings show the details of the skid mounted ventilation system that will be required for the task.

The Temporary Enclosures will have a self-contained ventilation system that will be operated when the tank riser is sealed off. The ventilation unit will be mounted on the roof of the Enclosure and provide a minimum of 0.1 inches negative pressure to the outside of the Enclosure. See drawing P-1 for the Temporary Enclosures ventilation system configuration.

1.1.2 Pressure/Vacuum Relief System Connections

1.1.2.1 WM-182 Lines. Both WM-182 10-inch lines, 10"-VGA-603 and 10"-VGA-604, will be isolated inside condenser pit CPP-721. Line10"-VGA-604 connected to the operational portion of the existing TFF VOG system will be capped, while the line 10"-VGA-603 connected to the tank will be connected to the temporary VOG system for a temporary VOG system. This temporary VOG system will be operational during the closure activities. See drawing P-1 for further details of connection and capping points.

1.1.2.2 WM-183 Lines. The 10-inch pressure/vacuum relief line 10"-VGA-602 will be used in the same fashion as WM-182. The VOG line, 10"-VGA-601 will be isolated outside condenser pit CPP-722, east room. The end connected to the operational portion of the existing TFF VOG system will remain in service for WM-185. The existing VOG line 10"-VGA-601 will be routed to grade and capped. See drawing P-2 for further detail on connection points for the ventilation system on Wm-183.

1.1.3 Drain Lines

Drain lines from the demister on the new ventilation system will be connected to existing drains back to the respective tank being closed. See drawings P-1 and P-2 for more detail on connection points.

1.1.4 Vaults

The Tank Vaults will be ventilated with the same skid configuration as the tanks. Connections will be made to the north and south access points to the vaults. Discharge from the ventilation skid will be into the Pressure/Vacuum Relief connection point used for Tank closure.

References:

Drawings: 057893, 057894, 057501, 105460, 105466, 105526, 105527, 057502, 377431, 377829, 377830, 377831, 377832, 377833, 377834, 377835, 377836, and 377837

Interview with Operations Personnel: Frank Ward

Document Review: INTEC TFF Tanks WM-182 and WM-183 Closure Study, INEEL EXT-98-00913

Equipment:

Skid mounted Fan; 5 Hp, 30-inch wheel, SWSI, Backward Inclined

Enclosure Exhaust Fan: 2 Hp, 15-inch wheel, SWSI, Forward Curved

Calculations

5/12/99 Enclosure / Tank Ventilation Rates BKG

Tank Volume: 300,000 gal

Assumed: $1 \frac{AC}{Hr}$

$$\frac{300{,}000\ gal \mid 0.1336\ ft^3 \mid}{\mid 1\ gal \mid} = 40{,}104.7\ ft^3$$

$$1 \frac{A.C.}{Hr} \Rightarrow \frac{40{,}104.7\ ft^3 \mid 1\ A.C. \mid Hr \mid}{\mid Hr \mid 60\ min \mid} = 668 \frac{ft^3}{min}$$

Enclosures:

Large : 16'x16'x12' => 3072 ft^3

Small : 12'x12'x12' => 1728 ft^3

Assumed: Zone 2 or Secondary containment
Once thru Air
4 A.C./Hr

Ventilation; Minimum

Large:

$$\frac{3072\ ft^3 \mid 4\ AC \mid 1\ Hr \mid}{\mid Hr \mid 60\ min \mid} = 204\ CFM$$

Assume 250 CFM for Robustness

Small:

$$\frac{1728\ ft^3 \mid 4\ AC \mid 1\ Hr \mid}{\mid Hr \mid 60\ min \mid} = 115\ CFM$$

Assume 150 CFM for Robustness

All Ventilation air to Enclosures will be used for ventilation Supply air to Tanks. Highest and lowest Ventilation Rates are:

Highest = 2 large Enclosures + 2 small Enclosures - operating
= 2 * 250 CFM + 2 * 150 CFM
= 800 CFM = 1.19 $\frac{A.C.}{Hr}$ - in tank

Lowest = 1 small Enclosure - operating
= 150 CFM = 0.22 $\frac{A.C.}{Hr}$ - in tank

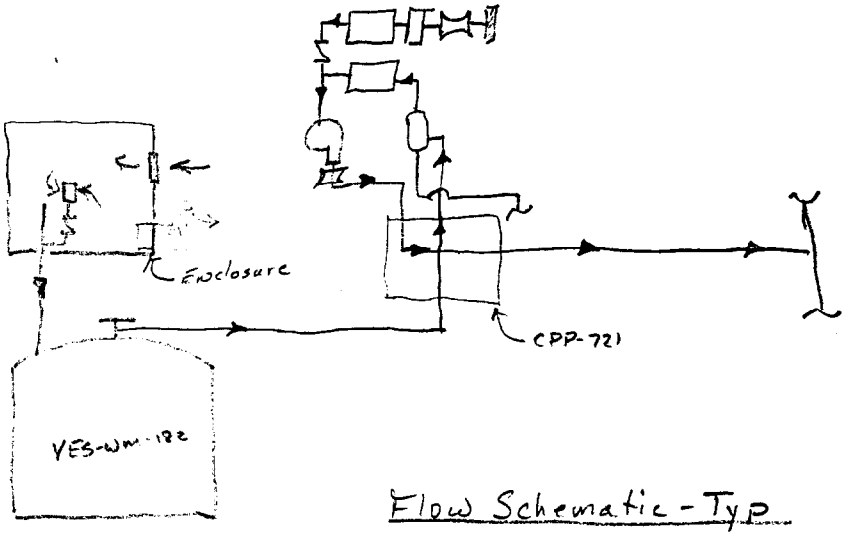
Air Volume can Vary anywhere between the above rates Depending on what Enclosures are in operation or Sequencing is taking Place.

VOC's in Tank:

Referencing Rod Kimmit on VOC contents, concentrations are Below any possible Concerns. See Supporting material from Rod.

13-782 500 SHEETS, FILLER 5 SQUARE
42-381 50 SHEETS EYE-EASE® 5 SQUARE
42-382 100 SHEETS EYE-EASE® 5 SQUARE
42-389 200 SHEETS EYE-EASE® 5 SQUARE
42-392 100 RECYCLED WHITE 5 SQUARE
42-399 200 RECYCLED WHITE 5 SQUARE
Made in U.S.A.
National® Brand

5/27/99 VES-WM-182 Static Pressure Calculation BKG



Flow Schematic - Typ

Enclosure:

Intake Louver - 0.1"
Prefilter-Dirty - 0.5"
HEPA filter - 0.5"
Balance Damper - 0.1"
1.2" S.P. W.C.

HEPA filter - 1.0"
Damper - 0.2"
Damper - 0.2"
1.4" S.P. W.C.

Spool

HEPA filters - 1.0"
Air check Valve - 0.1"
Butterfly Valve - 0.2"
1.3" S.P. W.C.

Piping

0.5"/100ft Assume 250' - 1.25" S.P. W.C.

Skid

Demister - 1.0"
HEPA filters - 2.0"
Flow Control - 0.5"
3.5" S.P. W.C.

TANK Ventilation
Total: 1.2" + 1.3" + 1.25" + 3.5" = 7.25" E.S.P. W.C. => 5Hp fan

Enclosure Ventilation
Total: 1.2" + 1.4" = 2.6" E.S.P. W.C. => 2Hp fan

Reference Information

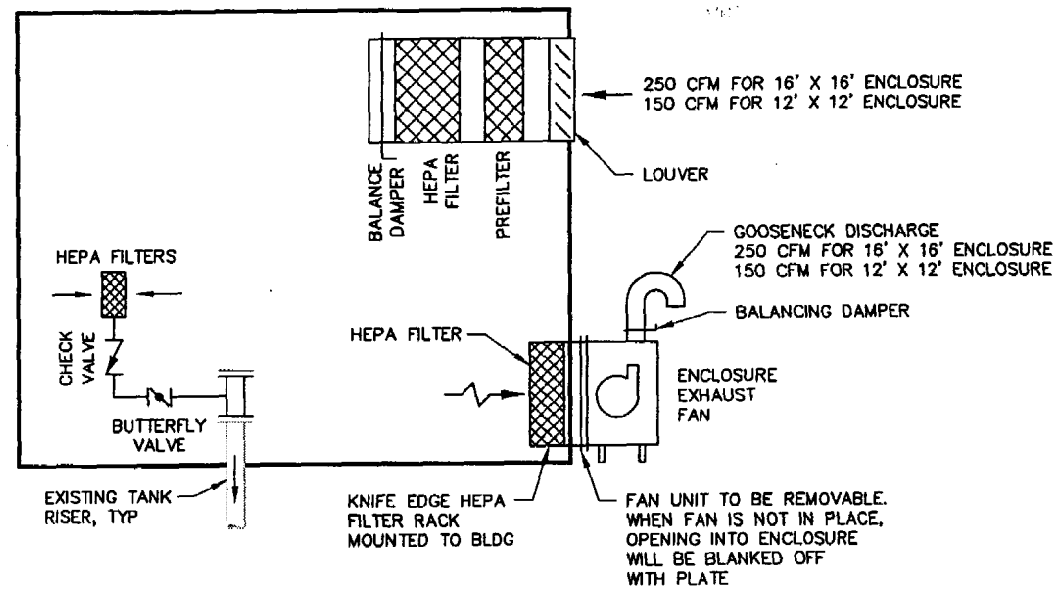
An estimate of the amount of organics in the SBW has been made by R.E. Schindler[1]. The estimate is based on INTEC chemical receipts and usages. The estimated concentrations in the liquid waste are small, most being less 10 parts per billion. Two species may be present in larger concentrations. Paradioxane (1,4-dioxane) may be in the waste at up to 4 parts per million. The maximum concentration of pyridine is 14 parts per million. While both of these species will burn, they are both completely miscible in water, and they both exhibit low vapor pressures in pure form (20 mm Hg and 10 mm Hg, respectively, at room temperature)[2,3]. No special ventilation should be required in the tanks, since the potential for organic vapor buildup is very low.

---

[1] Abbott, M.L., et. al., Screening Level Risk Assessment for the New Waste Calcining Facility, INEEL/EXT-97-00686, Revision 5a, May 1999, Appendix A.
[2] CRC Press, Handbook of Chemistry and Physics, 56th edition, 1976, Section C.
[3] Perry, J.H, et. al., Perry's Chemical Engineers' Handbook, 4th edition, McGraw-Hill, 1963, p 3-47

Drawings

REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE:



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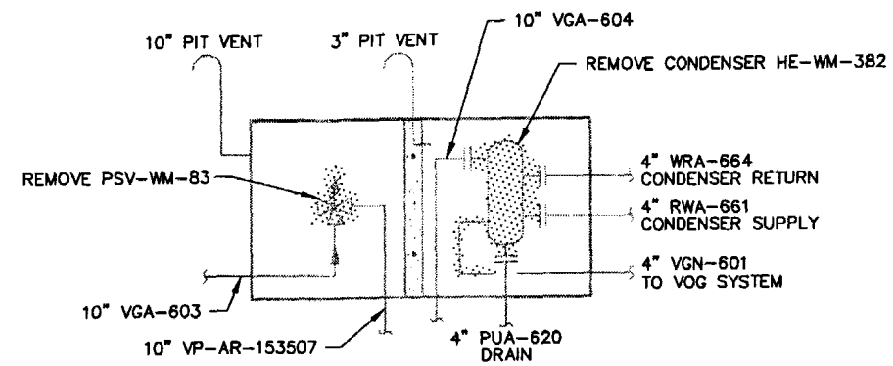
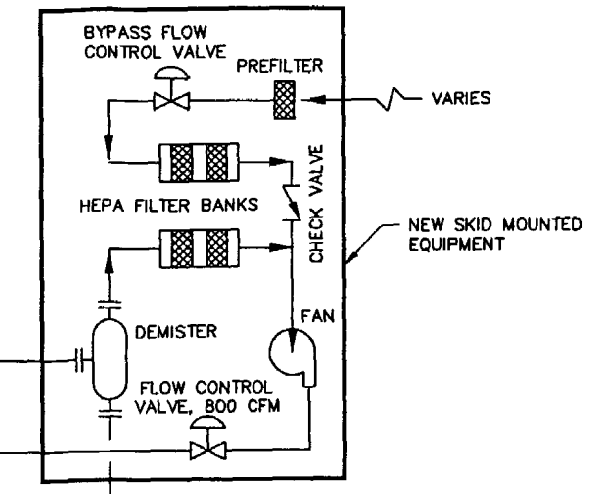
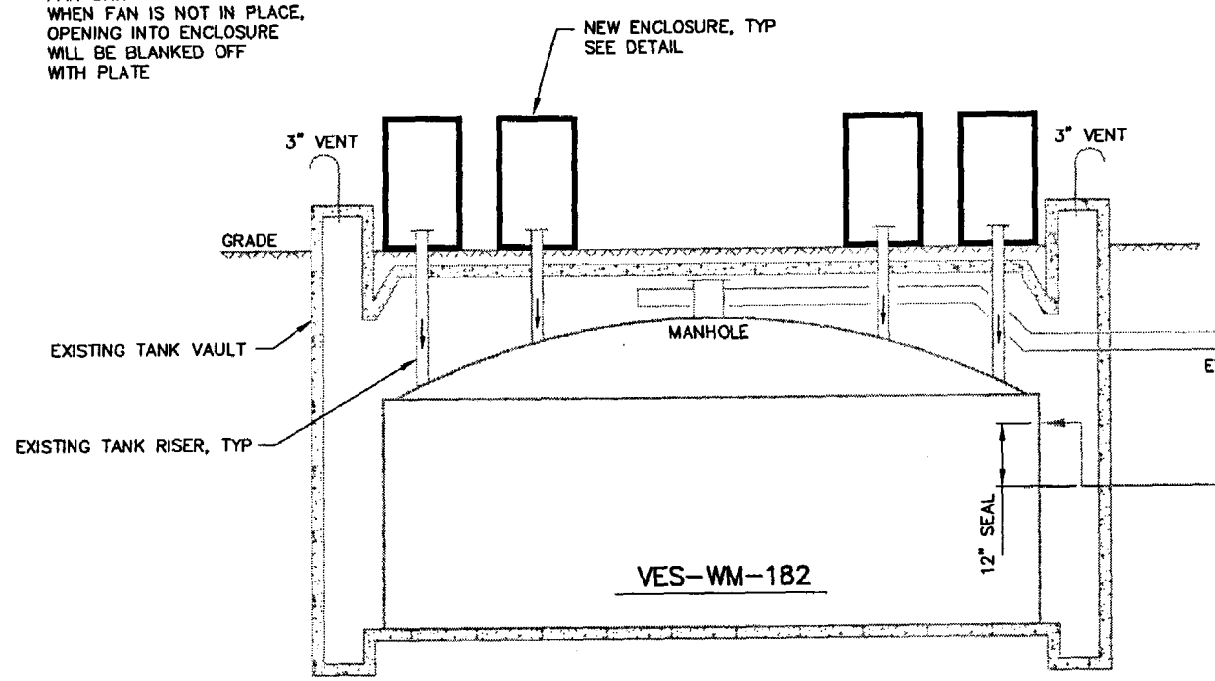
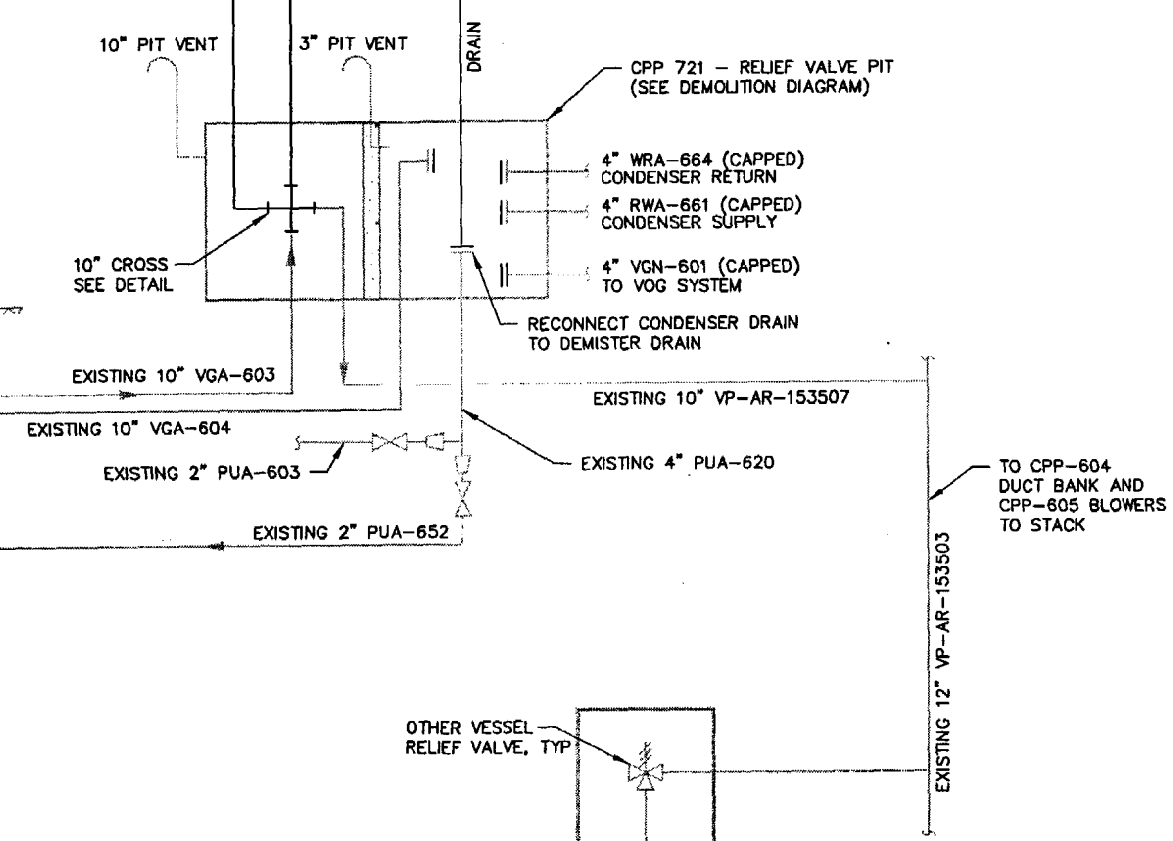
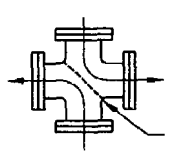


CPP-721 DEMOLITION DIAGRAM









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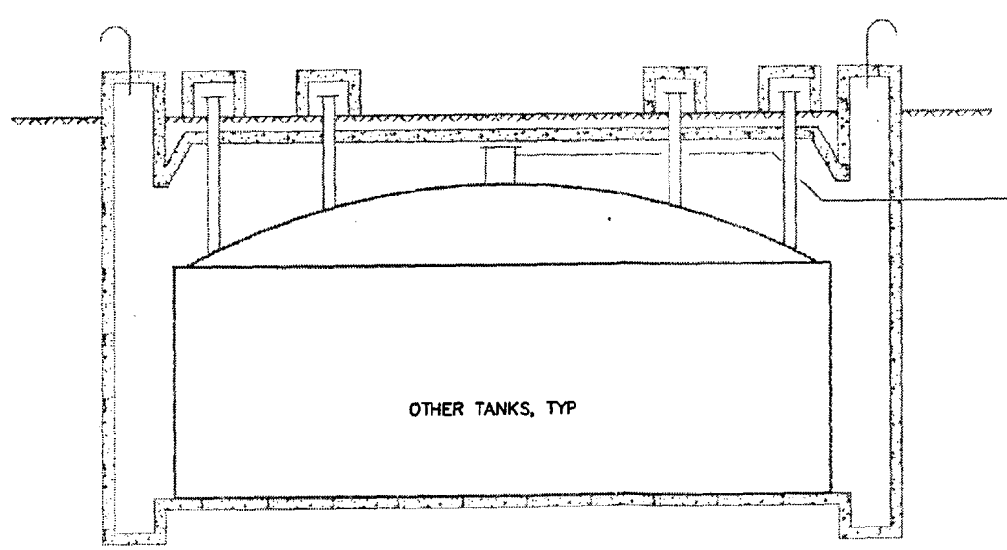

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	DESIGN: BLAIR GROVER	
	DRAWN: KEITH BRONSON	
	PROJECT NO.	
	SPEC CODE	
DESIGN PHASE: CONCEPTUAL	FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO.	SIZE D / CAGE CODE 01MF3 / INDEX CODE NUMBER AREA TYP Q 0 0 0 / 630 / DWG- / REV
QUALITY LEVEL: 3	EFFECTIVE DATE:	SCALE: NONE / SHEET P-1

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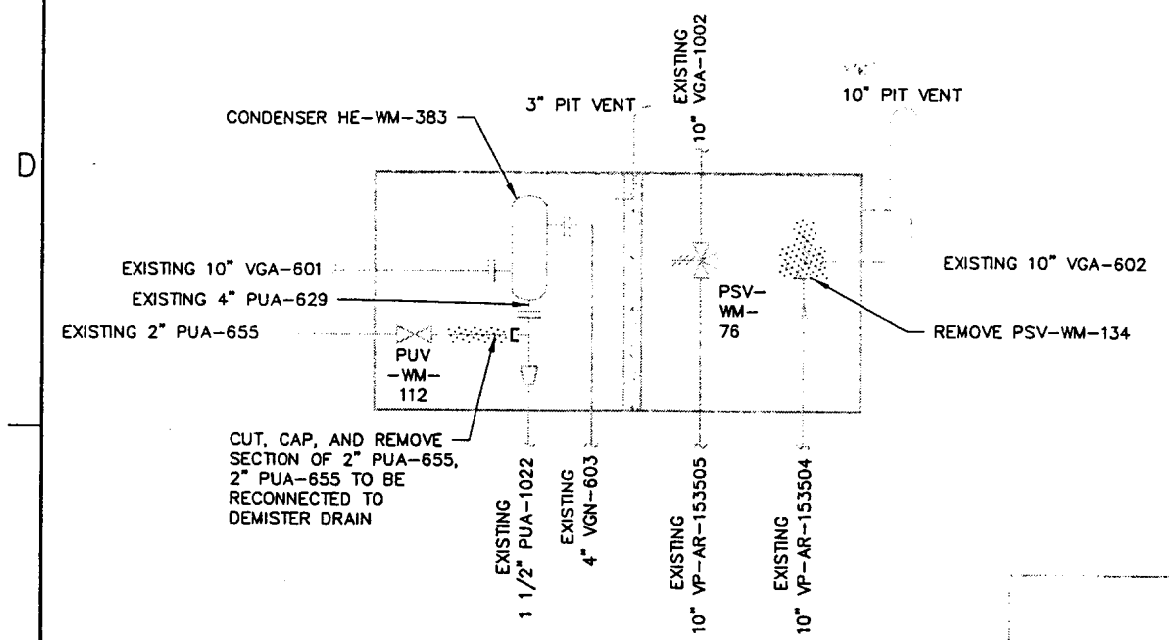
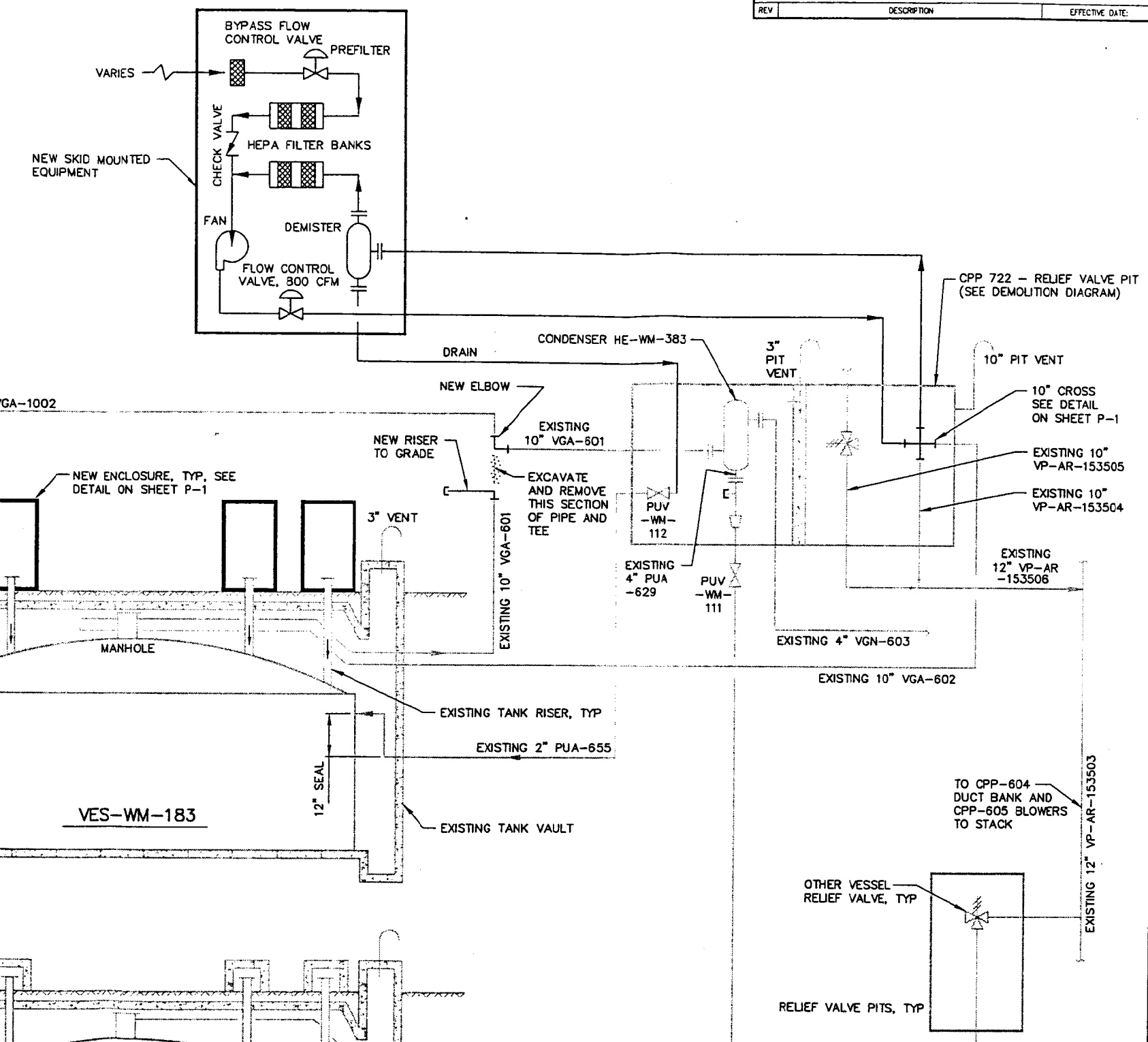


CPP-722 DEMOLITION DIAGRAM



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REV	DESCRIPTION	EFFECTIVE DATE:

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EDF-015722-025

ENGINEERING DESIGN FILE

Form L-0431.2#
(05-96-Rev.#02)

Project File Number: 015722

EDF Serial Number: 025

Functional File Number

Project/Task INTEC TANK FARM FACILITY DEACTIVATION / CONCEPTUAL DESIGN

Sub task HAZARDOUS WASTE CONSTITUENTS

TITLE: 4.5.5 Determine/Develop Arguments for Hazardous Waste Constituent

SUMMARY

This report is a part of the INTEC Tank Farm Facility Deactivation, Conceptual Design, Section 4.5 Environmental Engineering, Scope of Work. This task is identified in the INTEC Tank Farm Facility Deactivation, Conceptual Design, Scope of Work, Sub-section 4.5.5, "Determine/Develop Arguments for (RCRA) Hazardous Waste Constituents".

This report is a compilation of current information on hazardous waste codes and constituents associated with the INTEC Tank Farm Facility (TFF). The preliminary waste code information is based on current knowledge of waste that has entered the TFF tank system. A definitive list of hazardous waste codes and constituents can only be established through sampling and analysis of the waste within the each tank system component

Distribution:

Authors	Department	Reviewed	Approved
T.D. McIntire	7310	Date 6-28-99	Date 6/28/99

0.0 INTRODUCTION.

This report is a compilation of current information on Resource Conservation and Recovery Act (RCRA) hazardous waste codes and constituents associated with the INTEC Tank Farm Facility (TFF). The task is a part of the INTEC Tank Farm Facility Deactivation, Conceptual Design, Section 4.5, Environmental Engineering Scope of Work. The specifics of this task are identified in the INTEC Tank Farm Facility Deactivation, Conceptual Design, Scope of Work, Sub-section 4.5.5, "Determine/Develop Arguments for Hazardous Waste Constituents."

1.0 THIS ENGINEERING DESIGN FILE.

This EDF documents the current body of knowledge concerning waste streams and a minimum set of hazardous waste codes that have gone into the liquid waste system at INTEC. The TFF, as part of the INTEC liquid waste system (LWS), has received the same set of EPA coded waste as the overall LWS. The constituents are preliminarily identified by recent and previous investigations that have included knowledge of the listed hazardous waste codes and the potential underlying hazardous waste constituents (UHCs) for system waste, all of which have a radioactive component (i.e. mixed waste).

The preliminary list of constituents associated with the TFF have been reviewed and identified through the efforts of INTEC operations personnel, INEEL Environmental Affairs personnel, who reviewed process records for waste material having entered the TFF. The list of TFF constituents is preliminary and subject to change. The discovery of additional operational information or the results of specific TFF tank sampling and analytical testing of the contents of tanks and supporting systems and will probably affect the output of this initial evaluation.

2.0 SCOPE OF WORK

Review all waste streams that have gone into the liquid waste system at the INTEC. Determine the hazardous waste constituents associated with the hazardous waste codes for the purposes of identifying those constituents restricted from land disposal.

(Note: Information available to allow a complete and thorough review of all waste streams that may have gone into the liquid waste system is limiting. Consequently, this is a preliminary review of the waste that might exist in the TFF system. A more definitive assessment can only be performed after adequate sampling and analysis has been completed and a reassessment of existing documentation has been completed.)

3.0 DELIVERABLES.

A white paper/EDF prepared on the hazardous waste constituents of concern for the TFF.

(Note: Information available to allow a complete and thorough review of all waste streams that may have gone into the liquid waste system is limiting. Consequently, this is a preliminary review of the waste that might exist in the TFF system. A more definitive assessment can only be performed after adequate sampling and analysis has been completed and a reassessment of existing documentation has been completed.)

4.0 METHODOLOGY.

The INTEC Waste streams discharged into the PEWE were recently assessed and evaluated. This EDF gathers the most current listed and characteristic hazardous waste code information from existing waste records and documentation on the TFF waste streams and their underlying constituents. However it is subject to change upon receipt of analytical test results and reassessment. In both the case of the RCRA listed waste and underlying hazardous constituents, recent guidance and assessments are used to identify the constituents of concern.

Sampling and Analysis has been performed on some of TFF Tanks. Data obtained from this system-associated sampling will provide an indication of characteristic codes that may be applicable. However there may be additional characteristic codes identified and included for the TFF tanks upon the approval and acceptance of final form analytical test results.
The list of underlying hazardous constituents (UHCs) for the INTEC liquid waste treatment system was preliminarily evaluated in February 1999. Potential UHCs were identified using the input of INTEC laboratory personnel and a historical review of background documentation associated with a draft listed waste determination report produced by Westinghouse Idaho Nuclear Company.[2] The final list of constituents will depend on the results of final tank and system sampling.

5.0 THIS EDF REPORT

This report is a part of the INTEC Tank Farm Facility Deactivation, Conceptual Design, Section 4.5 Environmental Engineering, Scope of Work. This task is identified in the INTEC Tank Farm Facility Deactivation, Conceptual Design, Scope of Work, Sub-section 4.5.5, "Determine/Develop Arguments for (RCRA) Hazardous Waste Constituents".

This report is a compilation of available information on hazardous waste codes and constituents associated with the INTEC Tank Farm Facility (TFF). The preliminary waste code information is based on analytical results from limited sampling efforts. A definitive list of hazardous waste codes and constituents can only be established through sampling and analysis of the waste within the each tank system component.

6.1 TFF Listed waste codes

The evaluation of TFF listed hazardous waste codes were obtained from background documents and additional operational information documentation obtained from 1993 through 1998. There has not been any additional comprehensive studies of source waste material performed on the INTEC liquid waste system since *A regulator Analysis and Reassessment of U.S. Environmental Protection Agency Listed Hazardous Waste Numbers for Applicability to the INTEC Liquid Waste System,* was prepared in February, 1999[1] . This report identified and confirmed nine constituents that represent four U.S. Environmental Protection Agency (EPA) listed hazardous waste numbers for the INTEC Liquid Waste Treatment System including the ICPP Tank Farm. The report identified chemical constituents that were added to the PEWE liquid waste system and their EPA listed hazardous waste numbers based on confirmed use/confirmed disposal.

Because of the known acid condition of liquid waste in the industrial processes that feed the TFF tanks, the EPA hazardous waste number of D002 should be assigned denoting the characteristic of corrosivity for hazardous waste in the system.

Sampling and Analysis performed on TFF Tank WM-188 indicate the potential for three additional constituents (cadmium, chromium, and lead) plus the knowledge of the highly acidic process operation that feeds the TFF resulting in the characteristic of corrosivity.[4] These four codes are assumed to be present; but will require sampling and analysis to confirm there presence above regulated levels with in the tank system, as well as any additional characteristic codes.

Organic waste constituents are known to have been introduced to the TFF system and therefore have a potential of being present in the tanks of concern. The majority of these constituents are not reasonably expected to be present above RCRA LDR treatment standard. For all organic constituents listed, sampling and analysis will be required to determine if their respective characteristic codes apply.

The chemical constituents and listed hazardous waste codes are repeated here in Table 1 for convenience.

Table 1. Summary of constituents and applicable listed hazardous waste numbers.

CHEMICAL CONSTITUENT	CAS #	FINAL EPA HAZARDOUS WASTE NUMBER[a]
Acetone	67-64-1	N/A
Benzene	71-43-2	F005
Carbon disulfide	75-15-0	F005
Carbon tetrachloride	56-23-5	F001 F002
Cyclohexane	110-82-7	N/A
Cyclohexanone	110-94-1	N/A
Ethyl acetate	141-78-6	N/A
Hydrogen fluoride (hydrofluoric acid)	7664-39-3	U134
Methanol	67-56-1	N/A
Methyl isobutyl ketone (Hexone or 4-Methyl-2-pentanone)	108-10-1	N/A
Pyridine	110-86-1	F005
Tetrachloroethylene	127-18-4	F002
Toluene	108-88-3	F005
1,1,1-Tricholoroethane	71-55-6	F001 F002
Trichloroet+hylene	79-01-6	F001 F002
Xylene	1330-20-7	N/A

[a] N/A = Not applicable.

For the purposes of this report, the constituents and associated characteristic codes determined by analysis of WM-188 liquid waste, shown in Table 2, are assumed to be within the TFF tank system. Sampling and analysis of the contents of individual tanks and or associated components will provide a final list.

Table 2. WM-188 Summary of potential TCLP constituents and applicable listed hazardous waste numbers.

CHEMICAL CONSTITUENT	CAS #	FINAL EPA HAZARDOUS WASTE NUMBER
Cadmium	7440-43-9	D006
Chromium	7440-47-3	D007
Lead	7439-92-1	D008

6.2 TFF Underlying Hazardous Constituents

The underlying hazardous constituents (UHCs) for the INTEC liquid waste treatment system were also preliminarily assessed in February 1999. The UHCs listed within this report are to be considered a preliminary and draft list of UHCs that were identified from INTEC laboratory personnel input, a historical review of background documentation, and an associated draft listed waste determination report prepared by WINCO in June 1993.[2] The list of constituents in Table 3 are those that are suspected as having entered the INTEC liquid waste system and therefore are included as UHCs for the purpose of the initial sampling of the tanks. The final list of UHCs and characteristic waste codes can be determined only after the results from sampling and analysis are completed and reevaluated.

Table 3. Preliminary List of Underlying Hazardous Constituents

Metals	Organics
Silver	Phenol
Arsenic	Ethyl benzene
Barium	Chloroform
Beryllium	Methylene Chloride
Cadmium	Isobutyl alcohol
Chromium	2-Butanone
Mercury	Napthalene
Nickel	Nitrophenol (ortho & para)
Lead	Nitrobenzene
Selenium	
Antimony	
Thallium	
Vanadium	
Zinc	

It should be noted that listed hazardous waste numbers are normally initially assigned to waste streams based on known receipt of listed waste into a system and not based on sampling and analysis. Based on current knowledge about the materials that have entered the TFF, it will be necessary to rely on analysis to determine the characteristic hazardous waste numbers and UHCs that apply to the TFF. The results of this sampling effort will also determine applicable LDRs.

6.3 Land Disposal Restrictions

Final treatment standards that will be applicable may be ultimately determined through agency interaction (e.g. 268.42 (b) determination of equivalent treatment) and could result in a specified technology standards to be established or risk based standards to be established (e.g. high mercury subcategory).

Limited sampling and analysis has been performed on the contents of tanks within the TFF. Sampling and analysis of TFF tank WM-188 contents were performed and the resultant analysis is used here as an indicator of waste constituents that one can expect to find elsewhere in the tank system.[4] Two inorganic

samples of WM-188 were obtained and analyzed. The waste concentrations from the analyses were averaged within this report and then compared to the land disposal treatment standard (268.48 (a)). The results of this analysis indicate inorganic constituents within the TFF system to be in excess of the allowable waste concentrations for land disposal (e.g. 268.48 (b) Universal Treatment Standards). The relevant RCRA metals analysis data for WM-188 is included here in Table 4.

Table 4. RCRA Metals Analysis (WM-188)

Analyte	WM-188 8AE34 (ppm)	WM-188 8AJ06 (ppm)	SUM	SUM/2 (AVERAGE) (ppm)	LDR STANDARD (mg/L) 10CFR268.48	EXCEEDS REG. STD. Yes / No
ANTIMONY	2.45	2.45	4.90	2.45	1.15	YES
ARSENIC	55.3	38.90	94.2	47.1	5.0	YES
BARIUM	14.5	12.4	26.9	13.45	21.0	YES
BERYLLIUM	0.791	0.791	1.58	0.79	1.22	NO
CADMIUM	1460	1170.	2630	1315	0.11	YES
CHROMIUM	900.00	685.0	792.5	396.25	0.60	YES
LEAD	227.00	180.0	407	203.5	0.75	YES
NICKEL	284.00	252.0	536	268	0.11	YES
SELENIUM	6.28	6.28	12.56	6.28	5.7	YES
SILVER	5.51	4.65	10.16	5.08	0.14	YES
THALLIUM	6.78	6.78	13.56	6.78	0.20	YES
VANADIUM	1.75	1.21	2.96	1.48	1.6	YES
ZINC	68.80	48.5	117.3	58.65	4.3	YES
$MERCURY_1$	1410	1630	2800	1520	0.025	YES
$MERCURY_2$	1390	1680	3310	1535	0.025	YES

The final LDRs shall be determined from the waste final form or forms. Samples from each tank or system shall be considered and LDRs established based upon analytical results.

7.0 FOOTNOTES

[1]INEEL/EXT-98-01213, Rev. 1, A Regulatory Analysis and Reassessment of U.S. Environmental Protection Agency Listed Hazardous Waste Numbers for Applicability to the INTEC Liquid Waste System, February 1999.
[2] DRAFT "Listed Waste Determination Report," WINCO 1132, June 1993.
[3] C.L. Tellez letter to Lisa A. Green, CLT-14-99, Initial List of Underlying Hazardous Constituents (UHCs) for the INTEC Liquid Waste Treatment System, February 2, 1999.

[4] INEEL/INT-98-00931, Rev. 1, LIMITCO Internal Report, Analysis of the HLW Calcined During the NWCF Campaign H-4, HLW Program Office

EDF-015722-026

ENGINEERING DESIGN FILE

Form L-0431.2#

(05-96-Rev.#02)

Project File Number: 015722

EDF Serial Number: 026

Functional File Number: 7453

Project/Task: INTEC TANK FARM FACILITY DEACTIVATION / CONCEPTUAL DESIGN

Subtask: HISTORY OF RELEASE TO RCRA ENCLOSURES

TITLE: Scope of Work, 4.5.6 - Assessment of the History of Release to RCRA Enclosures

SUMMARY: This is an assessment of the historic release to pipe trenches and other encasements where liquid waste may have accumulated. The assessment does not include the tank vaults.

This assessment of historical releases to the environment in and around the INTEC Tank Farm Facility (TFF) is focused on those trenches and encasements that may have had releases of hazardous or radiological contaminants. The assessment is a part of the INTEC Tank Farm Facility Deactivation, Conceptual Design, Section 4.5 Environmental Engineering, and Scope of Work. This task is identified in the INTEC Tank Farm Facility Deactivation, Conceptual Design, and Scope of Work, Subsection 4.5.6, "Assess History of Release to RCRA Enclosures and Evaluate Decontamination Requirements."

The closure of the TFF Tanks is a part of the actions required to address the current environmental conditions at the TFF and to permanently close the facility and to address the extent of contamination in the closure process in a way that protects the human health and the environment. As a part of the process, an investigation of the piping system and the trenches and encasements is required to determine what if any releases may have occurred over the years of TFF operations. The information gathered by this assessment is represented in a fashion to clearly identify the encasements, and the trenches where possible, and their locations relative to the TFF Tanks.

Distribution:

Authors	Department	Reviewed	Approved
T.D. McIntire	**7310**	Date 6-28-99	Date 6/28/99

0.0 INTRODUCTION.

This assessment of historical releases to the environment in and around the INTEC Tank Farm Facility (TFF) is focused on those trenches and encasements that may have had releases of hazardous or radiological contaminants. The assessment is a part of the INTEC Tank Farm Facility Deactivation, Conceptual Design, Section 4.5 Environmental Engineering, and Scope of Work. This task is identified in the INTEC Tank Farm Facility Deactivation, Conceptual Design, Scope of Work, sub-section 4.5.6, "Assess History of Release to RCRA Enclosures and Evaluate Decontamination Requirements."

1.0 BACKGROUND.

The Department of Energy (DOE), Environmental Protection Agency (EPA), and the Idaho Department of Health and Welfare (IDHW) have a common goal to ensure that releases or threatened releases of hazardous substances at the INEEL are thoroughly investigated in accordance with the National Contingency Plan (NCP) and that appropriate response actions are undertaken and completed as necessary to protect human health and the environment. The framework for the response actions at the INEEL is described in the Federal Facility Agreement and Consent Order (FFA/CO) and Action Plan. This document identified 10 waste area groups (WAGs) at the INEEL of which the ICPP has been designated as WAG 3.

The Action Plan identified 83 release sites within WAG 3 and 12 additional release sites that include the OU 10-06 windblown area were subsequently added. To expedite evaluation, these 95 sites were combined into 13 operable units (OUs) based on similar waste streams and projected remedial actions. The action plan document was use as the mechanism for presenting the available data for WAG 3 concerning site conditions and the nature and extent of contamination, and assessing the potential risk to human health and the environment. A companion document, the feasibility study (FS), serves as the mechanism for the development, screening, and detailed evolution of various remedial actions to address the contamination identified in the RI/BRA.

2.0 THIS ENGINEERING DESIGN FILE.

The closure of the TFF Tanks is a part of the actions required to address the current environmental conditions at the TFF and to permanently close the facility and to address the extent of contamination in the closure process in a way that protects the human health and the environment. As a part of the process, an investigation of the piping system and the trenches and encasements is required to determine what if any releases may have occurred over the years of TFF operations. The information gathered by this assessment is represented in a fashion to clearly identify the encasements, and the trenches where possible, and their locations relative to the TFF Tanks.

3.0 SCOPE OF WORK.

Perform an assessment of the historic release to pipe trenches and other encasements where liquid waste may have been release and accumulated. The work scope does not include assessment of any accumulations that may have occurred in the tank vaults.

4.0 DELIVERABLES.

A list of trenches or encasements that have or potentially have had releases to them.

5.0 METHODOLOGY.

Reviews of recent documentation on historical releases that occurred within the boundary of the Tank Farm Facility documents were performed and documented in the INTEC TFF History Report[1]. Many of the documents reviewed used the valve boxes as a point of reference to indicate where there may have been a release of contamination within the TFF. Using this as an initial starting point, a list of valve boxes associated with releases of material in the TFF area of concern was established. From there the process lines that ran through or that were terminated in each of valve boxes were added. Next the type of encasement that was added to show the secondary containment where known.

6.0 REPORT

Releases to the environment have been identified in several documents and summarized in the Draft Work Plan for Operable Unit 3-14 and Tank Farm Waste Area Group 3 and RI/FS2 and additional unidentified releases in the INTEC TFF History Report. Information from the history report on possible TFF Undocumented Environmental Releases, has been included here in this document as Table 1. An additional column has been included to indicate the potential of the identified release entering the encasement system to complete the EDF.

Table 1. Possible TFF Undocumented Environmental Releases.[1]

TFF Potential Environmental Release Location	Occurrence Description	Occurrence Date	Environmental Release Substance	Remedial Action	Reference	Operable Unit/Site	Comments	Suspected release to Trench/ Encasements
Between CPP-655 AND CPP-636	Severed steam line	8-25-77	Steam (possible unknown contaminates such as chromates). Unknown volume or quantity.	Unknown	WCF Supervisor's Logbook, August 25, 1997, Page 33	3-07/CPP-26	See Appendix E of TFF History Report for original logbook pages.	No
CPP-605 building entrance	Jet discharge line for VES-WM-135 inside NWCF leaking condensate (Nox) due to incomplete butt weld.	12-1-98	Nox condensate solution. Two small puddles formed on the ground with less than a significant fraction of reportable quantity.	Removed contaminated gravel and spill.	Occurrence Report #ID-LITC-WASTEMGMT – 1997-0026	3-07/ CPP58	See Appendix E of TFF History Report for original logbook pages. Release is outside TFF area and not evaluated here.	Yes
Within the excavated area north of CPP-604.	During excavation for low-level waste tanks WL-132 and WL-133, soil contamination was discovered north of CPP-604.	1980's	Radionuclides. Unknown volume or quantity.	Unknown remediation actions. Excavated areas were back filled using soils with contact readings less than 5mR/hr. Contaminated soils may have been removed during the High Level Waste Tank Farm Replacement	H.L. Lord Report, 3-25-92, HLL-02-92, of Known Contamination in the ICPP High Level Waste Tank Farm	3-07/ CPP-25	A copy of the H.L. Lord report is located in Appendix E of TFF History Report.	Yes

[1] K.D. McAllister, et. al., INTEC TFF History Report Table 5-1, INEEL/EXT-98-00XXX, Draft: November 19, 1998.

TFF Potential Environmental Release Location	Occurrence Description	Occurrence Date	Environmental Release Substance	Remedial Action	Reference	Operable Unit/Site	Comments	Suspected release to Trench/ Encasements
				Project.				
Bottom of valve box A2	During excavation for low level waste tanks WL-132 and WL-133, soil contamination was discovered near the bottom of valve box A2	1980's	Radionuclides. Unknown volume or quantity.	Unknown remediation actions. Contaminated soils may have been removed during the High Level Waste Tank Farm Replacement Projects	H.L. Lord Report, 3-25-92, HLL-02-92, Description of Known Contamination in the ICPP High Level Waste Tank Farm	3-07/ CPP-79	A copy of the H.L. Lord report is located in Appendix E of TFF History Report.	Yes
Area between WM-191 and WM-106	Area was used to decontaminate construction equipment before WM-191 was constructed.	Prior to 1970	Steam condensate, Decontamination Solution, petroleum Products and radioactive contaminates. Unknown volume or quantity.	Excavated area for UW-191 construction but not contamination was found.	F.S. Ward Interview	Unknown	Although this area may have been used to decontaminate construction equipment no contamination was found during WM-191 construction. See Appendix E of TFF History Report for original interview notes.	No

TFF Potential Environmental Release Location	Occurrence Description	Occurrence Date	Environmental Release Substance	Remedial Action	Reference	Operable Unit/Site	Comments	Suspected release to Trench/ Encasements
Ground surface north of WM-187 and WM-189	Hydraulic oil spill from a P & H construction crane	Between 1986 and 1988	1 to 10 gallons of hydraulic oil.	Hydraulic oil was left on the ground covered with a plastic sheet and gravel.	F.S. Ward Interview	3-07/CPP-26	See Appendix E of TFF History Report for original interview notes.	No
TFF surface area	Above grade hose connection leaks while transferring vault liquid to PEWE.	Prior to 1975	Slightly contaminated liquid waste. Unknown volume or quantity.	No remediation actions	F.S. Ward Interview	3-07/CPP-20	See Appendix E of TFF History Report for original interview notes.	No
Adjacent to condenser pit CPP-387 and CPP-635	Chromate solution leak from two failed buried valves WRV-1 and WRV-2 (valve names may have changed to WRV-WM-1&2).	Prior to 1977	Chromate solution. Unknown volume or quantity.	Unknown remediation actions. Area was excavated for valve box C-20.	F.S. Ward Interview	3-07/CPP-26	See Appendix E of the TFF History Report for original interview notes. Valves now located inside valve box C20.	Yes
North of CPP-635 in a dirt bottom valve box (valve box has no name).	Chromate solution leak from a failed valve WSV-6 located inside a dirt bottom valve box.	Prior to 1977	Chromate solution. Unknown volume or quantity	Unknown past remediatioin actions, area is tested periodically no contamination found.	F.S. Ward Interview	3-07/CPP-26	See Appendix E of TFF History Report for original interview notes.	Yes

Since most of the TFF piping is routed through a network of valve boxes that connect processes to the TFF tanks, a listing of valve boxes was established where known or newly discovered releases were associated. These valve boxes are identified in Table 2.

For each of the valve boxes, a list of the lines or piping was identified that either terminate in, or are routed through a valve box on the way to another valve box, or to another piece of process equipment.

Many valve boxes were designed with collection sumps that drained into adjacent tank vaults. Early designs of the TFF piping system provided bellows seal type valves with a limited seal life (approximately 500 cycles). When a valve would leak and require seal repair, fluid would collect in the valve box sump. Each sump drain was piped to one of the nearby TFF tank vaults. Leaking valves in these valve boxes was a relatively common occurrence with the bellows seal valve design. Therefore the release of process fluid to the various tank vaults did occur with some frequency. One example of this occurred in valve box A-6 during the 1970's. Process fluid from a leaking valve accumulated in sump and was allowed to drain to the WM-183 vault south sump. Since it was a common occurrence for these early valves to begin leaking, it is probable that many of the vaults have received fluids from these valve box sumps. According to plant operations personnel TFF tanks WM-183, 184, 185, 186, 187, and 189 with valve box drain inlets are thought to have received some valve released process waste.[2]

Once the piping associated with each valve box was established, the encasement system type was determined by reviewing existing reports and assessments.

The piping within the TFF provides an initial barrier to the release of process waste material to the environment. Of the piping identified within the trenches and encasements in the TFF, only stainless steel was identified in applications where the TFF process fluids were transported or contained. In the event the pipe which provides the primary containment should be breached, the encasement or secondary containment system is designed to contain the process fluid and protect the surrounding environment. There were other non-process waste lines that serve as tank cooling solution, vacuum supply, or compressed gas lines that are constructed of carbon steel; but are not waste containing and, therefore, are not included in piping summaries.

A secondary containment, or as it is called here, the TFF Encasement System, consists of a collection of designs that function to provide an additional barrier to the release of unwanted liquid material to the environment. There are five primary types of encasement used in operating areas of the tank farm facility depending on the source of information. Each type of encasement is identified below in order of decreasing risk or likelihood of release of process fluid to the environment. This assessment of risk is not a statistical based evaluation of the risks associated, but is based on a subjective assessment of the relative merits of the individual containment designs.

The encasement systems are as follows:

Split tile - Ceramic cast pipe (Tile Encased)
Stainless Steel-lined concrete troughs (Concrete Trough Encased)
Direct buried pipes in concrete (Concrete Encased)
Double walled stainless steel pipe (Pipe in Pipe)
Tile Encased/Pipe in Pipe

The ceramic tile containment system offers an additional containment barrier to fluid leakage from a process fluid carrying pipe should that pipe be breached. The tile encasements systems were installed early in the history of the TFF. The tile encasement system was of a split ceramic tile design that requires grout to be applied to seal between each section of tile. Over time, and with the exposure to acidic process waste, the grout has a tendency to deteriorate and breach the secondary containment that the tile encasement was designed to provided. The second system, concrete encased pipe, is slightly better in providing process fluid containment. The inherent characteristic of curing concrete is to develop cracks that over time may also allow the possibility of process fluid to be released to the environment. Pipe in Pipe is third on the list only because it provides one less barrier than Tile Encased/Pipe in Pipe and is somewhat less likely to have containment failures because of its double barrier stainless steel construction. Last on the list is Tile Encased/Pipe in Pipe. This type of encasement is considered to offer a slightly higher degree of release protection/containment because of the one additional barrier.

Table 2. TFF Valve Boxes with Potential Environmental Releases.

TFF Potential Release Location	Occurrence Description	Occurrence Date	Environmental Release Substance	Remedial Actions	Reference	OU/Site	Comments
Valve Box A-2	During excavation for low-level waste tanks WL-132 and WL-133, soil contamination was discovered near the bottom of valve box A-2.	1980's	Radionuclides of unknown volume or quantity	Unknown remediation actions. Contaminated.	Dwg. 057501 Doc.	3-07/CPP-79	
Valve Box A-5 (Also see valve Box C-7)	Release of ~ 52,000 liter (14,000 gal) of HLLW to surrounding soils during a transfer between tank WM-181 and WM-180. Release was caused by failure of 7.6 cm (3 in) diameter WRN-1037 carbon steel, waste transfer line.		High Level Liquid Waste (Radionuclides)			3-07/CPP-31	Discovered contamination may have originated in trench/encasement leading to valve box. (Some references refer to WM-182 and WM-183 vs. WM-180 and WM-181.)
Valve Box B-4	2 R/hr soil detected southwest of valve box B-4 (assumed to be contaminated by leaking standpipe). Similar readings were detected 50 feet northwest of the same valve box.	1976	Radioactively Contaminated Condensate (Radionuclides)	Soil left in place and covered with soil, membrane, and soil. Further study was recommended.	H.L. Lord Report; March 27, 1992	3-07/CPP-32A (CPP-32W/E)	
Valve Box B6	Valve Box A6 is connected via piping to VB B-4 and is a probable release point.	1976	2 R/hr soil readings	No known remedial action.	H.L. Lord Report; March 27, 1992	TBD	
Valve Box B-9 (Adjacent to condenser pit CPP-387 and Northwest of CPP-635)	Leaks from two failed buried valves WRV-1 and WRV-2 (valve names may have changed to WRV-WM-1&2)	Prior to 1977	Chromate solution. Unknown volume or quantity.	Unknown remediation actions, area was excavated for valve box C-20		3-07/CPP-28	
Valve Box B9	Unknown contamination was found near VB-B9.	June 1975	Unknown	Soil was removed.	H.L. Lord Report, March 27, 1992	3-07/CPP-30	Soil with unknown contamination was removed. No mention of the source, waste constituents or system repair.

TFF Potential Release Location	Occurrence Description	Occurrence Date	Environmental Release Substance	Remedial Actions	Reference	OU/Site	Comments
Valve Box C-7 (Also see Valve Box A-5)	Release of ~ 52,000 liter (14,000 gal) of HLLW to surrounding soils during a transfer between tank WM-181 and WM-180. Release was caused by failure of 7.6 cm (3 in.) diameter WRN-1037 carbon steel, waste transfer line.		High Level Liquid Waste (Radionuclides)			3-07/CPP-31	Discovered contamination may have originated in trench/encasement leading to valve box

7.0 The valve box information and the process piping associated with each valve box was tabulated and is provided here in Table 3. The information in Table 3 was condensed and summarized on a version of the two-dimensional plan view drawings originally known as the "Underground Utilities Mapping at INTEC Tank Farm – Enlarged Area Plans"[4] These drawings are provided in Appendix A. Each drawing depicts in a color code fashion the different types of encasement systems used and where they are located relative to the tanks that are being removed. With these drawings, the INTEC TFF closure project will have another tool with which to plan and determine the best conceptual approach to closure of tanks at INTEC Tank Farm Facility. Table 3 provides a summary of the information gathered on the valve box, process piping, and encasement type identified to have had a spill or release association.

8.0 FOOTNOTES

[1] K.D. McAllister, et. al., *INTEC TFF History Report*, Draft, November 19, 1998
[2] Tel. Conv. Frank Ward concerning a suspected release from valves in valve box A6 that were collected in the A6 sump and drained to WM-183 tank vault south sump, June 16, 1999
[3] DOE-ID, February 1999, DOE-ID, *Draft Work Plan for Operable Unit 3-14, Tank Farm, Waste Area Group Comprehensive Remedial Investigation/Feasibility Study*, DOE/ID-10676, Rev 0, Lockheed Martin Idaho Technologies Company for the U.S. Department of Energy, Idaho Operations Office.
[4] 020906 INTEC, Underground Utilities Mapping at INTEC Tank Farm, Enlarged Plan Areas 1-8, p. C1-C13.

Table 3. TFF Valve Box, Piping and Encasements with Suspected Releases to Environment

Valve Box	Line No.	Description	Reference:	Encasement Type	Matl. Type	OU/Site	Comments
DVB-WM-PW-A2	1"PL-AR-153518	Process Waste Low Level. Line runs thru CPP-79.		Unknown	SST	CPP-79	{47} Misc. Structures. VB-A2 is abandoned. Ref: p. C5.
DVB-WM-PW-A2	1'PL-AR-153514	Process Waste Low Level. Line runs thru CPP-79.	057498-D4	Unknown	SST	CPP-79	{46} Misc. Structures. Ref: p.C5
DVB-WM-PW-A2	3"PW-AR-151825	Abandoned line is associated with VB-C37 and runs into CPP-79		Unknown	SST	CPP-79	
DVB-WM-PW-A2	3"PW-AR-151822	Line is associated with VB-C37 and runs into CPP-79. Believed to be abandoned.		Unknown	SST	CPP-79	
DVB-WM-PW-A2	1"DC-AR-151725	Line runs thru CPP-79.		Unknown	Unknown	CPP-79	P. C-5
DVB-WM-PW-A2	3"PW-AR-151009	Line runs thru CPP-79.		Unknown	Unknown	CPP-79	P. C-5
DVB-WM-PW-A2	1-1/2"PL--AR-115804	Runs between VB-A2 and CPP604. Process unknown	057501-F6	Unknown	Unknown	CPP-79	Line believed to be abandoned, but may have been removed. Pipe not shown in Table C, DOE/ID-10676(99)
DVB-WM-PW-A2	3"PLA-100163 *	VB-A2 Drain Line to 3"PWM-48048C	057501-A7	Pipe in Pipe	SST	CPP-79	[35]
DVB-WM-PW-A2	3"PWM-48048C	Abandoned. Capped in VB-C37 and terminates at VES-WL-102	096156-D7	Pipe in Pipe	SST	CPP-79	[212]
DVB-WM-PW-A2	1-1/2"PL-AR-20028 [1-1/2"PWM-10028Y]	Line passes through CPP-79. CarriesWM-100 sump liquid to VBC37.	096156-B6	Pipe in Pipe	SST	CPP-79	[222] Ref: P. C-5.
DVB-WM-PW-A2	1-1/2"PL-AR-3019	Process Waste Low Level. Line runs thru CPP-79.	096156-C8	Pipe in Pipe	SST	CPP-79	[223] {48} Misc. Structures
DVB-WM-PW-A2	1-1/2"PWM-3017Y or C	Carries process waste from above grade hose connection to WM-180.	057501-F7	Tile Encased/ Pipe in Pipe	SST	CPP-79	[2]
DVB-WM-PW-A2	3"PUA-1013	Abandoned. P.W. from CPP-604 to JB-2B	096156-B2	Tile Encased/ Pipe in Pipe	SST	CPP-79	[27] DOE/ID-10676(99) Rev. 0 Table A-1 indicates line removed

Valve Box	Line No.	Description	Reference:	Encasement Type	Matl. Type	OU/Site	Comments
DVB-WM-PW-A2	3"PWA-1014	Abandoned, but runs or ran thru CPP-79. Carried process waste from JB east to VB-A7.		Unknown	SST	CPP-79	[104, 105} Misc. Structures
DVB-WM-PW-A2	1"PUA-218 *	Tee's off 1"PUA-205 then capped and abandoned. Other termination location unknown.	057501-E7	Pipe in Pipe	SST	CPP-79	[34]
DVB-WM-PW-A2	1"PUA-209 *	Capped and abandoned line carried process waste from 1"PUA-205 to an unknown location.	057501-E7	Pipe in Pipe	SST	CPP-79	[33]
DVB-WM-PW-A2	1"PUA-205 *	VB-A2 Drain Line to 3"PLA-100163	057501-F6	Pipe in Pipe	SST	CPP-79	[32]
DVB-WM-PW-A2	3"PUA-203	Abandoned. Carried process waste or decontamination fluid from JB-2B to WM-181. Capped in and outside VB-A2 and outside JB-2B.	057501-E7	Tile Encased/ Pipe in Pipe	SST	CPP-79	[16], Intermediate routing unknown. Line runs thru CPP-79. DOE/ID-10676(99) Rev. 0 Table A-1 indicates line removed
DVB-WM-PW-A2	3"PWA-201	Abandoned. Carried process waste from VB-C12 to WM-181	057501-E6	Tile Encased/ Pipe in Pipe	SST	CPP-79	[15] Ref: Enlarged Plan p. C-13. DOE/ID-10676(99) Rev. 0 Table A-1 indicates line removed.
DVB-WM-PL-A5	3"PUA-601	Capped in A6. Carried process waste from VB-A5 to VES-WM-182.	092093-D7 377819-G7 057501-D3-7	Concrete encased/Pipe in Pipe	SST	CPP-31	[64], {3} VES-182-Extra.
DVB-WM-PL-A5	3"PUA-602	Abandoned and capped. Carried Process waste from VB-A5, A6, and C15 to VES-WM-182.	092093-D7 377819-G7 377837-G6	Concrete encased/Pipe in Pipe	SST	CPP-31	[63], {2} VES-182-Extra.
DVB-WM-PL-A5	3"PUA-610 3"PWA-610]	Carries process waste from VB-A5 to VES-WM-183.	057501-D5	Concrete encased	SST	CPP-31	[78]
DVB-WM-PL-A5	3"PUA-609 [3"PWA-609]	Carries process waste from VB-A5 to VES-WM-183.	057501-D5	Concrete encased	SST	CPP-31	[77]
DVB-WM-PL-A5	1"PUA-653 *	VB-A5 drain line to CPP-783 south sump.	057501	Pipe in Pipe	SST	CPP-31	[86] Drawing 057501 shows line in VB-A5; but drawing 377819 (upgrade drawing) does not show it.
DVB-WM-PL-A5	1"PUA-654 *	VB-A6 drain line. Drains to VB-A5.	057501-D3	Concrete Encased/Pipe in Pipe	SST	CPP-31	[89] Leaks in VBA6 drain to VB-A5 which then drain CPP-783.

Valve Box	Line No.	Description	Reference:	Encasement Type	Matl. Type	OU/Site	Comments
DVB-WM-PW-B4 (Abandoned)	3"PUA-204 [3"PWA-204]	Abandoned in place and capped. Capped at 3"PUA-1013. Travels from VB-B2 thru VB-B4 to VB-B5 where it is capped. Origin and termination points unknown	057502-E3	Concrete Encased	SST	CPP-32	[136]
DVB-WM-PW-B4 (Abandoned)	3"PUA-1005 [3"PWA-1005]	Capped inside VB-A6, terminates inside VB-B4. Line is abandoned in place.	057499-A3 057501-C3 057502-D2 057498-A5	Pipe in Pipe/Concrete encased	SST	CPP-32	[90] Active portion [91] Abandoned [92] Abandoned [93] Abandoned
DVB-WM-PW-B4 (Abandoned)	3"PUA-1023 3"PWA-1023]	VB-B4 drain line carries drain waste to 1"PUA-1023.	057502-D3	Pipe in Pipe	SST	CPP-32	[119] Spills in VB-B4 drain to 1"PUA-1023 [120] then to CPP-785 south sump.
DVB-WM-PW-B4 (Abandoned)	3"PUA-1030 [3"PWA-1030]	Abandoned in place and grouted. Capped inside VB-B4 and runs thru VB-B6 to WCF.	057502-D5 057502-D2 057498-A7	Concrete Encased	SST	CPP-32	[47, Abandoned [48, 49]
DVB-WM-PW-B4 (Abandoned)	3"PWA-1036 3"PWA-1036]	Abandoned in place and capped inside B4.Carries process waste from VB-B4 to VB-B2	057501-D2	Concrete Encased/Pipe in Pipe	SST	CPP-32	[92]
DVB-WM-PW-B4 (Abandoned)	3"PUA-1218 [3"PWA-1218]	Carries process waste from VB-B4 to VB-B5.	057502-D2	Concrete Encased	SST	CPP-32	[137]
DVB-WM-PW-B4 (Abandoned)	3"PUA-1219 [3"PWA-1219]	Carries process waste from VB-B4 to VB-B5.	057502-D2	Concrete Encased	SST	CPP-32	[138]
DVB-WM-PW-B4 (Abandoned)	1-1/2"PLS-104710	Runs adjacent to VB-B4. Carries process waste from VB-C23 to VB-C12.	057503-F5	Pipe in Pipe	SST	CPP-32	[96]
DVB-WM-PW-B6 (Abandoned)	3"PUA-1005	Abandoned in place and grouted. Carries process waste from VB-B6 and VB-B4.	057499-A3	Concrete Encased	SST	CPP-XX	[90]
DVB-WM-PW-B6 (Abandoned)	3"PUA-1030 3"PWA-1030	Abandoned in place and grouted. Capped inside VB-B4 and runs thru VB-B6 to WCF.	106326-C1	Concrete Encased	SST	CPP-XX	[47]
DVB-WM-PW-B6 (Abandoned)	3"PUA-1100 *	Process waste line may carry decontamination solution from VB-B6 to 3"PUA-1030.	057502-E2	Concrete Encased	SST	CPP-XX	[142]
DVB-WM-PW-B6 (Abandoned)	3"PUA-1101 *	Process waste line may carry decontamination solution from VB-B6 to 3"PUA-1005.	057502-E2	Concrete Encased	SST	CPP-XX	[143]

Valve Box	Line No.	Description	Reference:	Encasement Type	Matl. Type	OU/Site	Comments
DVB-WM-PW-B6 (Abandoned)	1"PUA-1213 *	VB-B6 drain line carries waste to WCF.	057502-E2	Pipe in Pipe	SST	CPP-XX	[139]
DVB-WM-PW-B6 (Abandoned)	3"PU-A-1215 *	Abandoned process Waste line that passes thru VB-B6 and capped at both ends.	057502-E2	Concrete Encased	SST	CPP-XX	[141]
DVB-WM-PW-B6 (Abandoned)	3"PU-A-1216 *	Process waste line that passes thru VB-B6	057502-E2	Concrete Encased	SST	CPP-XX	[142]
DVB-WM-PW-B9	1"PWA-1210	VB-B5 drain line, carries drain waste to vault CPP-713 north sump	057503-D7	Pipe in Pipe	SST	CPP-30	[154] Carries process waste from VB-B5 to CPP-713.
DVB-WM-PW-B9	3"PWA-1220	Carries process waste from VB-B5 to B11.	057503-D7	Concrete Encased	SST	CPP-30	[177] Pipe runs thru VB-B9.
	3"PWA-1221	Carries process waste from VB-B5 to B11.	057503-D7	Concrete Encased	SST	CPP-30	[174] Pipe runs thru VB-B9.
	3PWA-1222	Carries process waste from VB-B5 to B11.	057503-D6	Concrete Encased	SST	CPP-30	[176] Pipe runs thru VB-B9.
	3"PWA-1223	Abandoned. Carries process waste from VB-B5 to VB-B10, thru VB-B9.	057503-D7, D4	Concrete Encased	SST	CPP-30	[175] Capped in VB-B5.
DVB-WM-PW-C7	3"PUA-1014	Abandoned and capped line. Passed P.W. from VB-C7 to WM-181. And from VB-C7 to VB-C15 (per C-4)	057501-E3 377825-G2	Concrete Encased/Pipe in Pipe	SST	CPP-31	[28 Abandoned, 29, 30, 31]
DVB-WM-PW-C7	3"PUA-1033 [3"PWA-1033]	Carries process Waste from VB-C2 to VB-C3, C7 and C15.	92092-G6 377824-G5 057501-D7	Pipe in Pipe	SST	CPP-31	[70]
DVB-WM-PW-C7	3"PUA-1035	Carries process waste from VB-C5 to VB-C3 and VB-C7 via 3"PUA-1033 C7, where it tee's.	057501-E4	Pipe in Pipe	SST	CPP-31	Ref: [87]
DVB-WM-PW-C7	3"PUA-1036	Carries process waste from VB-C9 to VB-C7.	057501-F3	Pipe in Pipe	SST	CPP-31	[19]
DVB-WM-PW-C7	1"PLA-1047	Line runs adjacent to VB-C7. Origin and purpose unknown				CPP-31	
DVB-WM-PW-C7	3" PLA-104703	Line runs thru CPP-31. Carries process waste from 3"PUA-1036 to 3"PUA—1036 to VB-C10.	057501-F3	Pipe in Pipe	SST	CPP-31	[23]
DVB-WM-PW-C7	1"PUA-104771	VB-C5 drain line carries drain waste from VB-C5 to 1"PLA-104767 at C-4.	057501-D4	Pipe in Pipe	SST	CPP-31	[53]

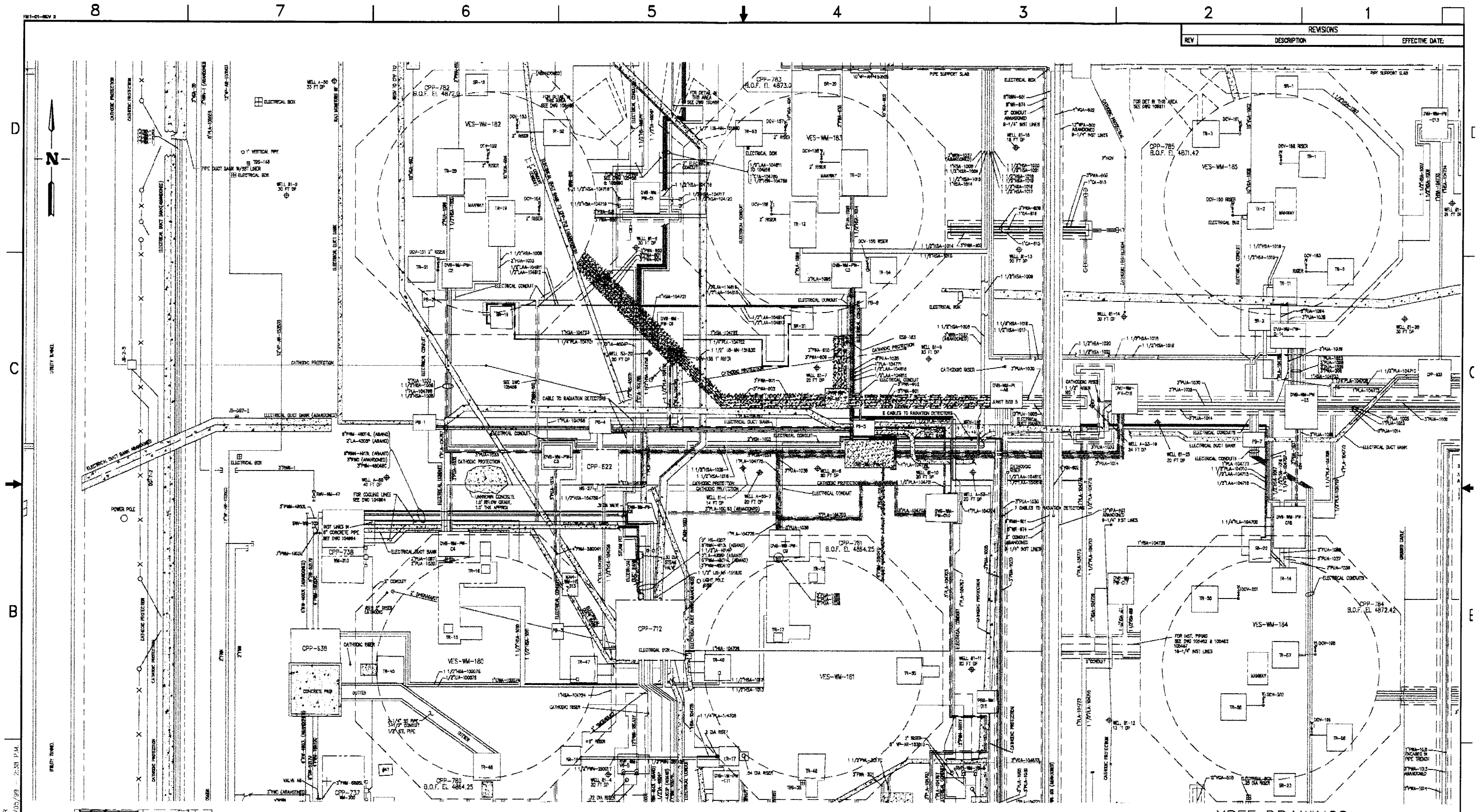
Valve Box	Line No.	Description	Reference:	Encasement Type	Matl. Type	OU/Site	Comments
DVB-WM-PW-C7	3"{IA-100163	Abandoned line tee's off 1"PUA-104775 or 3"PUA-1036 at C-4.	057501-G3	Pipe in Pipe	SST	CPP-31	[22]
DVB-WM-PW-C7	1"PLA-104772 *	VB-C7 drain line carries drain waste from VB-C7 to 1:PLA-104767 [42]@ VB-B4.	057501-E3	Pipe in Pipe	SST	CPP-31	[52] Leaking process waste inside VB-C7 will drain thru 1"PLA-104772 to 1"PLA-104767, which will drain to VB-C12.
DVB-WM-PW-C7	1"PLA-104773 *	Process Waste line from Vb-C7 to 1'PLA-104772	057501	Pipe in Pipe	SST	CPP31	[94] Ref: Draft Work Plan DOE/ID-10676(99) shows VB-C7 in Table A-1, but not in Table C-1.
DVB-WM-PW-C7	1"PLA-104775	Carries process waste fromVB-C7 to WM-181 via VB-C9.	057501-E3	Pipe in Pipe	SST	CPP-31	[26] Ref: 1"PLA 104773
DVB-WM-PW-C7	4"PWM-28104Y	Carries process waste from VB-C7 to VB-B5.	057501-E3	Tile Encased/Pipe in Pipe	SST	CPP-31	[21]
DVB-WM-PW-C7	3"PUA-1005	Line runs thru CPP-28A near VB-C12. Carries process waste from VB-C30 (at 3"PU-AR-113540 (item 243)) to VB-A6.	057499-A3	Pipe in Pipe/Concrete Encased	SST	CPP-28	
DVB-WM-PW-C7	3"PW-AR-1030 3"PUA-1030	Carries process waste from WM-100 inside Cpp-604 and routes thru VB-A6. Line runs thru 28-A near VB-C12	057498-D5	Concrete Encased	SST	CPP-28	
DVB-WM-PW-C12	3"PLA-104703	Carries process waste from VB-C10 to VB-C12	057501-D1	Pipe in Pipe	SST	CPP-28	[97]
DVB-WM-PW-C12	1-1/2"PLA-104705	Terminates – VB-C11 to VB-C12, in line sample sump.	057501-E1	Pipe in Pipe	SST	CPP-28	[12]
DVB-WM-PW-C12	1"PLA-104710	Carries process waste from VB-C23 to1"PLA-104713 (182) and VB-C12.	057503-F5	Pipe in Pipe	SST	CPP-28	[186] Process waste will drain to Valve Box C12 sump.
DVB-WM-PW-C12	1-1/2PLA-104710	Carries process waste VB-C23 to VB-C12.	057503-F5 377713-C5	Pipe in Pipe	SST	CPP-28	[96]
DVB-WM-PW-C12	3"PLA-104710	Carries process waste from VB-C12 TO VB-C37	057501-E2	Pipe in Pipe	SST	CPP-28	[210] It is assumed that the origin is in C12 and terminates is C37.
DVB-WM-PW-C12	1"PLA-104767	VB-C4 Drain Line, Waste from VB-C4 to VB-C12. VB-C7 drain is also attached	057501-E2	Pipe in Pipe	SST	CPP-28	[42]

Valve Box	Line No.	Description	Reference:	Encasement Type	Matl. Type	OU/Site	Comments
DVB-WM-PW-C12	1"PLA-104773	VB-C23 drain line, drains to VB-C12 Sump	057503-F5	Pipe in Pipe	SST	CPP-28	[94] C23, C21, C19, C16, C14, C10, C9 drain line all dump into VB-C12
DVB-WM-PW-C12	3"PLA-104776	Carries process waste from VB-C12 to VB-C12	057503-F5, 377713-C5	Pipe in Pipe	SST	SST	[96]
DVB-WM-PW-C12	1"PLA-104777	Terminates – Drain waste travels to VB-C12.	057501-E2	Pipe in Pipe	SST	CPP-28	[25]
DVB-WM-PW-C12	3"PWA-201	Carries process waste from VB-C12 to WM-181.	057501-E3	Tile Encased/Pipe in Pipe	SST	CPP-28	[15] {11} Once of process waste transfer line. Origination point unknown.
DVB-WM-PW-C12	3"PWA-203 [3"PUA-203]	Abandoned. Line runs thru CPP-28A to WM-181.	057501-E7, F4	Tile Encased/ Pipe in Pipe	SST	CPP-28	[16]
DVB-WM-PW-C12	4"PW-A-28106Y	Abandoned and Capped. Line runs thru CPP –28A and terminates at WM-181.	Unknown	Unknown	Unknown	CPP-28	{4} Capped exterior of VES-WM-181.(CPP-781)
DVB-WM-PW-C12	1-1/2"PWL-3017C	Carries process waste from vault VES-WL-102 from VB-A2 and VB-C12.	057501-F7	Unknown (Suspect Tile Encased/Pipe in Pipe)	Unknown	CPP-28	{6,11} VES-187, but 057501-F7 shows termination at VEW-180 not VEW-181. 8" nozzle penetration to CPP-787. (VB-A2 abandoned)

[ ] Indicates item number in Table C, Tank Farm process waste pipeline[1]
{ } Indicates item number in Line List, Appendix, INTEC Tank Farm Pipeline Lists 1-Inch and Larger

APPENDIX A

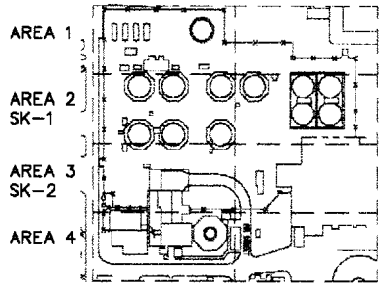
INTEC Tank Farm Facility Closure Trench/Encasement Plans



ENLARGED PLAN AREA 2

LEGEND

- VALVE BOX WITH POSSIBLE RELEASE
- CONCRETE ENCASED/ PIPE IN PIPE
- CONCRETE ENCASED POSSIBLE RELEASE
- TILE ENCASED/ PIPE IN PIPE



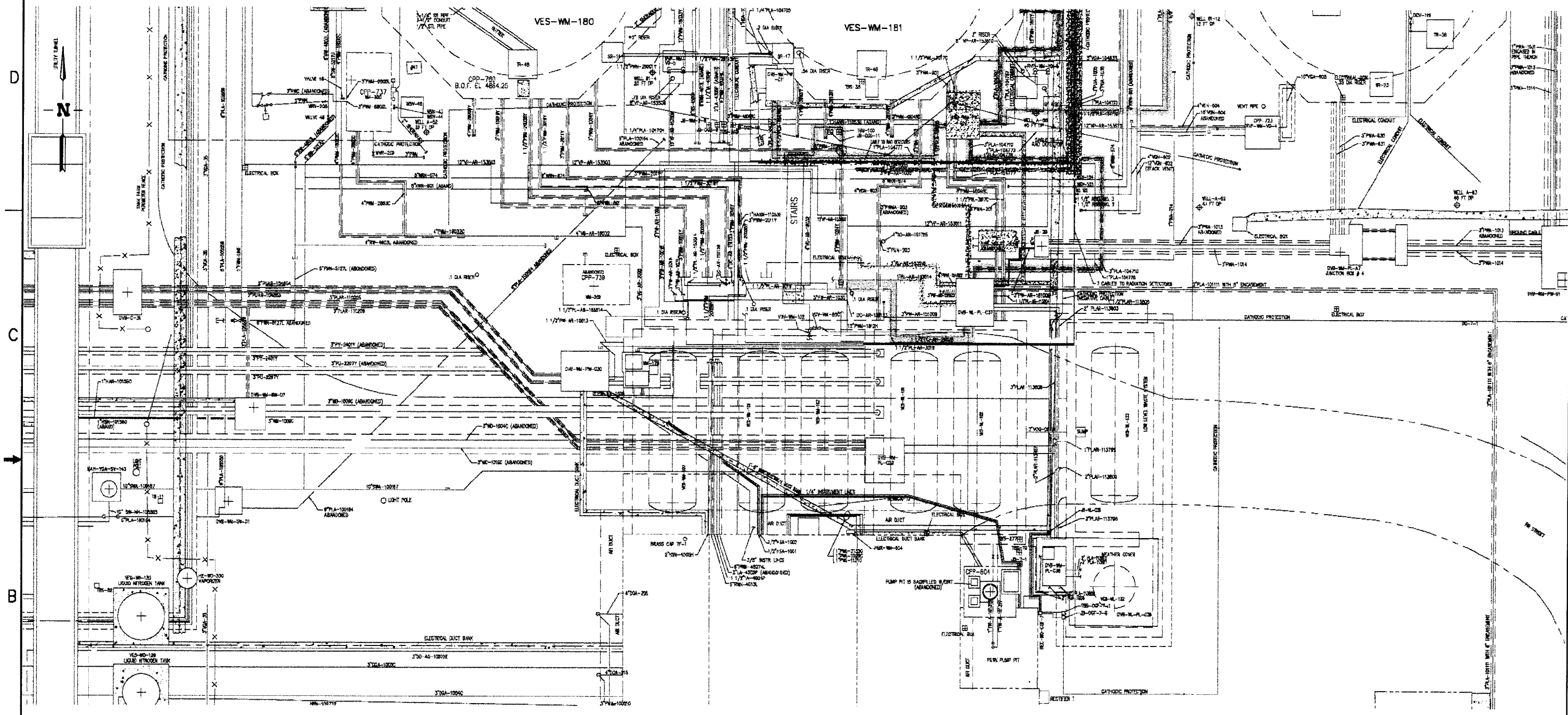
KEY MAP
NTS

XREF DRAWINGS
509100: BASED ON INTEC SITE SPECIFIC COORDINATES

FOR DRAWING INDEX SEE DRAWING NO.	SUBCONTRACT NO.	LOCKHEED MARTIN
SCALE: 1" = 10.0'	REQUESTER:	INTEC TANK FARM FACILITY CLOSURE TRENCH/ENCASEMENT PLAN
	DESIGN: TOM McINTIRE	
	DRAWN: KEITH BRONSON	
	PROJECT NO.	
	SPEC CODE	
DESIGN PHASE:	FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO.	SIZE D; CAGE CODE 01MF3; INDEX CODE NUMBER AREA 200 TYPE 0300 CL 02 DWG 530; DWG-; REV
QUALITY LEVEL:	EFFECTIVE DATE:	SCALE: 1"=10.0'; SHEET SK-1

File: 3627-kb-mc-1.dwg User: KBR
Path: G:\MKG\Intec-III Date: 05/05/99 - 2:38 P.M.

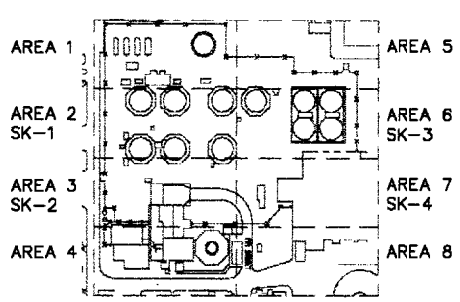
REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE:



ENLARGED PLAN AREA 3

LEGEND

- VALVE BOX WITH POSSIBLE RELEASE
- CONCRETE ENCASED/ PIPE IN PIPE
- CONCRETE ENCASED
- PIPE IN PIPE
- UNKNOWN PIPE ENCASEMENT TYPE
- TILE ENCASED/ PIPE IN PIPE



KEY MAP
NTS

XREF DRAWINGS

509100: BASED ON INTEC SITE SPECIFIC COORDINATES

FOR DRAWING INDEX SEE DRAWING NO.	SUBCONTRACT NO.	LOCKHEED MARTIN
SCALE: 1" = 10.0'	REQUESTER:	INTEC TANK FARM FACILITY CLOSURE TRENCH/ENCASEMENT PLAN
	DESIGN: TOM McINTIRE	
	DRAWN: KEITH BRONSON	
	PROJECT NO.	
	SPEC CODE	
DESIGN PHASE:	FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO.	SIZE D · CAGE CODE 01MF3 · INDEX CODE NUMBER AREA 200 TYPE 0300 G 02 DWG 530 · DWG- · REV
QUALITY LEVEL:	EFFECTIVE DATE:	SCALE: 1"=10.0' · SHEET SK-2

User: KBR
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REVISIONS		
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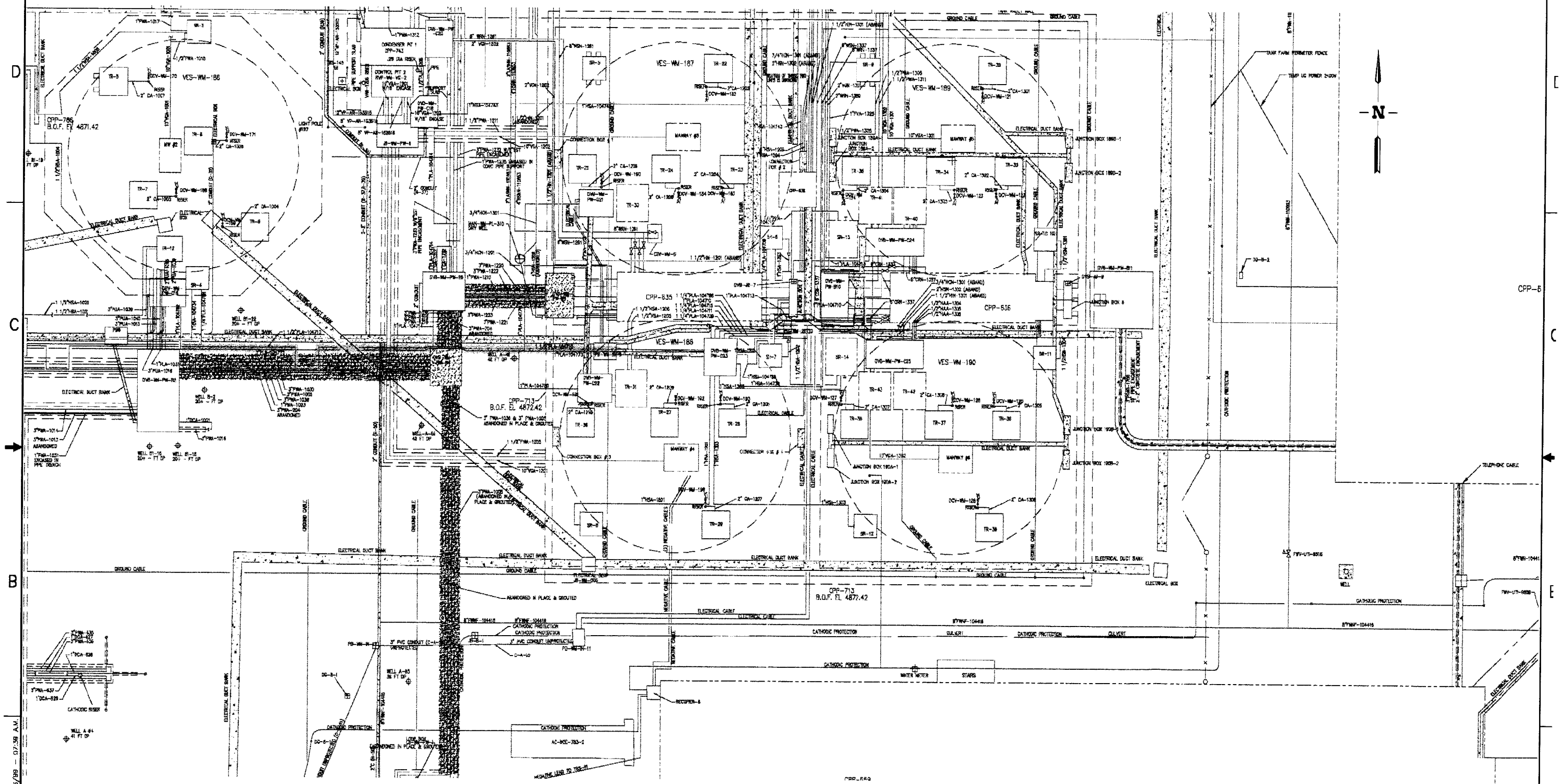
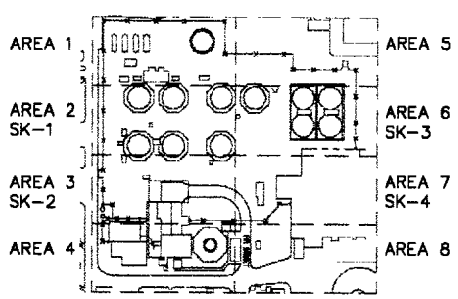




KEY MAP
NTS

LEGEND

- VALVE BOX WITH POSSIBLE RELEASE
- CONCRETE ENCASED
- PIPE IN PIPE

ENLARGED PLAN AREA 6

XREF DRAWINGS
509100: BASED ON INTEC SITE SPECIFIC COORDINATES

FOR DRAWING INDEX SEE DRAWING NO.	SUBCONTRACT NO.
	REQUESTER:
SCALE: 1" = 10.0'	DESIGN: TOM McINTIRE
	DRAWN: KEITH BRONSON
	PROJECT NO.
	SPEC CODE
DESIGN PHASE:	FOR REVIEW/APPROVAL SIGNATURES SEE BAR NO.
QUALITY LEVEL:	EFFECTIVE DATE:

LOCKHEED MARTIN

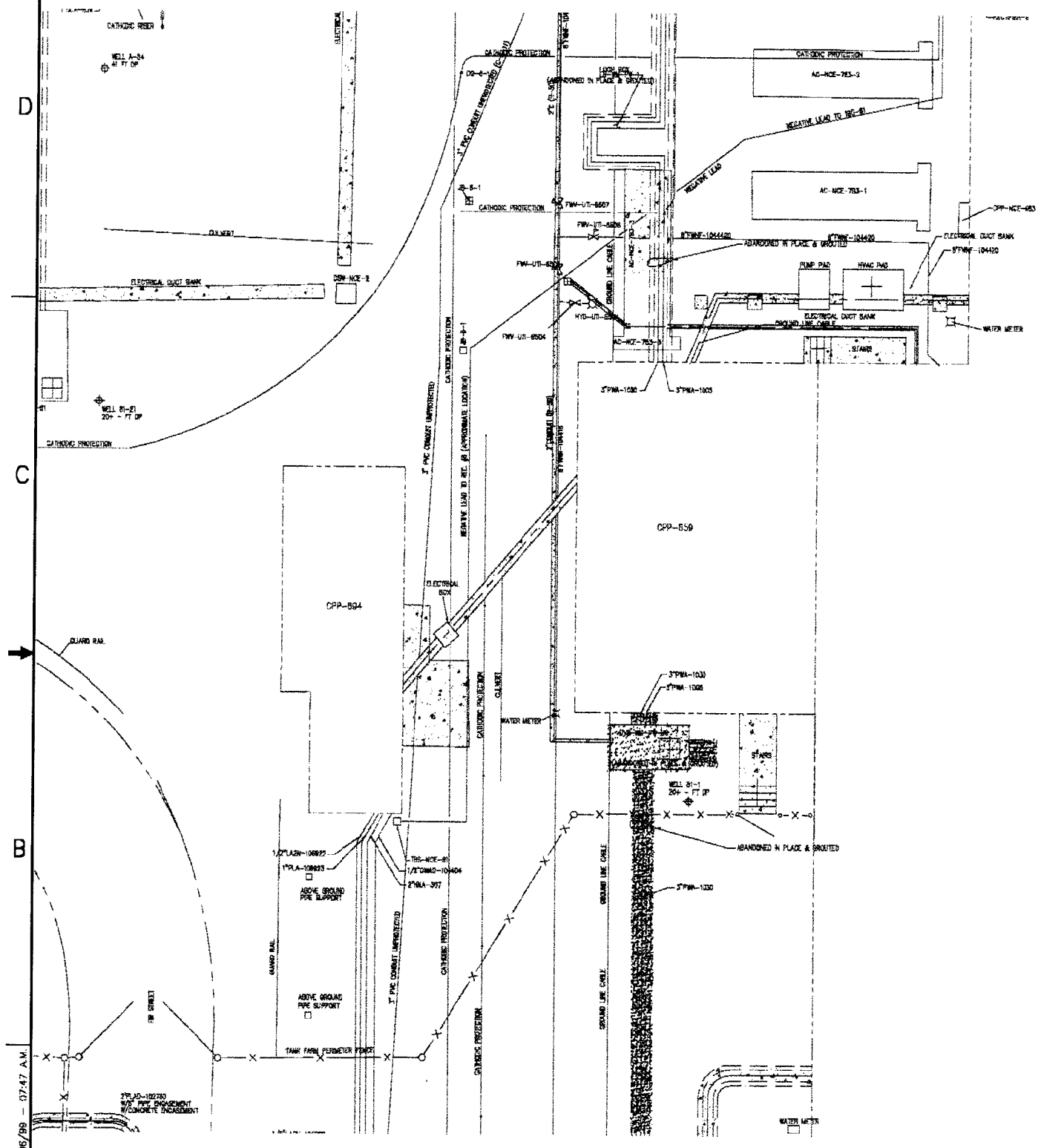
INTEC
TANK FARM FACILITY
CLOSURE
TRENCH/ENCASEMENT PLAN

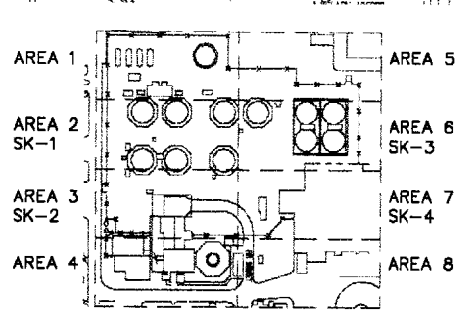
SIZE	CAGE CODE	INDEX CODE NUMBER					DWG-	REV
		AREA	TYPE	C	DWG			
D	01MF3	200	0300	02	530			

SCALE: 1"=10.0'
SHEET SK-3

File: 3627-KB-MC-3.dwg
Path: G:\MKG\intec-111
User: KBR
Date: 05/06/99 - 07:59 A.M.

REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE:





KEY MAP

NTS

LEGEND

VALVE BOX WITH POSSIBLE RELEASE

CONCRETE ENCASED

ENLARGED PLAN AREA 7

XREF DRAWINGS

509100: BASED ON INTEC SITE SPECIFIC COORDINATES

FOR DRAWING INDEX SEE DRAWING NO.	SUBCONTRACT NO.
	REQUESTER:
SCALE: 1" = 10.0'	DESIGN: TOM McINTIRE
	DRAWN: KEITH BRONSON
	PROJECT NO.
	SPEC CODE
DESIGN PHASE:	FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO.
QUALITY LEVEL:	EFFECTIVE DATE:

LOCKHEED MARTIN

INTEC
TANK FARM FACILITY
CLOSURE
TRENCH/ENCASEMENT PLAN

SIZE	CAGE CODE	INDEX CODE NUMBER					REV
		AREA	TYPE	D	ORD	DWG-	
D	01MF3	200	0300	02	530		

SCALE: 1"=10.0'

SHEET SK-4

User: KBR
Date: 05/06/99 - 07:47 A.M.
File: 3627-KB-MC-4.dwg
Path: G:\MKG\intec-tff

[1] K.D. McAllister, et. al., *INTEC TFF History Report*, Draft, November 19,1998
[2] DOE-ID, February 1999, *DOE-ID, Draft Work Plan for Operable Unit 3-14, Tank Farm, Waste Area Group 3, Comprehensive Remedial Investigation/Feasibility Study*, DOE/ID-10676, Rev 0, Lockheed Martin Idaho Technologies Company for the U.S. Department of Energy, Idaho Operations Office.
[3] 020906 *INTEC Underground Utilities Mapping at INTEC Tank Farm*, Enlarged Plan Areas 1 – 8, P. C1 – C13.

EDF-015722-027

ENGINEERING DESIGN FILE

Form L-0431.2#
(05-96-Rev.#02)

Project File Number	015722
EDF Serial Number	027
Functional File Number	7453

Project/Task 4.5 Environmental Engineering

Sub task 4.5.4 Evaluation of Paint for PCBs in Valve Boxes

TITLE: TITLE HERE
Assessment of Federal Regulations Applicable the Potential for PCBs in of INTEC Tanks 182 and 183 Valve Boxes

SUMMARY

This Project/Task identifies the Federal Toxic Substance Control Act (TSCA) requirements applicable to the closure of Tanks 182 and 183 located at INTEC. The requirements identified are a brief description of the requirements as they apply to PCBs in paint. The potential exists that paint used in the valve boxes may contain PCBs. This EDF describes, based on available information, several options for the management of PCBs in paint.

Distribution:

Authors	Department	Reviewed	Approved
W. J. Becker	Environmental Affairs	T.D. McIntire	
Wm Becker		Date 7.26.99	Date 7/26/99

Polychlorinated Biphenyls (PCBs) in Paint

The Tank Farm Facility (TFF) consists of eleven below-grade, 300,000-gallon storage tanks and their associated vaults. Equipment and structures that are ancillary to the TFF include waste transfer lines, instrumentation lines, decontamination lines, cooling coil lines, utility lines and vessel off-gas lines. In addition, valve boxes, condenser pits, and small buildings make up TFF. This EDF focuses on two of the eleven tanks in the TFF (WM-182 and WM-183) and their ancillary equipment.

The construction of Tanks WM-182 and WM-183 occurred in the mid-1950s. The possibility exists that paint containing PCBs was applied to surfaces of the tanks, supporting structures, and equipment, e.g., valve boxes. PCBs were routinely added to paint as part of its original formula prior to 1970. The purpose of this EDF is to define the requirements for the disposal of porous and nonporous surfaces with PCB contaminated paint.

On August 29, 1998, the Environmental Protection Agency (EPA) promulgated new regulations regulating the disposal of PCBs in paint. PCBs in paint are regulated for disposal as PCB Bulk product waste or PCB remediation waste. Painted surfaces on Tanks WM-182 and WM-183 and/or supporting ancillary equipment may potentially meet the definition of one of the two above-mentioned waste streams.

There are three ways to make a determination as to whether PCBs are present in paint. First, the least costly method of determining the presence of PCBs in paint is to identify the type of paint applied and the manufacture of the paint. The manufacturer can be contacted and provides information as to whether PCBs were in the paint formula. Generally, this type of information is given freely. Second, sampling and analysis of the paint may be performed to accurately determine which (if any) painted surfaces must be considered as PCB contaminated. Third, an assumption can be made that painted surfaces are contaminated with PCBs.

Dried applied paints are classified as PCB Bulk Product waste. PCB Bulk Product waste means waste derived from manufactured products containing PCBs in a non-liquid state, at any concentration where the concentration at the time of designation for disposal was $\geq$ 50 ppm PCBs. PCB bulk product waste includes, but is not limited to: Non-liquid bulk wastes or debris from the demolition of buildings and other man-made structures manufactured, coated, or serviced with PCBs... Examples of PCB bulk product waste include dried applied paints. PCB bulk product waste does not include any of the above-mentioned items contaminated with PCBs as a result of a spill of PCBs.

The requirements for the disposal of PCB bulk product waste are found in 40 CFR 761.62. The disposal of PCB bulk product waste must be performed in accordance with one of three options presented in the regulations. The options for disposal include: 1) performance-based disposal, 2) disposal in solid waste landfills, and 3) risk based disposal. However, the general PCB disposal requirements allow the disposal of

PCB/radioactive waste by considering only the radioactive portion of the PCB contaminated waste. The PCB waste located in the valve boxes is radioactively contaminated dried applied paint. The dried applied paint may be disposed of based solely on the radioactive component without any regard for the PCB component of the waste. The regulatory reference for this allowance is in 40 CFR 761.50(b)(7).

Risk based disposal may be considered when the disposal option chosen does not meet the criteria of performance based or solid waste landfill options. The risk based disposal option is initiated through submission of an application to EPA. The application must demonstrate that the disposal option of choice does not present a greater risk to human health and the environment than either the performance based or the solid waste landfill based options.

Summary

Several options exist if PCBs are found in paint on surfaces of Tanks 182 and 183.

1) The most practical option is to determine if the PCB/Radioactive waste qualifies for disposal based on the wastes radioactive properties only. This determination will be based on whether the radioactive component of the waste is allowed to be disposed by the proposed grouting in place.
2) Risk-based disposal may be a practical method for disposal. An application for risk-based disposal must be prepared and submitted to EPA. EPA may request additional information that it believes is necessary to evaluate the application. EPA will issue a written decision and will approve the application if it finds that the method will not pose an unreasonable risk of injury to health or the environment. A six-month time frame must be given to the agency for their determination. Proper project planning is necessary to ensure adequate time for EPA approval.

Manufacturer verification or sampling and analysis may or may not be required depending on the option chosen.

EDF-015722-028

ENGINEERING DESIGN FILE

Form L-0431.2#
(05-96-Rev.#02)

Project File Number: 15722

EDF Serial Number : 028

Functional File Number: 7453

Project/Task CONCEPTUAL DESIGN

Sub task HAZARDOUS WASTE GENERATION

Management of Waste Streams Generated by Closure of INTEC TFF Tanks WM-182 and WM-183

SUMMARY

Closure of these tanks will generate several liquid and solid waste streams and one gaseous waste stream. This EDF preliminarily identifies these waste streams and provides management options based on the assumption the tanks will be closed to landfill standards. Five criteria were used to determine these options:

1. Don't generate the waste stream if it is not necessary.
2. Any waste going to the PEWE system for treatment must meet its waste acceptance criteria.
3. Waste destined for disposal must have a RCRA hazardous waste determination (process knowledge and/or analysis) and a radiological characterization.
4. Any waste destined-to-be-grouted in place must also receive a hazardous waste determination.
5. Any off-gas generated during transfer of tank contents, decontamination activities and grouting will be HEPA filtered.

Distribution:

Authors	Department	Reviewed	Approved
G.R. Adamson	7310	T.D. McIntire	
Gary R Adamson		T.D. McIntire	
		Date 6-18-99	Date 6/15/99

1.0 INTRODUCTION

This EDF supports INEEL-98-000913, INTEC TFF Tanks WM-182 and WM-183 Closure Study

2.0 DELIVERABLES

An EDF describing anticipated waste streams and management options.

3.0 PURPOSE

The purpose of this EDF is to review the waste streams identified in the closure report, identify possible new waste streams, and suggest management options for these streams. This is preliminary information based on information in the closure report and telephone conversations with people knowledgeable about the systems. Unforeseen circumstances or change in closure approach could generate a new set of waste streams that would require appropriate management at the time of generation. Also the closure report itself is a preliminary report subject to change as more information and waste stream data becomes available.

4.0 SCOPE

The assumption for these management options is the tanks will be closed to landfill standards as described in the closure report. The following criteria were used to determine these options:

1. Don't generate a waste stream if it is not necessary.
2. Any waste going to the PEWE system for treatment must meet its waste acceptance criteria.
3. Waste destined for disposal must have a RCRA hazardous waste determination (process knowledge and/or analysis) and a radiological characterization. These data will determine whether a specific waste can be put in an existing industrial, radioactive, or mixed waste stream or become a new waste stream.
4. Any waste destined to be grouted in place must also receive a hazardous waste determination.
5. Any off-gas generated during transfer of tank contents, decontamination activities and grouting will be HEPA filtered.

ANTICIPATED WASTE STREAMS

The following table lists the anticipated waste streams. Waste streams identified in the INTEC TFF Tanks WM-182 and WM-183 Closure Study, INEEL/EXT-98-00913, September 1998 are identified by report page reference. All waste steams except the vessel off-gas (VOG) are RCRA solid wastes subject to characterization and appropriate treatment and disposal. The waste streams are divided into liquid and solid categories.

Waste Stream	Waste Type	Management Options
		Liquid
Tank contents rinsing using steam jets	Sodium bearing waste Mixed-TRU	The closure report states the contents of tanks 182 and 183 will be pumped to other tanks in the TFF. If the waste in all of the tanks is the same waste stream, this may be done without doing a RCRA hazardous waste determination prior to pumping.
Tank Heel	Sodium bearing waste Mixed-TRU	Page 9-1 describes characterizing the remaining heel then pumping out as much as possible while injecting grout. Contact with the grout could change the characterization. Because of the relatively low volume this could be a minor point. The possibility of leaving this portion of the heel in the tank to mix with the grout should be explored. Any waste that will be grouted in tanks 182 and 183 must receive a RCRA hazardous waste determination. Any characterization needs to wait until after inputs from decontamination and other activities are in the tank.
Flushing process lines (HNO3 first, then water)	Mixed-TRU	Decon solution will go into tank and then to PEWE
Rinsing (decontaminating) valve boxes.	Mixed-TRU	Decon solution will go into tank and then to PEWE
Decontaminating risers (p 8-17)	Mixed-TRU	Decon solution will go into tank and then to PEWE
Flushing cooling coil lines	Mixed	Flush will go to the PEWE.
Removal of infiltrated liquid from vault and jetting it into the PEWE system	Mixed-TRU	This has an existing waste stream. Old WMA #96202. New WMA #3597
Vessel Off Gas (VOG) liquid from U-trap flowing back into tank (p 14-4)	Mixed-TRU	Same waste as the tank contents
Material or equipment that	Radioactive	Characterization will determine disposition

becomes waste during grouting or other closure activities	Industrial if not radioactive	
Deconning washing machine (p 8-23)	Radioactive	The washing machine will be stored after decontamination for future use. It is assumed any decontaminating liquid will go back into the tank because the washing machine is to be decontaminated during removal. Any solid waste such as rags used to wipe it down will be radioactive (probably not TRU contaminated). If radioactive only, the solids may go into radioactive waste.
Solids		
Removing epoxy paint from valve box.	Radioactive	Leaving the paint intact should be pursued. If the paint is epoxy, it very likely does not have PCB.
HEPA filters from original and temporary VOG system.	Radioactive	Has existing waste stream. It is assumed this waste will be treated in the HEPA Filter Leach System (Section 3.2.7 of the Site Treatment Plan).
Containment tent disposal.	Radioactive	Re-use or send to RWMC. EDF-015722
Tank heel solids: insoluble sand, resin beads, metal oxides	Mixed-TRU	The characterization of the solids might not be the same as the rest of the heel. Do a RCRA hazardous waste determination for information on what will be grouted in the tank.
Removing steam jets from tanks	Radioactive	One will stay in the tank. The other will be removed to allow insertion of equipment into tank. The removed jet will go into a radioactive waste stream
Cutting cooling coil lines	Mixed-TRU	Lines will be grouted
Cutting instrument lines	Radioactive	Lines will be grouted
The ball valve removed from the process waste line (p 8-5)	Mixed-TRU	Leave ball valve mechanism in the valve pit and grout in when the pit is grouted.
Removing steam lines in the tank riser.	Radioactive	Lines in building are insulated but insulation has no asbestos (process knowledge).
Isolated portion of part of old VOG system in order to install temporary VOG.	Mixed-TRU	Lines from condenser pit CPP-721 will be grouted in place. Cut lines in the pit will be capped in place.
Temporary VOG	Radioactive or mixed-TRU	Characterization when the temporary system becomes waste will determine disposition.
Mockups (section 6.1,	Industrial	Mockups likely will not be contaminated. Waste can go to landfill or recycle.

p 6.4).		
Personnel Protective Equipment	Radioactive	Waste that has not come in contact with the tank contents or decon liquid is rad only. Anti-C clothing will be washed and reused or put in appropriate existing radioactive waste stream. PPE that is contaminated with tank contents could be mixed-TRU waste.
Equipment used inside tank for decontaminating tank	Mixed-TRU	Becomes part of the solids left in the tank.

ENGINEERING DESIGN FILE

Form L-0431.2#
(05-96-Rev.#02)

Project File Number 015722

EDF Serial Number 029

Functional File Number 7453

Project/Task 4.5 Environmental Engineering

Sub task 4.5.8 Assessment of Regulatory Drivers for Process/Project

TITLE: TITLE HERE
Assessment of Federal and State Regulations Applicable to the Closure of INTEC Tanks 182 and 183

SUMMARY

This Project/Task identifies the Federal and State Requirements applicable to the closure of Tanks 182 and 183 located at INTEC. The requirements identified are represented in tables with a brief description of the requirement at the beginning of each statute and the beginning of each section. Requirements identified come from the following regulatory drivers: The Resource, Conservation and Recovery Act, Clean Air Act, Clean Water Act, Safe Drinking Water Act, Toxic Substance Control Act, and Department of Energy Orders. The information presented in the attached tables is subject to revision based on information obtained from sampling and analysis of the tanks.

Distribution:

Authors	Department	Reviewed	Approved
W. J. Becker	Environmental Affairs	Date 6.2.99	Date 6/2/99

Federal and State Requirements Applicable to the Closure to Tanks 182 and 183

The Resource, Conservation and Recovery Act (RCRA) has established national standards that define the acceptable management of hazardous waste. The State of Idaho has the authority to implement the requirement of RCRA through the Idaho Division of Health and Welfare. The State regulations are incorporated by reference as provided in 40 CFR in the "Idaho Rules and Standards for Hazardous Waste," under administrative code known as the Idaho Administrative Procedures Act (IDAPA) 16.01.05. The table below identifies the Federal and State hazardous waste regulations and their applicability to the closure of Tanks 182 and 183.

Statute	Part	Subpart	Title	Applicable
Federal Hazardous Waste Regulations				
RCRA-Chapter 1	260		**Hazardous Waste Management System-General**	No
RCRA-Chapter 2	261		**Identification and listing of hazardous waste**	Part 261 establishes the framework for determining whether or not a waste is a hazardous.
		A	General	Yes
		B	Criteria for Identifying the Characteristics of Hazardous Waste and Listing Hazardous Waste…	
		261.10	Criteria for identifying the characteristics of hazardous waste	Yes
		261.11	Criteria for listing hazardous waste	Yes
		C	Characteristics of hazardous waste	
		261.21	Characteristic of ignitability	Yes
		261.22	Characteristics of corrosivity	Yes
		261.23	Characteristics of reactivity	Yes
		261.24	Characteristics of toxicity	Yes
		D	Lists of Hazardous Waste	
		261.30	General	Yes
		261.31	Hazardous wastes from non-specific sources	Yes
		261.32	Hazardous wastes from specific sources	Yes
		261.33	Discarded commercial chemical products…	Yes
		261.35	Deletion of certain hw codes etc…	Yes
RCRA-Chapter 3	262		**Standards Applicable to Generators of Hazardous Waste**	Part 262 describes the requirements imposed on generators of hazardous waste.
	262	A	General	Yes
		262.11	Hazardous Waste Determination	Yes
		262.12	EPA identification numbers	No
		B	The Manifest	No
		C	Pre-Transport Requirements	Yes
		262.30	Packaging	Yes
		262.31	Marking	Yes

Statute	Part	Subpart	Title	Applicable
		262.33	Placarding	Yes
		262.34	Accumulation Time	Yes
		D	Recordkeeping and Reporting	Yes
		262.40	Recordkeeping	Yes
		262.41	Biennial Report	No
		262.42	Exception Reporting	No
		262.43	Additional Reporting	No
		262.44	Requirements for Generators (100-1000)	No
		E	Exports of Hazardous Waste	No
		F	Imports of Hazardous Waste	No
		G	Farmers	No
		H	Tranfrontier Shipments…	No
Chapter 4	263		**Standards Applicable to Transporters of Hazards Waste**	Part 263 imposes requirements on transporters of hazardous waste. Any waste requiring a manifest must comply with this section.
	263	A	General	No
		B	Compliance with Manifest System	Yes
		C	Discharge of Hazardous Waste During Transportation	No
	264		**Standards Applicable to Owners and Operators of HW TSDs**	Part 264 requires all new facilities and facilities that have applied for and received a final permit that treat, store of dispose of hazardous waste to comply with the requirements of this section. This section of RCRA is not applicable to Tanks 182, 183 closure.
	265		**Interim Status Standards for TSDs**	Part 265 requires that facilities in operation prior to RCRA comply with the requirements of this part. Tanks 182, 183 are bound by the requirements of this section.
		A	General	Yes
		265.1	Purpose, Scope, and Applicability	Yes
		265.4	Imminent Hazard	No
		B	General Facility Standards	Selective portions of the general operating requirements apply to closure.
		265.10	Applicability	Yes
		265.11	EPA ID Number	No
		265.12	Required Notices	No
		265.13	General Waste Analysis	Yes
		265.14	Security	Yes
		265.15	General Inspection Requirements	Yes
		265.16	Personnel Training	Yes
		265.17	General Requirements for ignitable, reactive, or incompatible waste	Yes
		265.18	Location Standards	No

Statute	Part	Subpart	Title	Applicable
		C	Preparedness and Prevention	This section is applicable until final closure of the tanks.
		265.30	Applicability	Yes
		265.31	Maintenance and operation of facility	Yes
		265.32	Required Equipment	Yes
		265.33	Testing and Maintenance of equipment	Yes
		265.34	Access to communications or alarm	Yes
		265.34	Required Aisle Space	Yes
		265.37	Arrangements with local authorities	No
		D	Contingency Plan and Emergency Procedures	A contingency plan must remain in place for Tanks 182 and 183 until final closure.
		265.50	Applicability	Yes
		265.51	Purpose of implementation of contingency plan	Yes
		265.52	Content of Contingency Plan	Yes
		265.53	Copies of Contingency Plan	Yes
		265.54	Amendment of Contingency Plan	Yes
		265.44	Emergency Coordinator	Yes
		265.56	Emergency Procedures	Yes
		E	Manifest System, Recordkeeping, and Reporting	
		265.70	Applicability	Yes
		265.71	Use of Manifest	Yes
		265.72	Manifest	Yes
		265.73	Operating Records	Yes
		265.74	Availability, retention, and disposition of records	Yes
		265.74	Biennial Report	No
		265.76	Unmanifested waste report	No
		265.77	Additional Reports	No
		F	Ground Water Monitoring	If the tanks are closed as a landfill, the requirements of this section must be met or handed off to CERCLA.
		265.90	Applicability	Yes
		265.91	Ground Water Monitoring System	Yes
		265.92	Sampling and Analysis	Yes
		265.93	Preparation, evaluation, and response	Yes
		265.94	Recordkeeping and reporting	Yes
		G	Closure and Post-Closure	This section details the closure requirements for tanks 182 and 183.
		265.110	Applicability	Yes
		265.111	Closure performance standard	Yes
		265.112	Closure Plan; amendment plan	Yes
		265.113	Closure; time allowed for closure	Yes
		265.114	D&D of equipment, structures,etc	Yes

Statute	Part	Subpart	Title	Applicable
		265.115	Certification of closure	Yes
		265.116	Survey Plat	Yes
		265.117	Post-closure care and use of property	Yes
		265.118	Post-closure plan;amendment of plan	Yes
		265.119	Post-closure notices	Yes
		265.120	Certification of completion of post-closure care	Yes
		H	Financial Requirements	No
		I	Use and Management of Containers	This section applies if waste generated during closure is managed in containers.
		265.170	Applicability	Yes
		265.171	Condition of Containers	Yes
		265.172	Compatibility of waste with containers	Yes
		265.173	Management of containers	Yes
		265.174	Inspections	Yes
		265.176	Special Requirements for ignitable or reactive waste	Yes
		265.177	Special Requirements for incompatible waste	Yes
		265.178	Air emission standards	Yes
		J	Tank Standards	This section applies to the storage of hazardous waste in tanks. These requirements are in effect until final closure.
		265.190	Applicability	Yes
		265.191	Assessment of existing tank system's integrity	No
		265.192	Design and installation…	No
		265.193	Containment of Releases	No
		265.194	General Operating requirements	Yes
		265.195	Inspections	Yes
		265.196	Response to leaks or spills	Yes
		265.197	Closure and post-closure care	Yes
		265.198	Special requirements for ignitable of reactive wastes	Yes
		265.199	Special requirements of incompatible waste	Yes
		265.200	Waste analysis and trial tests	Yes
		265.201	Special requirements for generators of between 100 and 1000 kg	No
		K	Surface Impoundment	No
		M	Land Treatment	No
		N	Landfills	Landfill standards apply if the tanks cannot meet performance-based requirements required by the State.
		265.300	Applicability	Potentially
		265.301	Design and operation	Potentially

Statute	Part	Subpart	Title	Applicable
		265.302	Action leakage rate	No
		265.303	Response Action	No
		265.304	Monitoring and inspection	No
		265.309	Surveying and Recordkeeping	Potentially
		265.310	Closure and post-closure care	Potentially
		265.312	Special Requirements for ignitable or reactive waste	Potentially
		265.313	Special Requirements of incompatible waste	Potentially
		265.314	Special requirements for bulk and containerized liquids	Potentially
		265.315	Special requirements for containers	No
		265.316	Disposal of small containers of hazardous waste in overpacked drums	No
		O	Incinerators	No
		P	Thermal Treatment	No
		Q	Chemical, Physical and Biological Treatment	No
		R	Underground Injection	No
		W	Drip Pads	No
		AA	Air Emission Standards for Process Vents	No
		BB	Air Emission Standard for Equipment Leaks	Yes
		CC	Air Emission Standards for Tanks, SI and Containers	Yes
		DD	Containment Buildings	No
		EE	Hazardous Waste Munitions and Explosives Storage	No
Chapter 7	266		**Standards for materials being recycled**	No
Chapter 8	268		**Land Disposal Restrictions**	An assessment as to whether any newly generated waste is restricted from land disposal is required under this section.
		A	General	Yes
		268.1	Purpose, scope , applicability	Yes
		268.2	Definitions	Yes
		268.3	Dilution prohibited	Yes
		268.4	Treatment surface impoundment exemption	No
		268.5	Procedures for case by case extensions	No
		268.6	Petitions	No
		268.7	Testing, tracking and recordkeeping	No
		268.9	Special Rules	Yes
		B	Schedule for Standards	No
		C	Prohibitions on Land Disposal	

Statute	Part	Subpart	Title	Applicable
		268.30	Wood Preserving Waste	No
		268.31	Dioxin containing wastes	Yes
		268.37	Waste specific prohibitions…	Yes
		268.38	Waste specific prohibitions	Yes
		268.39	Waste specific prohibitions	No
		D	Treatment Standards	
		268.40	Applicable Treatment Standards	Yes
		268.41	Treatment Standards…	No
		268.42	T.S. as specified technologies	Yes
		268.43	T.S. as waste concentrations	Yes
		268.44	Variance from treatment standard	Yes
		268.45	T.S. for hazardous debris	Yes
		268.46	Alternative TS based on HTMR	No
		268.48	Universal Treatment Standards	Yes
		E	Prohibitions on Storage	No
Chapter 9	270		**Permit Programs**	No
Chapter 10	271		**State Hazardous Waste Programs**	No
Chapter 11	272		**State approved HW Programs**	No
Chapter 12	273		**Universal Waste**	No
Chapter 13	279		**Used Oil Management Stds**	No
Chapter 14	280		**Underground Storage Tanks**	No
Chapter 15	281		**State Programs for USTs**	No
Chapter 16	282		**State approved UST programs**	No
Chapter 17	148		**Underground Injection Wells**	No
Statute	**Part**	**Subpart**	**Title**	**Applicable**
State of Idaho Hazardous Waste Regulations				The State of Idaho has adopted the federal regulations by reference in the below mentioned reference.
IDAPA 16 Title 01 Chapter 5			**Rules and Standards for Hazardous Waste**	Yes
IDAPA 16 Title 01 Chapter 5	008		**Standards Treatment, Storage, and Disposal Facilities**	Yes

An air permit applicability determination (APAD) will be prepared to assess the potential air and radionuclide emissions from proposed TFF closure activities. Idaho regulates emissions of criteria air pollutants, toxic air pollutants and radionuclides associated with the Clean Air Act (CAA). The regulations for air pollution control in Idaho are located in IDAPA 16.01.01, Rules of the Department of Health and Welfare, Title 01, Chapter 01, "Rules for the Control of Air Pollution in Idaho." The APAD will identify whether the HWMA/RCRA Closure of the TFF will be eligible for an exemption or would require a permit to construct (PTC) from the State of Idaho as identified in IDAPA 16.01.01.201

The EPA, through the NESHAPs regulations of 40 CFR 61, regulates potential radionuclide emissions. The APAD will also identify the NESHAPs requirements. To determine NESHAPs compliance, modeling is conducted to estimate the dose to the maximally exposed individual (MEI) at that INEEL site boundary. If the modeled, unmitigated potential emissions exceed 0.1 mrem/year, then, in accordance with NESHAPs, a continuous emissions monitor would be required on a new or modified emission source. If the radionuclide emissions exceed 0.1 mrem/year using 40 CFR 61 Appendix D criteria, an application to construct (ATC) would be required. This monitoring would be required of all emission points for activities associated with the HWMA/RCRA Closure. All radiological emissions to the environment, including those from all point and diffuse sources, must demonstrate compliance with the NESHAP Standard [(40 CFR 61.93(a)] and be submitted for reporting in the INEEL NESHAP Annual Report per 40 CFR 61.94.

For nonrad emissions a Permit to Construct (PTC) will be required from the IDHW prior to the construction for each of the new emission points. The permit requires that the Hazardous Air Pollutants (HAPs) and the Toxic Air Pollutants (TAPs) or their potential emissions be quantified prior to permitting. The table below identifies the Federal and State air regulations and their applicability to the closure of Tanks 182 and 183.

IDAPA 16 Title 01Chapter 01			**Rules for the Control of Air Pollution in Idaho**	Yes
IDAPA 16 Title 01 Chapter 01	161		**Toxic Substances**	Yes
IDAPA 16 Title 01 Chapter 01	210		**Demonstration of Reconstruction Compliance with Toxic Standards**	Yes
IDAPA 16 Title 01Chpater 01	575		**Air Quality Standards and Area Classification**	Yes
IDAPA 16 Title 01Chpater 01	650		**Rules for Control of Fugitive Dust**	Yes
Clean Air Act-NESHAP	61-97		**National Emission Standard for Hazardous Air Pollutants**	Yes
Clean Air Act-NAAQPS			**National Ambient Air Quality Pollutants Standards**	Yes

The Clean Water Act prohibits the "discharge of toxic pollutants in toxic amounts" to navigable waters of the United States. To ensure that there are no improper discharges associated with the closure or post-closure activities, the project will be designed to eliminate the runoff from the site to the waters of the U.S. This would be accomplished by the design of the TFF stormwater management being integrated in the INTEC stormwater management system. As necessary, the INTEC Stormwater Pollution Prevention Plan would be revised to reflect any modifications required to manage runoff from the TFF during closure and post-closure activities. The table below identifies the Federal and water regulations and their applicability to the closure of Tanks 182 and 183.

Clean Water	122		**National Pollution Discharge Elimination System-Storm Water**	Yes
IDAPA 16 Title 01Chpater 02			**Water Quality Standards and Wastewater Treatment**	Yes
IDAPA 16 Title 01Chpater 08			**Idaho Rules for Public Drinking Water Systems**	No
IDAPA 16 Title 01Chpater 08	500		**Design Standards for Public Drinking Water Systems**	No
IDAPA 16 Title 01Chpater 08	551		**Construction Requirement for Public Water Systems"**	No
IDAPA 16 Title 01Chpater 09			**Idaho Radiation Control Rules**	Yes
IDAPA 16 Title 01Chpater 17			**Wastewater Land Application Permit Regulations**	Yes

The TFF is potentially eligible for listing in the National Register of Historic Places as contributing elements to the INEEL National Historic District. Activities associated with the closure of the TFF would require consultation with the Idaho State Historic Preservation Officer (SHPO) in accordance with 36 CFR Part 800, the regulations implementing the National Historic Preservation Act. Based on this consultation, the SHPO would identify stipulations that would need to be met prior to performing closure activities that would impact the facility. These stipulations would be documented in a "Memorandum of Agreement" that would identify the mitigation requirements. The table below identifies the Federal Historic Preservation regulations and their applicability to the closure of Tanks 182 and 183.

National Historic Preservation Act		800		Yes

The Table below identifies several Department of Energy Orders applicable to the radioactive waste management of Tanks 182 and 183.

DOE Orders	Order number	Order Title	Applicable
	5820.2A	Radioactive Waste Management	Yes
	Draft 435.1	Radioactive Waste Management	Yes
	5400.5	Radiation Protection of the Public and the Environment	Yes

The Toxic Substance Control Act identifies the regulatory requirements for the management of PCBs. PCBs may potentially be found in waste generated during closure. If PCBs are found, the table below identifies the Federal PCB regulations and their applicability to the closure of Tanks 182 and 183.

Statute	Part	Subpart	Title	Applicable
Toxic Substance Control Act				Applicable
	761		**PCBs**	Yes
		A	General	Yes
		761.1 & 3	Applicability	Yes
		B	Prohibitions and Authorizations	Yes
		761.20	Prohibitions	Yes
		761.30	Authorizations	Yes
		761.35	Storage for Reuse	Yes
		C	Marking of PCBs	
		761.40	Marking requirements	Yes
		761.45	Marking Formats	Yes
		761.50	General Disposal Requirements	Yes
		D	Storage and Disposal	
		761.60	Disposal Requirements	Yes
		761.61	PCB remediation waste	Yes
		761.62	Disposal of PCB bulk product waste	Yes
		761.64	Disposal of R&D waste	Yes
		761.65	Storage for Disposal	Yes
		761.70	Incineration	No
		761.71	High efficiency boilers	No
		761.75	Chemical Waste Landfills	No
		761.79	Decontamination Standards	Yes
		761.80	Exemptions	Yes
		G	PCB Spill Clean up	Yes
		J	General Records and Reports	Yes
		K	PCB waste disposal records	Yes

EDF-015722-030

ENGINEERING DESIGN FILE

1. Project File No. _____ 2. Project/Task INTEC Tank Farm Closure Project

3. Subtask Civil Systems – Utility Routing

4. Title: Utilities for INTEC Tank Farm Closure Project

5. Summary: This summary briefly defines the problem or activity to be addressed in the EDF, gives a summary of the activities performed in addressing the problem and states the conclusions, recommendations, or results arrived at from this task.

Various utilities will be required to support the Tank Farm Closure Project. This EDF, which was prepared in support of the project conceptual design, documents what the utility requirements are for the project; what utilities are currently available in the area; and what modifications will be necessary to provide the needed utilities. Demineralized water, raw water, and 50 psi plant air are available in Building CPP-628 on the tank farm. Connections will be made to the demineralized and raw water lines and headers provided on the exterior of the building where hoses can be connected and routed on grade to the needed locations. A 3000 gallon surge tank will be required for the demineralized water to provide adequate flow for the tank washing operations. Hoses would be routed on grade so that no excavation will be required. An air compressor with tank will be provided by the project to supply 100 psi air. The 50 psi plant air in Building CPP-628 may be utilized for cleaning the remote camera. If so, a connection will be required and a header provided on the exterior of the building. Low pressure air for dispersing dry grout will be supplied by a blower provided by the project. Existing facilities will be utilized for showers and restroom. An emergency eyewash and shower with a holding tank will be provided in a support trailer.

6. Distribution (complete package):

Distribution (summary package only):

Review (R) and Approval (A) Signatures (Minimum reviews and approvals are listed. Additional reviews/approvals may be added as necessary.)

	R/A	Printed Name	Signature	Date
Author	R	Brent G. Harris	B.G. Harris	8/25/99
Independent Verification	R	Tracy Langenwalter	T. Langenwalter	10/2/00
Requestor	A	Ed Anderson	E. Anderson	10/2/00

UTILITIES FOR INTEC TANK FARM CLOSURE PROJECT
8/25/99

Summary
This Engineering Design File (EDF) provides information on the required utilities, with the exception of electrical, for completion of the INTEC Tank Farm Closure Project. Electrical requirements are addressed in a separate EDF. The purpose is to document what the utility requirements are; what utilities are currently available at the project site; and what modifications will be necessary to provide those utilities which are not currently available.

Background
The INTEC Tank Farm Facility (TFF) is the primary location used to store High Level Liquid Waste (HLLW) and Sodium Bearing Waste (SBW) which has been generated from processing of spent nuclear fuel at INTEC. The TFF consists of nine 300,000 gallon tanks and two 318,000 gallon tanks. Each of the eleven tanks are located in an underground concrete vault. The Tank Farm Closure Project includes the following general activities for each of the eleven tanks:

- Rinsing the tanks (partial fill and drain) using existing TFF systems.
- Pumping out as much of the existing liquid from the tanks using the existing steam jets.
- Using the Light Duty Utility Arm (LDUA), take samples of the remaining liquid/residue to determine the radiation levels present.
- Removing one of the existing steam jets, and extending the other steam jet such that more of the liquid can be removed.
- Inserting the washing system assembly; and washing down the tank. Removing the liquid with the remaining steam jet.
- Using the LDUA, take RCRA samples. If desired tank closure levels are not met, additional washing and sampling will be required until they are achieved.
- The tank will then be completely filled with grout using a procedure that will allow removal of additional free liquid in the process.
- The piping penetrating the tank wall will also be filled grout.
- The annulus between the tank wall and the enclosure vault will then be filled with grout.

It is assumed that the work will take place when freezing of water lines is not a problem. Consequently, design measures to prevent freezing of the lines will not be necessary.

Required Utilities
The following utility services will be required to support the project:

Utility	Use	Amount Required
Steam	Steam jets used for removing liquid from tanks	Existing service is adequate
Plant Air	Cleaning camera, tools, etc.	50 psi for cleaning camera; 100 psi for tools

Low Pressure Air	Dispersing dry grout into tank	Relatively large Volumes; small pressures
Wash Water	Rinsing tanks, piping, etc.	50 gpm for period of 30 minutes; 8-10 times per tank over one or two week period (Reference 1)
Potable Water	Miscellaneous use by construction personnel for cleaning equipment, etc.	TBD
Sanitary Sewer	Rest rooms, wash rooms, showers for construction personnel	TBD

Existing Utilities

Steam

Each of the tanks is supplied with high pressure steam which operates the steam jets used to remove the liquid waste from the tanks.

Plant Air

50 psi plant air service in a 2 in. line (2" LASN-152695) is available in Building 628. 100 psi air is not available.

Low Pressure Air

50 psi air in a 2 in. line (2" LASN-152695) is available in Building 628. This would probably not supply sufficient volume for dispersing dry grout.

Wash Water

There is a 1-1/2" demineralized water line (line 1-1/2" DWN-601) in Building 628 which comes from Building 706. The maximum flow available from Building 628 is 32 gpm (Reference 2). There is also a 6" raw water line (line 6" RWN-152763) serving Building 628. Treated water is available in the utility tunnel (line 10" TWN-109825) located approximately 110 ft. west of Building 628.

Potable Water

No potable water is available within the tank farm. Raw water (6" RWN-152763) is available in CPP-628.

Sanitary Sewer

There are no sanitary sewer lines within or immediately adjacent to the tank farm.

Conclusions

Steam

Since there are no other needs for the steam, the existing service is adequate and no modifications will be required.

Plant Air

The 50 psi plant air available in Building 628 (line 2" LASN-152695) is probably sufficient for cleaning the remote camera, but not adequate for operating air tools. A connection could be made to that line and routed to the exterior of the building where portable hoses would be connected. The required volume of high pressure (100 psi) air is relative small, so a portable electric air compressor/tank unit which can be moved from tank to tank as required is probably the best option. This is considered more convenient and economical than modifying the existing high pressure air system to provide service at all of the required locations.

Low Pressure Air

A relatively large volume at very low pressure will provide adequate dispersion of the dry gout. It is recommended that a portable blower system be provided by the project for this function.

Wash Water

A 1-1/2 in. demineralized water line (line 1-1/2" DWN-601) is located in Building 628. This line originates in Building 606 and has a capacity of approximately 32 gpm. Since this less than the required 50 gpm, a storage tank will be provided such that enough for two cycles (approximately 3000 gal) is available. A new 1-1/2 in. line would be installed from Building 628 to the tank. It would be placed on existing grade. The tank would be located northeast of Building 628. A 2 in. flexible line would be run on grade from the tank to the point where the water is needed. A pump would be used to deliver the water from the storage tank to the washing location, and to provide approximately 100 psi of pressure.

Even though raw water (line 6" RWN-152763) is available in CPP-628, it is not desired for washing the tanks since it causes scaling in the PEW tank. Treated water is available in the nearby utility tunnel; however, the sodium in treated water causes problems with the calciner.

Reverse osmosis (RO) water is not currently available at INTEC but would also be acceptable since it does not contain the high sodium found in treated water or the calcium and silicates found in raw water. If RO water is available at the time of Title design, it should be considered in place of demineralized water for washing the tanks.

There is also the potential for using basin water from CPP-603 for rinse water. That issue is addressed in a separate EDF (Reference 3).

Potable Water

The main need for potable water is for cleaning equipment, tools, etc. Raw water would be sufficient for the that type of work. It could be provided by providing a connection in Building 628 (line 6" RWN-152763) and providing a valve and connection point on the exterior of the building. Portable 2 in. hoses would be routed to the location in the tank farm where the water is needed. Although the actual flow requirement has not been established, providing the required flow/pressure is not considered a problem.

Sanitary Sewer

There are adequate facilities adjacent to the tank farm where construction workers could wash and use the restroom. These facilities include TR-35, Buildings 699, 664, and 1678. If needed, portable toilets could also be provided adjacent to the Building 1672 through which personnel pass to access the tank farm. If a support trailer is required, it would be equipped with an eye wash and emergency shower. A self-contained system having a water supply tank and a holding tank would be provided.

References

1. Conversation between Clint Kingsford and Rod Kimmitt, referenced in Clint Kingsford memo to project file dated 3/31/99. (Attached)
2. Tank Farm Telecon No. 4, Conversation between Brent Harris and Rod Kimmitt, 7/21/99. (Record Attached)
3. Tank Farm Telecon No. 1, Conversation between Darrell Hall and Brent Harris, 6/22/99 (Record Attached)
4. Tank Farm Telecon No. 5, Conversation between Frank Ward and Brent Harris, 7/21/99 (Record Attached)
5. EDF-015722-031, "Feasibility of Using Existing Pipelines to Transfer CPP-603 Basin Water to Tank Farm".
6. Drawings (Attached): 106181 056382 094555 093126

Tank Farm Deactivation
March 31, 1999
Memo to File
Written by Clint Kingsford

Deionized Water

I met in person with Frank Ward on March 31, 1999 to get a better view of the utilities required for the Tank Farm deactivation.

He said that deionized water was available through 628, however, we may need a holding tank depending on how much volume we needed. He said the supply comes from Building 606 and Dave Suhre is the custodian of the utility boiler house in 606.

Frank said that the PEW is in Building 604. He emphasized that the basin water from 603 is available, but the decision has been made to use basin water only for general cleaning and not specific cleaning of the tanks. We still need to get information from Thornton Waite and others on the use of the basin water and the timing of the use of the basin water.

After returning back to Idaho Falls, I discussed the deionized water with several people Ed Anderson, Syl Losinski, Rod Kimmitt, and Darrel Hall. Darrel is the utility person who is over the plant air and deionized water.

In talking to Syl Losinski he questioned the use of deionized water for the washing of the tanks. He said that the current demand for deionized water is approximately 6 gallons per minute. He said that our water should be clean enough to wash the tanks. They are in the process of formulating a project to replace a 200-gallon per minute RO unit with at least one 400 gallon per minute RO unit, or at least maintain the 200 gallon per minute RO unit and adding a 400 gallon per minute RO unit. He said there are basically five types of water being used at INTEC. 1) There is raw water, that is brought directly from the wells, which is used for raw water purposes that is not treated for general purposes and firewater. 2) Potable water that is pulled from another well, and receives some chlorination for treatment to be used in sanitary situations. 3) There is treated or softened water, 4) there is water which is run through the reversed osmosises system, which replaces and removes the bulk of the mineral constituents. 5) Demin or deionized water is used for specialized situations where corrosion could be a problem. The conductivity and minerals are removed to a greater extent than in the aero water.

Rod Kimmitt is the process engineer who is working on the process of cleaning the tanks. He stated that RO water would be plenty adequate for their needs. The reason for using RO water is to avoid hardened water characteristics from accumulating on the sides of the tanks. Rod said that he would need approximately 50 gallons per minute for each rinse of the tank. He figured that he would probably need 8 to 10 rinses. This would amount to a maximum of 15,000 gallons during a week to two-week period of time.

As Rod stated the demand would not be consistent, only for each rinse would take one-half hour to an hour to accomplish. He did say that RO water was adequate. They are trying to increase the PH to 2.5 to 3, to reduce the radio nuclides and yet at the same time not have it so high that it would precipitate anymore solids. Wash water would be put in tank 187 or 183.

Mr. Ward stated that the NWCF High Level Waste Evaporator would evaporate about 200 gallons per hour. The PEWE will evaporate approximately 500 gallons per hour. There is also the possibility of using the LET&D for evaporation of wastewater.

Plant Air

In talking to Frank Ward there is 100-psi air in the utility tunnel immediately west of the tank farm. In talking to Darrel Hall he said that we could tap into that and supply the tank farm with portable hoses. Mr. Ward stated that there is an exterior manifold in building 628 that we could probably pipe into and then distribute the air from there also. Mr. Hall said that there would be no problem in supplying the air required 100-psi air. There is presently a 2-inch line coming from 606.

Steam

In talking to Mike Berry at our meeting on Monday, March 29, the steam is used to go through a venturi and is used to suck up the wash water. It has been called a pump, but it is not really a pump, it is used to create a negative pressure and pull vacuum the waste water into a discharge line which will be discharged to Tank 187 for storage and for later disposal. There is adequate steam available to accomplish this purpose.

Sanitary Sewer

In talking to Mr. Ward he stated that restroom facilities have been made available to construction personnel in TR-35 the construction management area. Building 699 where Mr. Ward's office is, Building 664, and Building 1678 the Construction Prefab Shop, which is to the Southwest of the tank farm 4 or 5 hundred feet. They are listed as Buildings 641, 734,796 temporary trailers T-1 through T-5 adjacent to Birch Street and Ash Avenue.

Mr. Ward said that there is also some construction trailers east of Building 699 and South of 1678 enclosure, which could be used by a contractor for personnel.

He did say that a temporary decon area may be required. He suggested that I talk to Lex Strain and Kirk Winterholler on what they have done on past projects.

Access

Frank stated that personnel access to the tank farm is through Building 1672, which is located on the Northeast corner of the tank farm fence. It is a small building where they

pass through and there are monitors that personnel go through. He stated that unless there is a need for excavation that anti Cs would not normally be required, only when they are working with decontaminated soil. There is a small bully barn just to the West of building 1672 where anti Cs are stored. Frank said that if anti Cs are used that they would cloth in Building 1672 and then go into the work area when they are done, then the anti Cs would be removed in the work area and specified people would package them and dispose of them. Basically Anti Cs are not salvaged.

Frank said that I should contact Lex Strain and Kirk Winterholler on procedures and what they have done on past projects in the tank farm area.

There are several gates around the tank farm perimeter fence, which can be used to drive access equipment into the tankfarm. However, the tankfarm loading requirements must be complied with as specified in the report "Tank Loading Or The Loading Requirements In Zones A, B, And C In The Tank Farm". However, there is a Mr. Nate that is doing a new load rating analysis and there is hope that his analysis will show that we can put in larger loads than is presently allowed by the current study. Basically most of the staging will be done outside the fence.

The tank farm area while it has certain ECAs inside is basically classified as an ECA-96.

Mr. Dennis Ronig manages CERCLA affairs in the excavation which is incompliance with CERCLA regulations must be put back in the hole. If it is RCRA situation, the soil must be boxed and disposed of in another location.

Frank Ward pointed out an area where there was a major spill next to tank 183 and 185. He basically drew a little contour showing where it had been classified as 1R and radionuclide contamination in the center the plume will go up to 10R. Valve boxes A5 and A6 are highly contaminated.

GEOTEC Membrane

Frank Ward drew a rough sketch of the outline of the membrane as it exists on the tankfarm. Basically it covers the area for Tanks 182, 183, 181, 180, 185, 184, 186, 187, 189, 190, and 188. A rough sketch was drawn on C-1 for project 020906 drawn by Gene Mace. Frank says that the membrane is acted as a two-edged sword while the original intent was to cover the ground to prevent moisture intrusion, it has acted as a conduit for moisture going into the ground. Once the moisture gets in the ground it can't get out because there is no opportunity for evaporation. He basically says that moisture, snow or rain that gets on the tank farm will seep through the membrane because it is not totally water tight. He said that one time, they conducted a dye test between Building 699 and the fence adjacent to tanks 189 and 190 and the dye had seeped under the membrane into the tank area. He did say the membrane has prevented weed growth and has been positive in that regard. For penetrations the membrane is fastened to vaults with redwood 2 x 4s or for circular penetrations is has been fastened with pipe clamps.

Planning is still in the mill as far as total enclosing the tankfarm area when the tanks have been deactivated but he said that there has been thoughts of pouring a concrete cap or using a new membrane over the whole area covered with soil. However, this has not been resolved as yet.

Stainless Steel

Frank Ward said that the stainless steels that have been used in the tankfarm area are 304-L, 347, 316, 316-L; he said that 316-L costs as much as you are willing to pay for a desired feature.

Mr. Ward stated that they could calcine 32 – 64 gallons per hour of waste.

Record of Conversation

ID: Tank Farm Telecon No. 4

Date: 7/21/99, 8:00 a.m.

People Involved in Conversation: Brent Harris, 526-3854
Rod Kimmitt, 526-5158

Subject: Water required for rinsing Tank Farm Tanks

Description of Conversation:

I explained to Rod that I was verifying the utilities required for the Tank Farm Closure Project and wanted to verify the amount of rinse water required. Up to now I had based my requirements on a memo to file written by Clint Kingsford on 3/31/99. It was stated in that memo that each rinse would require approximately 50 gpm for 30 minutes for a total of 1500 gallons. Each tank would probably need 8 to 10 rinses over a period of one or two weeks. That memo also stated that reverse osmosis water should be used for the rinsing because there was concern about hard water deposits accumulating on the sides of the tanks.

Rod said he was not really concerned about the hard water deposits, and felt that raw water would be okay for the rinsing. I stated that I thought Frank Ward had concerns about the raw water minerals being a problem in processing of the waste. Rod said that the raw water at INTEC contains about 300 ppm of calcium which is a lower concentration than the 1000 ppm of calcium which is in the existing tank waste. I said I would check with Frank again to see if he did have any concerns about using raw water for rinse water.

Rod said that his preliminary calculations showed that Tank WM-183 would require the most rinse water, approximately 23,000 gallons. Tank WM-182 is projected to take only about 5,000 gallons. These estimated amounts are based on doing numerous rinses with each rinse requiring about 1500 gallons. There would be time between each rinse for sampling, etc.

Record of Telephone Conversation

ID: Tank Farm Telecon No. 1

Date: 6/22/99, 2:25 p.m.

Person Calling: Brent Harris, 526-3854

Person Called: Darrell Hall, 526-3323

Subject: Availability of demineralized water in Building CPP-628 (Tank Farm Control House)

Description of Conversation:

I asked Mr. Hall if the water available in Building 628 (line 1-1/2" DW-601) was actually demineralized water and, if so, what flow capacity was available. He explained that it was demineralized water and the maximum flow available in Building 606 was 32 gpm. The actual flow available at Building 628 would be limited by the size of the line and the demand from other facilities.

Record of Telephone Conversation

ID: Tank Farm Telecon No. 5

Date: 7/21/99, 1:23 p.m.

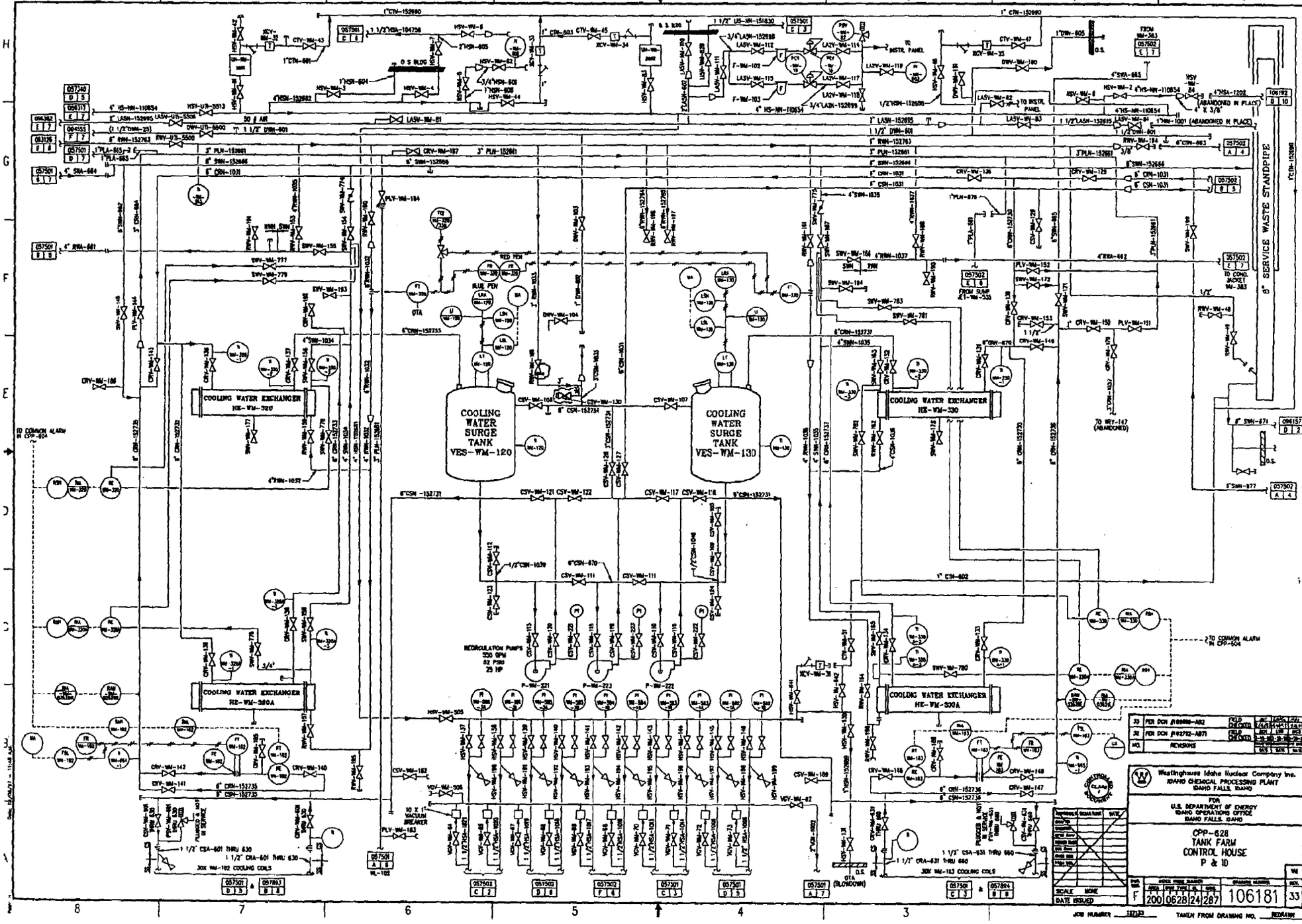
Person Calling: Brent Harris, 526-3854

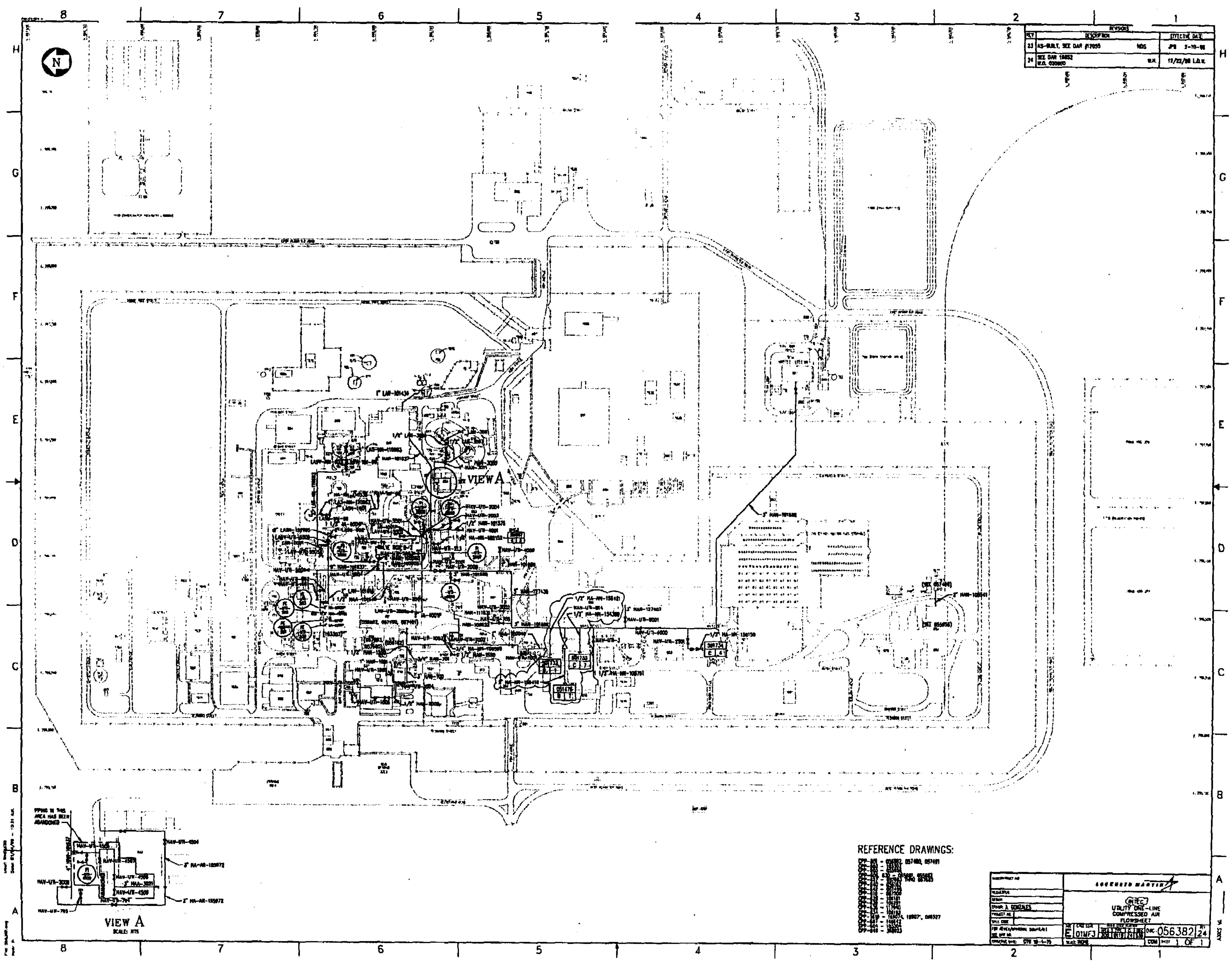
Person Called: Frank Ward, 526-3010

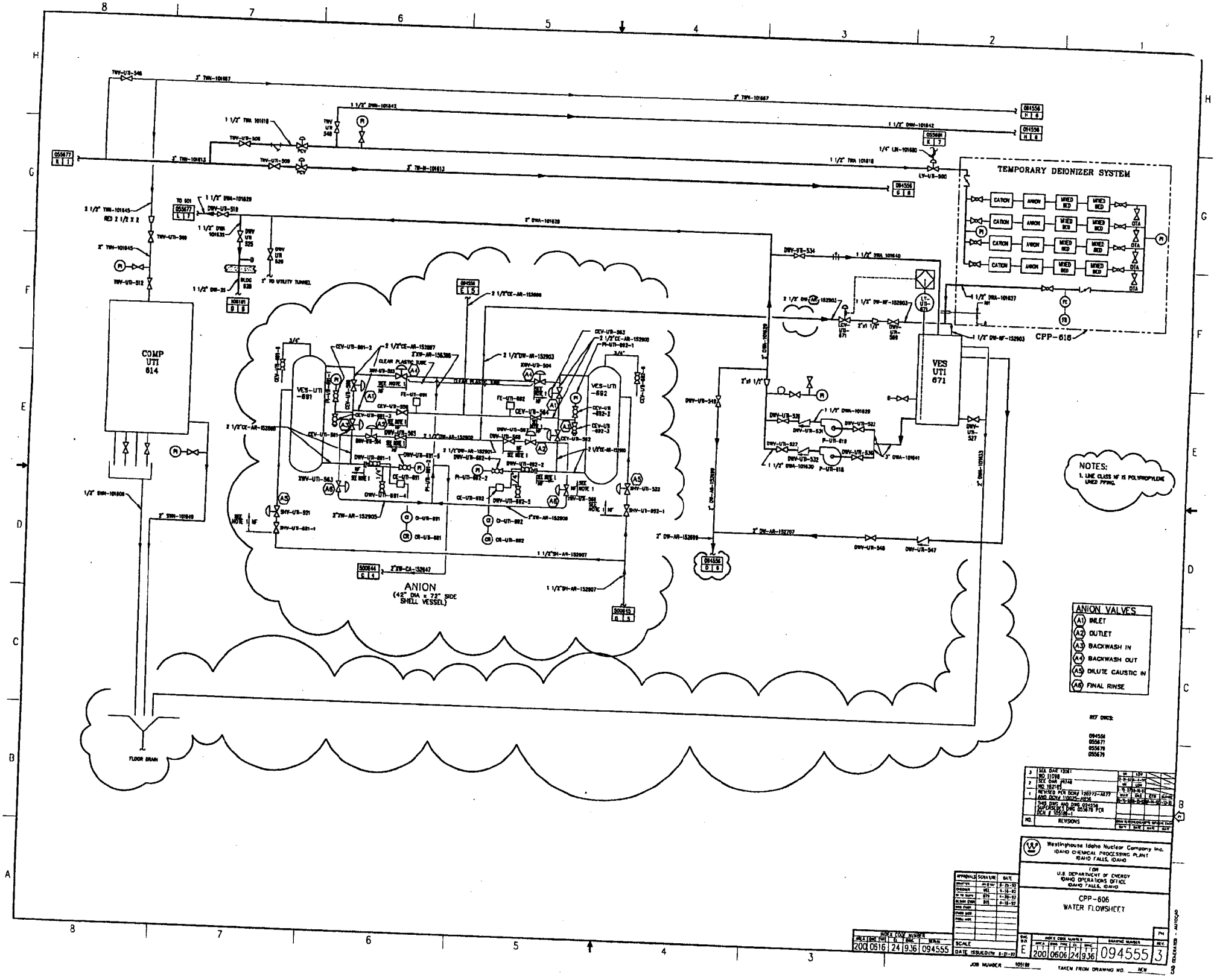
Subject: Use of raw water for washing Tank Farm Tanks

Description of Conversation:

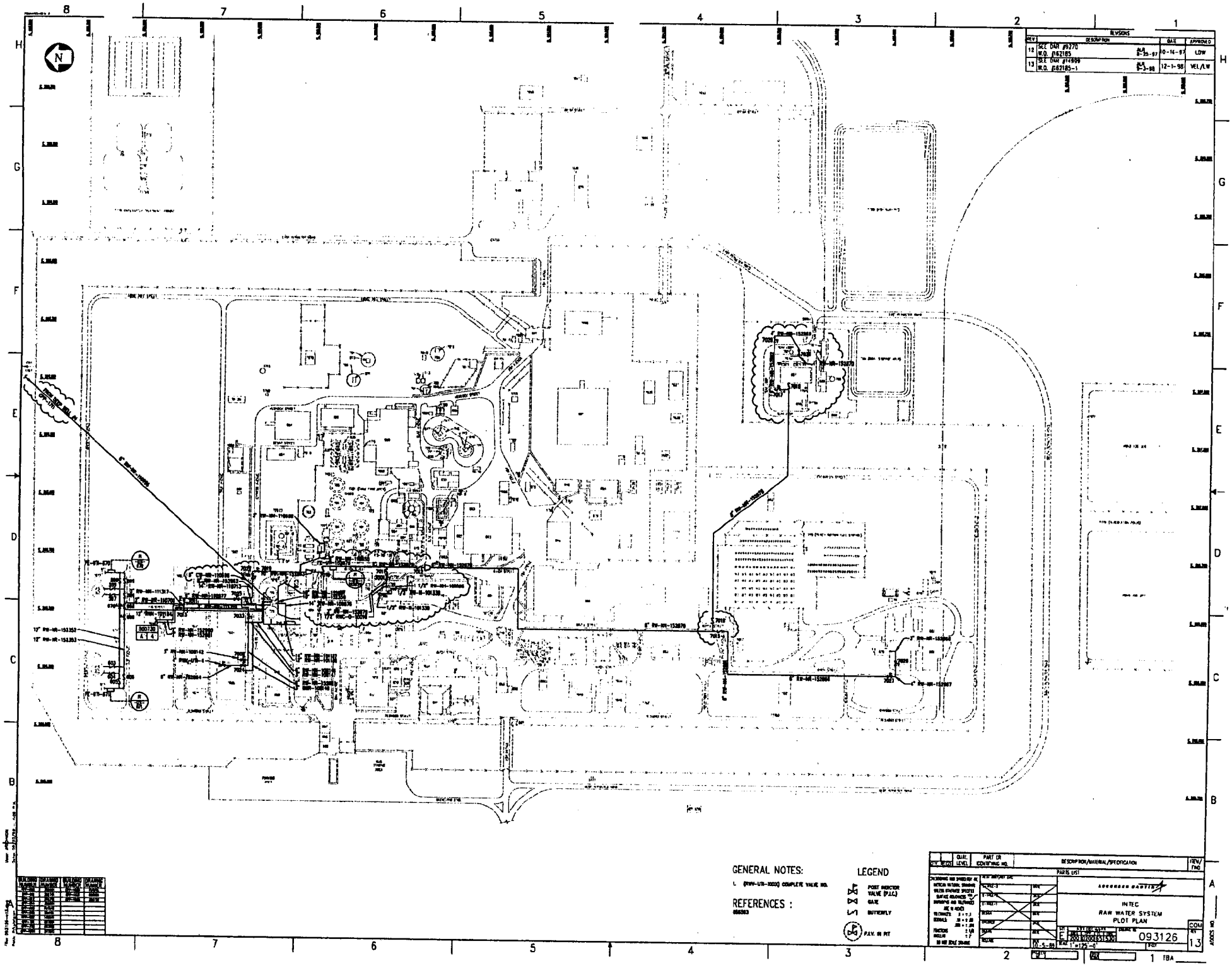
Frank returned a call I had made to him earlier in the day. He left a message explaining why he would prefer not to use raw water to wash the tanks. He said that the calcium and silicates in raw water cause scaling in the PEW evaporator. Raw water could be used but it would necessitate more rinsing of the evaporator. On the other hand, the sodium in treated water can cause problems in the calcining process. Reverse osmosis water or demineralized water would not create problems for either the evaporator or calciner.


COOLING WATER SURGE TANK VES-WM-120
COOLING WATER SURGE TANK VES-WM-130
COOLING WATER EXCHANGER HE-WM-320
COOLING WATER EXCHANGER HE-WM-320A
COOLING WATER EXCHANGER HE-WM-330
COOLING WATER EXCHANGER HE-WM-330A
RECIRCULATION PUMPS 350 GPM 52 PSIG 25 HP
SERVICE WASTE STANDPIPE
TO COMMON ALARM IN CPP-604
Westinghouse Idaho Nuclear Company Inc.
IDAHO CHEMICAL PROCESSING PLANT
IDAHO FALLS, IDAHO
FOR
U.S. DEPARTMENT OF ENERGY
IDAHO OPERATIONS OFFICE
IDAHO FALLS, IDAHO
CPP-628
TANK FARM
CONTROL HOUSE
P & ID
106181
33
SCALE NONE
DATE ISSUED
JOB NUMBER
TAKEN FROM DRAWING NO.
REDRAWN


REVISIONS
REV
DESCRIPTION
EFFECTIVE DATE
23 AS-BUILT, SEE DAR #12055 NDS
JPB 2-10-98
24 SEE DAR 18852
W.O. 020000
12/22/98
VIEW A
SCALE: NTS
PIPING IN THIS AREA HAS BEEN ABANDONED
REFERENCE DRAWINGS:
LOCKHEED MARTIN
INTEC
UTILITY ONE-LINE
COMPRESSED AIR
FLOWSHEET
DRAWN A. GONZALES
SIZE E
CAGE CODE 01MF3
DWG 056382
REV 24
SCALE: NONE
SHEET 1 OF 1



TEMPORARY DEIONIZER SYSTEM
CATION
ANION
MIXED BED
CPP-616
COMP UTI 614
VES-UTI -691
VES-UTI -692
VES UTI 671
ANION
(42" DIA x 72" SIDE SHELL VESSEL)
FLOOR DRAIN
NOTES:
1. LINE CLASS NF IS POLYPROPYLENE LINED PIPING.
ANION VALVES
A1 INLET
A2 OUTLET
A3 BACKWASH IN
A4 BACKWASH OUT
A5 DILUTE CAUSTIC IN
A6 FINAL RINSE
REF DWGS:
094556
055677
055679
055679
REVISIONS
Westinghouse Idaho Nuclear Company Inc.
IDAHO CHEMICAL PROCESSING PLANT
IDAHO FALLS, IDAHO
FOR
U.S. DEPARTMENT OF ENERGY
IDAHO OPERATIONS OFFICE
IDAHO FALLS, IDAHO
CPP-606
WATER FLOWSHEET
200 0616 24 936 094555
E 200 0606 24 936 094555 3
JOB NUMBER 105189
TAKEN FROM DRAWING NO. NEW



REVISIONS
REV | DESCRIPTION | DATE | APPROVED
12 | SEE DAR #9270 W.O. #162185 | 10-14-97 | LDW
13 | SEE DAR #14999 W.O. #162185-1 | 12-1-98 | VEL/LW
GENERAL NOTES:
1. (RWW-UTR-XXXX) COMPLETE VALVE NO.
REFERENCES :
LEGEND
POST INDICTOR VALVE (P.I.C.)
GATE
BUTTERFLY
P.I.V. IN PIT
QUAL. LEVEL
PART OR CONTROLLING NO.
DESCRIPTION/MATERIAL/SPECIFICATION
REV/FIND
PARTS LIST
INTEC
RAW WATER SYSTEM
PLOT PLAN
093126
13
1"=125'-0"
TBA

EDF-015722-031

ENGINEERING DESIGN FILE

1. Project File No. _____ 2. Project/Task INTEC Tank Farm Closure Project

3. Subtask Civil Systems – Utility Routing

4. Title: Feasibility of Using Existing Pipelines to Transfer CPP-603 Basin Water to Intec Tank Farm for use as Rinse Water for the Tank Farm Closure Project

5. Summary: This summary briefly defines the problem or activity to be addressed in the EDF, gives a summary of the activities performed in addressing the problem and states the conclusions, recommendations, or results arrived at from this task.

The fuel storage basin in CPP-603 contains approximately 1.5 million gallons of water which could potentially be used as wash water for the Tank Farm Closure Project. This EDF assesses the feasibility of using existing piping to transfer this water to the tank farm for use in the washing operation. The existing piping will allow transfer of the basin water at a flow of approximately 60 gpm, however, the pressure is low. In order to actually wash the walls of the tank, a method to connect the basin water piping at the tank farm to the tank washing system assembly will be required. Since the water is contaminated, precautions will need to be taken to prevent spread of contamination. Also, the current schedule calls for the basin to be emptied by December 2000. This would be prior to the scheduled beginning of the tank farm closure work.

6. Distribution (complete package):

Distribution (summary package only):

7. Review (R) and Approval (A) Signatures (Minimum reviews and approvals are listed. Additional reviews/approvals may be added as necessary.)

	R/A	Printed Name	Signature	Date
Author	R	Brent G. Harris	B.G. Harris	8/25/99
Independent Verification	R	Tracy Langenwalter	[illegible]	10/2/00
Requestor	A	Ed Anderson	[illegible]	10/3/00

FEASIBILITY OF USING EXISTING PIPELINES TO TRANSFER CPP-603 BASIN WATER TO THE INTEC TANK FARM FOR USE AS WASH WATER FOR THE TANK FARM CLOSURE PROJECT

8/25/99

Summary

This Engineering Design File (EDF) provides information on the feasibility of using existing piping to transfer the water in the CPP-603 storage basin such that it can be used as tank wash water for the Tank Farm Closure Project.

Background

The INTEC Tank Farm Facility (TFF) is the primary location used to store High Level Liquid Waste (HLLW) and Sodium Bearing Waste (SBW) which has been generated from processing of spent nuclear fuel at INTEC. The TFF consists of nine 300,000 gallon tanks and two 318,000 gallon tanks. Each of the eleven tanks is located in an underground concrete vault. The Tank Farm Closure Project includes the following general activities for each of the eleven tanks:

- Rinsing the tanks (partial fill and drain) using existing TFF systems.
- Pumping out as much of the existing liquid from the tanks using the existing steam jets.
- Using the Light Duty Utility Arm (LDUA), take samples of the remaining liquid/residue to determine the radiation levels present.
- Removing one of the existing steam jets, and extending the other steam jet such that more of the liquid can be removed.
- Inserting the washing system assembly; and washing down the tank. Removing the liquid with the remaining steam jet.
- Using the LDUA, take RCRA samples. If desired tank closure levels are not met, additional washing and sampling will be required until they are achieved.
- The tank will then be completely filled with grout using a procedure that will allow removal of additional free liquid in the process.
- The piping penetrating the tank wall will also be filled grout.
- The annulus between the tank wall and the enclosure vault will then be filled with grout.

Please note the meaning of rinsing versus the meaning of washing for this project. Rinsing refers to operations personnel adding water, using existing systems, to the tanks to dilute the remaining liquid in the tanks. The rinsing will be done prior to actual start of the Tank Closure Project operations. Washing will be done as part of the actual tank closure project using a washing system that will be lowered into the tanks in order to spray down the walls.

Wash Water Requirements

The water to be used for washing the tanks should not be hard water since it may cause mineral deposits to accumulate on the walls of the tanks. It is estimated that each tank will require approximately 15,000 gallons of rinse water (Reference 1), giving a total of 165,000 gallons to rinse all eleven tanks. This is based on each rinse consisting of 50 gpm for a period of 30 minutes, and each tank requiring approximately ten rinses.

Current Configuration

Building CPP-603 is located approximately ½ mile from the tank farm. The 603 basin currently contains approximately 1.5 million gallons of demineralized water that contains low levels of radioactivity. The water is no longer required in the basin, and using it as tank wash water would be a way to dispose of it and also accomplish a needed task. If the basin water could be used as wash water, it would eliminate generation of approximately 165,000 gallons of additional liquid waste.

In conversations with Frank Ward (References 2 and 3), he stated that they have already used some of the basin water in one of the tanks. They pumped approximately 25,000 gallons from the CPP-603 basin to tanks WM-100 and WM-101. He stated that the existing piping and pumping capacity can deliver approximately 60 gpm of basin water to the tank farm. They have transferred approximately 3400 gallons from WM-100 to WM-182 for rinsing (dilution) purposes.

Research of the existing drawings has identified the following routing of piping from the CPP-603 basin to the tank farm.

From	To	Pipe Label	Reference Drawings
CPP-603 Basin	Basin Filtration System	8" BWN-101200	057610 131131
Basin Filtration System	CPP-648	4" PLA-101208	056612
CPP-648	DVB-SAA-PL-C27	2" PLA-104803	138015 138014 057499
DVB-SAA-PL-C27	DVB-YDB-PW-C28	2" PLA-104803	138013 057499
DVB-YDB-PW-C28	DVB-YDA-PW-C29	2" PWA-1560	057499
DVB-YDA-PW-C29	DVB-WM-PW-C32	3" PLAR-110206	057499
DVB-WM-PW-C32	Evaporator/Tanks	3" PLAR-113801	096156

Potential Problems

This ETF assumes that the basin water has adequate purity for rinsing and/or washing of the tanks. It was also assumed that the existing piping is in good condition.

Based on a conversation with Frank Ward (Reference 2), the goal for having the basin water removed is December 2000. If that is a realistic date, using the water for washing tanks during the tank farm closure project is not feasible since closure of the first two tanks is not scheduled until 2003.

Since washing of the tank walls is required, a method of connecting the basin water piping at the tank farm to the tank washing system assembly will be required. Since the basin water is contaminated, precautions will be required to prevent spread of the contamination. Secondary containment of any piping used to transfer the basin water would be required. A pump would also be necessary to increase the pressure such that the washing system could operate properly.

Conclusions

The existing piping is adequate to transfer the CPP-603 basin water to the tank farm at a rate of approximately 60 gpm. The pressure is quite low, however. The proposed schedule for having the basin water removed will have the basin emptied prior to the beginning of the tank farm closure project. Also, if the decision to use the basin water as wash water is made, a method of connecting the basin water piping to the washing system assembly needs to be devised such that spread of contamination is not a concern. In addition, a pump would be required to provide the necessary pressure to the washing system. Without connection to the washing system, the water could only be used for dilution of the tank waste, not for washing of the tank walls.

References

1. Conversation between Clint Kingsford and Rod Kimmitt, referenced in Clint Kingsford memo to project file dated 3/31/99. (Attached)
2. Tank Farm Telecon No. 2, Conversation between Frank Ward and Brent Harris, 6/30/99. (Record Attached)
3. Tank Farm Telecon No. 3, Conversation between Frank Ward and Brent Harris, 7/7/99. (Record Attached)
4. Drawings (Attached): 057610 131131 056612 138015 138014 057499 138013 096156

Tank Farm Deactivation
March 31, 1999
Memo to File
Written by Clint Kingsford

Deionized Water

I met in person with Frank Ward on March 31, 1999 to get a better view of the utilities required for the Tank Farm deactivation.

He said that deionized water was available through 628, however, we may need a holding tank depending on how much volume we needed. He said the supply comes from Building 606 and Dave Suhre is the custodian of the utility boiler house in 606.

Frank said that the PEW is in Building 604. He emphasized that the basin water from 603 is available, but the decision has been made to use basin water only for general cleaning and not specific cleaning of the tanks. We still need to get information from Thornton Waite and others on the use of the basin water and the timing of the use of the basin water.

After returning back to Idaho Falls, I discussed the deionized water with several people Ed Anderson, Syl Losinski, Rod Kimmitt, and Darrel Hall. Darrel is the utility person who is over the plant air and deionized water.

In talking to Syl Losinski he questioned the use of deionized water for the washing of the tanks. He said that the current demand for deionized water is approximately 6 gallons per minute. He said that our water should be clean enough to wash the tanks. They are in the process of formulating a project to replace a 200-gallon per minute RO unit with at least one 400 gallon per minute RO unit, or at least maintain the 200 gallon per minute RO unit and adding a 400 gallon per minute RO unit. He said there are basically five types of water being used at INTEC. 1) There is raw water, that is brought directly from the wells, which is used for raw water purposes that is not treated for general purposes and firewater. 2) Potable water that is pulled from another well, and receives some chlorination for treatment to be used in sanitary situations. 3) There is treated or softened water, 4) there is water which is run through the reversed osmosises system, which replaces and removes the bulk of the mineral constituents. 5) Demin or deionized water is used for specialized situations where corrosion could be a problem. The conductivity and minerals are removed to a greater extent than in the aero water.

Rod Kimmitt is the process engineer who is working on the process of cleaning the tanks. He stated that RO water would be plenty adequate for their needs. The reason for using RO water is to avoid hardened water characteristics from accumulating on the sides of the tanks. Rod said that he would need approximately 50 gallons per minute for each rinse of the tank. He figured that he would probably need 8 to 10 rinses. This would amount to a maximum of 15,000 gallons during a week to two-week period of time.

As Rod stated the demand would not be consistent, only for each rinse would take one-half hour to an hour to accomplish. He did say that RO water was adequate. They are trying to increase the PH to 2.5 to 3, to reduce the radio nuclides and yet at the same time not have it so high that it would precipitate anymore solids. Wash water would be put in tank 187 or 183.

Mr. Ward stated that the NWCF High Level Waste Evaporator would evaporate about 200 gallons per hour. The PEWE will evaporate approximately 500 gallons per hour. There is also the possibility of using the LET&D for evaporation of wastewater.

Plant Air

In talking to Frank Ward there is 100-psi air in the utility tunnel immediately west of the tank farm. In talking to Darrel Hall he said that we could tap into that and supply the tank farm with portable hoses. Mr. Ward stated that there is an exterior manifold in building 628 that we could probably pipe into and then distribute the air from there also. Mr. Hall said that there would be no problem in supplying the air required 100-psi air. There is presently a 2-inch line coming from 606.

Steam

In talking to Mike Berry at our meeting on Monday, March 29, the steam is used to go through a venturi and is used to suck up the wash water. It has been called a pump, but it is not really a pump, it is used to create a negative pressure and pull vacuum the waste water into a discharge line which will be discharged to Tank 187 for storage and for later disposal. There is adequate steam available to accomplish this purpose.

Sanitary Sewer

In talking to Mr. Ward he stated that restroom facilities have been made available to construction personnel in TR-35 the construction management area. Building 699 where Mr. Ward's office is, Building 664, and Building 1678 the Construction Prefab Shop, which is to the Southwest of the tank farm 4 or 5 hundred feet. They are listed as Buildings 641, 734,796 temporary trailers T-1 through T-5 adjacent to Birch Street and Ash Avenue.

Mr. Ward said that there is also some construction trailers east of Building 699 and South of 1678 enclosure, which could be used by a contractor for personnel.

He did say that a temporary decon area may be required. He suggested that I talk to Lex Strain and Kirk Winterholler on what they have done on past projects.

Access

Frank stated that personnel access to the tank farm is through Building 1672, which is located on the Northeast corner of the tank farm fence. It is a small building where they

pass through and there are monitors that personnel go through. He stated that unless there is a need for excavation that anti Cs would not normally be required, only when they are working with decontaminated soil. There is a small bully barn just to the West of building 1672 where anti Cs are stored. Frank said that if anti Cs are used that they would cloth in Building 1672 and then go into the work area when they are done, then the anti Cs would be removed in the work area and specified people would package them and dispose of them. Basically Anti Cs are not salvaged.

Frank said that I should contact Lex Strain and Kirk Winterholler on procedures and what they have done on past projects in the tank farm area.

There are several gates around the tank farm perimeter fence, which can be used to drive access equipment into the tankfarm. However, the tankfarm loading requirements must be complied with as specified in the report "Tank Loading Or The Loading Requirements In Zones A, B, And C In The Tank Farm". However, there is a Mr. Nate that is doing a new load rating analysis and there is hope that his analysis will show that we can put in larger loads than is presently allowed by the current study. Basically most of the staging will be done outside the fence.

The tank farm area while it has certain ECAs inside is basically classified as an ECA-96.

Mr. Dennis Ronig manages CERCLA affairs in the excavation which is incompliance with CERCLA regulations must be put back in the hole. If it is RCRA situation, the soil must be boxed and disposed of in another location.

Frank Ward pointed out an area where there was a major spill next to tank 183 and 185. He basically drew a little contour showing where it had been classified as 1R and radionuclide contamination in the center the plume will go up to 10R. Valve boxes A5 and A6 are highly contaminated.

GEOTEC Membrane

Frank Ward drew a rough sketch of the outline of the membrane as it exists on the tankfarm. Basically it covers the area for Tanks 182, 183, 181, 180, 185, 184, 186, 187, 189, 190, and 188. A rough sketch was drawn on C-1 for project 020906 drawn by Gene Mace. Frank says that the membrane is acted as a two-edged sword while the original intent was to cover the ground to prevent moisture intrusion, it has acted as a conduit for moisture going into the ground. Once the moisture gets in the ground it can't get out because there is no opportunity for evaporation. He basically says that moisture, snow or rain that gets on the tank farm will seep through the membrane because it is not totally water tight. He said that one time, they conducted a dye test between Building 699 and the fence adjacent to tanks 189 and 190 and the dye had seeped under the membrane into the tank area. He did say the membrane has prevented weed growth and has been positive in that regard. For penetrations the membrane is fastened to vaults with redwood 2 x 4s or for circular penetrations is has been fastened with pipe clamps.

Planning is still in the mill as far as total enclosing the tankfarm area when the tanks have been deactivated but he said that there has been thoughts of pouring a concrete cap or using a new membrane over the whole area covered with soil. However, this has not been resolved as yet.

Stainless Steel

Frank Ward said that the stainless steels that have been used in the tankfarm area are 304-L, 347, 316, 316-L; he said that 316-L costs as much as you are willing to pay for a desired feature.

Mr. Ward stated that they could calcine 32 – 64 gallons per hour of waste.

Record of Telephone Conversation

ID: Tank Farm Telecon No. 2

Date: 6/30/99, 7:30 a.m.

Person Calling: Brent Harris, 526-3854

Person Called: Frank Ward, 526-3010

Subject: Transfer of water from the CPP-603 Basin to the Tank Farm Facility

Description of Conversation:

I explained to Mr. Ward that one of my tasks on the Tank Farm Closure Project was to determine if it was feasible to transfer the CPP-603 basin water to the Tank Farm Facility using existing pipelines. The main reason for such a transfer is to empty the 603 basin. Potentially, the water could also be used for rinsing the tanks as part of the closure project.

Mr. Ward explained that it is definitely possible and that some of the 603 basin water has already been transferred. Using existing piping, they can transfer about 60 gpm. He said that he was not aware that this would be part of the Tank Farm Closure Project. He said that Doug Preussner has stated that they would like to have the basin emptied prior to the year 2003 which is when the closure of the first tank (WM-182) is scheduled, in fact the current plan is to have the CPP-603 basin emptied by the end of 2000.

Mr. Ward said there are drawings with the waste flow diagrams which would provide information on the transfer from CPP-603 to the Tank Farm. The drawings are 057498, 057499, 057500, 057501, 057502, and 057503.

Record of Telephone Conversation

ID: Tank Farm Telecon No. 3

Date: 7/07/99, 9:45 a.m.

Person Calling: Brent Harris, 526-3854

Person Called: Frank Ward, 526-3010

Subject: 1. Use of CPP-603 basin water for rinsing Tank Farm Tanks
2. Availability of Treated Water in Building CPP-628

Description of Conversation:

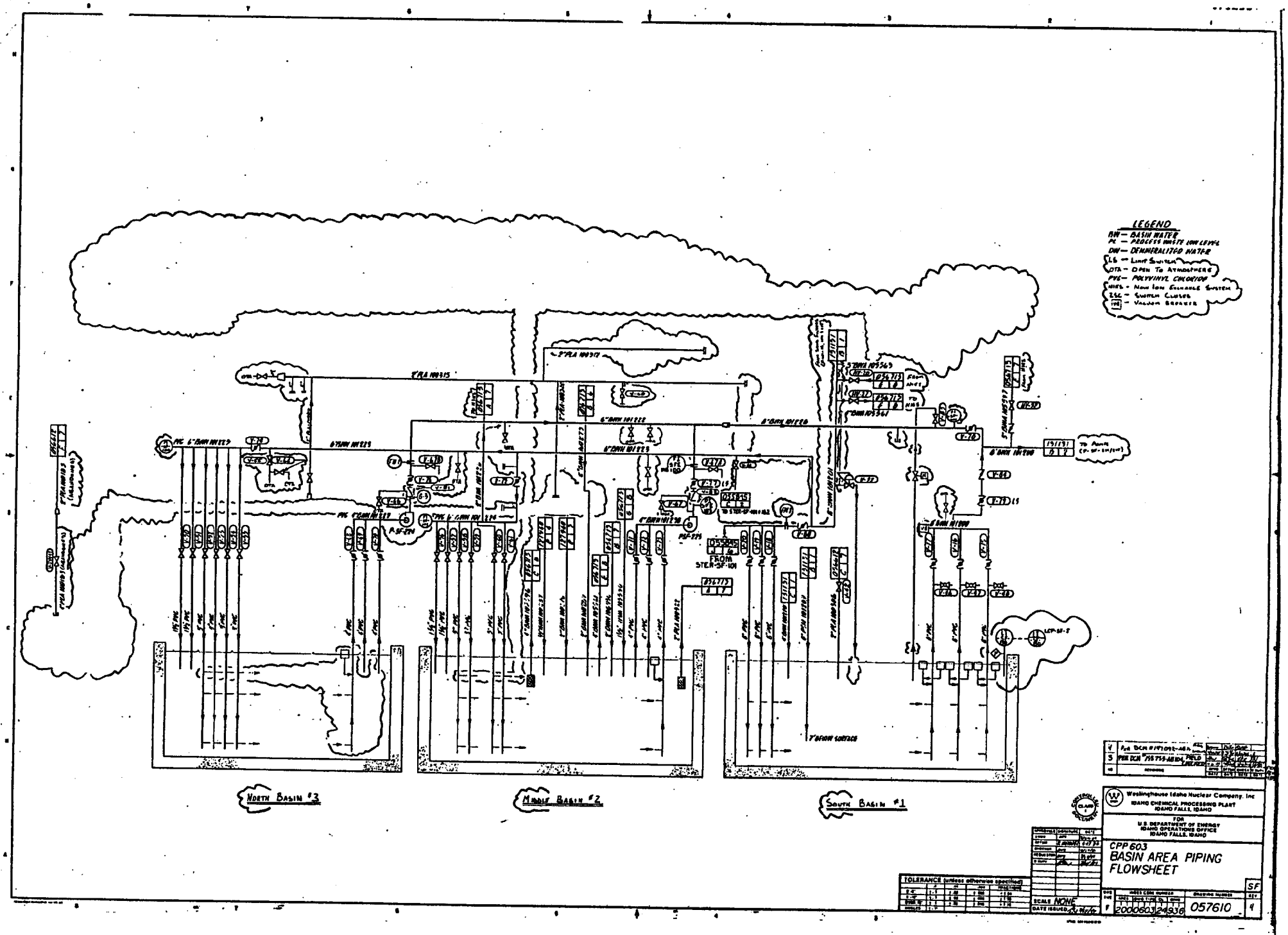
Item 1:
In Tank Farm Telecon No. 2, Frank and I had discussed the use of CPP-603 basin water for rinsing the tanks during the tank farm closure project. He had explained that the piping was available to transfer the basin water from CPP-603 to the tank farm.

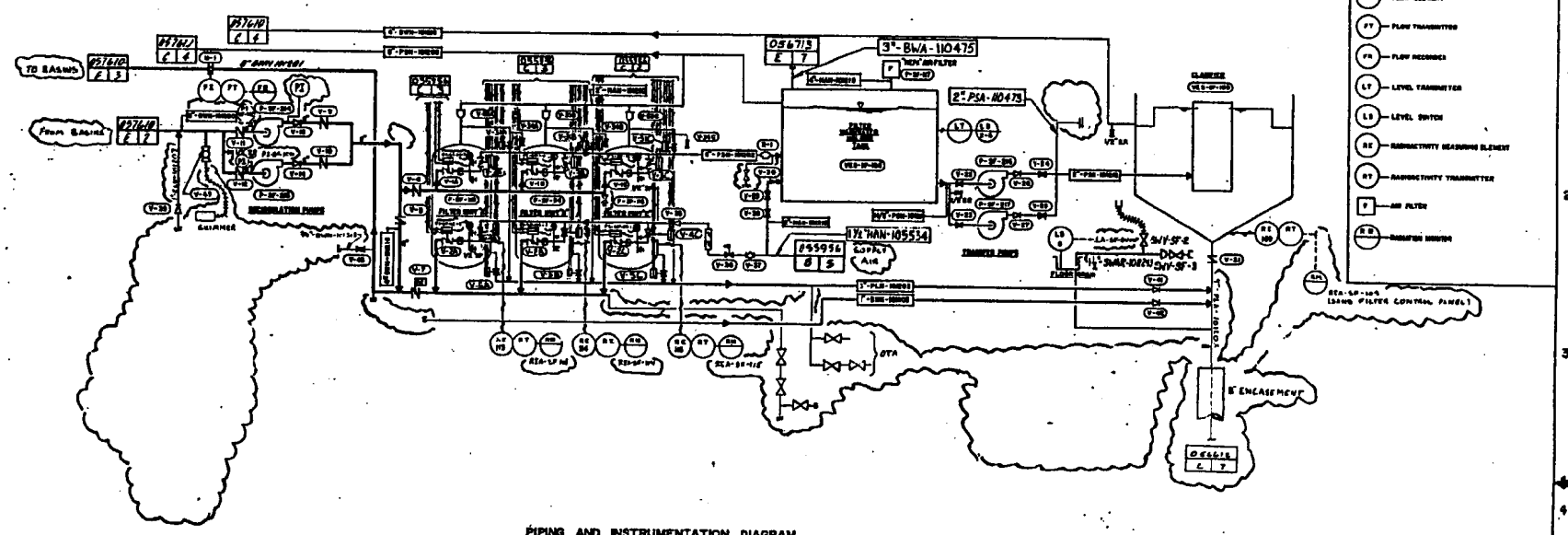
Today, I expressed concern that there may be a problem in connecting the source of the basin water to the tank wash assembly which would be used for rinsing the tanks since the basin water is contaminated. He agreed that could be a problem. Any new piping for the basin water would need to have secondary containment, and the basin water would contaminate the system. Also, the pressure would probably not be adequate to operate the tank wash assembly, so a pump would probably be necessary.

Frank said that they had transferred approximately 25,000 gallons from the CPP-603 basin to WM-100 and WM-101. They then transferred approximately 3400 gallons from WM-100 to WM-182. The purpose of this was to dilute the heel in WM-182. It is feasible to use the existing piping to transfer CPP-603 basin water to the tanks for dilution purposes, but actual washing of the walls is not possible.

Item 2:

Frank said that he thought there was raw water in Building CPP-628 but he did not believe there was any treated water. I stated that there was treated water available in the utility tunnel to the west of the tank farm. Frank said that they did not want to use treated water for rinsing the tanks because it contained sodium which caused problems during treatment of the waste.


LEGEND
BW — BASIN WATER
PL — PROCESS WASTE LOW LEVEL
DW — DEMINERALIZED WATER
LS — LIMIT SWITCH
OTA — OPEN TO ATMOSPHERE
PVC — POLYVINYL CHLORIDE
NIES — NOW ION EXCHANGE SYSTEM
ZSC — SWITCH CLOSED
VB — VACUUM BREAKER
FROM STER-SF-101
NORTH BASIN #3
MIDDLE BASIN #2
SOUTH BASIN #1
Westinghouse Idaho Nuclear Company, Inc
IDAHO CHEMICAL PROCESSING PLANT
IDAHO FALLS, IDAHO
FOR
U.S. DEPARTMENT OF ENERGY
IDAHO OPERATIONS OFFICE
IDAHO FALLS, IDAHO
CPP 603
BASIN AREA PIPING
FLOWSHEET
TOLERANCE (unless otherwise specified)
SCALE NONE
DATE ISSUED
DRAWING NUMBER
057610
SF
4
2000603249 36



PIPING AND INSTRUMENTATION DIAGRAM

VALVE SCHEDULE

VALVE NO.	SERVICE	SIZE	MAT'L	TYPE	OPERATOR
V-3A-C	INLET	6"	PVC	BUTTERFLY	PNEUMATIC
V-3A-C	OUTLET	6"	PVC	BUTTERFLY	PNEUMATIC
V-3A-C	BACKWASH	6"	PVC	BUTTERFLY	PNEUMATIC
V-4A-C	AIR INLET	2"	PVC	BALL	PNEUMATIC
V-5A-C	DRAIN	3"	PVC	BALL	PNEUMATIC
V-6	FILTER ISOLATION	6"	PVC	BUTTERFLY	MANUAL
V-7	FILTER ISOLATION	6"	PVC	BUTTERFLY	ELECTRIC
V-8	BY-PASS	6"	PVC	BUTTERFLY	MANUAL
V-9	PUMP DISCHARGE P-SF-1-1	6"	PVC	BUTTERFLY	MANUAL
V-10	PUMP DISCHARGE P-SF-1-2	6"	PVC	BUTTERFLY	MANUAL
V-11	PUMP DISCHARGE P-SF-1-3	6"	PVC	BUTTERFLY	MANUAL
V-12	PUMP SUCTION P-SF-1-1	6"	PVC	BUTTERFLY	MANUAL
V-13	PUMP SUCTION P-SF-1-2	6"	PVC	WAFER CHECK	—
V-14	PUMP DISCHARGE P-SF-1-3	6"	PVC	WAFER CHECK	—

VALVE NO.	SERVICE	SIZE	MAT'L	TYPE	OPERATOR
V-21	CLARIFIER BLOWDOWN	4"	PVC	BUTTERFLY	ELECTRIC
V-22	TRANSFER PUMP SUCTION P-SF-1-1	1-1/2"	PVC	BALL	MANUAL
V-23	TRANSFER PUMP SUCTION P-SF-1-2	1-1/2"	PVC	BALL	MANUAL
V-24	TRANSFER PUMP DISCHARGE P-SF-1-1	2"	PVC	BALL	MANUAL
V-25	TRANSFER PUMP DISCHARGE P-SF-1-2	2"	PVC	BALL	MANUAL
V-26	TRANSFER PUMP DISCHARGE P-SF-1-3	2"	PVC	BALL CHECK	—
V-27	TRANSFER PUMP DISCHARGE P-SF-1-3	2"	PVC	BALL CHECK	—
V-28	AIR GRID SUPPLY	2"	CS	BALL VALVE	PNEUMATIC
V-29	AIR GRID SUPPLY	2"	CS	BALL VALVE	MANUAL
V-30	AIR GRID SUPPLY	2"	PVC	BALL CHECK	—
V-31A-C	VENT	2"	PVC	BALL	PNEUMATIC
V-32A-C	FILTER AIR/VACUUM RELEASE VALVE	2"	CV30	AIR/VACUUM RELEASE	—

VALVE NO.	SERVICE	SIZE	MAT'L	TYPE	OPERATOR
V-34A-C	VENT	1"	PVC	BALL	MANUAL
V-35	AIR SUPPLY	2"	PVC	BALL CHECK	—
V-36	PRESSURE REDUCING VALVE	1"	BRONZE	REGULATOR	—
V-37	AIR SUPPLY	1"	BRONZE	PLUG/COCK	MANUAL
V-39	CHLORINE LINE	1"	PVC	BALL CHECK	—
V-40	POLYMER LINE	1/2"	PVC	BALL CHECK	—
V-41	DRAIN	2"	PVC	BALL CHECK	—
V-42	FLUSH LINE	1"	PVC	BALL CHECK	—
V-43	SHUT OFF	3/4"	PVC	BALL	MANUAL
V-44	SHUT OFF	1-1/2"	BRT	PLUG	MANUAL
V-45	VAC HOSE	1-1/2"	PVC	BALL	MANUAL
R-1	RATE OF FLOW CONTROLLER	6"	—	—	—
SWV-SF-2	SHUT OFF	1½"	SST	GATE	MANUAL
SWV-SF-3	SHUT OFF	3/4"	SST	GATE	MANUAL

REVISIONS			
6	4-3-76	PER DCN #154702-A86	
5	3-30-76	REV. PER DCN #142621-AE4	JPD
4	12-8-74	SEE DCN 5 SPA076184-PSPA4	
3	11-8-74	SEE DCN 3	
2	4-11-74	AS-BUILT	
1	9-26-74	SEE DCN 1 81-015	

REV.	DATE	DESCRIPTION	CHK.	APP.	APP.

CPP-603

BASIN WATER FILTRATION & SAND FILTER MODIFICATIONS PIPING INSTRUMENTATION & VALVE SCHEDULE

JAMES M. MONTGOMERY, CONSULTING ENGINEERS, INC.

U. S. ATOMIC ENERGY COMMISSION
IDAHO OPERATIONS OFFICE
IDAHO FALLS, IDAHO

	BY	DATE
DRAWN	JEB	9-26-74
CHECKED	JEB	10-8-74
APPROVED		12-26-74
APPROVED		
APPROVED		
ACE APPR.	GAV	12-26-74
ADD APPROVED		
ADD APPROVED		

SCALE: NONE

DWG. NO. 1482-CPP-603-P1 REV. 6

CONTROLLED DOCUMENT

SF

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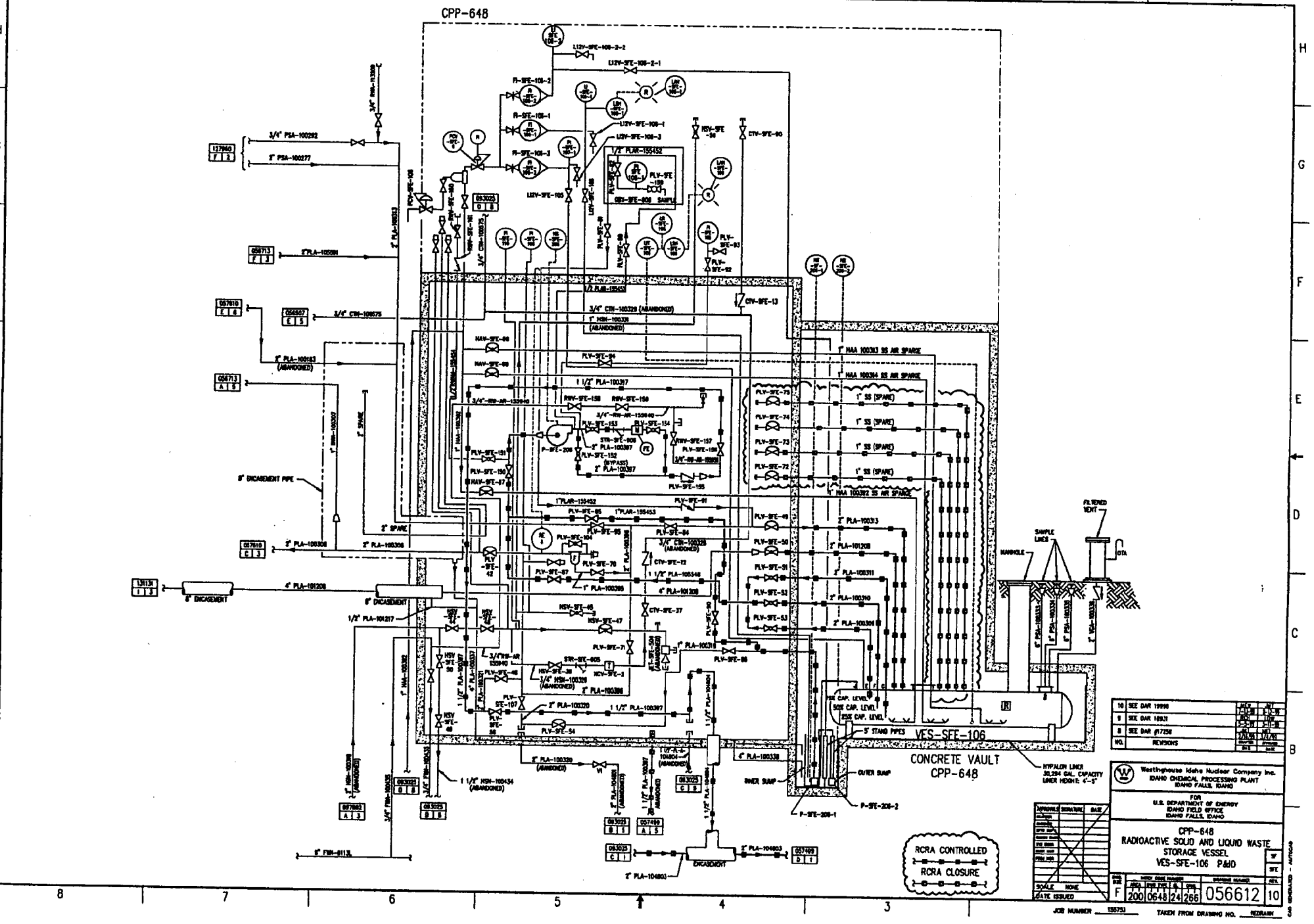
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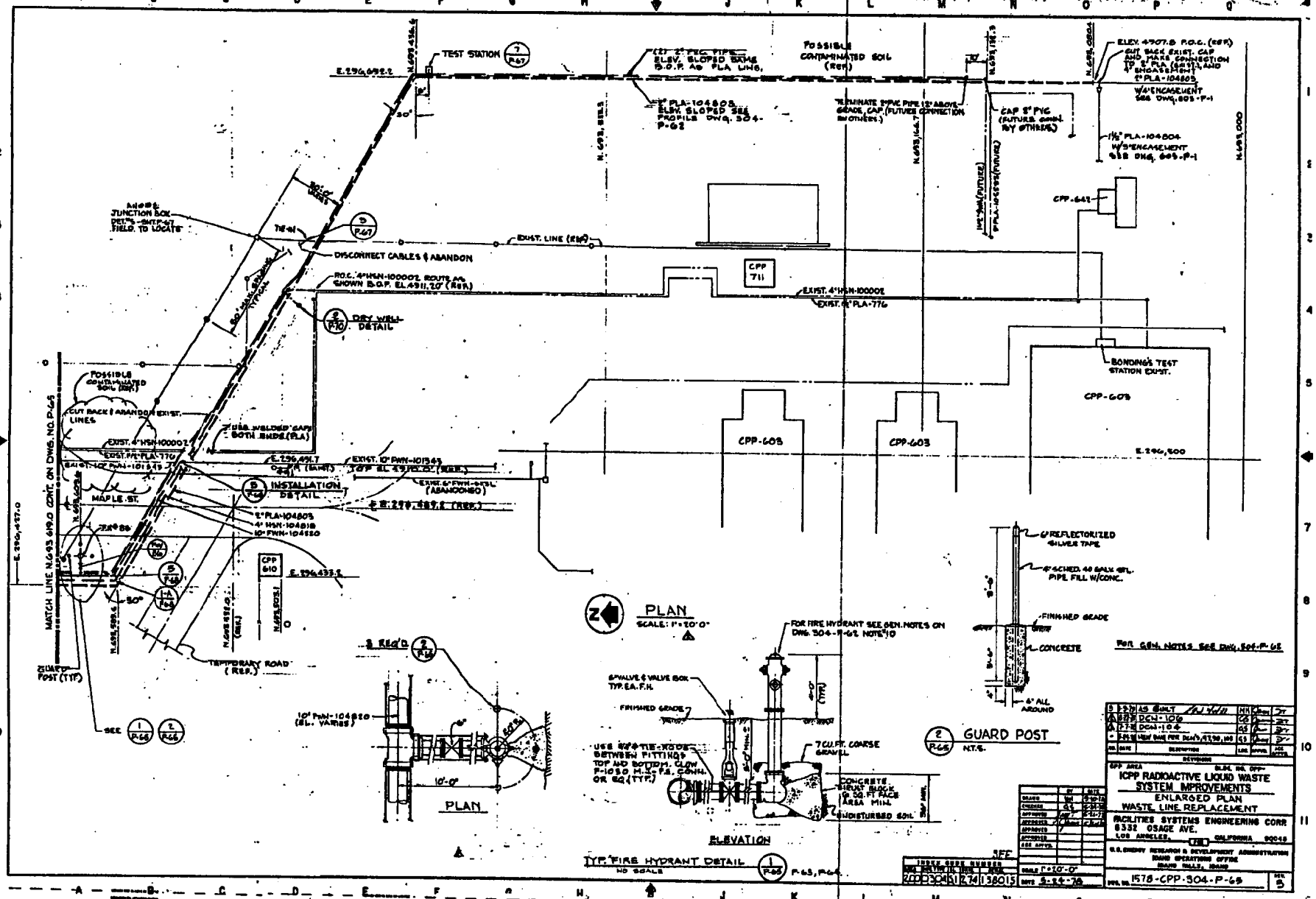
RCRA CLOSURE
10 SEE DAR 19996
9 SEE DAR 18931
8 SEE DAR #17258
NO. REVISIONS
Westinghouse Idaho Nuclear Company Inc.
IDAHO CHEMICAL PROCESSING PLANT
IDAHO FALLS, IDAHO
FOR
U.S. DEPARTMENT OF ENERGY
IDAHO FIELD OFFICE
IDAHO FALLS, IDAHO
CPP-648
RADIOACTIVE SOLID AND LIQUID WASTE
STORAGE VESSEL
VES-SFE-106 P&ID
F 200 0648 24 266 056612 10
JOB NUMBER 155753
TAKEN FROM DRAWING NO. REDRAWN


TEST STATION
POSSIBLE CONTAMINATED SOIL (REF.)
ELEV. 4707.8 P.O.C. (REF.)
CUT BACK EXIST. CAP AND MAKE CONNECTION TO 2" PLA
1½" PLA-104804
W/4" ENCASEMENT
CAP 2" PVC (FUTURE CONN. BY OTHERS)
CPP-642
CPP 711
EXIST. LINE (REF.)
DISCONNECT CABLES & ABANDON
DRY WELL DETAIL
BONDING & TEST STATION EXIST.
CPP-603
CPP-603
CPP-603
E. 296,500
POSSIBLE CONTAMINATED SOIL (REF.)
CUT BACK & ABANDON EXIST. LINES
EXIST. 4" HSN-100002
EXIST. 10" PWN-101343
INSTALLATION DETAIL
MAPLE ST.
CPP 610
TEMPORARY ROAD (REF.)
GUARD POST (TYP.)
MATCH LINE N.693,690.0 CONT. ON DWG. NO. P-65
PLAN
SCALE: 1" = 20'-0"
FOR FIRE HYDRANT SEE GEN. NOTES ON DWG. 304-P-62 NOTE #10
6" VALVE & VALVE BOX TYP. EA. F.H.
FINISHED GRADE
7 CU. FT. COARSE GRAVEL
CONCRETE THRUST BLOCK @ 50 FT FACE AREA MIN.
UNDISTURBED SOIL
ELEVATION
TYP. FIRE HYDRANT DETAIL
NO SCALE
6" REFLECTORIZED SILVER TAPE
4" SCHED. 40 BALK GAL. PIPE FILL W/CONC.
FINISHED GRADE
CONCRETE
4" ALL AROUND
GUARD POST
N.T.S.
REF. GEN. NOTES SEE DWG. 304-P-62
ICPP RADIOACTIVE LIQUID WASTE SYSTEM IMPROVEMENTS
ENLARGED PLAN
WASTE LINE REPLACEMENT
FACILITIES SYSTEMS ENGINEERING CORP.
8332 OSAGE AVE.
LOS ANGELES, CALIFORNIA 90045
U.S. ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION
IDAHO OPERATIONS OFFICE
IDAHO FALLS, IDAHO
1578-CPP-304-P-65
5
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DATE 5-24-76
138015
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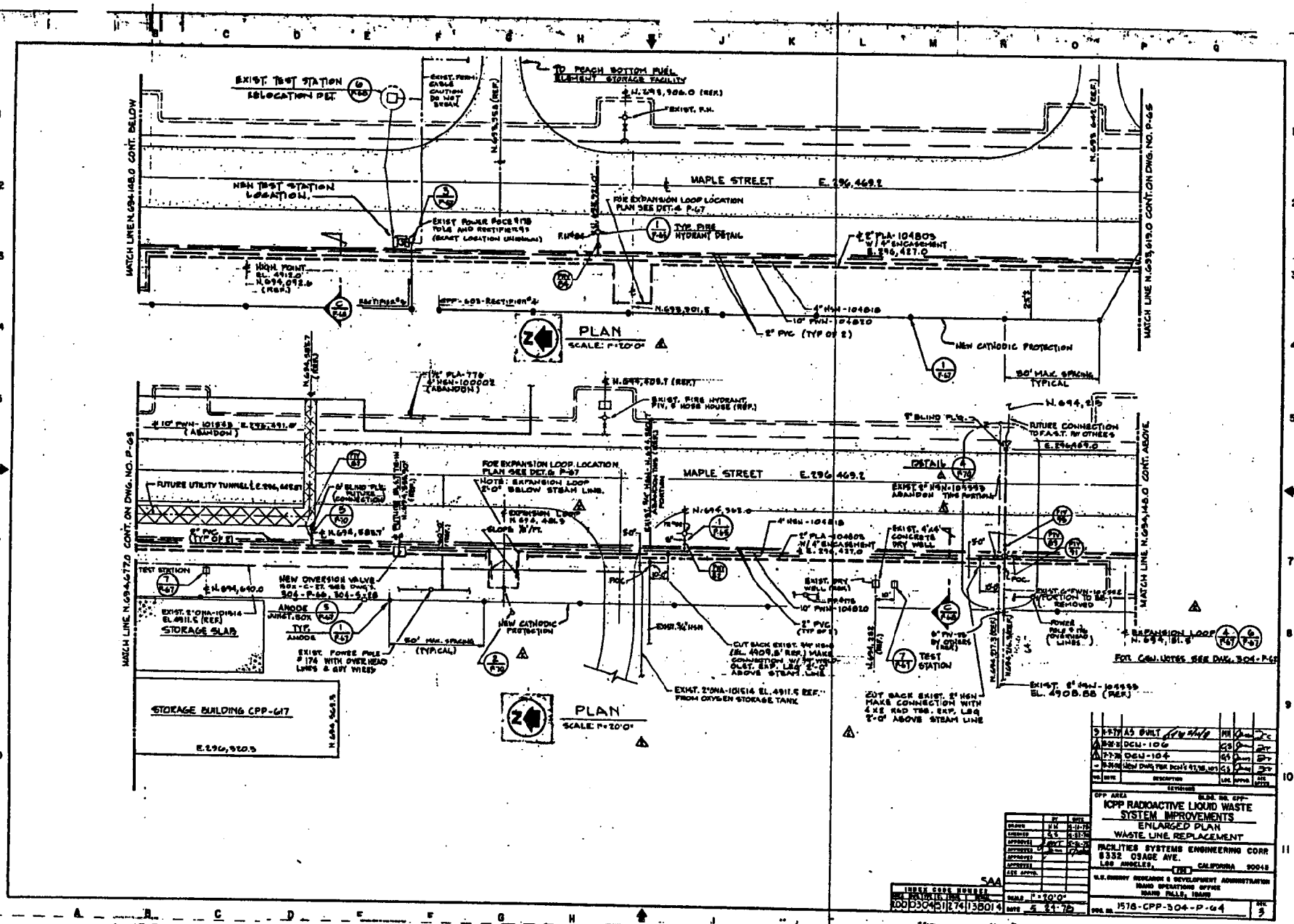

EXIST. TEST STATION RELOCATION DET.
TO PEACH BOTTOM FUEL ELEMENT STORAGE FACILITY
MAPLE STREET
E. 296,469.2
NEW TEST STATION LOCATION.
FOR EXPANSION LOOP LOCATION PLAN SEE DET. 4 P-67
TYP. FIRE HYDRANT DETAIL
HIGH POINT EL. 4912.0
PLAN
SCALE: 1"=20'0"
NEW CATHODIC PROTECTION
30' MAX. SPACING TYPICAL
MATCH LINE N.694,148.0 CONT. BELOW
MATCH LINE N.693,619.0 CONT. ON DWG. NO. P-65
MATCH LINE N.694,677.0 CONT. ON DWG. NO. P-65
MATCH LINE N.694,148.0 CONT. ABOVE
FUTURE UTILITY TUNNEL
FOR EXPANSION LOOP LOCATION PLAN SEE DET. 6 P-67
NOTE: EXPANSION LOOP 2'-0" BELOW STEAM LINE.
EXPANSION LOOP
NEW DIVERSION VALVE
STORAGE SLAB
STORAGE BUILDING CPP-617
E.296,320.5
TEST STATION
EXIST. 2" ONA-101514 EL. 4911.5 REF. FROM OXYGEN STORAGE TANK
CUT BACK EXIST. 2" HSN MAKE CONNECTION WITH 4 X 2 RED TEE. EXP. LEG 2'-0" ABOVE STEAM LINE
FUTURE CONNECTION TO F.A.S.T. BY OTHERS
EXPANSION LOOP
FOR CEN. NOTES SEE DWG. 304-P-65
EXIST. 2" HSN-104533 EL. 4908.88 (REF.)
AS BUILT
DCN-106
DCN-104
NEW DWG FOR DCN'S 97,98,101
REVISIONS
CPP AREA
BLDG. NO. CPP-
ICPP RADIOACTIVE LIQUID WASTE SYSTEM IMPROVEMENTS
ENLARGED PLAN
WASTE LINE REPLACEMENT
FACILITIES SYSTEMS ENGINEERING CORP.
8332 OSAGE AVE.
LOS ANGELES, CALIFORNIA 90045
U.S. ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION
IDAHO OPERATIONS OFFICE
IDAHO FALLS, IDAHO
SCALE 1"=20'0"
DATE 5-24-78
DWG. NO. 1578-CPP-304-P-64
REV. 3
INDEX CODE NUMBER
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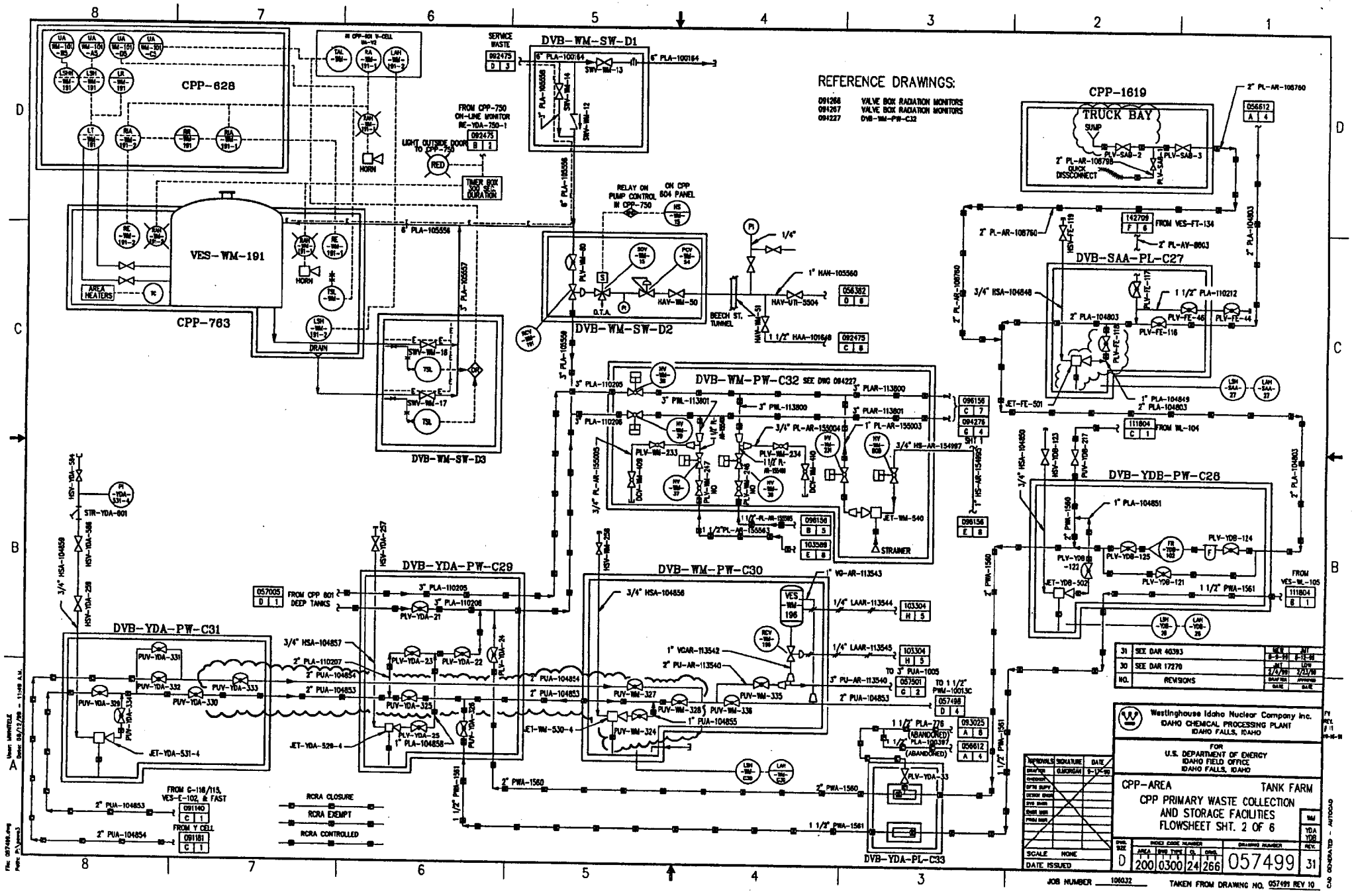
138014


REFERENCE DRAWINGS:
091266 VALVE BOX RADIATION MONITORS
091267 VALVE BOX RADIATION MONITORS
094227 DVB-WM-PW-C32
CPP-628
CPP-763
VES-WM-191
DVB-WM-SW-D1
DVB-WM-SW-D2
DVB-WM-SW-D3
CPP-1619
TRUCK BAY
DVB-SAA-PL-C27
DVB-WM-PW-C32 SEE DWG 094227
DVB-YDB-PW-C26
DVB-YDA-PW-C29
DVB-WM-PW-C30
DVB-YDA-PW-C31
DVB-YDA-PL-C33
FROM CPP-750 ON-LINE MONITOR RE-YDA-750-1
LIGHT OUTSIDE DOOR TO CPP-750
TIMER BOX 300 SEC. DURATION
RELAY ON PUMP CONTROL IN CPP-750
ON CPP 604 PANEL
SERVICE WASTE
FROM CPP 801 DEEP TANKS
FROM C-116/115, VES-E-102, & FAST
FROM Y CELL
RCRA CLOSURE
RCRA EXEMPT
RCRA CONTROLLED
31 SEE DAR 40393
30 SEE DAR 17270
NO. REVISIONS
Westinghouse Idaho Nuclear Company Inc.
IDAHO CHEMICAL PROCESSING PLANT
IDAHO FALLS, IDAHO
FOR
U.S. DEPARTMENT OF ENERGY
IDAHO FIELD OFFICE
IDAHO FALLS, IDAHO
CPP-AREA
TANK FARM
CPP PRIMARY WASTE COLLECTION AND STORAGE FACILITIES
FLOWSHEET SHT. 2 OF 6
SCALE NONE
DATE ISSUED
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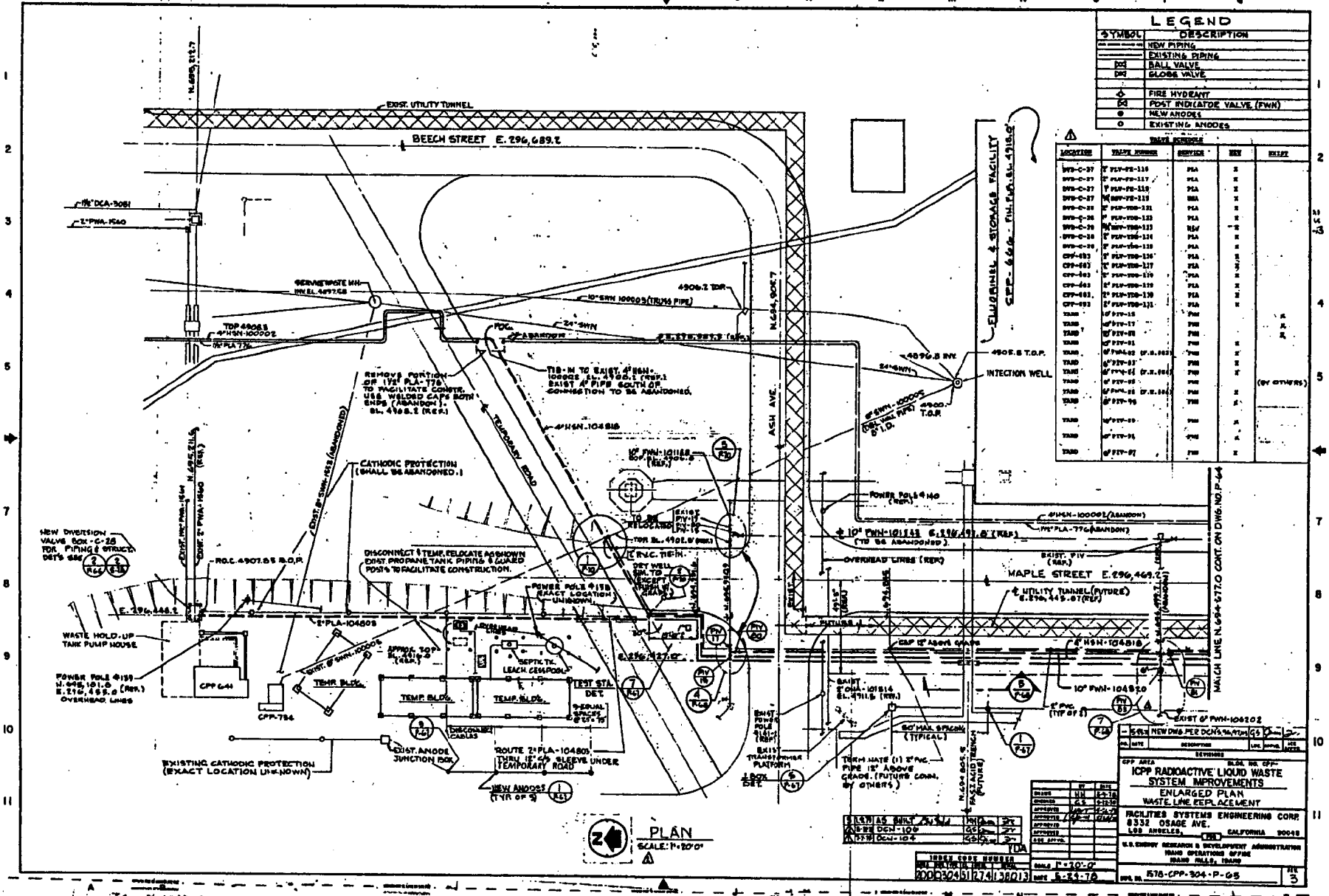
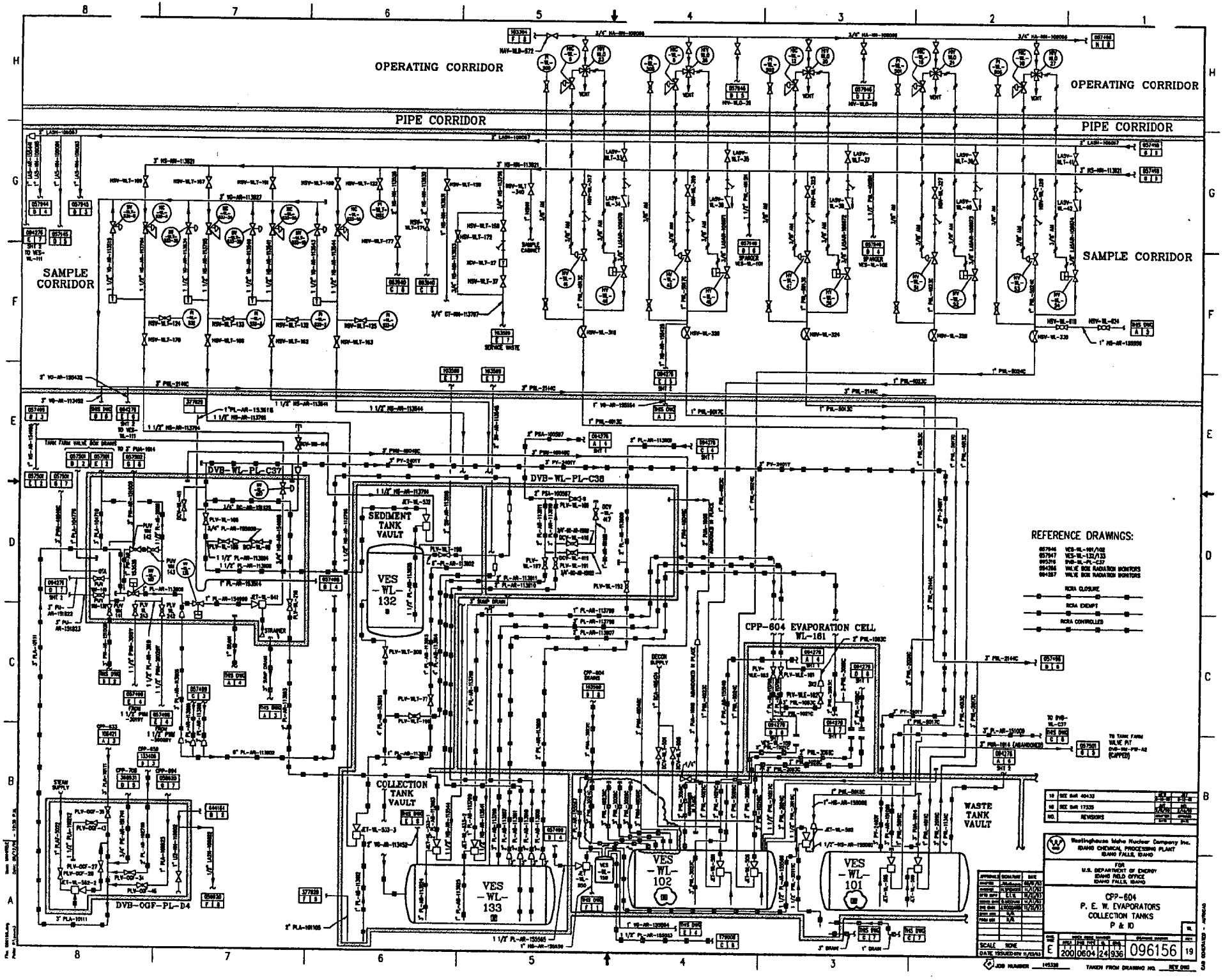
JOB NUMBER 106032
TAKEN FROM DRAWING NO. 057499 REV 10


LEGEND
SYMBOL
DESCRIPTION
NEW PIPING
EXISTING PIPING
BALL VALVE
GLOBE VALVE
FIRE HYDRANT
POST INDICATOR VALVE (FWN)
NEW ANODES
EXISTING ANODES
EXIST. UTILITY TUNNEL
BEECH STREET E. 296,689.2
MAPLE STREET E. 296,469.2
ASH AVE.
INTECTION WELL
FLUORINEL & STORAGE FACILITY
CPP-666 - FIN. FLR. EL. 4918.0'
CATHODIC PROTECTION (SHALL BE ABANDONED.)
TEMPORARY ROAD
WASTE HOLD-UP TANK PUMP HOUSE
POWER POLE #139
OVERHEAD LINES
CPP 641
CPP-734
TEMP. BLDG.
SEPTIC TK. LEACH CESSPOOL
TEST STA. DET.
EXISTING CATHODIC PROTECTION (EXACT LOCATION UNKNOWN)
DIST. ANODE JUNCTION BOX
ROUTE 2"PLA-104803 THRU 12" C/S SLEEVE UNDER TEMPORARY ROAD
NEW ANODES (TYP. OF 5)
NEW DIVERSION VALVE BOX-C-28 FOR PIPING & STRUCT. DET'S SEE
DISCONNECT & TEMP. RELOCATE AS SHOWN
EXIST. PROPANE TANK PIPING & GUARD POSTS TO FACILITATE CONSTRUCTION.
POWER POLE #138 EXACT LOCATION UNKNOWN.
OVERHEAD LINES (REF.)
UTILITY TUNNEL (FUTURE)
MATCH LINE N.694-677.0 CONT. ON DWG. NO. P-64
PLAN
SCALE: 1"=20'0"
ICPP RADIOACTIVE LIQUID WASTE SYSTEM IMPROVEMENTS
ENLARGED PLAN
WASTE LINE REPLACEMENT
FACILITIES SYSTEMS ENGINEERING CORP.
8332 OSAGE AVE.
LOS ANGELES, CALIFORNIA 90045
U.S. ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION
IDAHO OPERATIONS OFFICE
IDAHO FALLS, IDAHO
SCALE 1"=20'-0"
DATE 5-24-78
1578-CPP-304-P-65
3
138013


OPERATING CORRIDOR
PIPE CORRIDOR
SAMPLE CORRIDOR
DVB-WL-PL-C37
DVB-WL-PL-C36
SEDIMENT TANK VAULT
VES -WL- 132
CPP-604 EVAPORATION CELL WL-161
COLLECTION TANK VAULT
VES -WL- 133
VES -WL- 102
VES -WL- 101
WASTE TANK VAULT
DVB-OGF-PL-D4
REFERENCE DRAWINGS:
RCRA CLOSURE
RCRA EXEMPT
RCRA CONTROLLED
Westinghouse Idaho Nuclear Company Inc.
IDAHO CHEMICAL PROCESSING PLANT
IDAHO FALLS, IDAHO
FOR
U.S. DEPARTMENT OF ENERGY
IDAHO FIELD OFFICE
IDAHO FALLS, IDAHO
CPP-604
P. E. W. EVAPORATORS
COLLECTION TANKS
P & ID
SCALE NONE
E
200 0604 24 936
096156
19

EDF-015722-032

ENGINEERING DESIGN FILE

1. Project File No. _____ 2. Project/Task INTEC Tank Farm Closure Project

3. Subtask Civil Systems – TFF Membrane Ground Cover

4. Title: Procedure for Repairing the Tank Farm Below-Grade Membrane

5. Summary: This summary briefly defines the problem or activity to be addressed in the EDF, gives a summary of the activities performed in addressing the problem and states the conclusions, recommendations, or results arrived at from this task.

In 1977-78 a Dupont Polyalfin membrane was installed over essentially the entire INTEC tank farm. The membrane is approximately 4 in. below the surface and slopes from the center of the tank farm to the perimeter. Excavation work has the potential to penetrate the membrane. Through experience, operations personnel have found that the best way to repair a hole in the membrane is to apply a plastic sheet over the hole and glue it to the membrane with hot glue. Although there are no plans to penetrate the membrane as part of the Tank Farm Closure Project, if a penetration does occur, the same procedure now used by operations personnel would be used to repair the damaged area.

6. Distribution (complete package):

Distribution (summary package only):

7. Review (R) and Approval (A) Signatures: (Minimum reviews and approvals are listed. Additional reviews/approvals may be added as necessary.)

	R/A	Printed Name	Signature	Date
Author	R	Brent G. Harris	B.G. Harris	8/25/99
Independent Verification	R	Tracy Langenwalter	T. Langenwalter	10/2/00
Requestor	A	Ed Anderson	[signature]	10/2/00

Procedure for Repairing the Tank Farm Below-Grade Membrane
8/25/99

Summary

This Engineering Design File (EDF) provides information on a procedure which can be used to repair the below-grade membrane in the event it is damaged during the Tank Farm Closure Project.

Background

The TFF consists of nine 300,000 gallon tanks and two 318,000 gallon tanks. Each of the eleven tanks is located in an underground concrete vault. The Tank Farm Closure Project includes the following general activities for each of the eleven tanks:

- Pumping out as much of the existing liquid from the tanks using the existing steam jets.
- Using the Light Duty Utility Arm (LDUA), take samples of the remaining liquid/residue to determine the radiation levels present.
- Removing one of the existing steam jets, and extending the other steam jet such that more of the liquid can be removed.
- Inserting the washing system assembly; and washing down the tank. Removing the liquid with the remaining steam jet.
- Using the LDUA, take RCRA samples. Analyze the samples for Ph and radiation levels. If desired levels are not met, additional washing and sampling will be required until they are achieved.
- The tank will then be completely filled with grout using a procedure that will allow removal of additional free liquid in the process.
- The cooling piping and exhaust piping will also be filled grout.
- The annulus between the tank wall and the enclosure vault will then be filled with grout.

In 1977-78, a Dupont Polyalfin membrane was installed over the INTEC Tank Farm Facility. The membrane is approximately 4 in. below the ground surface and slopes from the center of the tank farm toward the perimeter. The purpose of the membrane was to prevent infiltration of moisture into the soil. According to Frank Ward (Reference 2), moisture does get below the membrane but the membrane has helped prevent weed growth in the area. Another benefit of the membrane is that it prevents soil contamination below the membrane from coming to the surface.

Over the years, the membrane has been damaged and operations personnel have experimented with ways to repair it. Frank Ward said they now apply a plastic sheet patch using a hot glue gun with standard glue. This method seems to be satisfactory.

Tank Farm Closure Impacts on the Membrane

Currently, none of the work planned for the Tank Farm closure project would involve penetrating the membrane. However, the potential exists for damaging the membrane inadvertently or in an unforeseen required operation. Consequently, materials for patching the membrane should be available during the project.

Conclusions

The procedure now used by operations personnel for patching the membrane are adequate and will be used, if required during the Tank Farm Closure Project. Although the project does not have any foreseen need to penetrate the membrane, material for patching should be available during the project in case membrane damage does occur.

References

1. Conversation between Clint Kingsford and Frank Ward, referenced in Clint Kingsford memo to project file dated 3/31/99. (Attached)

2. Drawings (Attached): 137918 137919 137920

Tank Farm Deactivation
March 31, 1999
Memo to File
Written by Clint Kingsford

Deionized Water

I met in person with Frank Ward on March 31, 1999 to get a better view of the utilities required for the Tank Farm deactivation.

He said that deionized water was available through 628, however, we may need a holding tank depending on how much volume we needed. He said the supply comes from Building 606 and Dave Suhre is the custodian of the utility boiler house in 606.

Frank said that the PEW is in Building 604. He emphasized that the basin water from 603 is available, but the decision has been made to use basin water only for general cleaning and not specific cleaning of the tanks. We still need to get information from Thornton Waite and others on the use of the basin water and the timing of the use of the basin water.

After returning back to Idaho Falls, I discussed the deionized water with several people Ed Anderson, Syl Losinski, Rod Kimmitt, and Darrel Hall. Darrel is the utility person who is over the plant air and deionized water.

In talking to Syl Losinski he questioned the use of deionized water for the washing of the tanks. He said that the current demand for deionized water is approximately 6 gallons per minute. He said that our water should be clean enough to wash the tanks. They are in the process of formulating a project to replace a 200-gallon per minute RO unit with at least one 400 gallon per minute RO unit, or at least maintain the 200 gallon per minute RO unit and adding a 400 gallon per minute RO unit. He said there are basically five types of water being used at INTEC. 1) There is raw water, that is brought directly from the wells, which is used for raw water purposes that is not treated for general purposes and firewater. 2) Potable water that is pulled from another well, and receives some chlorination for treatment to be used in sanitary situations. 3) There is treated or softened water, 4) there is water which is run through the reversed osmosises system, which replaces and removes the bulk of the mineral constituents. 5) Demin or deionized water is used for specialized situations where corrosion could be a problem. The conductivity and minerals are removed to a greater extent than in the aero water.

Rod Kimmitt is the process engineer who is working on the process of cleaning the tanks. He stated that RO water would be plenty adequate for their needs. The reason for using RO water is to avoid hardened water characteristics from accumulating on the sides of the tanks. Rod said that he would need approximately 50 gallons per minute for each rinse of the tank. He figured that he would probably need 8 to 10 rinses. This would amount to a maximum of 15,000 gallons during a week to two-week period of time.

As Rod stated the demand would not be consistent, only for each rinse would take one-half hour to an hour to accomplish. He did say that RO water was adequate. They are trying to increase the PH to 2.5 to 3, to reduce the radio nuclides and yet at the same time not have it so high that it would precipitate anymore solids. Wash water would be put in tank 187 or 183.

Mr. Ward stated that the NWCF High Level Waste Evaporator would evaporate about 200 gallons per hour. The PEWE will evaporate approximately 500 gallons per hour. There is also the possibility of using the LET&D for evaporation of wastewater.

Plant Air

In talking to Frank Ward there is 100-psi air in the utility tunnel immediately west of the tank farm. In talking to Darrel Hall he said that we could tap into that and supply the tank farm with portable hoses. Mr. Ward stated that there is an exterior manifold in building 628 that we could probably pipe into and then distribute the air from there also. Mr. Hall said that there would be no problem in supplying the air required 100-psi air. There is presently a 2-inch line coming from 606.

Steam

In talking to Mike Berry at our meeting on Monday, March 29, the steam is used to go through a venturi and is used to suck up the wash water. It has been called a pump, but it is not really a pump, it is used to create a negative pressure and pull vacuum the waste water into a discharge line which will be discharged to Tank 187 for storage and for later disposal. There is adequate steam available to accomplish this purpose.

Sanitary Sewer

In talking to Mr. Ward he stated that restroom facilities have been made available to construction personnel in TR-35 the construction management area. Building 699 where Mr. Ward's office is, Building 664, and Building 1678 the Construction Prefab Shop, which is to the Southwest of the tank farm 4 or 5 hundred feet. They are listed as Buildings 641, 734,796 temporary trailers T-1 through T-5 adjacent to Birch Street and Ash Avenue.

Mr. Ward said that there is also some construction trailers east of Building 699 and South of 1678 enclosure, which could be used by a contractor for personnel.

He did say that a temporary decon area may be required. He suggested that I talk to Lex Strain and Kirk Winterholler on what they have done on past projects.

Access

Frank stated that personnel access to the tank farm is through Building 1672, which is located on the Northeast corner of the tank farm fence. It is a small building where they

pass through and there are monitors that personnel go through. He stated that unless there is a need for excavation that anti Cs would not normally be required, only when they are working with decontaminated soil. There is a small bully barn just to the West of building 1672 where anti Cs are stored. Frank said that if anti Cs are used that they would cloth in Building 1672 and then go into the work area when they are done, then the anti Cs would be removed in the work area and specified people would package them and dispose of them. Basically Anti Cs are not salvaged.

Frank said that I should contact Lex Strain and Kirk Winterholler on procedures and what they have done on past projects in the tank farm area.

There are several gates around the tank farm perimeter fence, which can be used to drive access equipment into the tankfarm. However, the tankfarm loading requirements must be complied with as specified in the report "Tank Loading Or The Loading Requirements In Zones A, B, And C In The Tank Farm". However, there is a Mr. Nate that is doing a new load rating analysis and there is hope that his analysis will show that we can put in larger loads than is presently allowed by the current study. Basically most of the staging will be done outside the fence.

The tank farm area while it has certain ECAs inside is basically classified as an ECA-96.

Mr. Dennis Ronig manages CERCLA affairs in the excavation which is incompliance with CERCLA regulations must be put back in the hole. If it is RCRA situation, the soil must be boxed and disposed of in another location.

Frank Ward pointed out an area where there was a major spill next to tank 183 and 185. He basically drew a little contour showing where it had been classified as 1R and radionuclide contamination in the center the plume will go up to 10R. Valve boxes A5 and A6 are highly contaminated.

GEOTEC Membrane

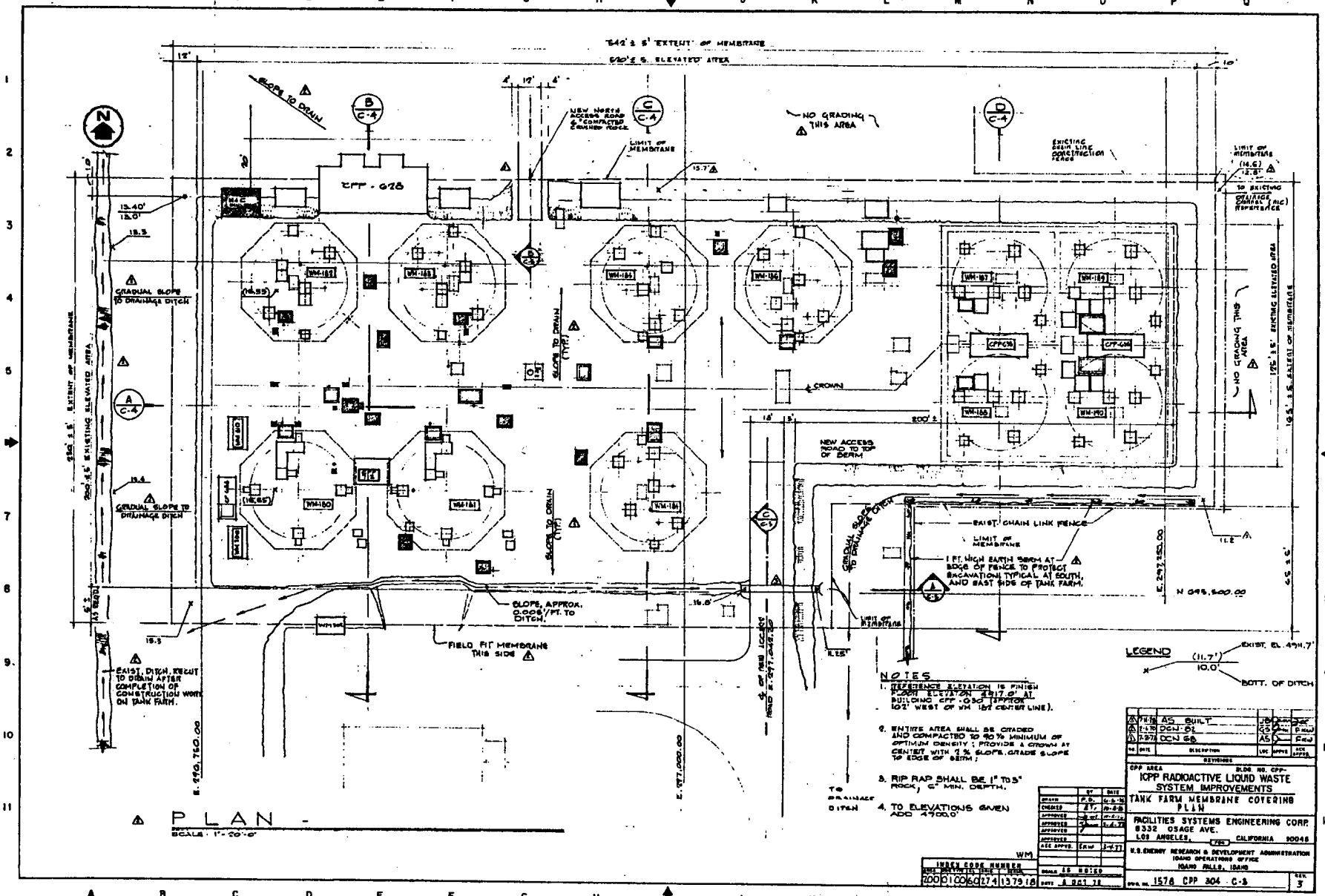
Frank Ward drew a rough sketch of the outline of the membrane as it exists on the tankfarm. Basically it covers the area for Tanks 182, 183, 181, 180, 185, 184, 186, 187, 189, 190, and 188. A rough sketch was drawn on C-1 for project 020906 drawn by Gene Mace. Frank says that the membrane is acted as a two-edged sword while the original intent was to cover the ground to prevent moisture intrusion, it has acted as a conduit for moisture going into the ground. Once the moisture gets in the ground it can't get out because there is no opportunity for evaporation. He basically says that moisture, snow or rain that gets on the tank farm will seep through the membrane because it is not totally water tight. He said that one time, they conducted a dye test between Building 699 and the fence adjacent to tanks 189 and 190 and the dye had seeped under the membrane into the tank area. He did say the membrane has prevented weed growth and has been positive in that regard. For penetrations the membrane is fastened to vaults with redwood 2 x 4s or for circular penetrations is has been fastened with pipe clamps.

Planning is still in the mill as far as total enclosing the tankfarm area when the tanks have been deactivated but he said that there has been thoughts of pouring a concrete cap or using a new membrane over the whole area covered with soil. However, this has not been resolved as yet.

Stainless Steel

Frank Ward said that the stainless steels that have been used in the tankfarm area are 304-L, 347, 316, 316-L; he said that 316-L costs as much as you are willing to pay for a desired feature.

Mr. Ward stated that they could calcine 32 – 64 gallons per hour of waste.



542' ± 5' EXTENT OF MEMBRANE
520' ± 5' ELEVATED AREA
SLOPE TO DRAIN
NEW NORTH ACCESS ROAD 6" COMPACTED CRUSHED ROCK
LIMIT OF MEMBRANE
NO GRADING THIS AREA
EXISTING CHAIN LINK CONSTRUCTION FENCE
CPP - 628
GRADUAL SLOPE TO DRAINAGE DITCH
SLOPE TO DRAIN (TYP.)
CROWN
NEW ACCESS ROAD TO TOP OF BERM
EXIST. CHAIN LINK FENCE
1 FT. HIGH EARTH BERM AT EDGE OF FENCE TO PROTECT EXCAVATION, TYPICAL AT SOUTH, AND EAST SIDE OF TANK FARM.
SLOPE, APPROX. 0.005'/FT. TO DITCH.
FIELD FIT MEMBRANE THIS SIDE
EXIST. DITCH, RECUT TO DRAIN AFTER COMPLETION OF CONSTRUCTION WORK ON TANK FARM.
N 695,500.00
E 297,250.00
E 296,750.00
E 297,000.00
LEGEND
EXIST. EL. 4911.7'
BOTT. OF DITCH
NOTES
1. REFERENCE ELEVATION IS FINISH FLOOR ELEVATION 4917.0' AT BUILDING CPP-630 (APPROX 102' WEST OF WM 182 CENTER LINE).
2. ENTIRE AREA SHALL BE GRADED AND COMPACTED TO 90% MINIMUM OF OPTIMUM DENSITY; PROVIDE A CROWN AT CENTER WITH 2% SLOPE. GRADE SLOPE TO EDGE OF BERM;
3. RIP RAP SHALL BE 1" TO 3" ROCK, 6" MIN. DEPTH.
4. TO ELEVATIONS GIVEN ADD 4900.0'
TO DRAINAGE DITCH
PLAN
SCALE: 1"=20'-0"
AS BUILT
DCN-82
DCN 68
REVISIONS
CPP AREA
BLDG. NO. CPP-
ICPP RADIOACTIVE LIQUID WASTE SYSTEM IMPROVEMENTS
TANK FARM MEMBRANE COVERING PLAN
FACILITIES SYSTEMS ENGINEERING CORP.
8332 OSAGE AVE.
LOS ANGELES, CALIFORNIA 90045
U.S. ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION
IDAHO OPERATIONS OFFICE
IDAHO FALLS, IDAHO
DWG. NO. 1578 CPP 304 C-3
REV. 3
INDEX CODE NUMBER
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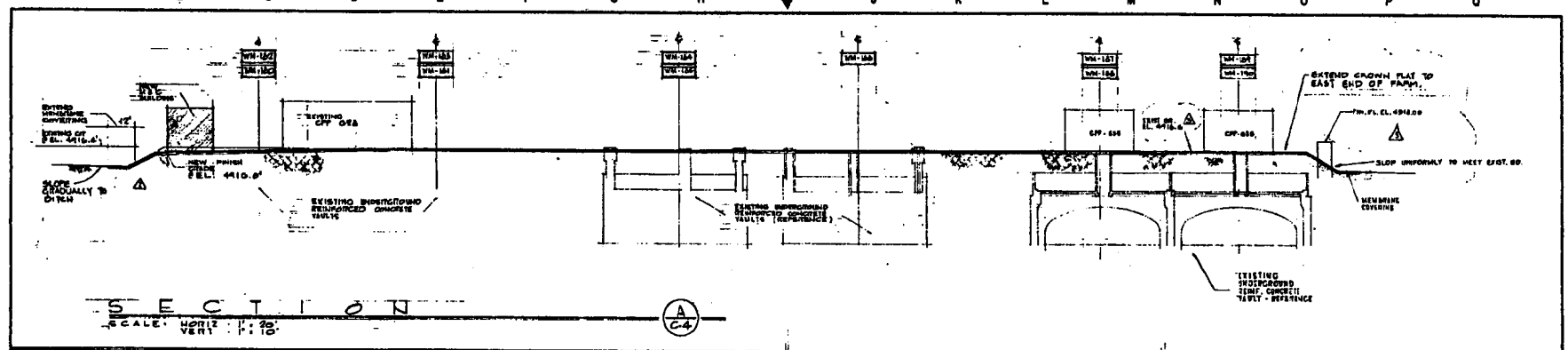
137918



SECTION A/C-4
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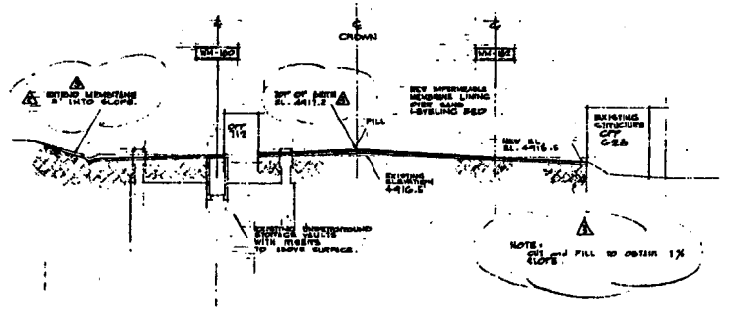
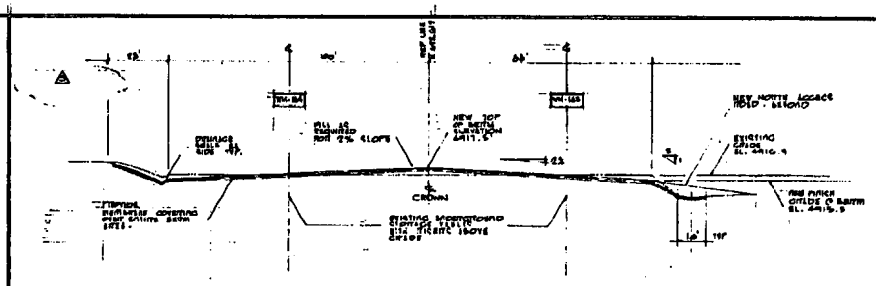
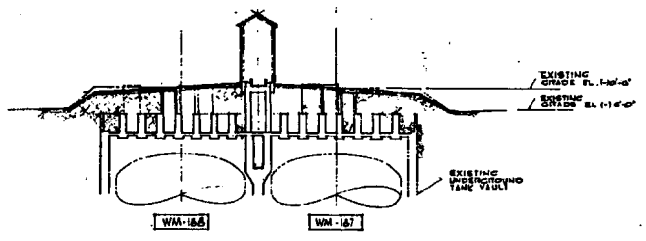
VERT: 1" = 10'



SECTION B/C-4
SCALE: HORIZ: 1" = 20'
VERT: 1" = 10'



SECTION C/C-4
SCALE: HORIZ: 1" = 20'
VERT: 1" = 10'



SECTION D/C-4
SCALE: HORIZ: 1" = 20'
VERT: 1" = 10'

NOTES:

1. AFTER EXCAVATION, MEMBRANE SHALL BE PLACED ON 3" SAND BED.
2. MEMBRANE LINER SHALL BE ELASTICIZED POLYOLEFIN SHEETING OR APPROVED EQUAL. SEE SPECS. C1.
3. LINER SHALL BE BONDED TOGETHER AT ALL JOINTS. JOINTS SHALL BE PLACED AT ALL PENETRATIONS AND CONNECTIONS.
4. TWO (2") INCHES OF SAND SHALL BE PLACED OVER THE LINER FOR PROTECTION PRIOR TO BACKFILL.
5. ALL DITCHES SHALL BE V-DITCHES, 4'-0" APPROX. WIDTH & 6" APPROX. MIN. DEPTH. SLOPE TO EXISTING LARGE DRAINAGE CHANNEL, AS SHOWN ON DRAWING C-3 AND DRAWING U-C.

NO.	DATE	DESCRIPTION	LOC	APPR	REV APPR
A	7-4-78	AS BUILT	JB		
A	2-6-78	DCN-82	GS		
A	3-5-77	DCN 68	AS		

REVISIONS

CPP AREA — BLDG. NO. CPP-

ICPP RADIOACTIVE LIQUID WASTE SYSTEM IMPROVEMENTS

TANK FARM MEMBRANE COVERING SECTIONS

FACILITIES SYSTEMS ENGINEERING CORP.
8332 OSAGE AVE.
LOS ANGELES, CALIFORNIA 90045

U.S. ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION
IDAHO OPERATIONS OFFICE
IDAHO FALLS, IDAHO

	BY	DATE
DRAWN	F.S.	6-6-76
CHECKED		
APPROVED		
APPROVED		
APPROVED		
APPROVED		
ACT APPR.	FEW	3-9-77

SCALE: AS NOTED
DATE: 6 OCT 76

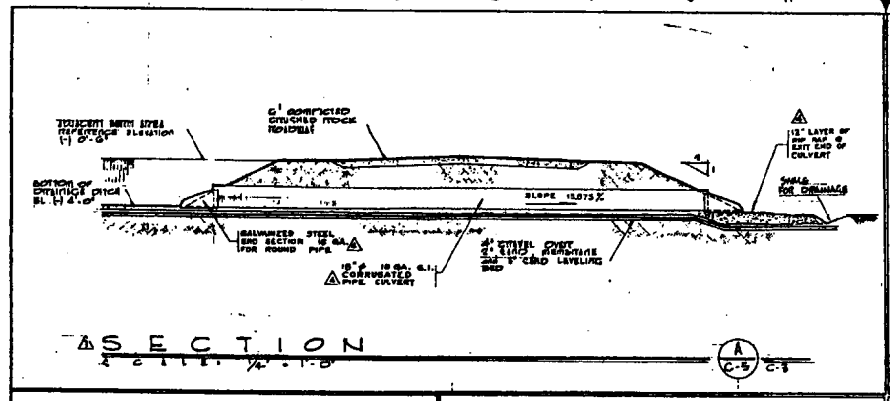
WM

INDEX CODE NUMBER

LOCK	DWG TYPE	CL	DATE	SERIAL
200	0100	60	274	137919

DWG. NO. 1676 CPP 304 C-4 — REV. 3

137919



SECTION

SCALE: 1/2" = 1'-0"

A / C-5 — C-5

DELETED

DETAIL

SCALE: 1 1/2" = 1'-0"

1 / C-5

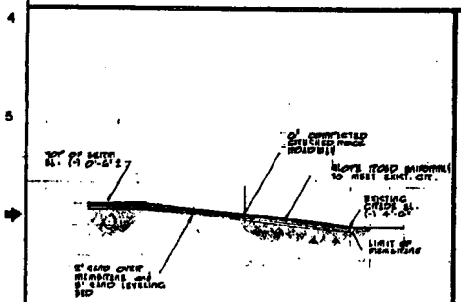
DELETED

TYPICAL PIPE PENETRATION

DETAIL

SCALE: 1 1/2" = 1'-0"

2 / C-5



SECTION

SCALE: 1" = 1'-0"

B / C-5 — C-5

DELETED

FLASHING-CONCRETE BUILDINGS
TYPICAL - ALL CONCRETE SURFACES OR WALLS

DETAIL

SCALE: 1 1/2" = 1'-0"

3 / C-5

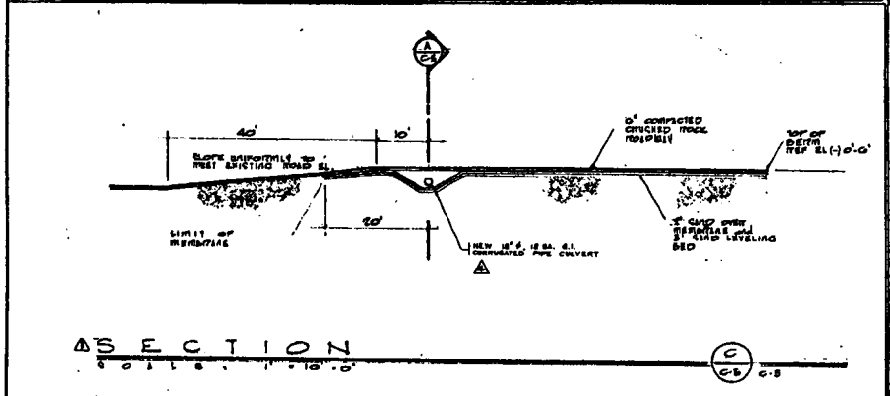
DELETED

SPLIT BOOT
TYPICAL - ALL PIPE PENETRATIONS

DETAIL

SCALE: 1 1/2" = 1'-0"

4 / C-5



SECTION

SCALE: 1" = 10'-0"

C / C-5 — C-5

DELETED

5-1-78	AS BUILT	CH		
1-6-78	DCN-82	GS		
7-25-77	DCN 68	AS		
6-1-77	PER DCN 56 (Rev)			
NO.	DATE	DESCRIPTION	LOC	APPR.	SCE APPR.

REVISIONS

CPP AREA — BLDG. NO. CPP-

ICPP RADIOACTIVE LIQUID WASTE SYSTEM IMPROVEMENTS

TANK FARM MEMBRANE COVERING DETAILS

FACILITIES SYSTEMS ENGINEERING CORP
8332 OSAGE AVE.
LOS ANGELES, CALIFORNIA 90045

U.S. ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION
IDAHO OPERATIONS OFFICE
IDAHO FALLS, IDAHO

	BY	DATE
DRAWN	P.B.	6-6-75
CHECKED	G.T.	6-10-75
APPROVED		6-10-75
APPROVED		7-8-75
APPROVED		
SCE APPR.		7-11

SCALE AS NOTED

DATE 6 OCT 76

WM

INDEX CODE NUMBER

SITE	PROJECT	FUNCTION	CLASS	SERIAL
2000	100	60	174	137920

1578 CPP 304 C-5

REV. 4

137920

REMOVE DRAWING NUMBER

REMOVE DRAWING NUMBER

REMOVE DRAWING NUMBER

REMOVE DRAWING NUMBER

EDF-015722-033

ENGINEERING DESIGN FILE

1. Project File No. _____ 2. Project/Task INTEC Tank Farm Closure Project

3. Subtask Civil Systems – Construction Sequence

4. Title: Conceptual Construction Sequence for Tank Farm Closure Project

5. Summary: This summary briefly defines the problem or activity to be addressed in the EDF, gives a summary of the activities performed in addressing the problem and states the conclusions, recommendations, or results arrived at from this task.

This ETA provides a sequential listing of the main construction activities required to complete closure of Tanks WM-182 and WM-183 located in the INTEC Tank Farm Facility.

6. Distribution (complete package):

Distribution (summary package only):

7. Review (R) and Approval (A) Signatures: (Minimum reviews and approvals are listed. Additional reviews/approvals may be added as necessary.)

Function	R/A	Printed Name	Signature	Date
Author	R	Brent G. Harris	B.G. Harris	8/25/99
Independent Verification	R	Tracy Langenwalter	[illegible]	10/2/00
Requestor	A	Ed Anderson	[illegible]	10/2/00

CONSTRUCTION SEQUENCE FOR TANK FARM CLOSURE PROJECT
8/25/99

Summary

This Engineering Design File (EDF) provides a listing of the major construction-phase tasks required to complete closure of Tanks WM-182 and WM183 at the INTEC Tank Farm.

Background

The INTEC Tank Farm Facility (TFF) is the primary location used to store High Level Liquid Waste (HLLW) and Sodium Bearing Waste (SBW) which has been generated from processing of spent nuclear fuel at INTEC. The TFF consists of nine 300,000 gallon tanks and two 318,000 gallon tanks. Each of the eleven tanks is located in an underground concrete vault. The Tank Farm Closure Project includes the following general activities for each of the eleven tanks:

- Rinsing the tanks (partial fill and drain) using existing TFF systems.
- Pumping out as much of the existing liquid from the tanks using the existing steam jets.
- Using the Light Duty Utility Arm (LDUA), take samples of the remaining liquid/residue to determine the radiation levels present.
- Removing one of the existing steam jets, and extending the other steam jet such that more of the liquid can be removed.
- Inserting the washing system assembly; and washing down the tank. Removing the liquid with the remaining steam jet.
- Using the LDUA, take RCRA samples. If desired tank closure levels are not met, additional washing and sampling will be required until they are achieved.
- The tank will then be completely filled with grout using a procedure that will allow removal of additional free liquid in the process.
- The piping penetrating the tank wall will also be filled grout.
- The annulus between the tank wall and the enclosure vault will then be filled with grout.

It is assumed that the work will take place when freezing of water lines is not a problem. Consequently, design measures to prevent freezing of the lines will not be necessary.

Construction Sequence

Following is an outline which lists the main construction activities associated with completing closure of Tanks WM-182 and WM-183.

I. Site Preparation
   A. Access to Site
      1. Install additional gates in the existing tank farm fence for vehicle access
      2. Install personnel access controls as required
   B. Setup Change Trailer
   C. Setup Control Trailer
   D. Erect Storage Bunkers for Contaminated Items
   E. Install berm over electrical duct where heavy vehicles will be crossing

II. Temporary Utility Installation

A. Demineralized water

1. Make connection to line in CPP-628 and provide header on outside of building
2. Install 3000 gallon storage tank on north side of Building 628 and install line from tank to header on CPP-628
3. Install flexible line with sufficient length to run from tank to required locations on tank farm
4. Install pump to pump water from tank to required locations

B. Raw water

1. Make connection to line in CPP-628 and provide header on outside of building
2. Install flexible line with length adequate to run from tank to required locations on tank farm

C. Plant Air

1. Make connection to line on south side of CPP-628 and provide quick disconnect fitting for hose attachment
2. Install flexible line with length to run from tank to required locations on tank farm
3. Provide portable compressor to provide 100 psi air for tools, etc.

III. Closure of Tank WM-182

A. Tank Isolation

1. Isolate process waste lines
2. Isolate vessel off-gas (VOG) system in the CPP-721 pit
3. Install temporary VOG system

B. Provide Access to Tank

1. Erect containments over TR-19, TR-20, TR-51 and TR-52
2. Install radiation shielding as required
3. Remove steam jet from TR-19
4. Modify steam jet in TR-20 such that it will remove more of the tank heel
5. Remove and bag level indicator from TR-52
6. Remove and bag corrosion coupon from TR-51
7. Install video and tank washing equipment in riser TR-19

C. Wash Interior of Tank

1. Wash tank interior
2. Sample and analyze heel
3. Rewash and sample until analysis results are acceptable
4. Remove as much of the heel as possible
5. Remove and decontaminate washing equipment from tank riser
6. Isolate and flush cooling coils
7. Isolate instrumentation lines

D. Heel Management

1. Install grout delivery equipment in tank riser
2. Place grout in 12" layers and simultaneously remove heel using steam jet; allow 7-day curing between grout layers
3. Apply dry grout as required to absorb free liquid

4. Remove and decontaminate grout delivery equipment
5. Remove and decontaminate video and lighting equipment
6. Install blind flanges on tank risers
7. Disconnect the temporary VOG system
8. Install passive HEPA filters in CPP-721

E. Vault Isolation
1. Jet any vault liquid to PEW Evaporator using existing steam jets
2. Install temporary VOG system for vault
3. Fill vault/tank annulus with grout

F. Grout Cooling Coils, Instrumentation Lines, and VOG lines

G. Fill the Tank Voids with Clean Grout or LLW Grout or CERCLA Waste

IV. Closure of Tank WM-183

A. Tank Isolation
1. Isolate process waste lines
2. Isolate vessel off-gas (VOG) system in the CPP-722 pit
3. Install temporary VOG system

B. Provide Access to Tank
1. Erect containments over TR-13, TR-21, TR-53 and TR-54
2. Install radiation shielding as required
3. Remove steam jet from TR-13
4. Modify steam jet in TR-21 such that it will remove more of the tank heel
5. Remove and bag level indicator from TR-53
6. Remove and bag corrosion coupon from TR-54
7. Install video and tank washing equipment in riser TR-13

C. Wash Interior of Tank
1. Wash tank interior
2. Sample and analyze heel
3. Rewash and sample until analysis results are acceptable
4. Remove as much of the heel as possible
5. Remove and decontaminate washing equipment from tank riser
6. Isolate and flush cooling coils
7. Isolate instrumentation lines

D. Heel Management
1. Install grout delivery equipment in tank riser
2. Place grout in 12" layers and simultaneously remove heel using steam jet; allow 7-day curing between grout layers
3. Apply dry grout as required to absorb free liquid
4. Remove and decontaminate grout delivery equipment
5. Remove and decontaminate video and lighting equipment
6. Install blind flanges on tank risers
7. Disconnect the temporary VOG system
8. Install passive HEPA filters in CPP-722

E. Vault Isolation
   1. Jet any vault liquid to PEW Evaporator using existing steam jets
   2. Install temporary VOG system for vault
   3. Fill vault/tank annulus with grout

F. Grout Cooling Coils, Instrumentation Lines, and VOG lines

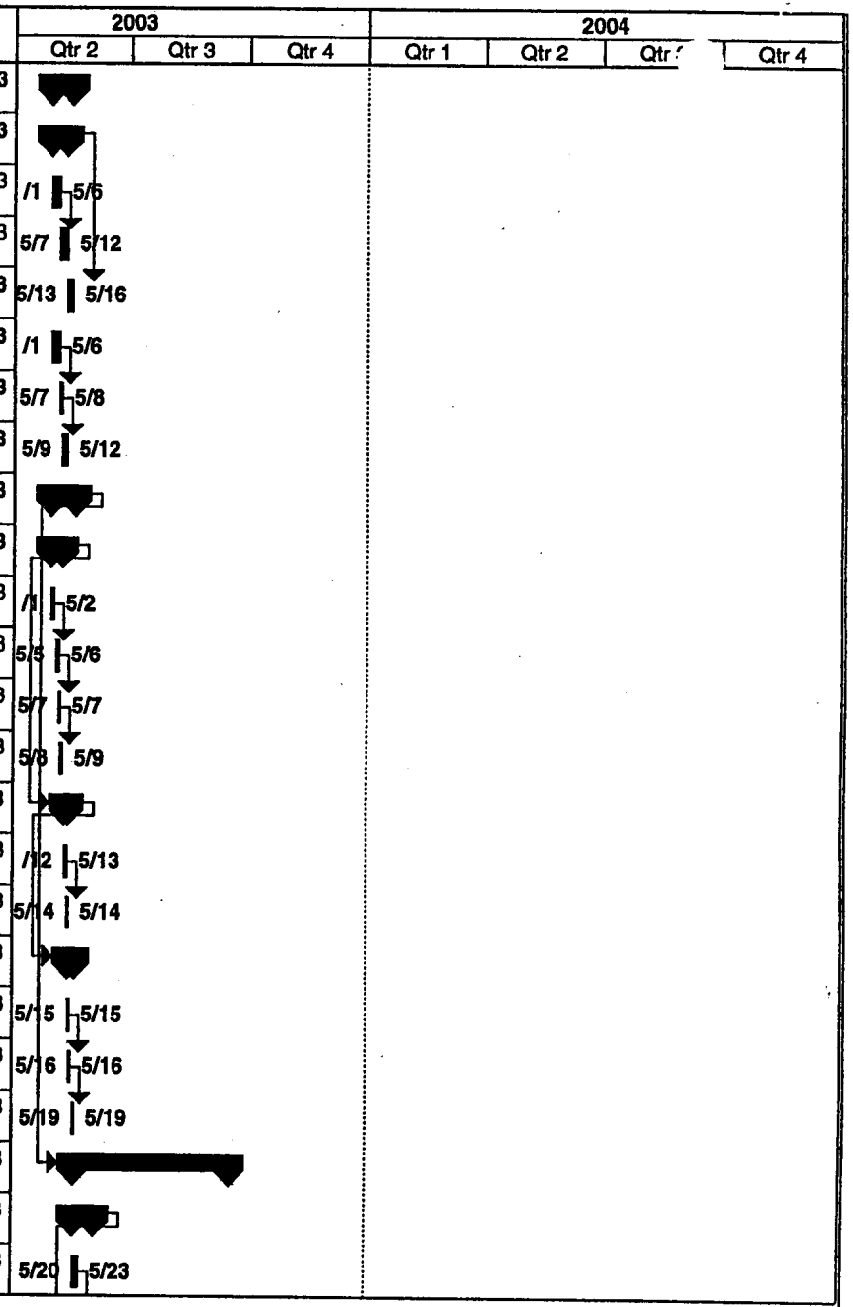
G. Fill the Tank Voids with Clean Grout or LLW Grout or CERCLA Waste

Attached is a Microsoft Project Gantt Chart with a schedule for the work. Task durations are estimated using a start dates of May 1, 2003 for site preparation, May 20, 2003 for closure of Tank WM-182, and June 1, 2004 for closure of Tank WM-183.

References

1. INTEC TFF Tanks WM-182 and WM-183 Closure Study, INEEL/EXT-98-, Spaulding, Chadwick, McAllister, and Tuott, September 1998.

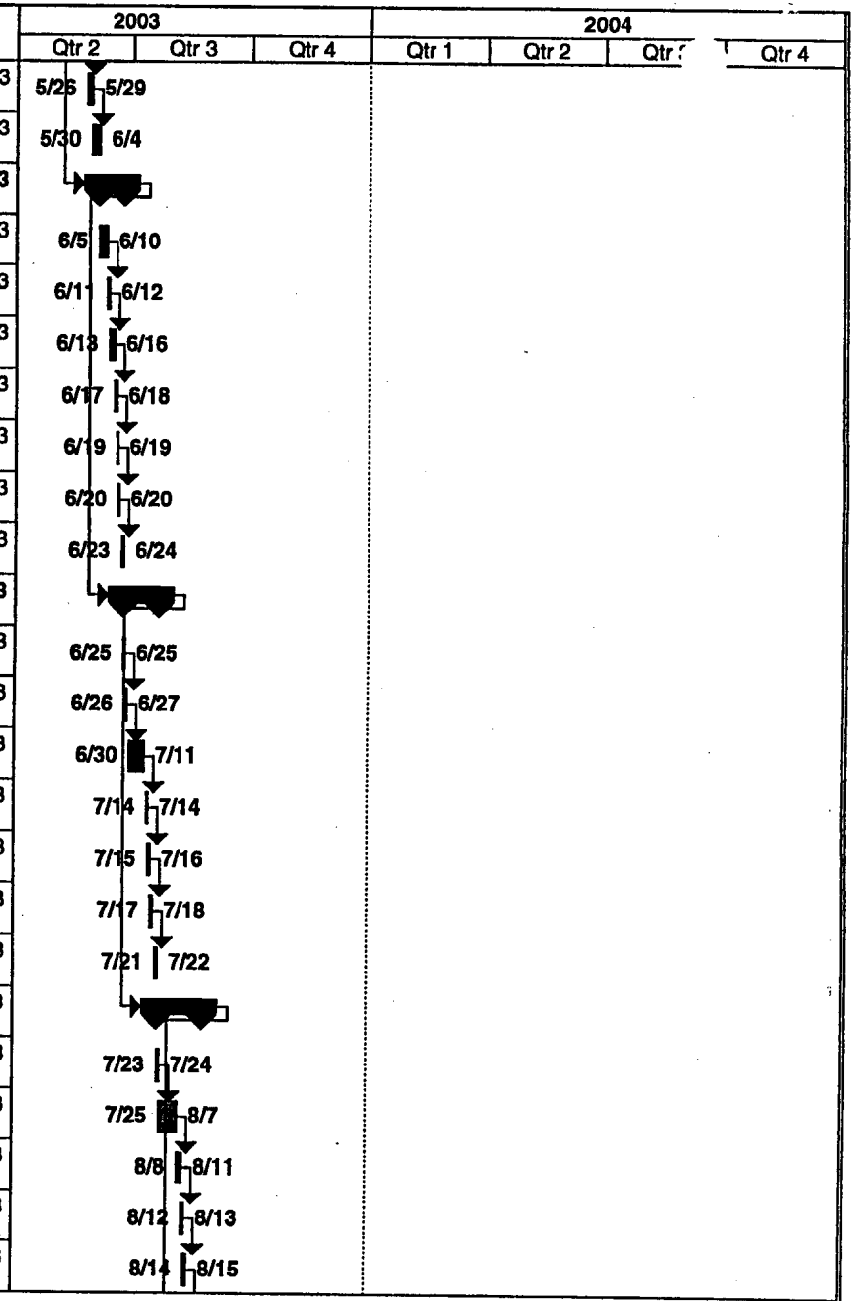
ID	Task Name	Duration	Start	Finish
1	Site Preparation	12d	5/1/03	5/16/03
2	Access to Site	8d	5/1/03	5/12/03
3	Install new gates in the tank farm fence for vehicle access	4d	5/1/03	5/6/03
4	Install personnel access controls as required	4d	5/7/03	5/12/03
5	Setup Change Trailer	4d	5/13/03	5/16/03
6	Setup Control Trailer	4d	5/1/03	5/6/03
7	Erect Storage Bunkers for Contaminated Items	2d	5/7/03	5/8/03
8	Install berm over electrical duct where required	2d	5/9/03	5/12/03
9	Temporary Utility Installation	13d	5/1/03	5/19/03
10	Demineralized water	7d	5/1/03	5/9/03
11	Make connection to line in CPP-628 and provide header	2d	5/1/03	5/2/03
12	Install 3000 gallon storage tank on n. side of Building 628	2d	5/5/03	5/6/03
13	Install flexible line from tank to required locations	1d	5/7/03	5/7/03
14	Install pump to pump water from tank	2d	5/8/03	5/9/03
15	Raw water	3d	5/12/03	5/14/03
16	Make connection to line in CPP-628 and provide header	2d	5/12/03	5/13/03
17	Install flexible line from tank to required locations	1d	5/14/03	5/14/03
18	Plant Air	3d	5/15/03	5/19/03
19	Make connection to line in CPP-628 and provide header	1d	5/15/03	5/15/03
20	Install flexible line from tank to required locations	1d	5/16/03	5/16/03
21	Provide portable compressor to provide 100 psi air	1d	5/19/03	5/19/03
22	Closure of Tank WM-182	87d	5/20/03	9/17/03
23	Tank Isolation	12d	5/20/03	6/4/03
24	Isolate process waste lines	4d	5/20/03	5/23/03



Project: INTEC Tank Farm Closure
Date: 9/17/99

Task
Progress
Milestone
Summary
Rolled Up Task
Rolled Up Milestone
Rolled Up Progress

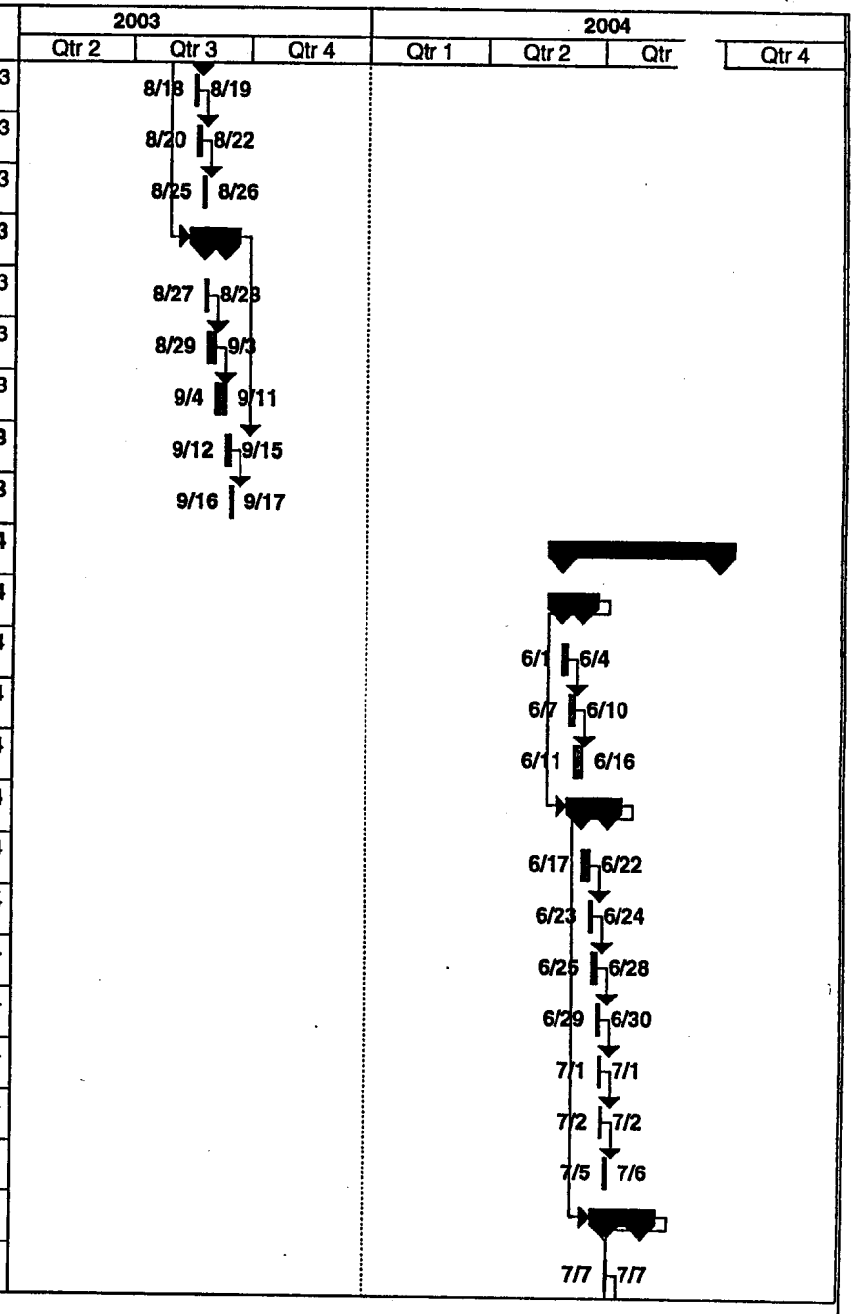
ID	Task Name	Duration	Start	Finish
25	Isolate vessel off-gas (VOG) system in the CPP-721 pit	4d	5/2[illegible]	5/29/03
26	Install temporary VOG system	4d	5/30/03	6/4/03
27	**Provide Access to Tank**	**14d**	**6/5/03**	**6/24/03**
28	Erect containments over TR-19, TR-20, TR-51 and TR-52	4d	6/5/03	6/10/03
29	Install radiation shielding as required	2d	6/11/03	6/12/03
30	Remove steam jet from TR-19	2d	6/13/03	6/16/03
31	Modify steam jet in TR-20 to remove more tank heel	2d	6/17/03	6/18/03
32	Remove and bag level indicator from TR-52	1d	6/19/03	6/19/03
33	Remove and bag corrosion coupon from TR-51	1d	6/20/03	6/20/03
34	Install video and tank washing equipment in riser TR-19	2d	6/23/03	6/24/03
35	**Wash Interior of Tank**	**20d**	**6/25/03**	**7/22/03**
36	Wash tank interior	1d	6/25/03	6/25/03
37	Sample and analyze heel	2d	6/26/03	6/27/03
38	Rewash and sample until analysis results are acceptable	10d	6/30/03	7/11/03
39	Remove as much of the heel as possible	1d	7/14/03	7/14/03
40	Remove and decontaminate washing equipment	2d	7/15/03	7/16/03
41	Isolate and flush cooling coils	2d	7/17/03	7/18/03
42	Isolate instrumentation lines	2d	7/21/03	7/22/03
43	**Heel Management**	**25d**	**7/23/03**	**8/26/03**
44	Install grout delivery equipment in tank riser	2d	7/23/03	7/24/03
45	Place grout in 12" layers and simultaneously remove heel	10d	7/25/03	8/7/03
46	Apply dry grout as required to absorb free liquid	2d	8/8/03	8/11/03
47	Remove and decontaminate grout delivery equipment	2d	8/12/03	8/13/03
48	Remove and decontaminate video and lighting equipment	2d	8/14/03	8/15/03



Project: INTEC Tank Farm Closure
Date: 9/17/99

Task | Progress | Milestone | Summary | Rolled Up Task | Rolled Up Milestone | Rolled Up Progress

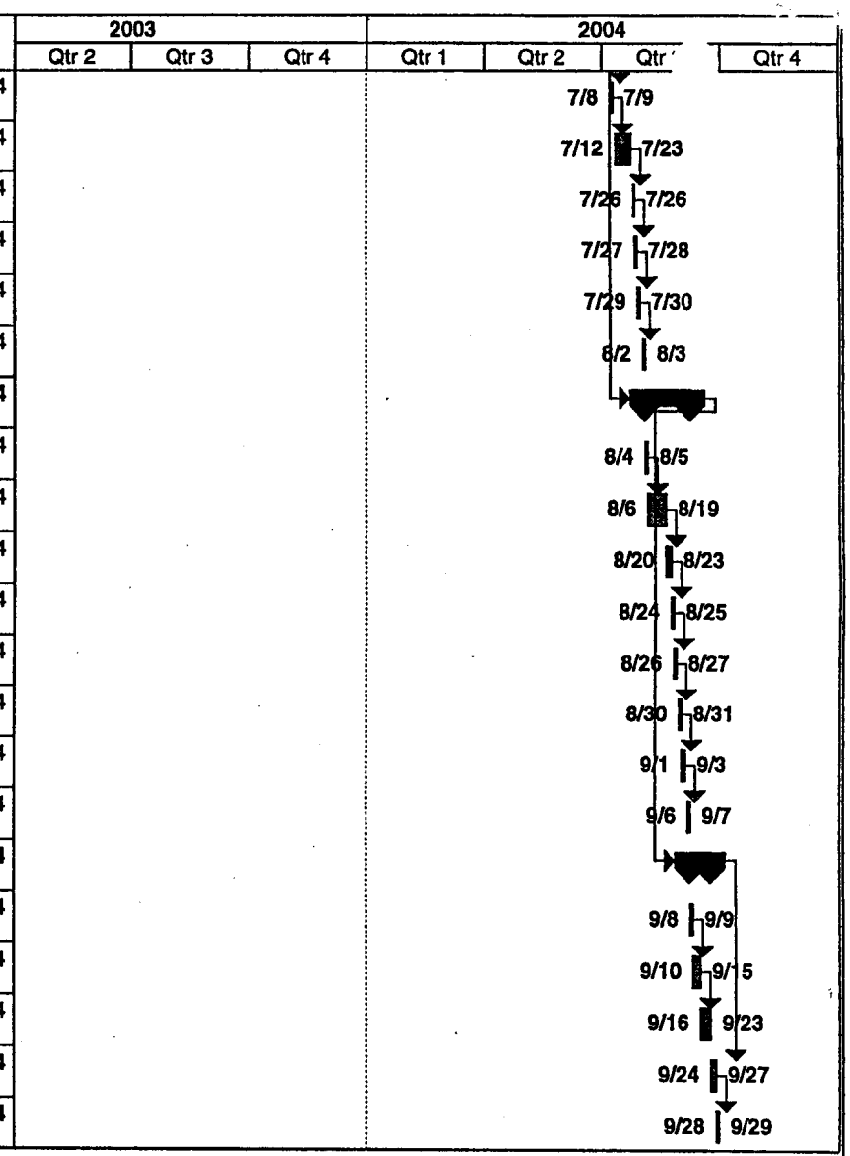
ID	Task Name	Duration	Start	Finish
49	Install blind flanges on tank risers	2d	8/18/03	8/19/03
50	Disconnect the temporary VOG system	3d	8/20/03	8/22/03
51	Install passive HEPA filters in CPP-721	2d	8/25/03	8/26/03
52	**Vault Isolation**	**12d**	**8/27/03**	**9/11/03**
53	Jet any vault liquid to PEW Evaporator using steam jets	2d	8/27/03	8/28/03
54	Install temporary VOG system for vault	4d	8/29/03	9/3/03
55	Fill vault/tank annulus with grout	6d	9/4/03	9/11/03
56	**Grout Cooling Coils, Instrumentation and VOG lines**	**2d**	**9/12/03**	**9/15/03**
57	**Fill the Tank Voids with Grout or CERCLA Waste**	**2d**	**9/16/03**	**9/17/03**
58	**Closure of Tank WM-183**	**87d**	**6/1/04**	**9/29/04**
59	**Tank Isolation**	**12d**	**6/1/04**	**6/16/04**
60	Isolate process waste lines	4d	6/1/04	6/4/04
61	Isolate vessel off-gas (VOG) system in the CPP-722 pit	4d	6/7/04	6/10/04
62	Install temporary VOG system	4d	6/11/04	6/16/04
63	**Provide Access to Tank**	**14d**	**6/17/04**	**7/6/04**
64	Erect containments over TR-13, TR-21, TR-53 and TR-54	4d	6/17/04	6/22/04
65	Install radiation shielding as required	2d	6/23/04	6/24/04
66	Remove steam jet from TR-13	2d	6/25/04	6/28/04
67	Modify steam jet in TR-21 to remove more tank heel	2d	6/29/04	6/30/04
68	Remove and bag level indicator from TR-53	1d	7/1/04	7/1/04
69	Remove and bag corrosion coupon from TR-54	1d	7/2/04	7/2/04
70	Install video and tank washing equipment in riser TR-13	2d	7/5/04	7/6/04
71	**Wash Interior of Tank**	**20d**	**7/7/04**	**8/3/04**
72	Wash tank interior	1d	7/7/04	7/7/04



Project: INTEC Tank Farm Closure
Date: 9/17/99

Task
Progress
Milestone
Summary
Rolled Up Task
Rolled Up Milestone
Rolled Up Progress

ID	Task Name	Duration	Start	Finish
73	Sample and analyze heel	2d	7/[illegible]	7/9/04
74	Rewash and sample until analysis results are acceptable	10d	7/12/04	7/23/04
75	Remove as much of the heel as possible	1d	7/26/04	7/26/04
76	Remove and decontaminate washing equipment	2d	7/27/04	7/28/04
77	Isolate and flush cooling coils	2d	7/29/04	7/30/04
78	Isolate instrumentation lines	2d	8/2/04	8/3/04
79	**Heel Management**	**25d**	**8/4/04**	**9/7/04**
80	Install grout delivery equipment in tank riser	2d	8/4/04	8/5/04
81	Place grout in 12" layers and simultaneously remove heel	10d	8/6/04	8/19/04
82	Apply dry grout as required to absorb free liquid	2d	8/20/04	8/23/04
83	Remove and decontaminate grout delivery equipment	2d	8/24/04	8/25/04
84	Remove and decontaminate video and lighting equipment	2d	8/26/04	8/27/04
85	Install blind flanges on tank risers	2d	8/30/04	8/31/04
86	Disconnect the temporary VOG system	3d	9/1/04	9/3/04
87	Install passive HEPA filters in CPP-722	2d	9/6/04	9/7/04
88	**Vault Isolation**	**12d**	**9/8/04**	**9/23/04**
89	Jet any vault liquid to PEW Evaporator using steam jets	2d	9/8/04	9/9/04
90	Install temporary VOG system for vault	4d	9/10/04	9/15/04
91	Fill vault/tank annulus with grout	6d	9/16/04	9/23/04
92	**Grout Cooling Coils, Instrumentation and VOG lines**	**2d**	**9/24/04**	**9/27/04**
93	**Fill the Tank Voids with Grout or CERCLA Waste**	**2d**	**9/28/04**	**9/29/04**



Project: INTEC Tank Farm Closure
Date: 9/17/99

Task | Progress | Milestone | Summary | Rolled Up Task | Rolled Up Milestone | Rolled Up Progress

EPI HLW-105 11

435.55
DRAFT 10
Rev. 00

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QA RECORD

1.	**Document ID. Number And Rev:**	HLW-105-11
2.	**Document Date:**	09/29/2000
3.	**Document Title (or description):**	INTEC Tank farm facility closure Conceptual Design Report, Project File No. 015722, Book 6 Volume 1, EDF's B 7/10/02
4.	**Addressee Name and Organization:**	N/A
5.	**Author Name and Organization:**	Keith Quigley/BBWI B 7/10/02
6.	**Key Words:**	QA Record, ~~Book 6, Volume 1~~, EDF-015722-021, EDF-015722-022, EDF-015722-023, EDF-015722-024, EDF-015722-025, EDF-015722-026, EDF-015722-027, EDF-015722-028, EDF-015722-029, EDF-015722-030, EDF-015722-031, EDF-015722-032, EDF-015722-033

7. **Uniform Filing Code:** 6153. 105 **Disposition Authority:** ☐ ENV1-k-1 ☐ RD1-A-2 ☒ ENV1-k-2-b ☐ RD1-B-9-b

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8.	**Document Type:**	Engineering Design Files
9.	**File Location:** (Indicate only one)	☐ WCB-100 ☐ INTEC-100 ☐ WCB-104 ☐ INTEC-104 ☐ WCB-101 ☐ INTEC-101 ☒ WCB-105 ☐ INTEC-105 ☐ WCB-102 ☐ INTEC-102 ☐ WCB-REF ☐ INTEC-REF ☐ WCB-103 ☐ INTEC-103
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10.	**If QA Record, Validator sign and date:**	Sign: [signature] Date: 7/3/2002 (Mark box only if it applies) ☒ QA Document Pages 234 3
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435.55
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Rev. 00

HLW PROGRAM
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Budgets	*Miscellaneous Documents*
Construction Documents	*Plan*
Data Sheets	*Presentation*
Electronic Mail	*Procedure*
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Environmental Monitoring	*Report*
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HLW-105-11

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QA RECORD

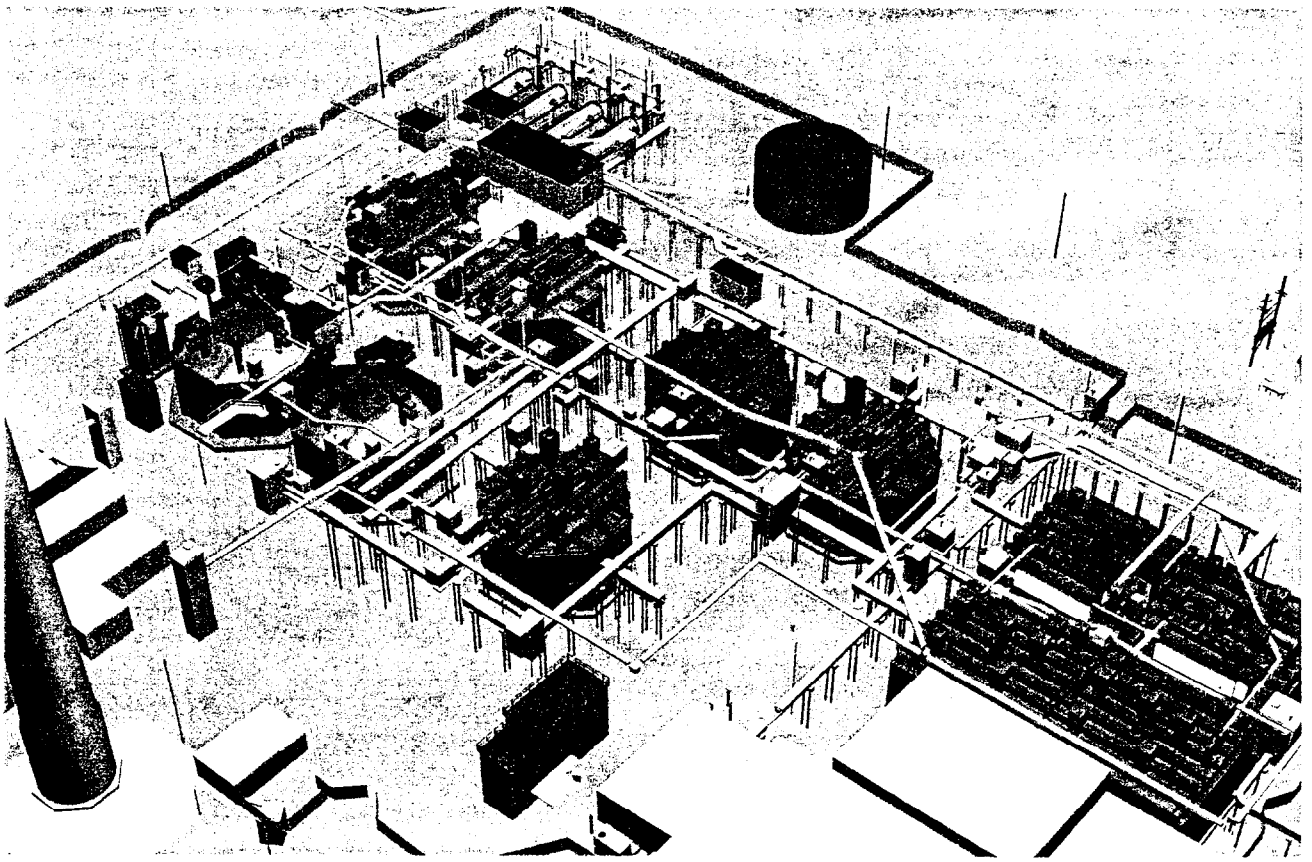
Revision: 0

Project File: 015722

CONCEPTUAL DESIGN REPORT

BOOK 6: EDFs

Volume 2 of 3



INTEC TANK FARM FACILITY CLOSURE

INEEL
Idaho National Engineering & Environmental Laboratory
BECHTEL BWXT IDAHO, LLC

INTEC TANK FARM CLOSURE CONCEPTUAL DESIGN REPORT

BOOK 1 GENERAL (Two Volumes)

Book 1 consists of design requirements, design descriptions, general project information, and summaries of EDFs. Book one provides an overall summary of the project and the approach to Tank Farm Closure. Where an EDF covers a subject in more detail, the EDF is referenced. EDFs reside in BOOK 6.

BOOK 2 JUSTIFICATION DOCUMENT

Book 2 provides the details and justification for the closure process selected for the INTEC Tank Farm. It includes an alternatives assessment and cost benefit analysis.

BOOK 3 MODELING AND ANIMATIONS (Two Volumes)

Book 3 consists of the 3D Model of the Tank Farm and various views of the model. In addition the closure sequence for WM-182 & WM-183 has been animated utilizing the 3D Model; and has been transferred to VHS tape. 3D views of each of the major closure steps are provided.

BOOK 4 MOCK-UPS (Two Volumes)

Book 4 provides details on the past, present, and future proof of process activities. Mock-up test plans, subcontracts, current data, and drawings are included.

BOOK 5 DRAWINGS

Book 5 contains the underground drawings, design drawings for equipment and systems, and four fully annotated 3D views of each of the Tanks.

BOOK 6 EDFS (Three Volumes)

Book 6 contains all of the EDFs developed under the Conceptual Design (FY 99 & 00). The EDFs are summarized throughout BOOK 1. EDFs developed prior to the Conceptual Design are not included, but are available upon request.

BOOK 7 LINE LISTS

Book 7 contains a complete set of underground drawings for the Tank Farm and a complete line list for all pipelines within the Tank Farm. The Line List is subdivided into sections referenced to the specific Tank to which the line is associated. In addition, abandoned line drawings and associated lines lists are provided.

BOOK 8 PHOTOS

Book 8 is a small subset of Tank Farm Photos and Mock-up Photos. An extensive photo library has been developed within the HLW Program and is available.

ENGINEERING DESIGN FILES
Volume 2 of 3

EDF-015722-034	Comparison of Existing Tank Farm Load Limits with Loads Proposed During the Tank Farm Closure Project	B. G. Harris	1/25/00
EDF-015722-035	Absorbing Free Liquids	M. Wilcox	2/28/00
EDF-015722-36	(Not Used)		
EDF-15722-037	PA Modeling Assumptions (Included in PA, not in this CDR)	Kevin Poor	April 19, 2000
EDF-15722-038	Closure Sequence for WM-184, 185, 186	Jim Benson	July17, 2000
EDF-15722-039	Pipeline Decontamination Assessment	Mike Wilcox	July 17, 2000
EDF-15722-040	Tank Farm Sludge Density Measurements	Adam Poloski	July 6, 2000
EDF-15722-041	Surrogate Sludge for Tank Farm Closure Mock-Up	Adam Poloski Mike Wilcox	July 17, 2000
EDF-15722-042	Integrated Surface Sequence	T. Langenwalter	July 17, 2000
EDF-015722-043	Grout Qualification	Ray Schwaller	6/1/00
EDF-15722-044	Tank Grout Requirements for 10 CFR 61 Class C Limits	David Thorne	6/21/00
EDF-15722-045	TFF Closure Regulatory Analysis	Kevin Poor Lisa Matis	6/1/00

ENGINEERING DESIGN FILE

1. Project File No. _____ 2. Project/Task INTEC Tank Farm Closure Project

3. Subtask Structural Systems – Loading on Tank Farm

4. Title: Comparison of Existing Tank Farm Load Limits with Loads Proposed During the Tank Farm Closure Project

5. Summary: This summary briefly defines the problem or activity to be addressed in the EDF, gives a summary of the activities performed in addressing the problem and states the conclusions, recommendations, or results arrived at from this task.

As part of the operations that will take place during the Tank Farm Closure Project, various surface loads will be applied in the area of the tank farm. These loads will be from such items as containment structures, cranes used to locate the containment structures, concrete delivery trucks, grout pumps, etc. Load limits have been developed previously for the tank farm to prevent overloading of the tank vaults. This Engineering Design File compares the proposed loadings that could occur during the closure project with the current load limits. Although all pertinent information is not available and further investigation will be required, the current information indicates that the proposed operations for tank farm closure will not cause the tank farm load limits to be exceeded.

6. Distribution (complete package):

Distribution (summary package only):

7. Review (R) and Approval (A) Signatures: (Minimum reviews and approvals are listed. Additional reviews/approvals may be added as necessary.)

	R/A	Printed Name	Signature	Date
Author	R	Brent G. Harris	B.G. Harris	9/30/99
Independent Verification	R	T.A. LANGENWALTER	[illegible]	1/24/00
Requestor	A	Edward C. Anderson	[illegible]	1/25/00

COMPARISON OF EXISTING TANK FARM LOAD LIMITS WITH LOADS PROPOSED DURING THE TANK FARM CLOSURE PROJECT

9/30/99

Purpose

This Engineering Design File (EDF) provides an estimation of the surface loads that could be applied as part of the Tank Farm Closure operations, and compares those loads with the load limits which are currently in place on the tank farm.

Background

The INTEC Tank Farm Facility (TFF) is the primary location used to store High Level Liquid Waste (HLLW) and Sodium Bearing Waste (SBW) which has been generated from processing of spent nuclear fuel at INTEC. The TFF consists of nine 300,000 gallon tanks and two 318,000 gallon tanks. Seven of the tanks are contained in their own underground concrete vaults, and the other four are contained in one common underground concrete vault.

A load study (Reference 1) was performed for the tank farm area by Advanced Engineering Consultants, Inc. to determine what vehicle loads could be applied on the tank farm surface without overloading the tank vaults or underground lines. Overloading of the tank vaults could result in damage to the HLLW tanks. The study also established specific operational load limits and restrictions on vehicles entering the tank farm.

The Tank Farm Closure Project includes the following general activities for each of the eleven tanks:

- Rinsing the tanks (partial fill and drain) using existing TFF systems.
- Pumping out the existing liquid from the tanks using the existing steam jets.
- Taking samples of the remaining liquid/residue to determine the radiation levels present, using the Light Duty Utility Arm (LDUA).
- Removing one of the existing steam jets, and extending the other steam jet such that more of the liquid can be removed.
- Inserting the washing system assembly; and washing down the tank. Removing the liquid with the remaining steam jet.
- Using the LDUA, take RCRA samples. If desired tank closure levels are not met, additional washing and sampling will be required until they are achieved.
- Filling the tank completely with grout using a procedure that will allow removal of additional free liquid in the process.
- Filling the piping which penetrates the tank wall with grout.
- Filling the annulus between the tank wall and the enclosure vault with grout.

In order to complete the above activities, it will be necessary to bring personnel, vehicles, and other equipment into the tank farm area. Precautions must be taken to prevent these activities from exceeding the existing load limits which have been placed on the tank farm facility or, if they are exceeded, providing a technical justification for doing so.

Existing Load Limits

Based on the Advanced Engineering study, a Management Control Procedure, INTEC-MCP-P7.5-A1 (Reference 2), was written to establish limits on vehicular and non-vehicular loads within the tank farm.

The tank farm was divided into four discrete areas or zones (A, B, C, and D) for the purpose of establishing load limits. Zones A, B, C, and D were further divided in subzones such as A-1, A-2, B-1, B-2, etc. In general, Zones A and B are located over the tanks and vaults; Zone C includes the region outside the tank vaults; and Zone D lies on the tank farm perimeter. Drawing 097726 (Reference 3) identifies these different zones. Zones A and B have the most restrictive load limits. The load study considered numerous types and sizes of vehicles that could potentially be needed in the tank farm area and then grouped them into four different categories. The information in Tables 1 thru 5 is taken from Reference 2 and lists the different vehicles in each of the four categories.

The load limitations for the different zones are given below. The limitations for zones A, B, and C were determined using the vehicle weight and its nominal full load weight.

1) Zone A: A maximum of two (2) category I vehicles (except Bobcat 753), at least 10 feet apart.

2) Zone B: A maximum of two (2) category I vehicles at least 10 feet apart.

3) Zone C: Zone C can accommodate one of the following vehicle combinations at any given time:

   a. Four (4) category I vehicles

   b. Two (2) category I vehicles and one (1) category II vehicle

   c. Two (2) category II vehicles

   d. One (1) category III vehicle

   e. Any other combination of vehicles with a sum weighing factor of 4.0 or less (see table category headings) is also allowed in Zone C.

4) Zone D: Any combination of vehicles in categories I, II, III, or IV ($\geq$ 50 ft. from VES-WM-180 through VES-WM-190 vault walls).

The following restrictions are also placed on the zone loadings:

1) Vehicles shall travel under 2.5 mph while in the tank farm zones to prevent amplification of the wheel pressure on the soil.

2) Vehicle loading restrictions are for dry soil conditions. Vehicles are not allowed in the zones during saturated soil conditions.

3) Vehicles are assumed to be carrying their rated capacity or 12,000 lbs., whichever is less.

4) Maximum lift loads for all cranes shall be 12,000 lbs.

5) Lift loads on cranes shall be kept near the ground when moved over the tank farm.

6) Non-vehicle loads shall be less than 1,000 lbs. per zone.

7) A group of less than 18 people in one zone requires no monitoring. If a group consisting of between 18 and 54 people are in one zone, the group needs to be monitored and controlled such that they do not exceed the load equivalency of one Category I vehicle. If groups consisting of between 55 and 108 people are in one zone, the group needs to be monitored and controlled such that they do not exceed the load equivalency of one Category II vehicle. Closely assembled groups of more than 108 people are not allowed in the tank farm area.

8) If more than 16 in. of surface snow is measured in the tank farm, no vehicles will be allowed in the tank farm area.

9) Listed vehicles may be replaced by other vehicles on a one for one basis, provided they have similar loads and configurations, and that the following additional conditions are met:

   (a) The total load of the new vehicle, including its combined weight and lift load, do not exceed the design loads of the vehicle it is to replace by more than 5%.

   (b) The new vehicle has the same number of axles and supports as the vehicle it is to replace.

   (c) The distance between the new vehicle axles and supports is within 5% of those of the vehicle it is to replace.

   (d) The contact area of the new vehicle supports (i.e., tires, pads, treads, etc.) is not less than 95% of the contact area of the supports of the vehicle it is to replace.

TABLE 1

Category I Vehicles (Weighing Factor equals 1.0)	
Trucks	
	Ford Ranger 4X2
	Ford Ranger 4X4
	Ford F150
	Ford F250 (GWV: 8600 lb)
	Ford F250 HD
	Dodge Ram 150 (GWV: 5250 lb)
	Chevy Cheyenne (GWV: 7200 lb)

TABLE 1 CON'T.

Loader	
	Bobcat 753
Vibratory Rammers	
	Wacker BS45Y
	Wacker BS60Y and GVF151Y
	Wacker BS62Y, 65Y
Roller	
	Stone Duomat DR60
Personnel	
	Accumulate group of 18 to 50

TABLE 2

Category II Vehicles (Weighing Factor equals 2.0)	
Trucks	
	Ford F350 SWR
	Ford F350 DRW
	Ford F350 SD
Tractor trucks (without load)	
	International 4854
	Ford L8000
Forklifts	
	Caterpillar V70F
	Caterpillar V80F
	Caterpillar V90F
	Caterpillar V100F
	Caterpillar VC110F
	Caterpillar V110B
Backhoes	
	Case 580 Backhoe
	Case 580E Extendahoe
	Case 580 Super K Loader
	Case 580D Backhoe
	John Deere 310D Loader
	John Deere 410D Loader
Crane	
	Grove AP 308
Drill Rigs	
	Long Year 2200
	Killman BK-B1
Vibratory Rollers	
	Wacker BS105Y
	Wacker Mikasa MT-85
	Wacker RS800A, H
	Wacker RD800V
	Wacker WDH86/110
	Wacker W55, 55T, 74, 74A
	Wacker RT560
	Wacker RT820
	Wacker R1000, S, B

TABLE 2 CONT'D.

	Stone Duomat R50P
	Stone Duomat DR70, 70P
	Stone Duomat R778, DR77
	Stone Duomat R90B
	Stone Duomat CP323, CS323
	Ingersol Rand DA-30 Roller
Crawler Tractors	
	D4H crawler
Manlift	
	Simon MPL-60
Personnel	
	Accumulate group of 55 to 108

TABLE 3

Category III Vehicles (Weighing Factor equals 4.0)	
Trucks	
	10 Yd Dump Truck
	Truck Tractor with 40 foot trailer
	10 Yd Concrete Truck
	GM Two-ton Truck
Forklifts	
	Hyster Forklift A66 (Mudduck)
	Caterpillar V130B
	Caterpillar V155B
	Liftall HT150
Drill Rig	
	Becho
	CME 55
Cranes	
	P&H 18
	P&H 35
	P&H 120
	P&H 122
	P&H 128
	Grove RT58C
	Grove RT58E*
	Grove RT418
	Grove RT500
	Grove RT550
	Grove RT528C
	Grove RT630B
Backhoe	
	Hitachi Trackhoe UH082
Loader	
	International 520
	Caterpillar 966C
Roller	
	Caterpillar CB434
Single Loader Hot Waste Box	

*No other vehicles are permitted in the A, B and C zones of the Tank Farm at the same time as the Grove RT58E.

TABLE 4

Category IV Vehicles (Weighing Factor equals 5.0)	
Cranes	
	P&H 150
	P&H 165
	P&H 750
	Grove RT740B
	Grove RT760
	Grove RT865B
	Grove RT990
Loader	
	Caterpillar 235

TABLE 5

Light Duty Utility Arm (LDUA) Equipment	
LDUA - Trailer Mounted	See approved LDUA Tank Farm Access Load Study for specific tank.
LDUA - Truck Mounted	See approved LDUA Tank Farm Access Load Study for specific tank.
Hydraulic Power Unit Trailer	See approved LDUA Tank Farm Access Load Study for specific tank.
Utility Trailer	See approved LDUA Tank Farm Access Load Study for specific tank.
Operational Control Trailer	See approved LDUA Tank Farm Access Load Study for specific tank.

Proposed Loads on the Tank Farm

In order to accomplish the tank farm closure project, it is anticipated that the loadings shown in Table 6 will be imposed on the tank farm. These loads are based on conceptual design information and may change as the Title I and Title II designs progress.

TABLE 6

Proposed Loadings from Tank Farm Closure Project				
Item	**Estimated Weight**	**Location (Zone)**	**Within Load Limit**	**Comments**
1. Personnel	Less than 18 people	All Zones	Yes	No restrictions are required when less than 18 people are in any one zone.
2. Trailers (a) Control Trailer (b) Change Trailer	 TBD TBD	 D-1 D-1	 Yes Yes	Trailers will be outside the fence.
3. Containment Buildings (a) Small Buildings (2) (b) Large Buildings (2)	 7,000 lbs ea 5,000 lbs ea	 A, B A, B	 Yes Yes	There will be 2 small and 2 large buildings over each tank. Hatches will be removed while the containment buildings are in place.

TABLE 6 CONT'D.

4. Concrete Hatch Covers		A, B, ?		Storage location while they are removed.
5. VOG System (a) Filter Skid (b) Shielding for Skid (c) Shielding for Lines (d) Blower Skid	 TBD TBD TBD TBD			
6. Tank Washdown System (a) Water Storage Tank (b) Utility Piping (c) Washing Arm Assembly	 TBD TBD TBD	 D A, B, C, D A, B	 Yes Yes Yes	
7. Grouting System (a) 10 cy Concrete Truck (b) Grout Pump (c) 4" Grout Line (d) Grout Placement Arm (e) Grout Flushing System	 66,100 lbs 6,500 lbs 19 lbs/ft TBD TBD	 C C A,B,C,D A,B		See Reference 6.
8. Heavy Equipment (a) Crane (b) Backhoe	 TBD 50,000 lbs	 C C		Max. lift on crane will be 12,000 lbs.
9. LDUA Equipment (a) LDUA (b) HPU Trailer (c) Supporting Trailer (d) AT Trailer	 23,800 lbs 11,000 lbs 10,100 lbs 11,370 lbs	 A, B, C A, B C C		See Reference 8.

The following paragraphs provide additional information on the proposed loadings.

1) Personnel Loads
It is not anticipated that there will be more than 17 people in any one zone at the same time during the tank farm closure operations. Consequently, personnel loading is not considered a problem

2) Trailers
Both the 10 ft. x 40 ft. Control Trailer and the 10 ft. x 24 ft. Change Trailer will be located outside the fence of the tank farm facility in Zone D-1. The weights of these trailers will not be significant compared to the load limits for Zone D. See paragraph 9 below for information on the LDUA trailers.

3) Containment Buildings
Portable containment buildings will be placed over the openings in the tank vault during the washing and grouting operations. Two small (12 ft. x 12 ft.) and two large (16 ft. x 16 ft.) buildings will be used simultaneously. Reference 4 shows the proposed location of these buildings on tanks WM-182 and WM-183. The estimated weights of these buildings were calculated in Reference 5. Since these buildings weigh considerably less than the concrete hatch covers on the vaults, and they will not be placed over the vaults until after the hatch covers are removed, loading should not be a problem. Calculated weights for the hatch covers are contained in Table 7.

TABLE 7

Tank	Riser	Cover Weights	References
WM-180	TR-15	Inner: 2 @ 1,400 lbs ea. Outer: 1 @13,800 lbs	Drawings 138098 & 138099
	TR-16	Inner: 2 @ 1,400 lbs ea. Outer: 1 @13,800 lbs	Drawings 138098 & 138099
	SR-16	Four @ 1400 lbs ea.	Drawing 138100
	TR-45	Inner: 2 @ 1,400 lbs ea. Outer: 1 @13,800 lbs	Drawings 138098 & 138099
	TR-46	Inner: 2 @ 1,400 lbs ea. Outer: 1 @13,800 lbs	Drawings 138098 & 138099
	TR-47	Inner: 2 @ 1,400 lbs ea. Outer: 1 @21,000 lbs	Drawings 138098 & 138099
WM-181	TR-17	Inner: 2 @ 1,400 lbs ea. Outer: 1 @13,800 lbs	Drawings 138098 & 138099
	TR-18	Inner: 2 @ 1,400 lbs ea. Outer: 1 @13,800 lbs	Drawings 138098 & 138099
	SR-17	Four @ 1400 lbs ea.	Drawing 138100
	TR-48	Inner: 2 @ 1,400 lbs ea. Outer: 1 @21,000 lbs	Drawings 138098 & 138099
	TR-49	Inner: 2 @ 1,400 lbs ea. Outer: 1 @13,800 lbs	Drawings 138098 & 138099
	TR-50	Inner: 2 @ 1,400 lbs ea. Outer: 1 @13,800 lbs	Drawings 138098 & 138099
WM-182	TR-19	Upper-9,200 lbs Lower-18,400 lbs	Drawing 106150
	TR-20	Upper-9,200 lbs Lower-18,400 lbs	Drawing 106150
	SR-18	Three @ 1,400 lbs ea. One @ 1,500 lbs	Drawing 138100
	SR-19	Two Covers @ 1,400 lbs ea One Base @ 5,500 lbs	Drawing 138100
	TR-51	Inner: 2 @ 1,400 lbs ea. Outer: 1 @12,200 lbs	Drawings 138098 & 138099
	TR-52	Inner: 2 @ 1,400 lbs ea. Outer: 1 @19,500 lbs	Drawings 138098 & 138099
WM-183	TR-13	Upper-9,200 lbs Lower-18,400 lbs	Drawing 106150
	TR-21	Upper-9,200 lbs Lower-18,400 lbs	Drawing 106150
	SR-20	Three @ 1,400 lbs ea. One @ 1,500 lbs	Drawing 138100
	SR-21	Two Covers @ 1,400 lbs ea One Base @ 5,500 lbs	Drawing 138100
	TR-53	Inner: 2 @ 1,400 lbs ea. Outer: 1 @19,500 lbs	Drawings 138098 & 138099
	TR-54	Inner: 2 @ 1,400 lbs ea. Outer: 1 @ 12,200 lbs	Drawings 138098 & 138099

TABLE 7 CONT'D.

WM-184	TR-14	14,000 lbs (Below Grade)	Drawing 106149
	TR-55	Inner: 2 @ 1,400 lbs ea. Outer: 1 @ 12,200 lbs	Drawings 138098 & 138099
	TR-56	Inner: 2 @ 1,400 lbs ea. Outer: 1 @ 12,200 lbs	Drawings 138098 & 138099
	TR-57	Inner: 2 @ 1,400 lbs ea. Outer: 1 @ 19,500 lbs	Drawings 138098 & 138099
	TR-58	Inner: 2 @ 1,400 lbs ea. Outer: 1 @ 12,200 lbs	Drawings 138098 & 138099
	SR-22	Two Covers @ 1,400 lbs ea One Base @ 5,500 lbs	Drawing 138100
	SR-23	Three @ 1,400 lbs ea. One @ 1,500 lbs	Drawing 138100
WM-185	TR-1	Inner: 2 @ 1,400 lbs ea. Outer: 1 @ 12,200 lbs	Drawings 138098 & 138099
	TR-2	Inner: 2 @ 1,400 lbs ea. Outer: 1 @ 19,500 lbs	Drawings 138098 & 138099
	TR-3	Inner: 2 @ 1,400 lbs ea. Outer: 1 @ 12,200 lbs	Drawings 138098 & 138099
	TR-6	Inner: 2 @ 1,400 lbs ea. Outer: 1 @ 12,200 lbs	Drawings 138098 & 138099
	TR-11	14,000 lbs (Below Grade)	Drawing 106149
	SR-1	Inner: 2 @ 1,400 lbs ea. Outer: 1 @ 19,500 lbs	Drawings 138098 & 138099
	SR-2	Four @ 1400 lbs ea.	Drawing 138100
WM-186	TR-5	Inner: 2 @ 1,400 lbs ea. Outer: 1 @ 12,200 lbs	Drawings 138098 & 138099
	TR-6	Inner: 2 @ 1,400 lbs ea. Outer: 1 @ 12,200 lbs	Drawings 138098 & 138099
	TR-7	Inner: 2 @ 1,400 lbs ea. Outer: 1 @ 12,200 lbs	Drawings 138098 & 138099
	TR-8	Inner: 2 @ 1,400 lbs ea. Outer: 1 @ 19,500 lbs	Drawings 138098 & 138099
	TR-12	14,000 lbs (Below Grade)	Drawing 106149
	SR-3	Three @ 1,400 lbs ea. One @ 1,500 lbs	Drawing 138100
	SR-4	Four @ 1400 lbs ea.	Drawing 138100
WM-187	TR-22	Inner: 2 @ 1,400 lbs ea. Outer: 1 @ 12,200 lbs	Drawings 138098 & 138099
	TR-23	Inner: 2 @ 1,400 lbs ea. Outer: 1 @ 19,500 lbs	Drawings 138098 & 138099
	TR-24	Inner: 2 @ 1,400 lbs ea. Outer: 1 @ 12,200 lbs	Drawings 138098 & 138099
	TR-25	Inner: 2 @ 1,400 lbs ea. Outer: 1 @ 12,200 lbs	Drawings 138098 & 138099
	TR-30	34,500 lbs	Drawing 106316
	SR-5	Three @ 1,400 lbs ea. One @ 1,500 lbs	Drawing 138100
	SR-6	Four @ 1400 lbs ea.	Drawing 138100

TABLE 7 CON'T.

WM-188	TR-26	Inner: 2 @ 1,400 lbs ea. Outer: 1 @ 19,500 lbs	Drawings 138098 & 138099
	TR-27	Inner: 2 @ 1,400 lbs ea. Outer: 1 @ 12,200 lbs	Drawings 138098 & 138099
	TR-28	Inner: 2 @ 1,400 lbs ea. Outer: 1 @ 12,200 lbs	Drawings 138098 & 138099
	TR-29	Inner: 2 @ 1,400 lbs ea. Outer: 1 @ 12,200 lbs	Drawings 138098 & 138099
	TR-31	34,500 lbs	Drawing 106316
	SR-7	Four @ 1400 lbs ea.	Drawing 138100
	SR-8	Three @ 1,400 lbs ea. One @ 1,500 lbs	Drawing 138100
WM-189	TR-32	Inner: 2 @ 1,400 lbs ea. Outer: 1 @ 12,200 lbs	Drawings 138098 & 138099
	TR-33	Inner: 2 @ 1,400 lbs ea. Outer: 1 @ 12,200 lbs	Drawings 138098 & 138099
	TR-34	Inner: 2 @ 1,400 lbs ea. Outer: 1 @ 12,200 lbs	Drawings 138098 & 138099
	TR-35	Inner: 2 @ 1,400 lbs ea. Outer: 1 @ 19,500 lbs	Drawings 138098 & 138099
	TR-40	34,500 lbs	Drawing 117979
	TR-41	34,500 lbs	Drawing 117979
	SR-9	Three @ 1,400 lbs ea. One @ 1,500 lbs	Drawing 138100
	SR-10	Three @ 1,400 lbs ea. One @ 1,500 lbs	Drawing 138100
	SR-13	34,500 lbs	Drawing 117979
WM-190	TR-36	Inner: 2 @ 1,400 lbs ea. Outer: 1 @ 12,200 lbs	Drawings 138098 & 138099
	TR-37	Inner: 2 @ 1,400 lbs ea. Outer: 1 @ 12,200 lbs	Drawings 138098 & 138099
	TR-38	Inner: 2 @ 1,400 lbs ea. Outer: 1 @ 19,500 lbs	Drawings 138098 & 138099
	TR-39	Inner: 2 @ 1,400 lbs ea. Outer: 1 @ 12,200 lbs	Drawings 138098 & 138099
	TR-42	34,500 lbs	Drawing 117979
	TR-43	34,500 lbs	Drawing 117979
	SR-11	Three @ 1,400 lbs ea. One @ 1,500 lbs	Drawing 138100
	SR-12	Three @ 1,400 lbs ea. One @ 1,500 lbs	Drawing 138100
	SR-14	34,500 lbs	Drawing 117979

4) Concrete Hatch Covers

In order to access the tanks and vaults, the concrete hatch covers on the risers will need to be removed. Calculated weights of these hatch covers are shown in Table 7. The storage locations for placement of these hatch covers while they are removed needs to be selected such that the tank farm load limits are not exceeded.

5) Vessel Off-Gas (VOG) System
Although, information on the weight and location of the VOG system components is not currently available, it is not assumed that these items will create any significant problems. This assumption will need to be verified when the required information is available.

6) Tank Washdown System
Demineralized water will be used to wash the inside of the tanks. Since the existing demineralized water capacity at INTEC is not adequate to deliver the desired flow, a 3,000 gallon surge tank will be provided to the northeast of Building CPP-628 in Zone D. Above grade lines would be used to fill the tank from CPP-628 and then supply the water from the surge tank to the Washing Arm Assembly that would be lowered into the waste tanks. Placing the surge tank in Zone D should not be a problem, and the weight of the fill and supply lines will be minimal.

7) Grouting System
The grouting operations will require a grout pump, concrete trucks to deliver the grout, and a hose through which the grout will be pumped. The grout pump will be located in Zone C to allow access by the delivery trucks. The pump will deliver the grout to the desired location using a 4" line. A grout placement arm will be lowered into the tank and used to place the grout in the desired location. Since a 10 cubic yard concrete truck is a category III vehicle, and only one category III vehicle is allowed in Zone C at a given time, a method of staging the trucks in order to maintain a continuous supply of grout to the pumps will be important.

8) Heavy Equipment
A crane will be required to remove/replace the vault hatch covers and install the containment buildings. The crane will also be used to handle the washing arm assembly and the grout placement arm. The crane size and capacity, which will be based on the weight of the largest item being lifted as well as the maximum required reach, have not yet been determined. It is anticipated that the crane will be a category III vehicle.

Although excavation within the tank farm will be minimal, a backhoe will be needed. Backhoes, but not trackhoes, are classified as category II vehicles. Trackhoes are category III vehicles. In addition to excavating, the backhoe will be used to move equipment and tools.

9) Light Duty Utility Arm (LDUA) Equipment
A structural analysis was performed to determine the effect of the LDUA equipment on loading of the tank farm (Reference 8). This study only addressed tanks WM-182 and WM-183. The study concluded that the LDUA may access the tank farm load control zones. The LDUA shall be considered a category II vehicle while being moved and positioned within Zone C areas. The LDUA and tow vehicle together shall be considered as two category I vehicles in determining total load in a Zone B. Support trailers shall be considered as category I vehicles in determining total load zone limits. The HPU trailer may be positioned near the LDUA (within Zone B) as necessary to provide the required proximity for operation of the LDUA. The LDUA shall access the area from the east and west directions, remaining generally perpendicular (within 15 degrees) to the roof framing of the respective vaults.

Special Considerations

The following items require planning and coordination to prevent tank farm closure operations from exceeding the existing tank farm load limits:

1) The concrete delivery trucks, Category III vehicles, will discharge the grout to the grout pumps which will be located in Zone C. The current load limit allows only one Category III vehicle in Zone C. The trucks will need to be staged in Zone D such that one could move to the grout pump immediately after the previous truck leaves Zone C.

2) Depending on the categorization of the crane, it may not be possible to have the crane in Zone C at the same time as the concrete truck. This will need to be coordinated.

3) The storage location of the vault hatch covers need to be determined such that they do not limit the necessary movement and placement of other equipment.

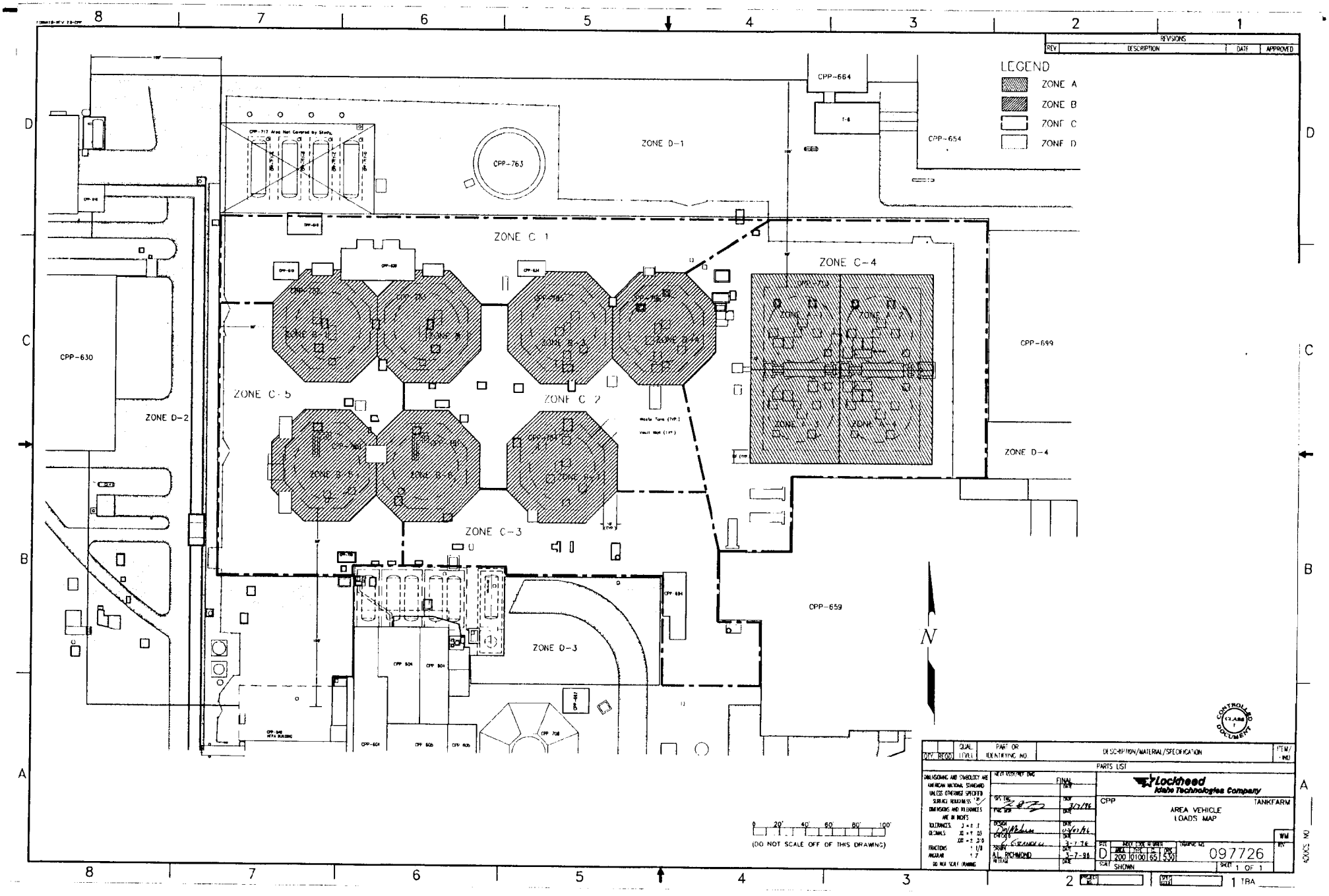
4) It is assumed that credit can be taken for the decrease in weight on the vaults when the riser hatch covers are removed; however, this has not been addressed in previous studies and needs to be approved by a structural engineer familiar with the tank loading limits.

Conclusions

Based on currently available information, and with proper planning, it appears that the proposed loads that will be applied to the tank farm during the closure project will be within the current load limits. In order to verify this, however, further investigation will be required to better define the loads and also to determine the sequence of operations.

References

1) "Evaluation of Existing Vaults for Vehicle Loads", HLWTFR Project, Advanced Engineering Consultants, Inc., San Francisco, CA, August 1993.
2) INTEC-MCP-P7-5-A1, Revision 8, "Tank Farm Load Limitations", March 22, 1999.
3) Drawing 097726 (Attached)
4) Conceptual Drawing entitled "INTEC Tank Farm Facility Closure Site Plan" (Attached)
5) "Secondary Enclosures Weight Calculations", Tracy Langenwalter, 7/22/99
6) EDF-TFC-038, "Tank Farm Load Limitations", K. D. McAllister, January 1997.
7) TS42B14.R0, "Load Controls for ICPP High-Level Liquid Waste Tank Vaults", Revision 0, February 29, 1996.
8) "Structural Analysis for Light Duty Utility Arm (LDUA) Tank Farm Access Load Study for VES-WM-182 and VES-WM-183", Document 2832-INTEC, Revision 1, 9/30/99.
9) Drawings 138098, 138099, 138100, 106149, 106150, 106316, 117979



LEGEND
ZONE A
ZONE B
ZONE C
ZONE D
ZONE D-1
ZONE D-2
ZONE D-3
ZONE D-4
ZONE C-1
ZONE C-2
ZONE C-3
ZONE C-4
ZONE C-5
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CPP-664
CPP-654
CPP-763
CPP-699
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EDF-015722-035

ENGINEERING DESIGN FILE

1. Project File No. 015722 2. Project/Task INTEC Tank Farm Facility Closure - Mock-up Support

3. Subtask Fix Free Liquids - Qualitative evaluation of absorbents for Fix Free Liquid Mock-Up

4. Title: **Aquaset® II HG - selected product for Fix Free Liquid Mock-up absorbent**

5. Summary: This summary briefly defines the problem or activity to be addressed in the EDF, gives a summary of the activities performed in addressing the problem and states the conclusions, recommendations, or results arrived at from this task.

Nine products were qualitatively evaluated for use as absorbent to demobilize the anticipated free liquid in tank WM 182. This free liquid will contain a wide variety of relatively low levels of inorganic salts and is expected to have a pH between about 3.5 - 5.0. Salt concentrations and pH will depend on how much INTEC Basin water is used to flush tank WM 182 and the effectiveness of mixing from dilution and wash-ball operations. Aquaset® II HG, a product from Fluid Tech, Inc. appears to be a highly qualified candidate as an absorbent for the anticipated free liquids remaining after initial grout layering within tank WM 182. Various parameters were qualitatively evaluated to select this absorbent, including compressive strength, radiation effects, salt loading, pH, adsorption qualities, and dust generation. Aquaset® II HG should be further evaluated as an effective absorbent during the planned mock-up for fixing free liquids.

6. Distribution (complete package):

Distribution (summary package only):

7. Review (R) and Approval (A) Signatures: (Minimum reviews and approvals are listed. Additional reviews/approvals may be added as necessary.)

	R/A	Printed Name	Signature	Date
Author	R	Michael R. Wilcox	Michael R. Wilcox	2/10/00
Independent Verification	R	Rodney R. Kimmitt	R. R. Kimmitt	2/28/00
Requestor	A	Edward C. Anderson	[illegible]	2/28/00

Qualitative evaluation of absorbents for Fix Free Liquid Mock-Up

Background:

As part of the Idaho Nuclear Technology and Engineering Center (INTEC) Tank Farm Facility (TFF) system closure project, five grout installments of varying slump rates are planned to physically push solids remaining within tank WM 182 toward the steam jet for transport to the WM 183 tank. There will be some solids encapsulation and solidification though not homogenous. Nevertheless, some solids are anticipated to remain in tank WM 182 after a series of waste dilutions and drainage. These dilutions consist of three relatively small volume washes, a very large volume basin water dilution and drain, followed by a relatively small volume wash-ball operation used to scour and suspend solids from the tank's inner walls and bottom. Some free liquids (an estimated 20 - 400 gallons) are anticipated to remain after grout placement/pumping activities. It is desired that no free liquids remain after the five grout installments and absorption material is added.

Summary:

Nine products were qualitatively evaluated for use as absorbent to demobilize the anticipated free liquid in tank WM 182. This free liquid will contain a wide variety of relatively low levels of inorganic salts and is expected to have a pH between about 3.5 - 5.0. Salt concentrations and pH will depend on how much INTEC Basin water is used to flush tank WM 182 and the effectiveness of mixing from dilution and wash-ball operations. Aquaset® II HG, a product from Fluid Tech, Inc. appears to be a highly qualified candidate as an absorbent for the anticipated free liquids remaining after initial grout layering within tank WM 182. Various parameters were qualitatively evaluated to select this absorbent, including compressive strength, radiation effects, salt loading, pH, adsorption qualities, and dust generation. Aquaset® II HG should be further evaluated as an effective absorbent during the planned mock-up for fixing free liquids.

Evaluation Discussion:

Nine readily available products were qualitatively evaluated for use as absorbent to demobilize the anticipated free liquid in tank WM 182. Herein, the term "absorbent" means the capability of a product to retain a liquid such that the absorbed mass passes the Paint Filter Test (EPA Method #9095) for the intended application. The ability of a waste managed to withstand groundwater attack (assumed to be acidic) is measured for radioactive wastes by Test ANSI/ANS 16.1, "Measurement of the Leachability of Solidified Low-Level Radioactive Wastes by a Short-Term Test Procedure"; for chemically hazardous wastes by the EPA Toxic Characteristic Leaching Procedure (TCLP) 40 CFR part 261, Appendix II); and, for mixed wastes, by both. This evaluation did not involve the development of bench scale studies or recipes based on analysis of measured absorbency/adsorption effectiveness based on any simulated waste. Ideally, in selecting an absorbent for use to demobilize waste certain parameters including compressive strength, radiation effects, salt loading, pH, adsorption qualities, and dust generation should be measured or calculated based on a surrogate. The table following "Health & Safety Concerns" delineates each product name, related uses, the company, the points of

contact (POC) who provided technical information, and some key technical information and concerns applicable to fixing free liquids in tank WM 182.

Compressive Strength:

It is desirous to have an absorbent that will not be displaced easily by subsequent grout/concrete additions. Most of the polymer (polyacrylate) based absorbents resemble a "pasty oatmeal", "cream of wheat", to a "rubbery" type of consistency under "normal use" as an absorbent. Polyacrylate based absorbents (under normal usage ratios) would be easily displaced with heavy overburden. Pure Western sodium bentonite although having excellent absorption and chemical adsorption properties has a consistency of a medium-thick gel under conventional uses. This wetted material can be displaced and ooze vertically through cracks with heavy overburden. Materials such as cement clinkers, Class C fly ash, cement kiln baghouse dust (CKD), some Aquaset® and Petroset® products would most likely achieve a compressive strength of 50 PSI (with pH conditions above pH 4) which would be suitable for over-placement addition of grout/concrete. It may be desirous to perform bench scale compressive product testing on surrogate samples with varying pH before the planned fix free liquid mock-up, and the absorbed product resultant from the mock-up. Without mixing (which is not planned), encapsulated pockets of liquids are quite possible with the addition of materials that harden primarily consisting of fine particles - such as Class C fly ash, cement kiln baghouse dust, and some Aquaset® and Petroset® products. Appropriately ground cement clinkers and granular Aquaset® II HG (Hardening, Granular) would provide effective hardening and compressive strength without mixing. If very large quantities of pure granular sodium bentonite are used relative to the liquid to be absorbed adequate overall dry granular forces may produce the substrate needed to provide an adequate foundation for subsequent grout/concrete layers. If, however, water in the future could enter this sodium bentonite zone, substantial forces caused by the significant swelling properties of pure sodium bentonite may not be desirable. A redeeming feature of swelled sodium bentonite is its adsorption (contaminant containment) characteristics and its gel/thixotropic nature. If significantly stressed, the sodium bentonite would not crumble and fragment into smaller particle sizes as is typical of many cements/grouts, etc. whose adsorption properties are not as great and therefore exists the potential for increased leaching with an increased surface area.

Radiation Testing:

It is not possible to accurately calculate the radiation flux into an absorbent to be used in tank WM 182 primarily because the geometry of the remaining solids within and around the placed grout will not be homogenous and cannot be fully predicted. A conservative worst case enveloping calculation could perhaps be compared against some of the irradiation testing done by some polyacrylate based product manufacturers. There is some positive irradiation data showing significantly high irradiation rates available from the manufacturers of polyacrylate based absorbents. However, the unknown combined salt complexity within tank WM 182 and pH effects on absorbency make inorganic clays such as sodium bentonite (montmorillonite) and sepiolite (a category of palygorskite), cement clinkers, fly ash, baghouse dust, etc a less risky choice. Inorganic clays used with actual waste (Fluid Tech, Inc.) has shown effective use with more significant radiation fluxes than those found in this evaluation for polyacrylate based absorbents.

Salt, pH, Adsorption:

Although the total salt concentration after tank WM 182 dilutions is anticipated to be substantially less than some percentages of simple salts given in polyacrylate based product literature (such as KOH, NaCl, and CaCl), the complexity of the different types of salts on absorbency/adsorption is unknown. With all products (some more than others), absorbency is adversely effected by pH, salt and organic concentrations. Acidity levels (pH) and salt concentrations of the waste present in WM 182 will effect the absorbency and adsorption ability of any absorbent used. Polyacrylate products such as STERGO® and Quick-Solid® have strong ion exchange capability that allows for heavy metals to be bound which has been shown to provide for some wastes to pass the TCLP. Perhaps an overall ionic strength of the salts within tank WM 182 and salts listed in polyacrylate based product literature tests (which are limited) could be estimated. By comparing an overall ionic strength versus absorbency of an absorbent product to an overall ionic strength of waste in tank WM 182, some absorbency predictions as applied with waste in tank WM 182 could be extrapolated, but this is questionable.

In general, for all products examined, it is desirous to absorb a liquid with a pH towards neutral. This would maximize the absorbency (and adsorption ratio where applicable) of water to waste and provide for a material with higher compressive loading. Certain clays such as such as sodium bentonite and sepiolite (used in pure form or as a primary ingredient) have tremendous chemical adsorption capability. Sodium bentonite is not a good choice for absorbing salty solutions, but a product like Aquaset® II HG (containing sepiolite, not montmorillonite) is preferred for salty wastes.

With the large amount of dilution planned, tank WM 182 liquid will probably contain fairly low levels of salt and either clay may prove effective as an absorbent. As acid levels increase (particularly below pH 4), the mineral structure and adsorption capability of sodium bentonite rapidly deteriorates. With a pH of the liquid above pH 4 (which is possible with adequate amounts of INTEC Basin water for dilution and hydrogen ion migration into the basin water from the solids) sodium bentonite's mineral structure is sound. Salt and low pH effects (reduces) absorption and adsorption capabilities of sodium bentonite (Aquaset®) much more so than sepiolite (Aquaset® II HG). Other inorganic absorbents such as fly ash and cement kiln baghouse dust are predicted to have reduced absorption and adsorption capabilities with lowering pH as well. Cement clinkers provide absorption and hardening around some contaminants (encapsulation), but not much chemical adsorption. The mineral structure degradation of sepiolite (Aquaset® II HG) is not as sensitive to lowering pH as sodium bentonite (Aquaset®). In addition, Aquaset® II HG has neutralizing capacity. Curing and compressive loading is projected to degrade with lowering pH for all inorganic absorbent materials - sodium bentonite based products like Aquaset®, and other non sodium bentonite products like Aquaset® II HG, cement clinkers, fly ash, and cement kiln baghouse dust.

Though it is not planned to obtain and analyze samples of the absorbed liquid waste to measure leaching, the use of clay based products such as sodium bentonite or sepiolite is prudent for their chemical adsorption capabilities. Fluid Tech, Inc. products, by means of this clay technology, have been demonstrated and deployed throughout the DOE complex. Over the years, hundreds of Fluid Tech, Inc. tests have been performed on waste streams that range from low concentrations of salt to saturated solutions. Some samples have been relatively clean solutions while others have been mixed with sludge. Solutions tested have nitrates, phosphates, chlorides, carbonates, sulfates, and mixtures of salts that represent surrogates of various process solutions. In all of these tests, a combination of Fluid Tech, Inc. products have been capable of solidifying the solutions and, in the event the solutions contained Resource Recovery & Conservation Act (RCRA) regulated toxic metals, the final

products were maintained below leachability (TCLP) requirements for land disposal. Many clay based product applications have resulted in waste forms passing Test ANSI/ANS 16.1 and the TCLP. While the final absorbed waste form in tank WM 182 will not have leach testing/analysis performed, these results indicate the strong adsorption characteristics of clays in somewhat similar applications.

Dust Generation:

Slurries or wet grout mixtures provide an advantage of eliminating likelihood of dust generation problems that may enter the off-gas system. However, these methodologies require preparation mixing and may be logistically more difficult to execute and most likely involving more mechanical parts for placement within the tank. During this evaluation, there were no slurries or wet grout mixtures that appeared to be adequate/reliable for absorbing the free liquids. Since mixing is not planned for the absorption task within tank WM 182, liquid pocket formation is quite possible when using grout type slurries according to some industry experts consulted.

Polyacrylate absorbents, along with some clay species like sodium bentonite, swell substantially depending on the amount of water available until their maximum volume swell (up to 350 X for polyacrylates and up to 15 X is not uncommon for sodium bentonite). If airborne, sufficient quantities of these materials could possibly undergo airborne migration to the ventilation system and swell under humid conditions causing some obstruction on inner piping walls, filters, etc. It would be best to keep dust settling maximized by keeping the off-gas flow rate to a minimum. Materials such as non-granular bentonite (including Aquaset® II), Class C fly ash, cement kiln baghouse dust would most likely generate an extreme amount of dust. Placement of materials such as granular bentonite (Aquaset®), Aquaset® II HG (G for granular), and not too finely ground cement clinkers, would still generate dust, but the amount would be less then a powdered form. The amount of swelling of airborne settled particles would be smaller to non-existent. Aquaset® is primarily sodium bentonite, whereas Aquaset® II HG contains sepiolite a category of palygorskite (effective for salt containing wastes) and is anticipated to swell less per mass. Accumulating airborne cement, fly ash, and cement kiln baghouse dust may form a crust in piping filters, etc. During the mock-up dust problems need to be examined. The highest percentage of airborne dust generated from using Aquaset® II HG is expected to be from the cement mixed in with the granular form clay. The cement is mixed in with the clay in this product to harden the product. Humid conditions within tank WM 182 should help ease dusting.

Freeze-Thaw Effects:

Because the absorbent material will be well below grade, freeze and thawing will not be experienced as the temperature at that depth is relatively constant and above freezing.

Recommendation:

It is recommended that Aquaset® II HG from Fluid Tech, Inc. be tested in the planned mock-up for use as an absorbent for fixing free liquids remaining within tank WM 182. From those evaluated, this product appears to be the best choice as applicable to the criteria outlined above. The product is very easy to use because it is simply deposited into the waste liquid until it covers the top of the liquid and then left to set up. This is ideal for this remote operations application. Volume efficiencies at this time appear to be in the 70% range - equating to 35 to 40 gallons of waste liquid in an 88-gallon drum.

The second material recommended is (would be) the bulk use of granular sodium bentonite. Because of patent issues, it turns out that for radiological waste application, purchase of sodium bentonite will need to be from Fluid Tech, Inc. (as the product Aquaset®) who owns the patent. Fluid Tech, Inc. purchases sodium bentonite for their product mixtures from WYO-BEN, Inc. According to Fluid Tech, Inc. the cost for the two products are basically identical, which equates to an estimated $3,000 for 400 gallons of tank WM 182 waste liquid. Therefore, even if low salt concentrations and nearer to neutral pH conditions would allow the use of granular Aquaset®, the only project gain may be less dusting for Aquaset® because it does not contain hardening cement as does Aquaset® II HG. However, this would be at the expense of probably not achieving a desired structural stability rating of 50 PSI.

It may be desirous to have a contingency reserve of absorbent product available during the actual absorbing of waste liquid in tank WM 182.

During the mock-up, logistical placement of the absorbent product needs to be evaluated. This includes dust generation concerns.

If very large quantities of Aquaset® II HG are used relative to the liquid to be absorbed, adequate overall dry granular forces may produce the substrate needed to provide an adequate foundation for subsequent grout/concrete layers. Executing D1883-99 Standard Test Method for CBR (California Bearing Ratio) of Laboratory-Compacted Soils, or other recognized method, may be useful in provide a basis for assessing structural stability. If there is doubt or question on structural integrity of the tank monolith after complete tank filling (with grout/concrete) - it is assumed structural calculations (if needed) would show the discontinuous phase of absorbed liquids would not compromise the overall intent and effort of the tank closure.

Health & Safety Concerns:

The primary health concern with clay based materials which includes Aquaset® II HG and Aquaset®, are the low concentrations of crystalline silica in the form of quartz, crystobalite, and trimydite that may be present in airborne mineral dusts. The concentration level of total free silica in airborne mineral dust is variable depending upon the origin of the mineral ore, fineness of product, moisture content of the product, local humidity and wind, and method of application. During the mock-up, the use of respirators approved by NIOSH/MSHA for silica bearing dust is advised and may be required by an Industrial Hygienist. Individuals using the product will need to be Fit Tested for Respirator use. This health concern needs to be addressed in the Liquid Mock-Up test plan. Like many clay-based materials Aquaset® II HG and Aquaset® products are likely in their application to be very slippery when wet.

Product	Related Uses	Company & POC	Technical information/concerns applicable to fixing free liquids in the INTEC TFF WM 182 tank
SAFE-T-SET	Radioactive waste disposal and radiological research. Note: **SAFE-T-SET** is a rubbery material (powder before mixing with water/liquid) very similar to **TX151** made by the same company. **TX151** has an enormous amount of industry uses.	**Oil Center Research, Inc.** PH: (915)-570-9414 also 877/570-9414 FAX: (915)-684-6561 POC: Bob Ahrabi PH: 800-256-8977	Strongly pH dependent. Will not work @ pH under about 6. Though the pH is expected to increase after the addition of the initial grout layers used to move the solids towards the steam jet, without an additional increase in pH reliably planned and executed the Safe-T-Set material will be in a liquid form. If the pH of the liquid within the tank can be brought up to pH 6 or pH 7, the product may be able to be introduced in a slurry form from an ice bath type of feed tank. The cold solution would slow the thickening of the SAFE-T-SET product. It is likely that properly hardened material would not achieve compressive strength of 50 PSI. Endothermic reaction.
STERGO®	Solid, granular cross-linked Polyacrylate /Polyalchol-Copolymer Advanced Superabsorbent Polymer that rapidly absorbs and retains large volumes of aqueous solutions.	**CORPEX Technologies Inc.** PH: (919)-388-2300 FAX: (919)-388-2300 POC: John Pirotte	Using this product may cause undesirable dust generation and uncertain inorganic salt absorption interference issues. The pH of the waste water within TFF tank WM 182 that is to be absorbed is unknown but at minimum is expected to be pH 2. The effect of a low pH along with salt effects would need to be evaluated if it would be desirous to investigate the product's implementation as an absorbent as absorbency is a recognizable function of pH and salt concentration. Possible radiological effects on determining quantity and effectiveness of absorbent. The material has some irradiation testing and some KOH salt concentration testing.
Quick-Solid®	Solid, granular cross-linked Polyacrylate /Polyalchol-Copolymer Advanced Superabsorbent Polymer that rapidly absorbs and retains large volumes of aqueous solutions. Product is basically like **STERGO®**, except for the ground size is smaller than **STERGO®**. Therefore the use of **Quick-Solid®** relative to **STERGO®** may produce somewhat more dusting.	**Colloid Environmental Technologies Company (CETCO)** PH: (847)-818-7751 FAX: (847)-506-6150 allen.bullock@cetco.com POC: Allen Bullock	Using this product may cause undesirable dust generation and uncertain inorganic salt absorption interference issues. The pH of the waste water within TFF tank WM 182 that is to be absorbed is unknown but at minimum is planned to be pH 2. The effect of a low pH along with salt effects would need to be evaluated if it would be desirous to investigate the product's implementation as an absorbent as absorbency is a recognizable function of pH and salt concentration. Possible radiological effects on determining quantity and effectiveness of absorbent. The material has some irradiation testing and some NaCl and NaOH salt concentration testing.
NOCHAR - A660 Acid Bond	Dry granular material specifically designed to immobilize acid spills. Nochar Inc. has a number of absorbent products. However, A660 was recommended per telecon with Dennis Campbell, President of Nochar, Inc., as most likely being the best choice Nochar, Inc. product for the TFF application particularly due to acidic nature of the liquid.	**Nochar, Inc.** PH: (770)-297-5120 FAX: (770)-297-6231 inquiry@nochar.com POC: Dennis Campbell DOE focus area POC (Fernald): Ward Brunkow, PH: 937-865-3826	A Nochar product is used for oil containing radiological wastes at Fernald. It is anticipated that the product adsorbed with water (in the TFF case of an acidic inorganic aqueous solution) will have a consistency of "Cream of Wheat" but pass the Paint Filter test. A rubber ball consistency is produced with some waste forms. It is not anticipated that this product would produce compressive strength of 50 PSI. TCLP testing has passed refers to Nochar products other than A660 Acid Bond. Did not receive irradiation testing data from Nochar, Inc.

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Product	Related Uses	Company & POC	Technical information/concerns applicable to fixing free liquids in the INTEC TFF WM 182 tank
Wyoming Bentonite (Western - sodium bentonite)	Naturally occurring colloidal clay (aluminum silicate) composed chiefly of montmorillonite. Used commonly in drilling fluids and cement slurries because of it's strongly thixotropic properties; used in around well casings because of it's swelling and sealing properties, and as a nearly impermeable boundary layer in ponds, lagoons, etc. NOTE: There are legal/patent/ licensing issues relative to purchasing and using bentonite toward the application/methodology of radiological waste management (see "Recommendation" in evaluation).	**WYO-BEN, Inc.** PH: (406)-652-6351 POC: Richard Brown	Product dust generation but may be greatly reduced using granular bentonite, as opposed to powdered bentonite. Excellent absorption and adsorption properties, though the mass ratio of bentonite needed per liquid to be absorbed increases with pH deviation from neutral. Bentonite and the absorbed liquid would not provide compressive strength of 50 PSI. The mixed product would have compressive strength characteristics much like that of a putty or wet spackling compound. A possible advantage may be attributed to its thixotropic behavior. If agitated in place, say by an earthquake, the material would not crumble or break apart forming increased surface area for environmental contaminant mass transfer as perhaps some weak to mildly rigid cement/grout waste forms. After agitation, a bentonite waste form, (based on using pure bentonite) would "set up" retaining it's its higher initial viscosity after the peak disturbance. Unlike many cations, which are readily adsorbed into the mineral structure of bentonite, **calcium** interferes with adsorption capabilities. Aluminum silicate (bentonite) dissociates with acid, definitely at pH 2. A pH of 5 or 6 is desirous. A pH of 4 has been reported for a successful landfill operation bentonite application. Using large quantities of bentonite may be justifiable to dilute degrading effects of low pH (see note below). NOTE: Granular bentonite is **very inexpensive** and perhaps could technically be used in bulk such that the ratio of liquid needed absorbed per bentonite added, would reduce any oozing that may be associated with subsequent concrete/grout addition on top of the absorbed liquid layer. Basically, this approach would be similar to adding concrete/grout over a dry bed of granular bentonite.
Aquaset® II GH GH = Granular and Hardening	One of many Fluid Tech, Inc. solidification/stabilizing agents. There are several **Aquaset®** and **Petroset®** products. **Petroset®** and **Aquaset®** some products require power mixing. However, a new Fluid Tech, Inc. product called **Aquaset® II GH** is a granular and hardening version of the **Aquaset®** products that have been used widely throughout the DOE complex and does note require mixing unlike some other of the Fluid Tech, Inc. products. In numerous cases, depending on the inorganic and organic nature of the waste and recipe formulation, **Aquaset®** and **Petroset®** have produced waste forms that have passed TCLP tests which indicates great adsorption and many active chemical sites for contaminant species.	**Fluid Tech, Inc.** PH: (702)-871-1884 FAX: (702)-871-3629 drowsell@fluid-tech-inc.com POC: Dean Rowsell	Available in granular form to limit dusting problems. Bentonite, a primary constituent has been shown to very successful chemically adsorb a wide variety of chemical/radiological species. Unlike pure bentonite, **Aquaset® II GH** (primarily sepiolite clay, a category palygorskite) swelling is kept to a minimum. Salt and low pH adversely effect sodium bentonite (**Aquaset®**) much more so than sepiolite (**Aquaset® II HG**). In addition, **Aquaset® II HG** has neutralizing capacity. It is anticipated that the hardened form should equal or exceed compressive strength of 50 PSI.

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Product	Related Uses	Company & POC	Technical information/concerns applicable to fixing free liquids in the INTEC TFF WM 182 tank
Cement Clinkers	Clinkers are large chunks (up to around 2 inches in length) of cement produced during the manufacturing of cement that needs to be ground to the desired particle size to be mixed with adequately sized particles during the same manufacturing process. This cement is mixed with gypsum to form cement used in the cement/concrete/grout industry.	Variety of manufacturers - **Ash Grove Cement**; Inkom, ID POC: Leonard Beitz PH: (208)-323-4583	Clinkers may be milled to a size suitable for the need. However there will be some dusting. An advantage of using cement clinkers is the compressive strength will be quite high (well over 50 PSI). However cement does not have the chemical adsorption abilities as bentonite and the polyacrylates and this would not be a selling advantage. Cement clinkers harden very quickly. INEEL (or an INEEL subcontractor) would have to mill Cement Clinkers to a suitable size to use for this TFF closure project application.
Class C Fly Ash	**Class C Fly Ash** hardens whereas **Class F Fly Ash** does not. Fly Ash is widely used in cement/concrete/grout to increase the chemical reaction efficiency and smooth out the physical placement of laying (finishing) cement/concrete/grout formulations.	Variety of manufacturers - **Ash Grove Cement**; Inkom, ID POC: Leonard Beitz PH: (208)-323-4583	Severe dusting problems. May not have the particle size to produce adequate settling/dispersion such that pockets of liquid may be entrained over a hardened shell of Fly Ash without being mixed. Compressive strength of over 50 PSI should easily be achieved. Quite exothermic reaction.
"CKD" Dust	Cement Kiln baghouse dust - having been used	**Ash Grove Cement**; Inkom, ID POC: Leonard Beitz PH: (208)-323-4583	Severe dusting problems. Super fine dust -from cement kiln baghouse. May not have the particle size to produce adequate settling/dispersion such that pockets of liquid may be entrained over a hardened shell of dust without being mixed. Alkaline material. Product compressive strength should easily reach 50-100 PSI.

EDF-015722-038

ENGINEERING DESIGN FILE

PROJECT FILE NO. 051722

EDF SERIAL NO. 051722-38

FUNCTIONAL FILE NO.

PROJECT/TASK **INTEC Tank Farm Facility Closure conceptual Design**

SUBTASK **WM-184, WM-185 & WM-186 Closure**

EDF PAGE NO. 1 OF 1

TITLE **General Pipeline/Enclosure Closure Sequence and Criteria**

SUMMARY

This Engineering Design File (EDF) establishes the sequence for decontamination and grouting the lines associated with tanks WM-184, WM-185 and WM-186. included in this EDF are the criteria from which the closure sequence was derived for these tanks in the Tank Farm Facility (TFF).

The closure steps for the tank and vault are included, but not given in detail. The emphasis is on the line closure sequence. The line closure sequence details the isolation points and locations for the various piping and instrumentation lines. Brief outlines and detailed sequences are included for each of the three tanks. Three-dimensional drawings and a two-dimensional plan view depict each tank, vault and piping system.

This closure sequence is intended for application in conjunction with other TFF closure procedures for the three tanks specified.

See attachment.

QUALITY LEVEL ☐ 1 ☐ 2 ☒ 3

KEYWORDS (e.g. area, structure no., general subject matter, etc.)

TFF, pipe grout, tank closure, pipe decontamination

DISTRIBUTION (COMPLETE PACKAGE):

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AUTHOR	CHECKED	APPROVED/ACCEPTED
J. L. Benson — DATE 10/25/00	B. L. Searle — DATE 10/25/00	D. D. Quigley — DATE
	BBWI REVIEW — E. C. Anderson — DATE 10/25/00	BBWI REVIEW — DATE

Discussion

This Engineering Design File (EDF) summarizes the closure criteria and isolation of TFF tanks WM-184, WM-185 and WM-186. The tank closure order is tank WM-184 first followed by WM-186 and finally WM-185 as outlined in the attached schedule. Two tanks, WM-182 and WM-183 in the TFF are assumed closed prior to the beginning of the closure of these three tanks. Similar guidelines are followed in preparing the closure sequence for tanks WM-184, WM-185 and WM-186 that were applied to the closure sequence of tanks WM-182 and WM-183. At this point no tank closures have been initiated in the TFF and no lessons learned are available for application to the closure sequence for these three tanks. The three tanks addressed in this closure sequence have different configurations that require modifications to the closure procedures applied to tanks WM-182 and WM-183.

The closure process will follow a similar process applied to the previous tanks, although each tank requires a unique sequence for closing. Closure of tanks will consist of decontamination of piping associated with each tank, and the tank itself. Piping directly connected to the tank and isolated from the TFF shall be grouted. The tank and vaults shall also be filled with grout after the decontamination process and washing procedure is complete. All associated piping, including process waste lines, steam lines, ventilation lines, instrumentation lines, sample lines and decon lines, shall be closed. Pipe casings directly connected to the tank/vault shall be decontaminated and grouted as well. All lines and casing will have a termination point identified in order to isolate an individual tank from the existing TFF. Not all lines and encasements are accessible due to their location below grade, but all penetrations to the tank are sealed with the closure process.

General Criteria

1. The "as low as reasonable achievable" (ALARA) principal shall be used throughout the closure process. ALARA is the most critical requirement regarding tank closure. ALARA requires that radiation exposure to personnel is as low as reasonable achievable. Reduce radiation fields and exposure through decontamination, shielding and distance, to ensure the safety and health of personnel. An ALARA assessment is included in the scope of the Conceptual Design.

2. Interference from the tank closure process to ongoing TFF operations shall be kept to a minimum. This enables the continued transfer of liquid waste within the active tanks and to processing facilities.

3. Decontamination of process piping will consist of three acidic solution rinses, (e.g. 0.5 molar aluminum nitrate), followed by two deionized or demineralized water rinses. The volume of each rinse is determined from the calculated pipe volume. This method was used for prior TFF projects. Although not directly related this has been used as a procedure standard in Closure Plans and is assumed acceptable for pipe flushing. Coupled with the hazardous debris standard this method for pipe decontamination should be acceptable. The majority of these lines will also be filled with grout and capped.

4. Process piping that can be isolated from the tank will be considered a yard line and as such decontaminated but will not require grouting. Once decontaminated these lines do not provide a method for liquid to enter a closed tank and do not pose a threat to human health or the environment.

5. Utility and instrumentation lines that do not penetrate into the tank will be cut and capped in place. Since these lines lack openings into the tank, they will not accept fill and they do not present a path for entry to or exit from the tank.

6. Instrumentation lines that penetrate the tank will be filled with an epoxy or grout to the extent possible and then permanently capped.

Closure Equipment

Several specialized components and equipment are referenced in the closure sequence for each tank. Each are listed below giving the reference location for the procedure and physical design. An exhaustive list of equipment is not listed here due to the numerous amount of equipment required for tank closure.

- Split Flow Valves: The installation and design is provided in the CDR. Split flow valves are limited to modifying 3" valves only.

- Single Flow Valves: The installation and design is provided in the CDR. Single flow valves are limited to modifying 2" valves only.

- Trench End Plates: The trench end plates are required for grouting specified concrete encasements from valve boxes to each tank/vault. The fabrication as well as installation guidelines are provided in a drawing and attached to this report.

- Temporary Vessel Off-Gas (VOG) System: The procedure for installation and the required equipment is provided in the CDR.

- Tank Washing/Video Equipment: The equipment required for tank washing and video monitoring is listed in detail in the CDR for this project.

Sequence Format

The first step in developing the tank closure sequence is to identify each line connected to the tank and determining a termination point that will isolate the line from the existing TFF. Lines were identified from the compiled TFF line list and 3-dimensional drawings. The isolation points selected cannot interfere with present or future tank closure procedures.

The sequence format consists of a table detailing termination points in valve boxes or buildings in the TFF. The location of each termination point is given and the action taken to begin decontamination as required or grouting. The sequential order is given in a separate table for each tank. Each tank is reviewed in this report with a description and outline for individual tank closure sequences.

Each tank will have a temporary ventilation system installed using the existing VOG lines prior to beginning any closure activity. This will require cutting into the VOG system at an accessible location. Once the temporary ventilation system is in place, decontamination of valve boxes and associated TFF buildings continues. The temporary VOG system will remain in operation until the tank is closed. Decontamination is required for accessing the predetermined termination points for specified lines, including VOG modification. Within each decontaminated valve box

specified lines are prepared for closure by installing appropriate fittings. Specified lines are decontaminated and are then temporarily capped until grouting. If there are any other lines connected to the vault they are also decontaminated or filled and sealed, i.e. small instrumentation lines. All instrumentation lines connected to the tank are also filled and sealed at this time. Additional decontamination liquid is required and added to the vaults, in order to decontaminate the process waste lines on the discharge side of the jet pumps. The steam supply lines to the vault jet pumps are left operable in order to remove liquid from the vaults. At this point all lines entering and leaving the vault are decontaminated. Special consideration should be given to the process waste lines on the discharge side of the vault jets going to Valve Box C16, in order to ensure proper decontamination. Any remaining lines going into the tank are decontaminated with the exception of the lines connected to the tank steam jets and the VOG lines. Tank WM-185 contains cooling coils and these will be purged and grouted. The tank risers are accessed and modified for the installation of the washing and video equipment. Depending on the volume of solids present in each tank, a washing and steam jet pumping cycle is performed before displacing residual heel with placements of grout. Once the grout placements are completed and heel minimized then grouting of lines may begin. Prior to grouting lines entering the vaults, the vault sumps are filled with a shallow layer of grout in order to plug the steam jet inlets for the three vault jets. This is done in order to pump grout from the steam lines through the jet and into the process waste lines on the discharge side of the jets. There are three vault jets, two discharge through lines into the tank and the third discharge line goes to Valve Box C16 where it is isolated. The remaining lines are grouted going into the tank and vault, except for the VOG lines. The tank and vault are filled with alternate pours until both are filled with grout. The temporary VOG system is removed and the VOG lines connected to the tank are filled with grout. Each tank and vault riser is topped with grout isolating the tank and completing the tank closure.

Some valve boxes and other TFF buildings are shared by several tanks. No valve box will be grouted during any tank closure sequence. Several valve boxes will no longer have active lines within them, but shall be left accessible for any future modifications or closure plan. All active or inactive lines must be confined with temporary or permanent caps or other devices, i.e. split flow valves, single flow valves.

Tank WM-184 Closure Sequence Outline

The closure sequence for WM-184 does not directly decontaminate or grout three 3" lines, one 1" line, one ½" line and one unnamed drain line.

- The three 3" lines not decontaminated and directly grouted exit the top east side of the tank. These three lines were intended for future connections with other tanks and were never used to transfer process waste. These three lines are in a concrete encasement for a short distance and then they are encased individually in 6" pipe. Each of these 3" lines is capped and has a 1" decontamination line connected at each capped end and the decontamination lines are also capped below grade. All three lines are grouted at the tank interface near the top edge of the wall as the tank is filled with grout.
- The 1" PUA-659 line is a drain for the pipe encasement on the east side of the tank. The pipe encasement contains the three unused 3" lines described above. This 1" PUA-659 drain line connects to another drain line entering the vault that is grouted.
- The ½" PUA-642 condensate drain line is from a VOG line to another drain line that flows directly into the vault. The line draining to the vault is grouted as well as the VOG line, isolating the ½" condensate drain line from the tank.
- The unnamed drain line originates from a concrete encasement housing 3" PUA-630 and 631 and attaches to 1" PUA-657 emptying into the vault sump. The 1" PUA-657 line as well as the pipe encasement shall be grouted.

1. CPP-723: Closure sequence begins with installing the temporary VOG system to support the tank closure process. The installation of the temporary VOG system is contained in the Conceptual Design Report (CDR).

2. Valve Box A7: Decontaminate the valve box and specified lines going to the tank and the vault.

3. CPP-628: Fill ¼" instrumentation lines going to tank and cap.

4. WM-184 North (SR-22) & South (SR-23) Vault Risers: Supply decontamination liquid and if necessary, decontaminate the sample lines.

5. WM-184 Tank Risers: Decontaminate the tank risers through decontamination lines and prepare risers for the tank closure equipment installation. Begin tank closure process ending with grout placements.

6. WM-184 North (SR-22) & South (SR-23) Vault Risers: Add grout to plug vault jet suction inlets.

7. Valve Box A7: Grout process waste lines to vault and tank. Also grout trench going to WM-184.

8. CPP-628: Prepare steam lines for grouting.

9. Valve Box C16: Decontaminate valve box and prepare line for grout venting and grout specified line.

10. CPP-628: Grout steam lines.

11. Valve Box C16: Grout specified lines and cap.

12. Valve Box C17: Prepare steam lines and pump grout through steam lines into the vault sump jets and out through the discharge lines that connect to Valve Box C16.

13. Valve Box C16: Stop grouting from Valve Box C17 when grout is visible through the discharge lines from the vault sump jets.

14. Valve Box C17: Cap grouted steam lines after grouting is complete.

15. WM-184 North (SR-22) & South (SR-23) Vault and Tank Risers: Grout alternating layers of grout between tank and vaults. There are three 3" process waste lines that exit the tank and are capped within the yard. These lines will be grouted at the tank by filling the tank with grout.

16. CPP-723: Remove temporary VOG system. Fill VOG line going to tank with grout.

17. WM-184 Tank Risers and North (SR-22) & South (SR-23) Vault Sump: Top off each riser with grout and close tank.

Action	Result **WM-184**	Flow Destination
Install temp VOG system in CPP-723 = modification of 10 VGA-605	Modify 10 VGA-605	into 184
****Decon CPP-723** = decon drain line = decon 1 PUA-657 - Cap or permanently plug drain	**This will be accomplished when the temp VOG **system is installed. Decon of sump drain for CPP-723 Connects to 1 PUA-657 & 658 Drain may not be directly accessible.	into 1 PUA-657 into vault
Decon Valve Box A7 - IF sump drain is NOT capped THEN = decon 1 PUA-658 - IF sump drain is capped THEN - Uncap sump drain - Decon line 1 PUA-658 - Install grout connection to sump drain - Replace valve PUV-WM-22 w/ split flow - Temp cap tube going to 3 PUA-1014 - Prep line 3 PUA-631 for decon - Decon line 3 PUA-631 - Remove cap - Install decon/grout connection - Decon Line 3 PUA-630	Decon of 1 PUA-658, sump drain for A7 Supply steam to 1 HS-AR-156327 to remove liquid Sump drain line 1 PUA-658 feeds into 1 PUA-657 space within the sump is limited. Valve for line 3 PUA-631 Do NOT decon line tube going to 3 PUA-1014 For line 3 PUA-630	into 1 PUA-657 into 1 PUA-657 into 184 into 184
Access/Decon CPP-628 - Fill 1/4 INST-601 thru 604 - Fill 1/4 INST-605 thru 619 - Cap 2" Conduit, wires for (10) instruments - Cap all instrumentation lines	Fill as much as possible the (4) inst. lines Fill as much as possible the (15) inst. lines Fills the 1/2 INST lines, (10) temp. indicator lines that go into the west and east side of the tank from junction boxes on each side. (5) per side.	into vaults into 184 into J-box
Access N (SR-22) & S (SR-23) vault risers - Add decon liquid to vaults	IF 1-1/2 SAMPLE lines (2) accessible THEN decon This liquid needed to decon waste lines off the (3) vault steam jets	
Activate all (3) vault jets = decon 1-1/4 PLA-104706 = decon 2 PUA-638 = decon 2 PUA-639 = decon 2 PUA-641 = decon 2 PUA-640	(3) steam lines do not require decon Intake and waste transfer for JET WM-584-4 Off JET WM-537 Off JET WM-536 Intake line from sump to jet WM-537 Intake line from sump to jet WM-536	out to C-16 into 184 into 184
Decon 2 DCN-609 thru 612	Decons the (4) tank risers by ext quick connects	into 184
Access the (4) tank risers	Prepare for tank closure equipment installation	

Action	Result **WM-184**	Flow Destination
Install washing/grouting equip - Wash the tank - Activate tank steam jets - Begin grout placements - Activate tank steam jets - Finish grout placements - Fix free liquids	Install riser interface, washball, video camera and grout mast in appropriate order Empty tank to heel Displace heel to be removed by tank jets	
Access N & S vault risers - Fill N & S vault w/ shallow layer of grout = line 2 PUA-640 is partially grouted = line 2 PUA-641 is partially grouted - Allow grout to cure	Cover the suction inlet of all jet pumps but do NOT flood the nozzle chamber with grout Suction inlet for vault JET-WM-536 Suction inlet for vault JET-WM-537 Cure sufficiently to plug inlet of jet pumps	
Access Valve Box A7 - Grout line 1 PUA-658 = line 1 PUA-657 is grouted also = 1 PUA-659 is isolated from tank - Cap 1 PUA-658 - Grout line 3 PUA-631 - Cap 3 PUA-631 - Grout line 3 PUA-630 - Cap 3 PUA-630 - Measure trench opening and piping - Install trench end-plate - Grout trench using grout connection - Leave end-plate in place	1 PUA-659 drained into 1 PUA-657 Permanent cap Permanent cap for grouted split flow opening, Temp cap for split flow opening connected to 3 PUA-1014 Permanent cap For trench with lines 3 PUA-630 & 631 Field fit according to instructions for trench end-plate Allow grout to cure	into 1 PUA-657 into S vault into 184 into 184
Access CPP-628 - Isolate steam line 1-1/2 HSA-1016 - Modify for grout connection - Install grout connection - Do NOT grout at this time - Isolate steam line 1-1/2 HSA-1017 - Modify for grout connection - Install grout connection - Do NOT grout at this time	Isolate from main steam header and other lines Cut and cap lines as necessary Isolate from main steam header and other lines Cut and cap lines as necessary	
Decon Valve Box C16 - Remove Valve PLV-WM-5 - Cap end going to 1-1/2 PLA-104710 - Modify 1-1/4 PLA-104706 - Monitor during grouting from Valve Box C17	For line 1-1/4 PLA-104706 Allow air displaced by grout to vent Watch for grout and allow displaced air to vent	

Action	Result **WM-184**	Flow Destination
- Replace valve PUV-WM-133 w/ split flow - Cap opening going to tee with 2 PUA lines - Install grout connection - Grout line 3 PUA-1037 going to tank - Cap grouted line - Replace valve PUV-WM-132 w/ single flow - Replace valve PUV-WM-134 w/ single flow	For line 3 PUA-1037 Do not obstruct line between 2 PUA-1093 & 3 PUA-1037 For line 2 PUA-1039 For line 2 PUA-1093	 into 184
Within CPP-628 - Grout line 1-1/2 HSA-1016 - Grout line 1-1/2 HSA-1017 - Cap both steam lines		 into 184 into 184
Within Valve Box C16 - Grout line 2 PUA-1039 going to tank - Grout line 2 PUA-1093 going to tank - Cap both process waste lines		 into 184 into 184
Access Valve Box C17 (no decon) - Cut & cap incoming steam supply line - Remove valve HSV-WM-229 - Install grout connection to 1 HSA-104729 - Grout line 1 HSA-104729 = line 1-1/4 PLA-104706 is grouted also - Cap 1 HSA-104729 - Remove valve HSV-WM-228 - Install grout connection 1 HSA-608 - Grout line 1 HSA-608 = line 1-1/2 HSA-608 is grouted also = line 2 PUA-639 is grouted also - Cap 1 HSA-608 - Remove valve HSV-WM-227 - Install grout connection to 1 HSA-607 - Grout line 1 HSA-607 = line 1-1/2 HSA-607 is grouted = line 2 PUA-638 is grouted also - Cap 1 HSA-607	Line 1 HSA-104726, downstream of Valve HSV-WM-226 leaving valve intact and operational Remove pipe as necessary for line 1 HSA-104729 This is accomplished by forcing grout through the jet to the open end of line 1-1/4 PLA-104706 in Valve Box C16 stop grouting 1 HSA-104729 when grout is visible at C16 Remove pipe as necessary for line 1 HSA-608 This is accomplished by forcing grout throught the open end of line 2 PUA-639 into tank 184 Remove pipe as necessary for line 1 HSA-607 This is accomplished by forcing grout throught the open end of line 2 PUA-638 into tank 184	 into N vault out to C16 into 1-1/2 HSA into N vault into 184 into 1-1/2 HSA into S vault into 184

Action	Result **WM-184**	Flow Destination
Within Valve Box C16 - Stop grouting from Valve Box C17 - Cap tube connected to 1-1/4 PLA-104706	When grout is visible	
Access N (SR-22) & S (SR-23) vault risers & tank risers - Beginning with the vault pour alternating layers of grout between the tank and vault - Fill both tank and vaults with layers = 3 PUA-635 will be grouted at the tank = 3 PUA-636 will be grouted at the tank = 3 PUA-637 will be grouted at the tank	Keep the overall levels of grout in the tank and vaults approximately equivalent Exits tank and is capped underground, not accessible Exits tank and is capped underground, not accessible Exits tank and is capped underground, not accessible	
Within CPP-723 - Remove the temporary VOG system - Cap the section not connected to 184 - Fill 10 VGA-605 going to 184 w/ grout = line 1/2 PUA-642 is grouted at both ends	This will fill the tank and the manway	into 184
Access the tank risers and vault risers - Top off each riser with grout - Grout (4) tank riser decon lines = lines 2 DCN-609 thru 612 grouted	Tank and vault will be closed	into 184

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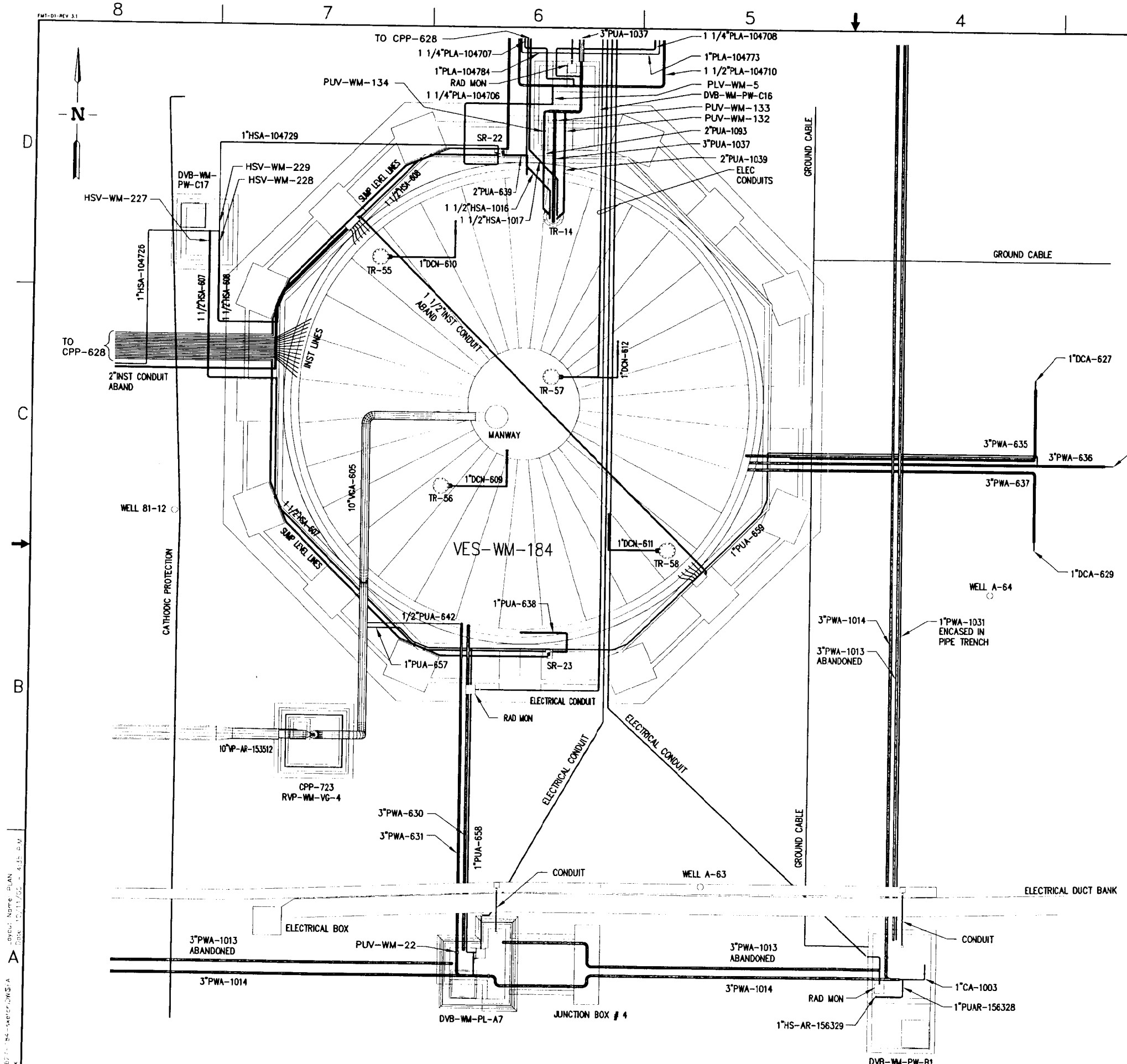

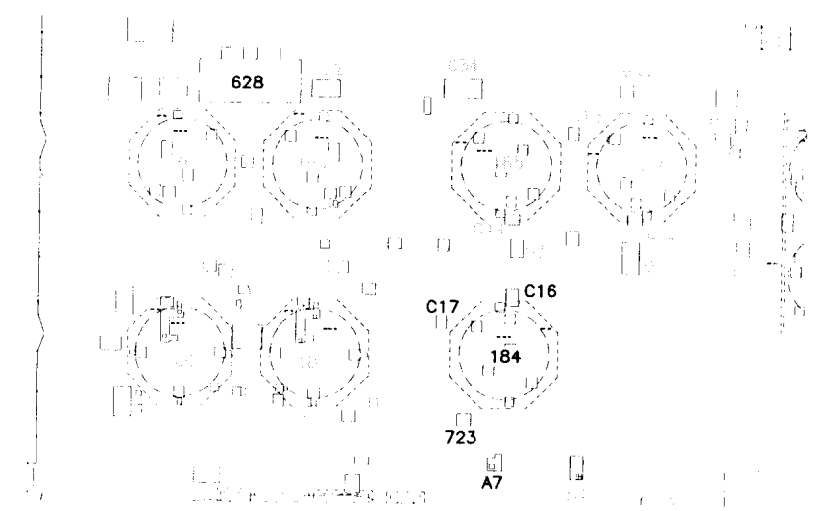

KEY MAP
SCALE: NONE

NOTES

1. TANK VAULT, CONCRETE TANK RISERS, CONCRETE SUMP RISERS, CONCRETE TRENCHES, AND PILES, ARE NOT SHOWN IN THIS VIEW.

FOR DRAWING INDEX SEE DRAWING NO.	SUBCONTRACT NO.	INEEL
SCALE: 3/16" = 1'-0"	REQUESTER: K.D. QUIGLEY DESIGN: ED ANDERSON DRAWN: KEITH BRONSON PROJECT NO. 015722 SPEC CODE	INTEC TANK FARM FACILITY CLOSURE VES-WM-184 PLAN VIEW
DESIGN PHASE: CONCEPTUAL	FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO.	SIZE D; CAGE CODE; INDEX CODE NUMBER AREA / TYPE / CL / ORIG 090; DWG-; REV
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FMT-01-REV 3.1

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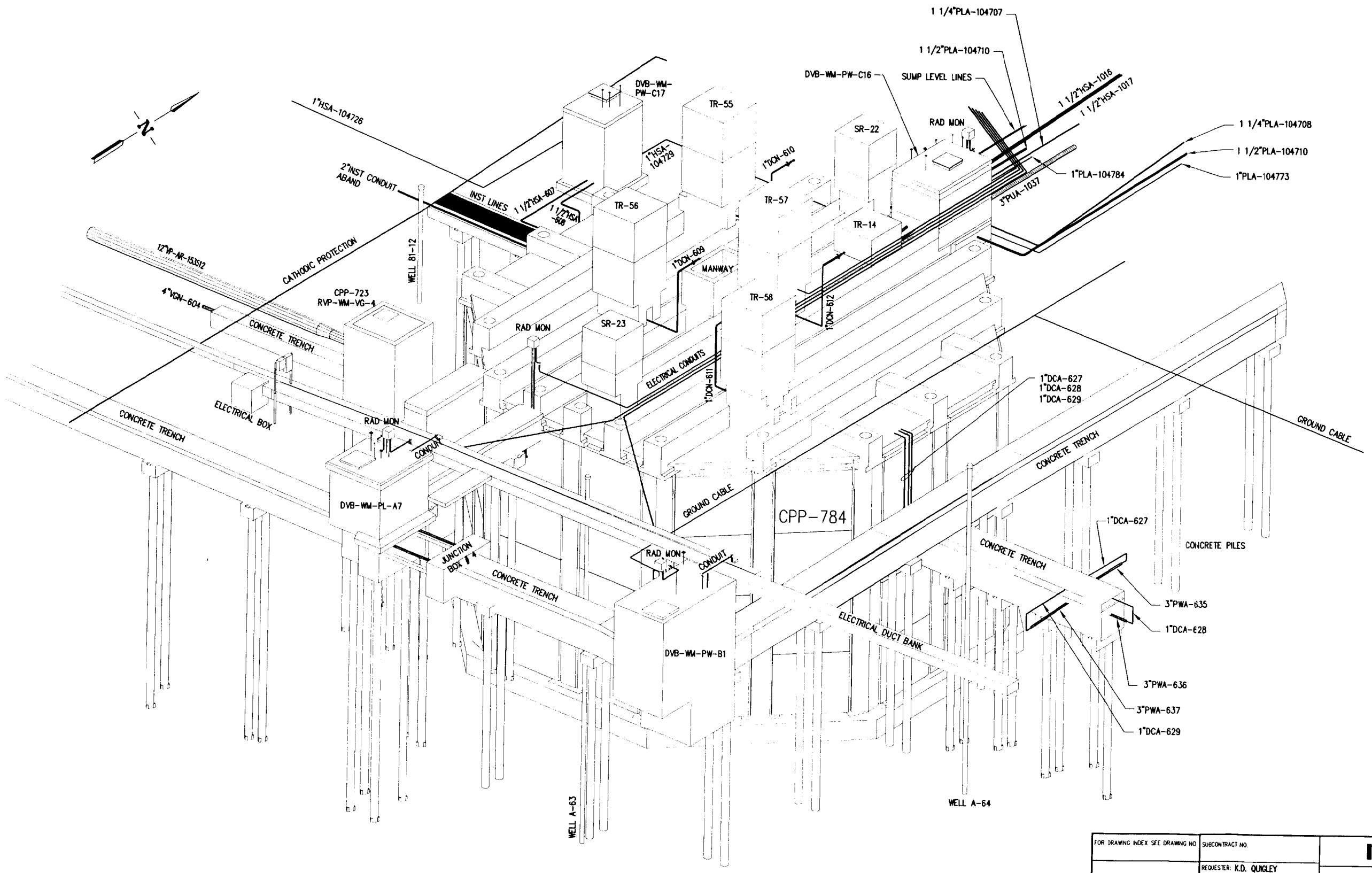

FOR DRAWING INDEX SEE DRAWING NO	SUBCONTRACT NO.	INEEL (Idaho National Engineering and Environmental Laboratory) BECHTEL BWXT IDAHO, LLC
NO SCALE	REQUESTER: K.D. QUIGLEY DESIGN: ED ANDERSON DRAWN: KEITH BRONSON PROJECT NO. 015722 SPEC CODE	INTEC TANK FARM FACILITY CLOSURE VES-WM-184 VIEW OF VAULT LOOKING NORTHWEST
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QUALITY LEVEL: 3	EFFECTIVE DATE:	SCALE: NONE; SHEET U-SK29

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FMT-D1-REV 3.1

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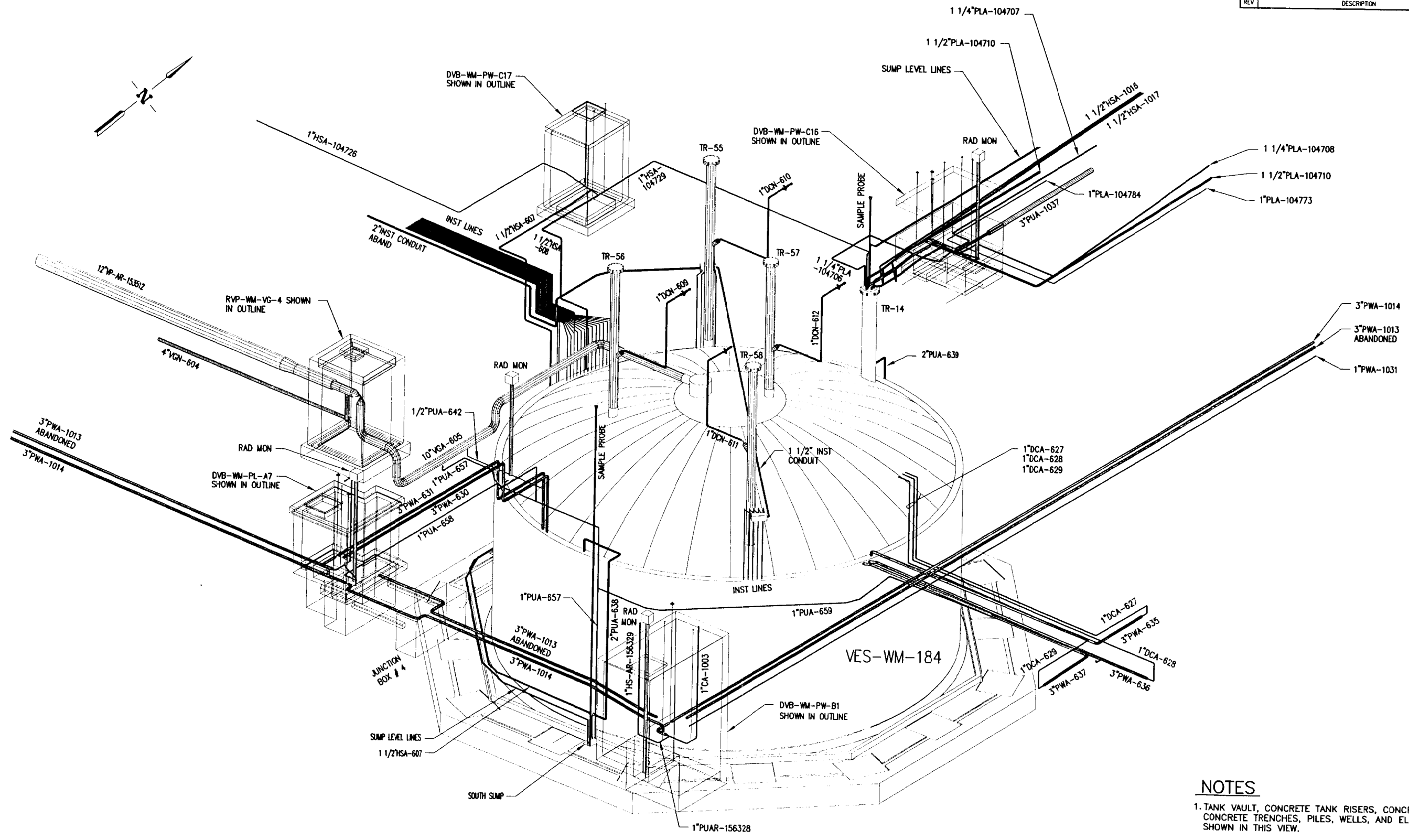

NOTES

1. TANK VAULT, CONCRETE TANK RISERS, CONCRETE SUMP RISERS, CONCRETE TRENCHES, PILES, WELLS, AND ELECTRICAL ITEMS NOT SHOWN IN THIS VIEW.

FOR DRAWING INDEX SEE DRAWING NO.	SUBCONTRACT NO.	INEEL (Idaho National Engineering & Environmental Laboratory) BECHTEL BWXT IDAHO, LLC
NO SCALE	REQUESTER: K.D. QUIGLEY DESIGN: ED ANDERSON DRAWN: KEITH BRONSON PROJECT NO. 015722 SPEC CODE	INTEC TANK FARM FACILITY CLOSURE VES-WM-184 VIEW OF TANK LOOKING NORTHWEST
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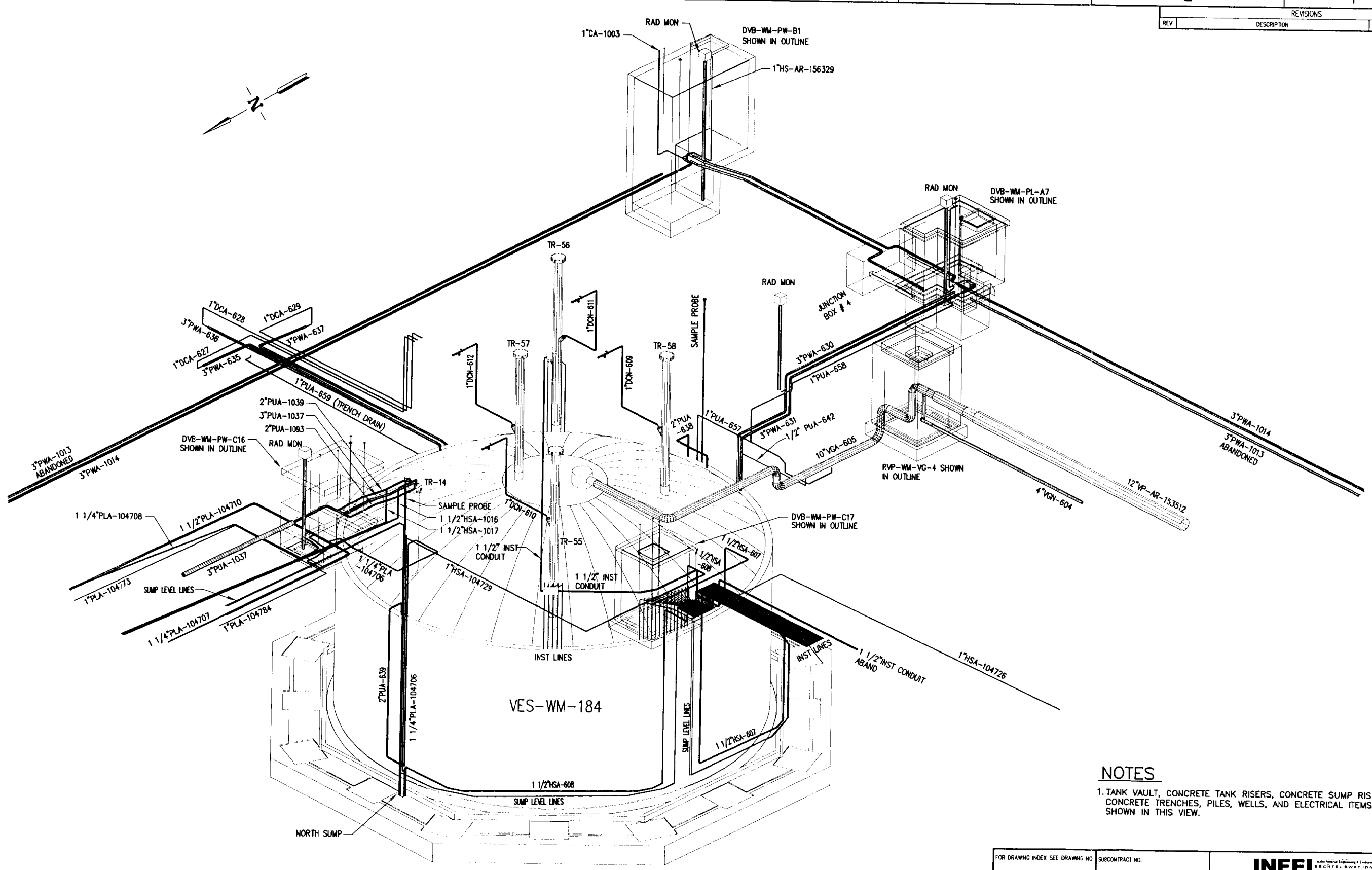

NOTES

1. TANK VAULT, CONCRETE TANK RISERS, CONCRETE SUMP RISERS, CONCRETE TRENCHES, PILES, WELLS, AND ELECTRICAL ITEMS NOT SHOWN IN THIS VIEW.

FOR DRAWING INDEX SEE DRAWING NO.	SUBCONTRACT NO.	INEEL (Idaho National Engineering and Environmental Laboratory) BECHTEL BWXT IDAHO, LLC
NO SCALE	REQUESTER: K.D. QUIGLEY DESIGN: ED ANDERSON DRAWN: KEITH BRONSON PROJECT NO. 015722 SPEC CODE	INTEC TANK FARM FACILITY CLOSURE VES-WM-184 VIEW OF TANK LOOKING SOUTHEAST
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Tank WM-185 Closure Sequence Outline

The closure sequence for WM-185 does not directly decontaminate or grout an unnamed drain line.

- The unnamed drain line originates from a concrete encasement housing lines 3" PUA-1028, 1029 and 208 and attaches to 1" PUA-1023 drain line emptying into the vault sump. The 1" PUA-1023 drain line as well as the pipe encasement shall be grouted.

1. Install temporary VOG system near CPP-722 to support the tank closure process. The installation of the temporary VOG system is contained in the Conceptual Design Report (CDR).

2. CPP-722: Decontaminate valve box and the specified line going to the tank.

3. Valve Box B4: Decontaminate only. This decontaminates the valve box drain line that empties into the south vault (SR-2).

4. Valve Box B3: Decontaminate and prepare three lines for grouting by decontaminating.

5. CPP-634: Fill ¼" instrumentation lines going to tank and cap.

6. WM-185 North (SR-1) & South (SR-2) Vault Risers: Supply decontamination liquid and if necessary, decontaminate the sample lines.

7. CPP-634: Purge each cooling coil supply and return line with compressed air. Send cooling solution to processing and grout each cooling coil.

8. WM-185 Tank Risers: Decontaminate the tank risers through decontamination lines and prepare risers for the tank closure equipment installation. Begin tank closure process ending with grout placements.

9. WM-185 North (SR-1) & South (SR-2) Vault Risers: Add grout to plug vault jet suction inlets.

10. Valve Box B3: Grout the specified lines going into tank. Install trench end plate then grout the pipe encasement.

11. Valve Box B4: Install grout connection to sump drain and grout line.

12. CPP-628: Prepare steam lines for grouting.

13. Valve Box C14: Prepare specified lines for grouting.

14. CPP-628: Grout steam lines and cap.

15. Valve Box C14: Grout specified lines and cap.

16. Valve Box C16: Decontaminate valve box and prepare for grout venting.

17. Valve Box C13: Prepare and grout specified steam lines, one line connects to Valve Box C16 and grouting will stop when visible in Valve Box C16.

18. Valve Box C16: Stop grouting from Valve Box C13 when grout is visible.

19. CPP-722: Grout and cap specified line.

20. WM-185 North (SR-1) & South (SR-2) Vault Risers and Tank Risers: Grout alternating layers of grout between tank and vaults.

21. Remove temporary VOG system near CPP-722. Fill VOG line going to the tank with grout.

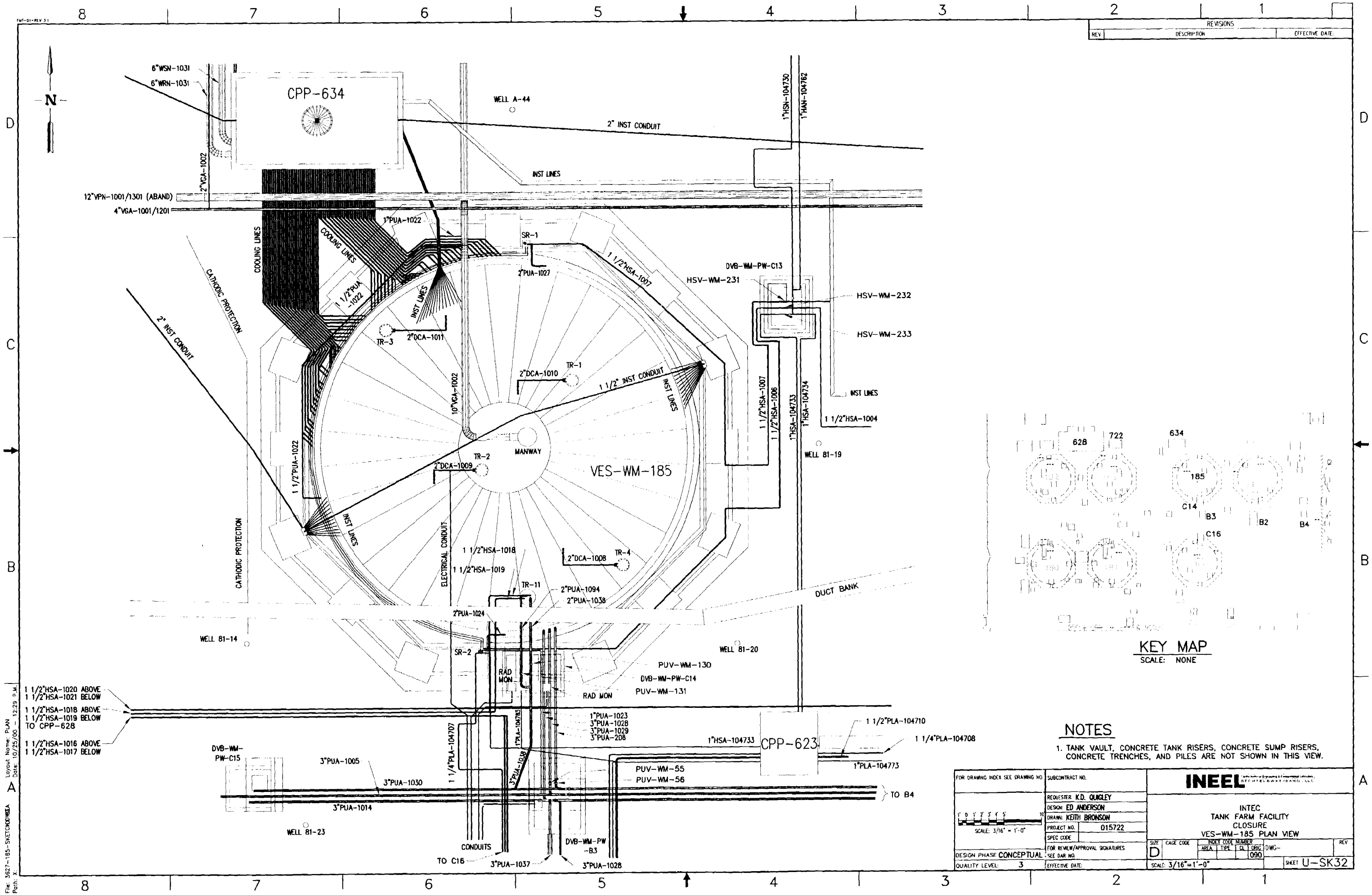
22. WM-85 Tank risers and North (SR-1) & South (SR-2) Vault risers: Top off each riser with grout and closed tank.

Action	Result **WM-185**	Flow Destination
Install temp VOG system near CPP-722	Modify 10 VGA-1002	
Decon CPP-722 - Remove valve PUV-WM-111 - Cap opening connected to HE-WM-383 - Prep line 1-1/2 PUA-1022 for decon - Install decon/grout connection - Decon line 1-1/2 PUA-1022	Activate JET-WM-535 to remove decon liquid as needed Valve for line 1-1/2 PUA-1022	into 185
Decon Valve Box B4	Decon drain line 1 PUA-1023 from B4 to 185 S (SR-2) vault	into S vault
Decon Valve Box B3 - Remove cap on line 1 CA-1012 - Install decon/grout connection - Decon line 1 CA-1012 = line 3 PUA-1028 is deconed also - Replace valve PUV-WM-55 w/ split flow - Temp cap the tube going to 3 PUA-1005 - Prep line 3 PUA-1029 for decon - Decon line 3 PUA-1029 - Replace valve PUV-WM-56 w/ split flow - Temp cap the tube going to 3 PUA-1030 - Prep line 3 PUA-208 for decon - Decon line 3 PUA-208	This will decon the sump drain into line 1 PUA-1023 1 CA-1012 is connected to 3 PUA-1028 Valve for line 3 PUA-1029 Do NOT decon the line going to 3 PUA-1005 Valve for line 3 PUA-208 Do NOT decon the line going to 3 PUA-1030	into S vault into 3 PUA-1028 into 185 into 185 into 185
Access /Decon CPP-634 - Fill 1/4 INST-LI-3 & 5 - Fill 1/4 INST-SPARE - Fill 1/4 INST-P - Fill 1/4 INST-L1 thru L5 - Fill 1/4 INST-S1 thru S8 - Cap all instrumentation lines	Fill as much as possible the (2) inst. lines Fill as much as possible the (2) inst. lines Fill as much as possible the (1) inst. line Fill as much as possible the (5) inst. lines Fill as much as possible the (8) inst. lines	into vault into vault into tank into tank into tank
Access N (SR-1) & S (SR-2) vault risers - Add decon liquid to vaults	IF 1-1/2 SAMPLE lines (2) accessible THEN decon This liquid needed to decon waste lines off the (3) vault steam jets	
Activate all (3) vault jets = decon 1-1/4 PLA-104707 = decon 2 PUA-1024 = decon 2 PUA-1027 = decon 2 PUA-1025 = decon 2 PUA-1026	(3) steam lines do not require decon Intake and waste transfer for JET WM-585-4 Off JET WM-585-1 Off JET WM-585-2 Intake line from sump to jet WM-585-1 Intake line from sump to jet WM-585-2	out to C-16 into 185 into 185

Action	Result **WM-185**	Flow Destination
Access CPP-634 - Purge cooling coils with compressed air - Grout each cooling supply line = each cooling return line grouted - Cap each cooling supply line - Cap each cooling return line	Either through the individual coils or through the solution supply line 6 CSN-1031. The cooling solution must go to processing. Lines 1-1/2 WSA(CSN)-1001 thru 1030 Lines 1-1/2 WRA(CRN)-1001 thru 1030	 into 185 out of 185
Decon 2 DCA-1008 thru 1011 = decon 12 VGA-1003 thru 1006	Decons the (4) tank risers by external quick connects The (4) access risers for tank 185	into 185
Access the (4) tank risers	Prepare for tank closure equipment installation	
Install washing/grouting equip - Wash the tank - Activate tank steam jets - Begin grout placements - Activate tank steam jets - Finish grout placements - Fix free liquids	Install riser interface, washball, video camera and grout mast in appropriate order Empty tank to heel Displace heel to be removed by tank jets	
Access N (SR-1) & S (SR-2) vault risers - Fill N & S vault w/ shallow** layer of grout = line 2 PUA-1025 is partially grouted = line 2 PUA-1026 is partially grouted - Allow grout to cure over jet suction inlets	**Cover the suction inlet of all jet pumps but do NOT flood the nozzle chamber with grout Suction inlet to JET-WM-585-1 Suction inlet to JET-WM-585-2 Cure sufficiently to plug inlet of jet pumps	
Access Valve Box B3 - IF decon solution needed to access B3 - Grout line 1 CA-1012 = line 3 PUA-1028 is grouted also - Cap 1 CA-1012 - Grout line 3 PUA-208 - Cap 3 PUA-208 - Grout line 3 PUA-1029 - Cap 3 PUA-1029 - Measure trench opening and piping - Install trench end-plate - Grout trench using grout connection - Leave end-plate in place - Permanently cap or plug drain in sump Replace Valve Box B3 cover	THEN activate S vault jet 585-4 Permanent cap Permanent cap For trench with lines 3 PUA-1028, 1029 & 208 Field fit according to instructions for trench end-plate Connected to line 1 PUA-1023	 into 3 PUA-1028 into 185 into 185 into 185

Action	Result **WM-185**	Flow Destination
Access Valve Box B4		
- IF decon solution needed to access B4	THEN activate S vault jet 585-4	
- Install grout connection to sump drain	Line 1 PUA-1023 is the drain line for Valve Box B4 space within Valve Box B4 sump is limited.	
- Grout line 1 PUA-1023		into S vault
- Cap 1 PUA-1023	Permanent cap	
Access CPP-628	Grout lines 1-1/2 HSA-1018 & 1019	
- Isolate steam line 1-1/2 HSA-1018	Isolate from main steam header and other lines	
- Modify for grout connection	Cut and cap lines as necessary	
- Install grout connection		
- Do NOT grout at this time		
- Isolate steam line 1-1/2 HSA-1019	Isolate from main steam header and other lines	
- Modify for grout connection	Cut and cap lines as necessary	
- Install grout connection		
- Do NOT grout at this time		
Decon Valve Box C14		
- Replace valve PUV-WM-130 w/ single flow	For line 2 PUA-1038	
- Replace valve PUV-WM-131w/ single flow	For line 2 PUA-1094	
Within CPP-628		
- Grout line 1-1/2 HSA-1018		into 185
- Grout line 1-1/2 HSA-1019		into 185
- Cap both steam lines	Permanent cap	
Within Valve Box C14		
- Grout line 2 PUA-1094 going to tank		into 185
- Grout line 2 PUA-1038 going to tank		into 185
- Cap both process waste lines		
Decon Valve Box C16		
- Remove Valve PLV-WM-6	For line 1-1/4 PLA-104707	
- Cap end going to 1-1/2 PLA-104710		
- Modify 1-1/4 PLA-104707	Allow air displaced by grout to vent	
- Monitor during grouting in Valve Box C13	Watch for grout to appear from opening	
Access Valve Box C13 (no decon)		
- Remove valve HSV-WM-233	Remove pipe as necessary for line 1 HSA-104733	
- Cap opening connected to steam supply	Steam supply line 1 HSN-104730 or 1 HAA-104762	
- Install grout connection to 1 HSA-104733		
- Grout line 1 HSA-104733		into S vault
= line 1-1/4 PLA-104707 is grouted also	This is accomplished by forcing grout through the jet to the open end of line 1-1/4 PLA-104707 in Valve Box C16 stop grouting 1 HSA-107733 when grout is visible at C16	out to C16

Action	Result **WM-185**	Flow Destination
- Cap 1 HSA-104733 - Remove valve HSV-WM-232 - Cap opening connected to steam supply - Install grout connection to 1 HSA-1006 - Grout line 1 HSA-1006 = line 2 PUA-1024 is grouted also - Cap 1 HSA-1006 - Remove valve HSV-WM-231 - Cap opening connected to steam supply - Install grout connection to 1 HSA-1007 - Grout line 1 HSA-1007 = line 2 PUA-1027 is grouted also - Cap 1 HSA-1007	Remove pipe as necessary for line 1 HSA-1006 Steam supply line 1 HSN-104730 or 1 HAA-104762 This is accomplished by forcing grout throught the open end of line 2 PUA-1024 into tank 185 Remove pipe as necessary for line 1 HSA-607 Steam supply line 1 HSN-104730 or 1 HAA-104762 This is accomplished by forcing grout through the open end of line 2 PUA-1027 into tank 185	into S vault into 185 into N vault into 185
Within Valve Box C16 - Stop grouting from Valve Box C13 - Cap tube connected to 1-1/4 PLA-104707		
Access CPP-722 - Grout line 1-1/2 PUA-1022 - Cap 1-1/2 PUA-1022		into 185
Access N (SR-1) & S (SR-2) vault risers & tank risers - Beginning with the vault pour alternating layers of grout between the tank and vault - Fill both tank and vaults with layers	Keep the overall levels of grout in the tank and vaults approximately equivalent	
Adjecent to CPP-722 - Remove the temporary VOG system - Cap the section not connected to 185 - Fill 10 VGA-1002 going to 185 w/ grout = line 1 PUA-1022 is grouted at both ends	This will fill the tank and the manway	into 185
Access the tank risers and vault risers - Top off each riser with grout - Grout (4) tank riser decon lines = lines 2 DCA-1008 thru 1011 grouted	Tank and vault will be closed	into 185



KEY MAP
SCALE: NONE

NOTES

1. TANK VAULT, CONCRETE TANK RISERS, CONCRETE SUMP RISERS, CONCRETE TRENCHES, AND PILES ARE NOT SHOWN IN THIS VIEW.

REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE:

FOR DRAWING INDEX SEE DRAWING NO.	SUBCONTRACT NO.	INEEL
SCALE: 3/16" = 1'-0"	REQUESTER: K.D. QUIGLEY	INTEC TANK FARM FACILITY CLOSURE VES-WM-185 PLAN VIEW
	DESIGN: ED ANDERSON	
	DRAWN: KEITH BRONSON	
	PROJECT NO. 015722	
	SPEC CODE	
DESIGN PHASE CONCEPTUAL	FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO.	SIZE D; CAGE CODE; INDEX CODE NUMBER: AREA, TYPE, CL, ORG 090; DWG-; REV
QUALITY LEVEL: 3	EFFECTIVE DATE:	SCALE: 3/16"=1'-0"; SHEET U-SK32

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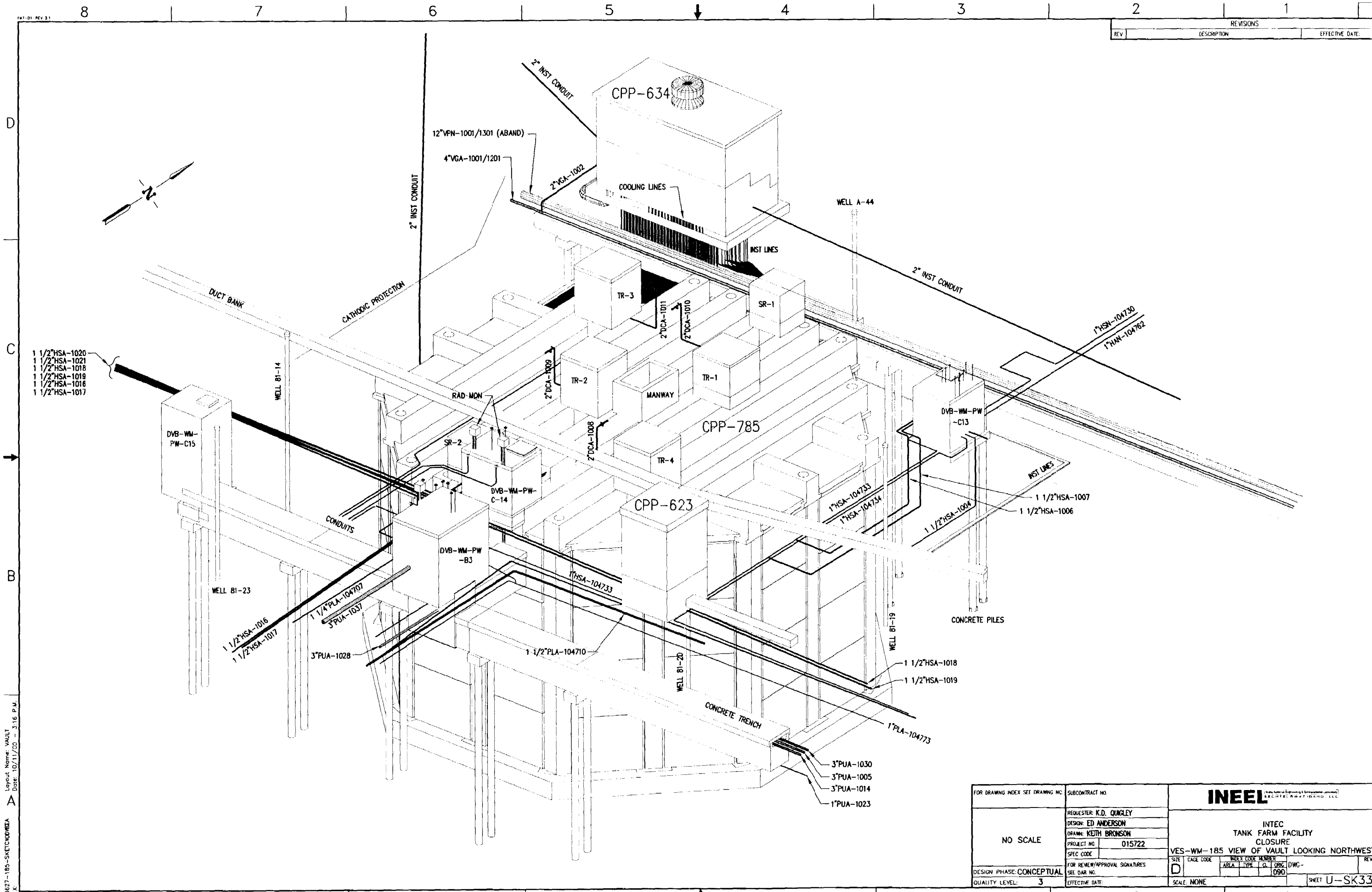

REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE:

FOR DRAWING INDEX SEE DRAWING NO.	SUBCONTRACT NO.	INEEL
NO SCALE	REQUESTER: K.D. QUIGLEY DESIGN: ED ANDERSON DRAWN: KEITH BRONSON PROJECT NO. 015722 SPEC CODE	INTEC TANK FARM FACILITY CLOSURE VES-WM-185 VIEW OF VAULT LOOKING NORTHWEST
DESIGN PHASE: CONCEPTUAL	FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO.	SIZE D · CAGE CODE · INDEX CODE NUMBER: AREA, TYPE, Q, ORIG 090 · DWG- · REV
QUALITY LEVEL: 3	EFFECTIVE DATE:	SCALE: NONE · SHEET U-SK33

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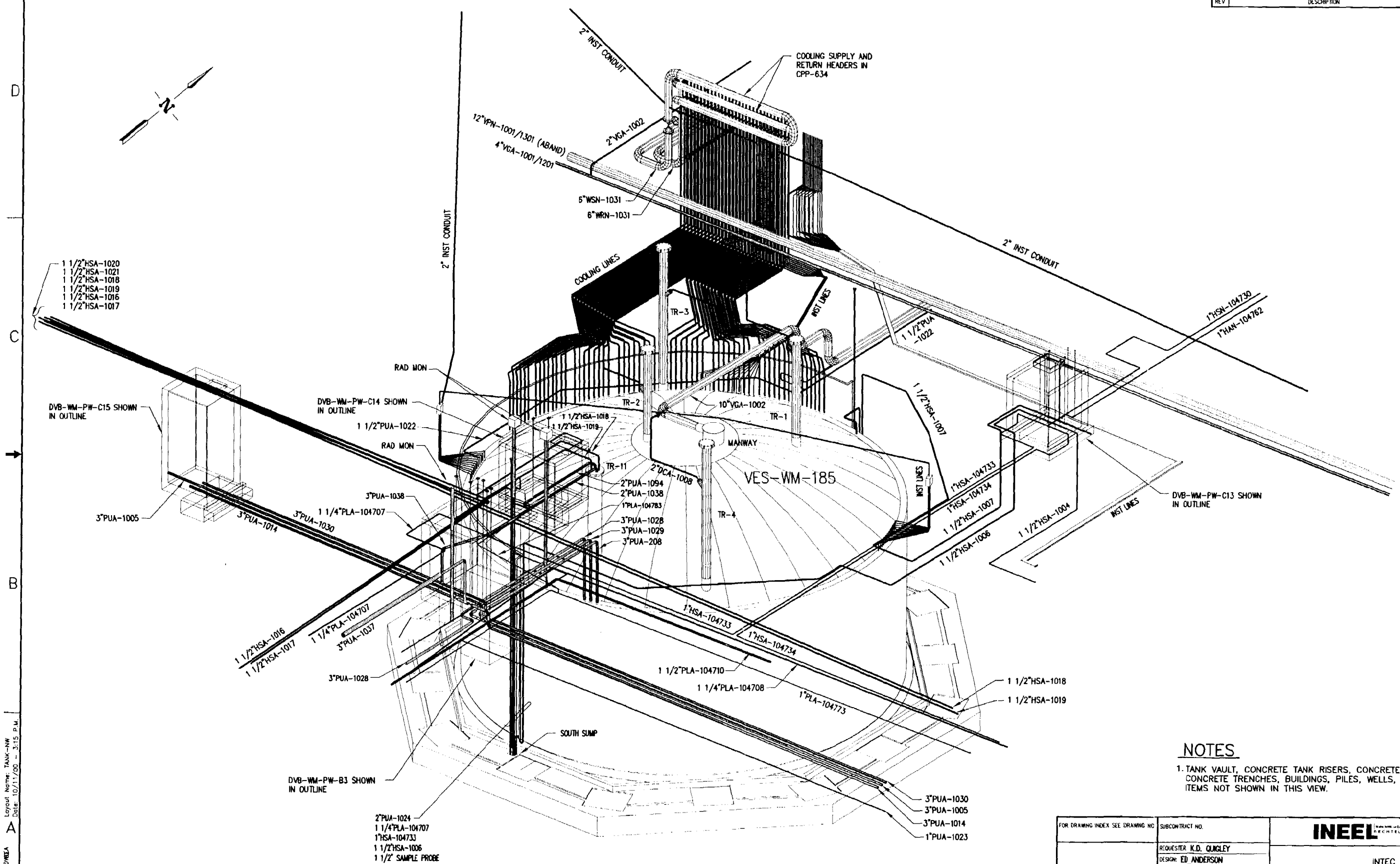
Layout Name: VAULT
Date: 10/11/00 - 3:16 P.M.



NOTES

1. TANK VAULT, CONCRETE TANK RISERS, CONCRETE SUMP RISERS, CONCRETE TRENCHES, BUILDINGS, PILES, WELLS, AND ELECTRICAL ITEMS NOT SHOWN IN THIS VIEW.

REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE

FOR DRAWING INDEX SEE DRAWING NO	SUBCONTRACT NO.	INEEL
NO SCALE	REQUESTER K.D. QUIGLEY DESIGN: ED ANDERSON DRAWN: KEITH BRONSON PROJECT NO. 015722 SPEC CODE	INTEC TANK FARM FACILITY CLOSURE VES-WM-185 VIEW OF TANK LOOKING NORTHWEST
DESIGN PHASE: CONCEPTUAL	FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO.	SIZE D · CAGE CODE · INDEX CODE NUMBER: AREA, TYPE, CL, ORIG 090 · DWG- · REV
QUALITY LEVEL: 3	EFFECTIVE DATE:	SCALE: NONE · SHEET U-SK34

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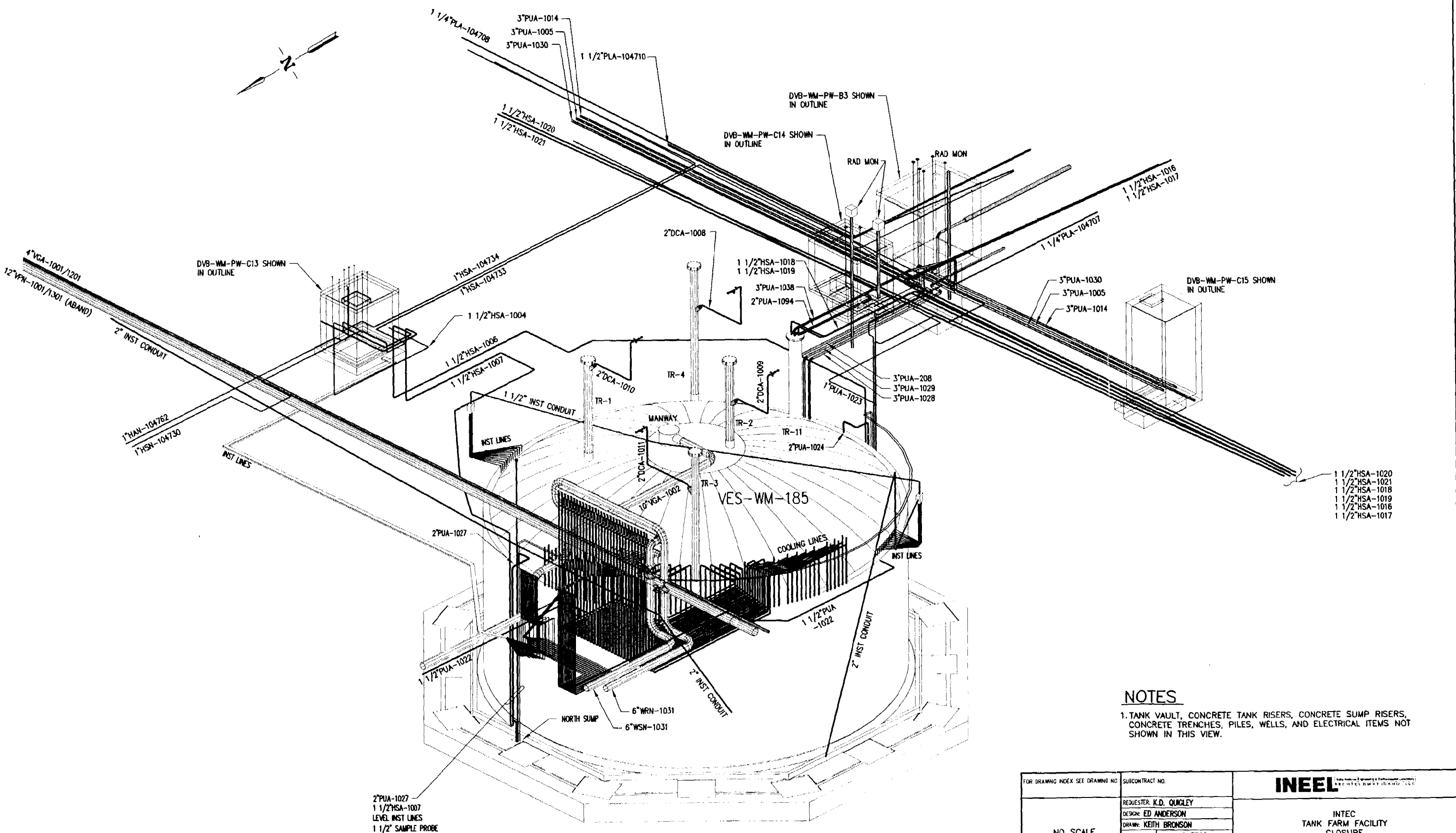


NOTES

1. TANK VAULT, CONCRETE TANK RISERS, CONCRETE SUMP RISERS, CONCRETE TRENCHES, PILES, WELLS, AND ELECTRICAL ITEMS NOT SHOWN IN THIS VIEW.

FOR DRAWING INDEX SEE DRAWING NO	SUBCONTRACT NO.	INEEL
NO SCALE	REQUESTER: K.D. QUIGLEY DESIGN: ED ANDERSON DRAWN: KEITH BRONSON PROJECT NO 015722 SPEC CODE	INTEC TANK FARM FACILITY CLOSURE VES-WM-185 VIEW OF TANK LOOKING SOUTHEAST
DESIGN PHASE: CONCEPTUAL	FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO.	SIZE D · CAGE CODE · INDEX CODE NUMBER: AREA, TYPE, CL, ORIG 090 · DWG- · REV
QUALITY LEVEL: 3	EFFECTIVE DATE:	SCALE: NONE · SHEET U-SK35

REVISIONS

REV	DESCRIPTION	EFFECTIVE DATE:

File: 3627-185-SKETCH00VBEA Path: X:
Layout Name: TANK-SE Date: 10/11/00 - 3:10 P.M.

WM-186 Closure Sequence Outline

The closure sequence for WM-186 does not directly decontaminate or grout an unnamed drain line and ½" condensate drain line.

- The unnamed drain line originates from a concrete encasement housing 3" PUA-1016, 1013 and 1014 and attaches to 1" PUA-1031 drain line emptying into the vault sump. The 1" PUA-1031 drain line as well as the pipe encasement shall be grouted.
- The ½" PUA-1015 condensate drain line originates from the 10" VGA-1001 line and empties into the tank via a process waste line. Both the process waste line and the 10" VGA line shall be grouted.
- Line 3" PUA-1013 is considered an abandoned line. This 3" line will be uncapped in Valve Box B2 and closed according to the closure sequence detailed in this report.

1. Control Pit #1: Install temporary VOG system to support the tank closure process. The installation of the temporary VOG system is contained in the Conceptual Design Report (CDR). Modify pit drain for future grouting.

2. Valve Box B2: Decontaminate valve box and the lines going to the tank.

3. Valve Box B1: Decontaminate valve box and the specified lines going to the tank and the vault.

4. CPP-634: Fill as much as possible and cap specified ¼" instrumentation lines.

5. CPP-628: Fill as much as possible and cap specified ½" instrumentation lines.

6. WM-186 North (SR-3) & South (SR-4) Vault Risers: Accessed in order to supply decontamination liquid and decontaminate sample lines.

7. WM-186 Tank Risers: Decontaminate the tank risers through decontamination lines and prepare risers for the tank closure equipment installation. Begin tank closure process ending with grout placements.

8. WM-186 North (SR-3) & South (SR-4) Vault Risers: Add grout to plug vault jet suction inlets.

9. Control Pit #1: Grout the specified lines going into tank. Install trench end plate then grout the pipe encasement.

10. Valve Box B2: Grout the specified lines going into tank. Install trench end plate then grout the pipe encasement.

11. Valve Box B1: Grout and cap specified line.

12. CPP-628: Prepare steam lines for grouting

13. Valve Box C19: Prepare process waste lines for grouting.

14. CPP-628: Grout steam lines and cap.

15. Valve Box C19: Grout specified lines and cap.

16. Valve Box C16: Decontaminate valve box and prepare the specified line for grout venting.

17. Valve Box C13: Prepare and grout specified steam lines, one line connects to Valve Box C16 and grouting will stop when visible in Valve Box C16.

18. Valve Box C16: Stop grouting from Valve Box C13 when grout is visible.

19. WM-186 North (SR-3) & South (SR-4) Vault Risers and Tank Risers: Grout alternating layers of grout between tank and vaults.

20. Control Pit #1: Remove temporary VOG system. Fill VOG line going to tank with grout.

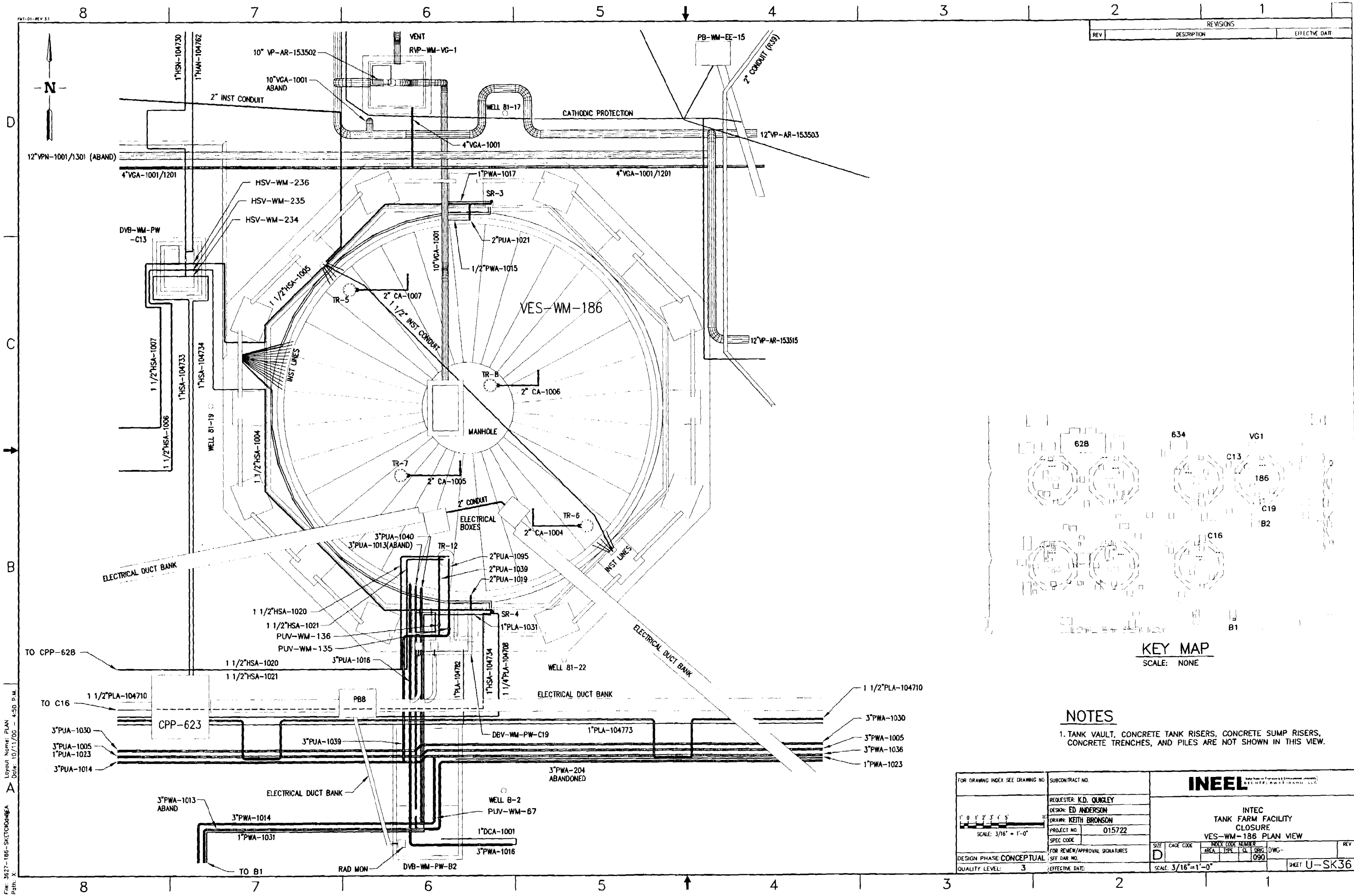
21. WM-186 Tank Risers and North (SR-3) & South (SR-4) Vault Risers: Top off each riser with grout and close tank.

Action	Result **WM-186**	Flow Destination
Install temp VOG system in Cntrl Pit #1	Modify 10 VGA-1001	
Decon Control Pit #1 = decon 1 PUA-1017 - Install grout connection to sump drain	 Line 1 PUA-1017 is the drain line for Control Pit #1 space within the sump is limited.	 into N vault
Decon Valve Box B2 - Remove cap from 1 DCA-1001 - Install decon/grout connection - Decon line 1 DCA-1001 = line 3 PUA-1016 is deconed also - Remove cap from 3 PUA-1013 - Install decon/grout connection - Decon line 3 PUA-1013 - Replace valve PUV-WM-67 w/ split-flow - Temp cap tube goint to 3 PUA-1014 - Prep line 3 PUA-1040 for decon - Decon line 3 PUA-1040	Will decon a portion of line 1 PUA-1031 Valve for line 3 PUA-1040 Do NOT decon the line going to 3 PUA-1014	into S vault into 3 PUA-1016 into 186 into 186 into 186
Decon Valve Box B1 - Remove cap from 1 PUA-1031 - Install decon/grout connection - Decon line 1 PUA-1031	May require activating JET-WM-542 to drain valve box this will require supplying steam to 1 HS-AR-156329	 into S vault
Access/Decon CPP-634 - Fill 1/4 INST-P - Fill 1/4 INST-L1 thru L5 - Fill 1/4 INST-S1 thru S8 - Fill 1/4 INST-L1-6 & 7 - Fill 1/4 INST-SPARE	 Fill as much as possible the (1) inst. line Fill as much as possible the (5) inst. lines Fill as much as possible the (8) inst. lines Fill as much as possible the (2) inst. lines Fill as much as possible the (2) inst. lines	 into 186 into 186 into 186 into vault into vault
Access/Decon CPP-628 - Fill 1/2 INST-T2, T4, T6, T8 & T10, even - Fill 1/2 INST-T1, T3, T5, T7 & T9, odd	 Fill as much as possible the (5) inst. lines Fill as much as possible the (5) inst. lines	 into J-box into J-box
Access N & S vault risers - Add decon liquid to vaults	IF 1-1/2 SAMPLE lines (2) accessible THEN decon This liquid needed to decon waste lines off the (3) vault steam jets	
Activate all (3) vault jets = decon 1 PLA-104708 = decon 2 PUA-1019 = decon 2 PUA-1021 = decon 2 PUA-1018 = decon 2 PUA-1020	(3) steam lines do not require decon Intake and waste transfer for JET-WM-586-4 Off JET WM-586-1 Off JET WM-586-2 Intake line from sump to jet WM-586-1 Intake line from sump to jet WM-586-2	 out to C-16 into 186 into 186
Decon 2 DCA-1004 thru 1007 = decon 12 VGA-1007 thru 1010	Decons the (4) tank risers by external quick connects The (4) access risers for tank 186	into 186

Action	Result **WM-186**	Flow Destination
Access the (4) tank risers	Prepare for tank closure equipment installation	
Install washing/grouting equip - Wash the tank - Activate tank steam jets - Begin grout placements - Activate tank steam jets - Finish grout placements - Fix free liquids	Install riser interface, washball, video camera and grout mast in appropriate order Empty tank to heel Displace heel to be removed by tank jets	
Access N (SR-3) & S (SR-4) vault risers - Fill N & S vault w/ shallow** layer of grout = line 2 PUA-1018 is partially grouted = line 2 PUA-1020 is partially grouted - Allow grout to cure over jet suction inlets	**Cover the suction inlet of all jet pumps but do NOT flood the nozzle chamber with grout Suction inlet to JET-WM-586-1 Suction inlet to JET-WM-586-2 Cure sufficiently to plug inlet of jet pumps	
Access Control Pit #1 - Grout line 1 PUA-1017 - Cap 1 PUA-1017 - Measure trench opening and piping - Install trench end-plate - Grout trench using grout connection - Leave end-plate in place	 For trench with line 1 PUA-1017 Field fit according to instructions for trench end-plate Allow grout to cure	into N vault
Access Valve Box B2 - IF decon solution needed to access B3 - Grout line 1 DCA-1001 = line 3 PUA-1016 is grouted also - Cap 1 DCA-1001 - Grout line 3 PUA-1013 - Cap 3 PUA-1013 - Grout line 3 PUA-1040 - Cap 3 PUA-1040 - Measure trench opening and piping - Install trench end-plate - Grout trench using grout connection - Leave end-plate in place - Permanently cap or plug drain in sump	THEN activate S vault jet WM-586-4 Through split flow tube For trench with lines 3 PUA-1013, 1016 & 1040 Field fit according to instructions for trench end-plate Allow grout to cure Connected to line 1 PUA-1031	 into 3 PUA-1016 into 186 into 186 into 186
Access Valve Box B1 - Grout line 1 PUA-1031 - Cap 1 PUA-1031		into S vault

Action	Result WM-186	Flow Destination
Access CPP-628		
- Isolate steam line 1-1/2 HSA-1020	Isolate from main steam header and other lines	
- Modify for grout connection	Cut and cap lines as necessary	
- Install grout connection		
- Do NOT grout at this time		
- Isolate steam line 1-1/2 HSA-1021	Isolate from main steam header and other lines	
- Modify for grout connection	Cut and cap lines as necessary	
- Install grout connection		
- Do NOT grout at this time		
Decon Valve Box C19		
- Replace valve PUV-WM-136 w/ single flow	For line 2 PUA-1039	
- Replace valve PUV-WM-135 w/ single flow	For line 2 PUA-1095	
Within CPP-628		
- Grout line 1-1/2 HSA-1020		into 186
- Grout line 1-1/2 HSA-1021		into 186
- Cap both steam lines		
Within Valve Box C19		
- Grout line 2 PUA-1095 going to tank		into 186
- Grout line 2 PUA-1039 going to tank		into 186
- Cap both process waste lines		
Decon Valve Box C16		
- Remove Valve PLV-WM-7	For line 1-1/4 PLA-104708	
- Cap end going to 1-1/2 PLA-104710		
- Modify 1-1/4 PLA-104708	Allow air displaced by grout to vent	
- Monitor during grouting in Valve Box C13	Watch for grout to appear from opening	
Access Valve Box C13 (no decon)	To grout line 1 HSA-104734 and prepare other lines	
- Remove valve HSV-WM-234	Remove pipe as necessary for line 1 HSA-104731	
- Cap opening connected to steam supply	Steam supply line 1 HSN-104730 or 1 HAA-104762	
- Install grout connection to 1 HSA-104734		
- Grout line 1 HSA-104734		into S vault
= line 1-1/2 PLA-104708 is grouted also	This is accomplished by forcing grout through the jet to the open end of line 1-1/4 PLA-104708 in Valve Box C16 stop grouting 1 HSA-107731 when grout is visible at C16	out to C16
- Cap 1 HSA-104731		
- Remove valve HSV-WM-235	Remove pipe as necessary for line 1 HSA-1004	
- Cap opening connected to steam supply	Steam supply line 1 HSN-104730 or 1 HAA-104762	
- Install grout connection to 1 HSA-1004		
- Grout line 1 HSA-1004		into S vault
= line 2 PUA-1019 is also grouted	This is accomplished by forcing grout throught the open end of line 2 PUA-1019 into tank 186	into 186
- Cap 1 HSA-1004		

Action	Result **WM-186**	Flow Destination
- Remove valve HSV-WM-236 - Cap opening connected to steam supply - Install grout connection to 1 HSA-1005 - Grout line 1 HSA-1005 = line 2 PUA-1021 is grouted also - Cap 1 HSA-1005	Remove pipe as necessary for line 1 HSA-1005 Steam supply line 1 HSN-104730 or 1 HAA-104762 This is accomplished by forcing grout throught the open end of line 2 PUA-1021 into tank 186	 into N vault into 186
Within Valve Box C16 - Stop grouting from Valve Box C13 - Cap tube connected to 1-1/4 PLA-104708		
Access N (SR-3) & S (SR-4) vault risers & tank risers - Beginning with the vault pour alternating layers of grout between the tank and vault - Fill both tank and vaults with layers	Keep the overall levels of grout in the tank and vaults approximately equivalent	
Within Control Pit #1 - Remove the temporary VOG system - Cap the section not connected to 186 - Fill 10 VGA-1001 going to 186 w/ grout = 1/2 PUA-1015 is grouted at both ends	This will fill the tank and the manway	into 186
Access the tank risers and vault risers - Top off each riser with grout - Grout (4) tank riser decon lines = lines 2 DCA-1004 thru 1007 grouted	Tank and vault will be closed	into 186



KEY MAP
SCALE: NONE

NOTES

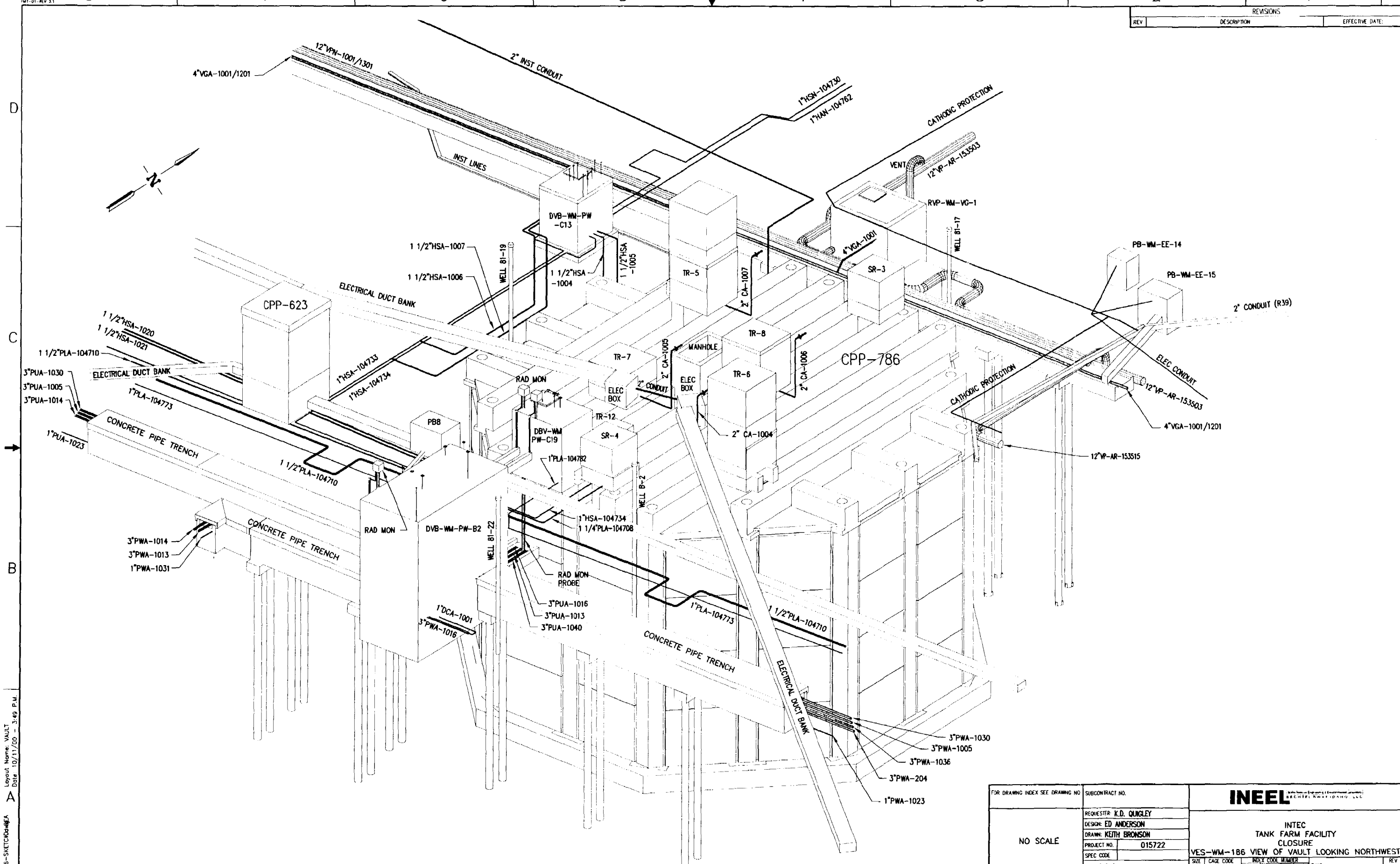
1. TANK VAULT, CONCRETE TANK RISERS, CONCRETE SUMP RISERS, CONCRETE TRENCHES, AND PILES ARE NOT SHOWN IN THIS VIEW.

REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE

FOR DRAWING INDEX SEE DRAWING NO	SUBCONTRACT NO.	INEEL
SCALE: 3/16" = 1'-0"	REQUESTER: K.D. QUIGLEY	INTEC TANK FARM FACILITY CLOSURE VES-WM-186 PLAN VIEW
	DESIGN: ED ANDERSON	
	DRAWN: KEITH BRONSON	
	PROJECT NO. 015722	
	SPEC CODE	
DESIGN PHASE: CONCEPTUAL	FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO.	SIZE D; CAGE CODE; INDEX CODE NUMBER AREA TYPE CL ORIG 090; DWG-; REV
QUALITY LEVEL: 3	EFFECTIVE DATE:	SCALE: 3/16"=1'-0"; SHEET U-SK36

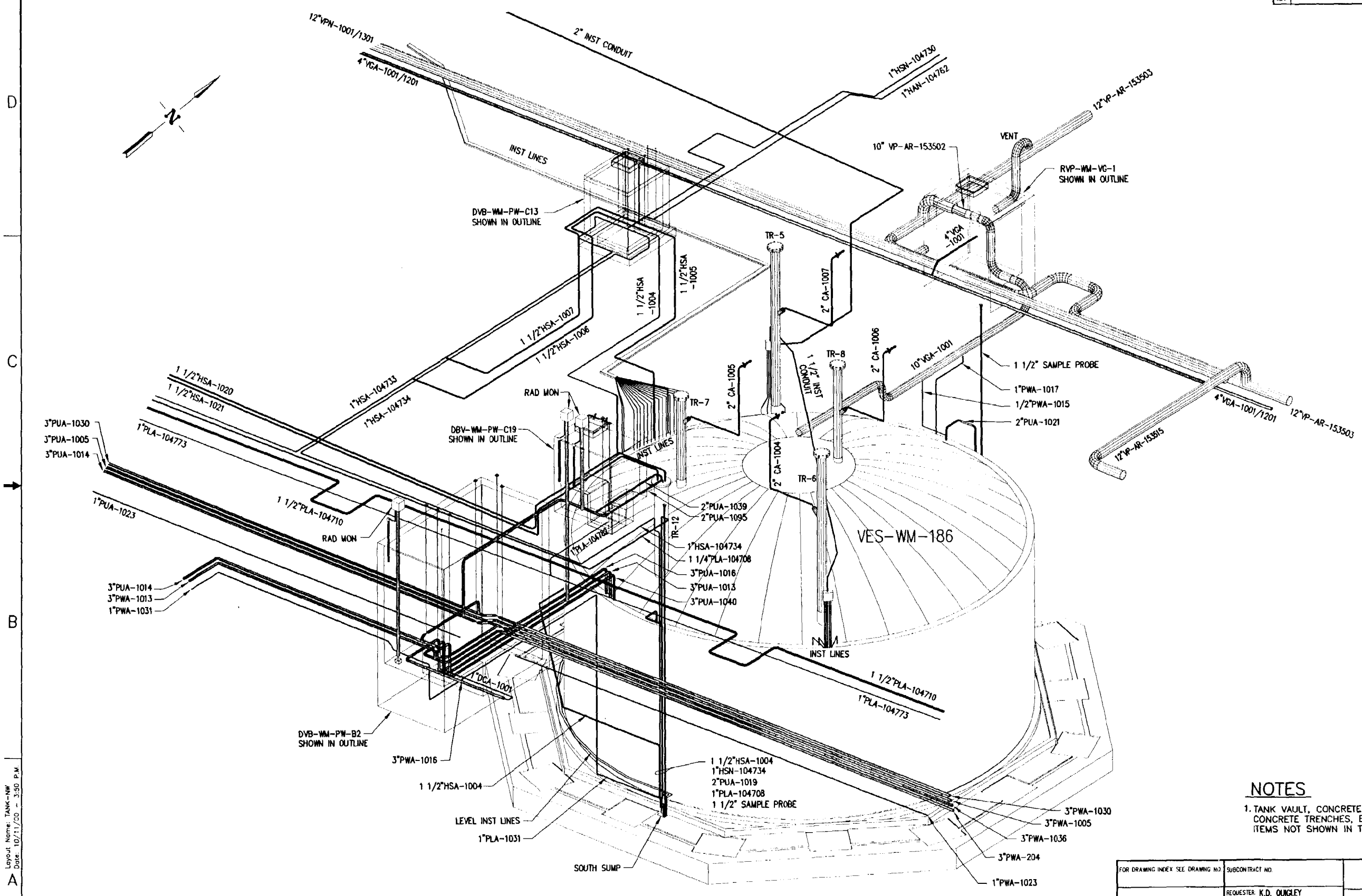
File: 3527-186-SKETCH0dwg
Path: X:
Layout Name: PLAN
Date: 10/11/00 - 4:50 P.M.

REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE:



FOR DRAWING INDEX SEE DRAWING NO	SUBCONTRACT NO.	INEEL (Battelle Energy Alliance, LLC Environmental Management) BECHTEL BWXT IDAHO, LLC
NO SCALE	REQUESTER: K.D. QUIGLEY DESIGN: ED ANDERSON DRAWN: KEITH BRONSON PROJECT NO. 015722 SPEC CODE	INTEC TANK FARM FACILITY CLOSURE VES-WM-186 VIEW OF VAULT LOOKING NORTHWEST
DESIGN PHASE: CONCEPTUAL	FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO.	SIZE D; CAGE CODE; INDEX CODE NUMBER: AREA, TYPE, CL, ORG 090; DWG-; REV
QUALITY LEVEL: 3	EFFECTIVE DATE:	SCALE: NONE; SHEET U-SK37

Layout Name: VAULT
Date: 10/11/00 - 3:49 P.M.
File: 3627-186-SKETCH.DWG
Path: X:



NOTES

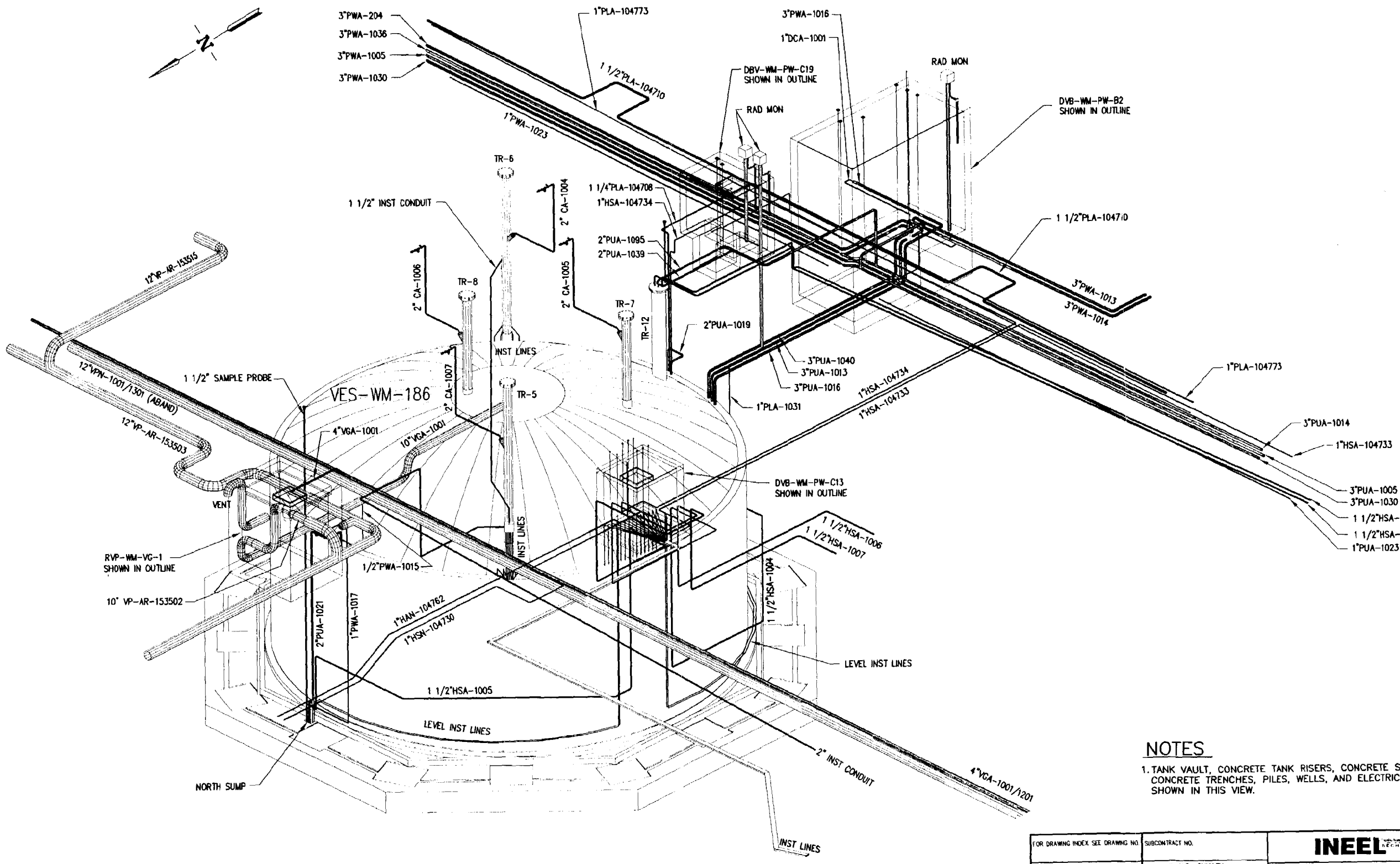
1. TANK VAULT, CONCRETE TANK RISERS, CONCRETE SUMP RISERS, CONCRETE TRENCHES, BUILDINGS, PILES, WELLS, AND ELECTRICAL ITEMS NOT SHOWN IN THIS VIEW.

FOR DRAWING INDEX SEE DRAWING NO.	SUBCONTRACT NO.	INEEL
NO SCALE	REQUESTER: K.D. QUIGLEY DESIGN: ED ANDERSON DRAWN: KEITH BRONSON PROJECT NO. 015722 SPEC CODE	INTEC TANK FARM FACILITY CLOSURE VES-WM-186 VIEW OF TANK LOOKING NORTHWEST
DESIGN PHASE: CONCEPTUAL	FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO.	SIZE D · CAGE CODE · INDEX CODE NUMBER: AREA, TYPE, CL, ORIG 090 · DWG- · REV
QUALITY LEVEL: 3	EFFECTIVE DATE:	SCALE: NONE · SHEET U-SK38

REVISIONS

REV	DESCRIPTION	EFFECTIVE DATE:

File: 3627-186-SKETCH.dwg
Path: X:
Layout Name: TANK-NW
Date: 10/11/00 - 3:50 P.M.



NOTES

1. TANK VAULT, CONCRETE TANK RISERS, CONCRETE SUMP RISERS, CONCRETE TRENCHES, PILES, WELLS, AND ELECTRICAL ITEMS NOT SHOWN IN THIS VIEW.

FOR DRAWING INDEX SEE DRAWING NO.	SUBCONTRACT NO.	INEEL
NO SCALE	REQUESTER: K.D. QUIGLEY DESIGN: ED ANDERSON DRAWN: KEITH BRONSON PROJECT NO. 015722 SPEC CODE	INTEC TANK FARM FACILITY CLOSURE VES-WM-186 VIEW OF TANK LOOKING SOUTHEAST
DESIGN PHASE: CONCEPTUAL	FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO.	SIZE D · CAGE CODE · INDEX CODE NUMBER AREA TYPE Q ORG 090 · DWG- · REV
QUALITY LEVEL: 3	EFFECTIVE DATE:	SCALE: NONE · SHEET U-SK39

REVISIONS

REV	DESCRIPTION	EFFECTIVE DATE:

File: 3627-186-SKETCHDWG.SEA Layout Name: TANK-SE
Path: X: Date: 10/11/00 - 3:53 P.M.

EDF-015722-039

ENGINEERING DESIGN FILE

1. Project File No.: 015722
2. Project/Task: INTEC Tank Farm Facility Closure - Conceptual Design
3. Subtask: Pipeline Decontamination Assessment

4. Title: INTEC Tank Farm Facility Ancillary Process Waste Line Mass Estimate

5. Summary: This summary briefly defines the problem or activity to be addressed in the EDF, gives a summary of the activities performed in addressing the problem and states the conclusions, recommendations, or results arrived at from this task.

This EDF provides an estimate of the residual mass to be used as a basis to determine specie source term values within the ancillary piping of the Idaho Nuclear Technology and Engineering Center (INTEC) Tank Farm Facility (TFF) per SOW - INTEC TFF Closure FY 2000 Conceptual Design (Task 4.3.6). This mass, estimated as 60 kg, may be multiplied by the specie concentrations and activities per mass of solids determined as representative within the TFF sludge. The resultant product numbers would be piping source term estimates. Specie selectivity within the film plated inside the piping is unknown, and it is assumed that the tank particle and pipe film concentration and activity are the same. This EDF provides an enveloping mass estimate of material left within the TFF process waste lines to provide a basis for source term calculations until specie specific plating on the inner walls of the TFF piping is determined from sampling, geometrically detailed radiation measurements, and radiological calculations.

6. Distribution (complete package):
E. C. Anderson, MS 3650; K.D. Quigley, MS 3211; G. C. McCoy, MS 5209; M. R. Wilcox, MS 3625
Distribution (summary package only):

7. Review (R) and Approval (A) Signatures:
(Minimum reviews and approvals are listed. Additional reviews/approvals may be added.)

	R/A	Printed Name/Organization	Signature	Date
Performer	R	Michael R. Wilcox	Michael R. Wilcox	8/8/00
Independent Reviewer	R	(Mac) G. C. McCoy	[illegible]	8/10/00
Requestor	A	Edward C. Anderson	[illegible]	8/8/00
Approver	A	Edward C. Anderson	[illegible]	8/8/00

INTEC TFF Process Waste Line Mass Estimate

This EDF provides an estimate of the residual mass to be used as a basis to determine specie source term values within the ancillary piping of the Idaho Nuclear Technology and Engineering Center (INTEC) Tank Farm Facility (TFF). This mass, estimated as 60 kg, may be multiplied by the specie concentrations and activities per mass of solids determined as representative within the TFF sludge. The resultant product numbers would be piping source term estimates. Specie selectivity within the film plated inside the piping is unknown, and it is assumed that the tank particulate and pipe film concentration and activity ratios are the same.

The residue mass is based on a .002 inch film thickness coating the internal surface of process waste piping not including vessel off-gas lines. During conversations with Michael Wilcox and Edward Anderson, Dave Machovec estimated the piping residue thickness within the C2 valve box piping to be about 2 mil (.002 in.) on the "bottom" portion of the piping. For conservative reasons and to account for unknown deposition relative to structures such as elbows, valves, etc. the entire internal piping surface was given a 2 mil thickness. It was assumed that off-gas lines would harbor insignificant activity relative to the transfer process lines. The specific gravity of the residue is assumed to be the same as the particle specific gravity (within the sludge) determined to be 2.0 per EDF 15722-040. As delineated in EDF-015722-021 "General Pipeline/Enclosure Criteria and Associated Process Flow Development" plans are to decontaminate with 0.5 molar aluminum nitrate and water. According to individuals at INTEC, this decontamination approach has been shown to have a minimal effect on removing contaminants within the plated layer. It is assumed that decontamination with 0.5 molar ammonium nitrate and water will not have an effect on residues estimated to be currently present.

Length estimations of TFF piping with respect to pipe size and function were estimated by scaling from INTEC TFF Area Plan drawings 509664-509672. Edward Anderson provided these values.

Attachment 1 shows calculated parameters based on the assumptions addressed above. Because of the assumptions used, mass, and thus subsequent source term estimates would be linearly proportional to the volume of piping. For 10,600 feet of TFF process transfer lines (vessel off-gas lines assumed as non-contributors) there are 60 kg mass.

This EDF provides an enveloping mass estimate of material left within the TFF process waste lines to provide a basis for source term calculations until specie specific plating on the inner walls of the TFF piping is determined from sampling, geometrically detailed radiation measurements, and radiological calculations.

INEEL individuals consulted for this evaluation include the following:

Edward C. Anderson, Advisory Engr/Sci, Civil Engineering

Edward P. Wagner, Consulting Engr/Sci, Mechanical Engineering
David C. Machovec, Advisory Engr/Sci, Facilities Engineering
Douglas R. Wenzel, Consulting Engr/Sci, Radiological Engineering
Frank S. Ward, Advisory Engr/Sci, Waste Processing
G. C. (Mac) McCoy, Consulting Technical Specialist, Radiological Engineering
R. Wayne Kanady, Pr Technical Spec, Radiological Engineering

TFF Closure Process Waste Piping Mass Estimate Basis

Pipe Size	Pipe Function	Length (estimated) (ft)	Inside Diam. pipe (in)	Pipe Volume (gal)	Residue Cross Section (ft2)	Residue Volume (gal)	Residue Mass (lb)	Residue Mass (kg)	Residue Volume per pipe foot (gal/ft)	Residue mass per pipe foot (lb/ft)	Residue mass per pipe foot (kg/ft)
1 in.	PWA/PUA	1.800E+03	9.570E-01	6.736E+01	4.17E-05	5.61E-01	9.37E+00	4.25E+00	3.12E-04	5.20E-03	2.36E-03
1 1/2 in.	PWA/PUA	1.100E+03	1.500E+00	1.011E+02	6.54E-05	5.38E-01	8.98E+00	4.07E+00	4.89E-04	8.16E-03	3.70E-03
2 in.	PWA/PUA	1.000E+03	1.939E+00	1.536E+02	8.45E-05	6.32E-01	1.06E+01	4.79E+00	6.32E-04	1.06E-02	4.79E-03
3 in.	PWA/PUA	6.700E+03	3.068E+00	2.577E+03	1.34E-04	6.71E+00	1.12E+02	5.08E+01	1.00E-03	1.67E-02	7.58E-03
4 in.	VGA	1.000E+03	4.026E+00	6.623E+02	Assume 0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
6 in.	PWM	5.000E+02	6.065E+00	7.515E+02	Assume 0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
10 in.	VOG	1.500E+03	1.042E+01	6.655E+03	Assume 0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
12 in.	VOG	1.400E+03	1.239E+01	8.781E+03	Assume 0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		1.600E+04		1.976E+04		8.44E+00	1.41E+02	6.39E+01			

Pipe lengths estimated from scaling lengths from INTEC TFF Area Plan drawings 509664-509672.

Based on the following inside diameters: 1", 1 1/2", and 2" piping is Schedule 80S, 3", 4",and 6", piping is Schedule 40S, 10" and 12" piping is Schedule 10S.

Inner diameters taken from Chemical Engineer's Handbook, Perry & Chilton.

The specific gravity of the residue is assumed to be the particle specific gravity (within the sludge) determined to be 2.0 per EDF 15722-040.

Assume no specie selectivity within the plated piping film; therefore, the tank particle concentration and activity equals the pipe film concentration.

Assume zero residue plated out on inner walls of vessel off-gas lines.

Residue thickness assumed to be 2 mil (.002 in) around complete inner circumference of the piping.

Residue film thickness based on observations from Dave Machevoc relayed via telephone to Ed Anderson and Mike Wilcox

Dave reported a visual of 2 mil on the "bottom part" of piping from the C2 valve box when worked on in late 1995 early 1996.

For conservative reasons and to account for unknown deposition relative to geometries such as elbows, valves, etc. the full interior surface was given a 2 mil thickness for the estimate determinations for all liquid process waste lines.

EDF-015722-040

431.02
08/12/98
Rev. 06

ENGINEERING DESIGN FILE

Functional File No. _____
EDF No. 15722-040

1. Project File No. 15722 2. Project/Task Tank Farm Closure

3. Subtask Process

4. Title: INTEC Tank Farm Sludge Density Measurements/Calculations

5. Summary: Recently obtained LDUA solids density data are evaluated. This evaluation indicates that the sludge in the INTEC tank farm has the following properties:

- 75% interstitial liquid by volume
- 25% solid particles by volume
- 2.0 (g/ml) solids particle density

With these data, the 50-ft diameter INTEC tanks have the following properties (assuming no cooling coils):

- 918 gal of interstitial liquid / inch of sludge heel height
- 306 gal of solid particles / inch of sludge heel height
- 5,110 lbs. of solids / inch of sludge heel height

6. Distribution (complete package):

Distribution (summary package only):

7. Review (R) and Approval (A) Signatures: (Minimum reviews and approvals are listed. Additional reviews/approvals may be added as necessary.)

	R/A	Printed Name	Signature	Date
Author	R	Adam P. Poloski, Ph.D.	[signature]	06-Jul-00
Technical Review	R	Rod Kimmitt	R. R. Kimmitt	7/11/00
Requestor	A	Edward Anderson	[signature]	7/12/00

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2 RAL Measurements 4

3 Density Calculations 5

4 Quantity of Solids in a Tank 6

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1 Key WM-183 Density Data 5

1 Introduction

Quantifying the amount of solids in the INTEC Tank Farm is of great import for many reasons. These reasons include being able to grasp the overall magnitude of the amount of solids in the tank farm and using the chemical and radionuclide *per gram of solids* data effectively. The first step in this quantification process is taking some basic measurements of the mass and volume of the LDUA samples. Fortunately, this has been performed on WM-182 and WM-183 samples. Unfortunately, most of these measurements have been performed on samples that have been centrifuged and/or oven-dried. These processes change the nature of the solids in such a way that the data obtained from these samples cannot be directly applied to the solids in their current state in the tank farm. This is explained below:

Centrifugation This process alters the packing of the sludge from a gravity settled regime to a compressed regime where many more solid particles occupy a volume of sample. Therefore water content measurements on centrifuged samples must typically be discounted.

Oven-drying The samples are placed in an oven to remove the interstitial liquid and various mass measurements can be performed on these solids. However, oven-drying also removes much of the hydrated water in the crystalline structure of the solids. Loss of this hydrated water results in dehydrated solids mass measurements that result in dehydrated solids density measurements. Since the other analytical laboratory data is given in a *per gram of air-dried solids* basis, measurements based on oven-dried samples must be discounted in many instances.

However, a sample from WM-183 was not centrifuged or oven-dried and data was obtained from this sample. Since WM-183 contains the majority of the solids in the tanks we have observed to date, applying these solids data to the solids in the entire tank farm seems like a reasonable assumption. In this EDF, we will discuss the results from this sample.

2 RAL Measurements

The RAL data we have obtained is included in the Appendix A. After talking with Gary Heustis the only data obtained for non-centrifuged, air-dried WM-183 solids are on pages 14,14, and 18. From the RAL logbook, page 18, the key density data are shown in Table 1.

Please note that these measurements involved air-drying the solids and then adding deionized water to reconstitute the sludge. Through this process, the interstitial liquid chemistry is significantly altered from the chemistry in the tank farm (e.g. pH, molar concentration of significant species, etc.). Changing the interstitial liquid chemistry can, in turn, change the solids surface chemistry. Changing the surface chemistry alters the so-called *zeta potential*, which is an indicator of how the solid particles interact with each other. Ultimately, the solids packing and interstitial liquid fraction can be significantly altered by the chemistry of the interstitial liquid (the particle density measurements should be unaffected). Even with

Table 1: Key WM-183 Density Data

59.43	wt. % of water in sludge
1.179	Air-dried solids mass (g)
2.906	sludge mass (g)
2.33	sludge volume (ml)
0.995	water density at 30.8° C (g/ml)

this potential source of error, these RAL data are the best available tank farm sludge density data.

3 Density Calculations

Since we have the sludge mass and volume, the average sludge density can be calculated.

$$Density = \frac{Mass}{Volume} \tag{1}$$

$$Sludge\ Density = \frac{2.906 \text{ g sludge}}{2.33 \text{ ml sludge}} = 1.25\frac{\text{g}}{\text{ml}} \tag{2}$$

Starting with 100 g of sludge as a basis, and assuming that sludge is defined to consist only of solids particles (i.e. solids) and interstitial liquid (i.e. water), the following calculations can be performed.

$$0.5943\frac{\text{g water}}{\text{g sludge}} \times 100 \text{ g sludge} = 59.4 \text{ g water} \tag{3}$$

$$100 \text{ g sludge} - 59.43 \text{ g water} = 40.6 \text{ g solids} \tag{4}$$

$$\frac{100 \text{ g sludge}}{1.25\frac{\text{g sludge}}{\text{ml sludge}}} = 80.2 \text{ ml sludge} \tag{5}$$

$$\frac{59.4 \text{ g water}}{0.9954\frac{\text{g water}}{\text{ml water}}} = 59.7 \text{ ml water} \tag{6}$$

$$80.2 \text{ ml sludge} - 59.7 \text{ ml water} = 20.5 \text{ ml solids} \tag{7}$$

$$\frac{59.7 \text{ ml water}}{80.2 \text{ ml water}} \times 100\% = \boxed{74.5 \text{ \% water by volume}} \tag{8}$$

$$100\ \% - 74.5\ \%\ \text{water by volume} = \boxed{25.5\ \%\ \text{solids by volume}} \tag{9}$$

$$\frac{40.6\ \text{g solids}}{20.5\ \text{ml solids}} = \boxed{1.98\frac{\text{g solids}}{\text{ml solids}}} \tag{10}$$

As one can see, this particle density agrees nicely with the logbook calculations of 1.88 g solids/ml solids given on page 14. Using the logbook particle density of 1.88 g/ml, one can perform an alternative set of calculations:

$$\frac{1.179\ \text{g solids}}{1.88\frac{\text{g solids}}{\text{ml solids}}} = 0.627\ \text{ml solids} \tag{11}$$

$$\frac{0.627\ \text{ml solids}}{2.33\ \text{ml sludge}} \times 100\ \% = \boxed{26.9\ \%\ \text{solids by volume}} \tag{12}$$

$$100\ \% - 26.9\ \%\ \text{solids by volume} = \boxed{73.1\ \%\ \text{water by volume}} \tag{13}$$

Since both sets of calculations agree nicely and the first set of calculations are slightly more conservative, a conservative basis for estimating the quantity of solids in the tank farm would be:

- 75% Interstitial liquid in sludge by volume
- 25% Air-dried solids in sludge by volume
- 2.0 g/ml air-dried solids particle density

4 Quantity of Solids in a Tank

Using the density basis discussed above, we will now estimate the amount of solids present in a tank farm tank as a function of sludge height (assuming no cooling coils). The volume of sludge in an INTEC tank farm tank varies as follows:

$$\textit{Sludge Volume} = \frac{7.481\pi 25^2}{12} h\ \text{gal} = 1224 \cdot \text{h gal} \tag{14}$$

where,

$$h = \text{Sludge Height (inches)} \tag{15}$$

This equates to the following:

$$\textit{Solids Volume} = 0.25(1224 \cdot h\ \text{gal}) = \boxed{306 \cdot h\ \text{gal}} \tag{16}$$

$$Interstial\ Liquid\ Volume = (1224 - 306) \cdot h = \boxed{918 \cdot h \text{ gal}} \tag{17}$$

$$Solids\ Mass = \frac{62.4}{7.481} \cdot 2.0 \cdot 306 \cdot h \text{ lbs} = \boxed{5110 \cdot h \text{ lbs}} \tag{18}$$

Since WM-182 has approximately 4 inches of sludge in the bottom of the tank, and applying the above equations would yield the following:

- $\boxed{1,224 \text{ gal of solid particles in WM-182}}$
- $\boxed{3,672 \text{ gal of interstitial liquid in WM-182}}$
- $\boxed{20,419 \text{ lbs of solid particles in WM-182}}$

Since WM-183 has approximately 8 inches of sludge in the bottom of the tank, and applying the above equations would yield the following:

- $\boxed{2,448 \text{ gal of solid particles in WM-183}}$
- $\boxed{7,344 \text{ gal of interstitial liquid in WM-183}}$
- $\boxed{40,838 \text{ lbs of solid particles in WM-183}}$

A Appendix–RAL Logbook Data

MAR 27 '00 03:49PM ANAL LABS P.1/4

INTERSTITIAL WATER HOLDUP OF WM-182 SOLIDS NARRATIVE

An aliquot of wet solids was placed in a calibrated and pre-weighed glass settling tube. Water was added to the full mark and the solids were stirred to offer complete mixing and settling. Mixing also minimized the effects of trapped air bubbles within the particles. After settling took place, the water level was siphoned off to the top calibrated mark of the tube. The tube containing the solids and water was then weighed on a balance, which measures to the nearest milligram. The tare weight of the tube was subtracted from this weight to determine the weight of the solids plus water. The volume of the settled solids was determined and the tube as then centrifuged for five minutes. The volume of the settled solids was then determined. The remaining water was siphoned off and the weight of the tube plus solids was measured. The volume of settled solids was subtracted from the volume of water measured at the top calibration mark. This calculation determined the volume of water above the settled solids. Based on the operating temperature during analysis, the density of water was determined and applied in the water weight calculation by multiplying it by the water volume. This calculated water weight was subtracted from the sample + water weight to determine the weight of the sample + interstitial water holdup. The weight of the wet solids was determined by subtracting the tube tare weight from the tube + solids weight. The calculated weight of the wet solids was then subtracted from the calculated solids + water holdup value. Finally, the wet solids value was subtracted from the solids + interstitial water holdup value. This calculation determined the interstitial water holdup value. This result was divided by the sample + water holdup value and multiplied by 100 to determine the percent interstitial water holdup result. In order to determine the interstitial water holdup for centrifuged solids, the centrifuged solids volume was substituted for the settled solids volume in the calculations.

These percent interstitial water holdup values are considered to be low percentage calculations of the true result. This is because the solids were not available for an air-dried weight.

Post-it® Fax Note 7671	Date 3-27
To ADAM Polaski	From Gary Hu
Co./Dept.	Co.
Phone # 6-6100	Phone # 6-3837
Fax # 6-6803	Fax # 6-6067

Gary M. Hu

3-27-00

MAR 15 '00 02:42PM ANAL LABS P.1/11

Post-it® Fax Note 7671	Date 3-15	# of pages ▸ 11
To ADAM POLOSKI	From GARY HUESTIS	
Co./Dept.	Co.	
Phone # 6-6802	Phone # 6-3837	
Fax #	Fax # 6-0067	

61

WM:182-183 - All log #s attached to WM:182-183
Calibration of Sedimentation Tubes 3-14-00

3 new tubes were made for Density analyses
Procedure
A. Tare weights were determined using the Hot Cell 3-place balance at station 6

B. the tubes were filled at the 7.0 + 5.0 ml marks and the weights were determined + recorded

C. the cell temperature was determined + recorded.

	TUBE #1		TUBE #2		TUBE #3	
Volume	5.0 ml	7.0 ml	5.0 ml	7.0 ml	5.0 ml	7.0 ml
Gross wt g	20.929 g	22.955 g	21.241 g	23.220	21.040 g	23.047 g
Tare wt g	15.990 g	15.990 g	16.312 g	16.312	16.124 g	16.124 g
Water wt g	4.939 g	6.965 g	4.929 g	6.908	4.916 g	6.923 g
Temperature	30.2 °C	30.2 °C	30.2 °C	30.2 °C	30.2 °C	30.2 °C
Water Density	0.99559 g/cc	0.99559 g/cc	0.99559 g/cc	0.99559 g/cc	0.99559 g/cc	0.99559 g/cc
Calc volume	4.96 ml	7.00 ml	4.95 ml	6.94 ml	4.94 ml	6.95 ml

Sedimentation Tube #5 was previously calibrated + recorded in Log Book # LN545, p99.

@ 30°C the volumes were calibrated at the following marks:

Mark #	Volume
8.0	1.58 ml
6.0	3.58 ml
4.0	5.57 ml
1.0	8.54 ml

Gary M. Huestis 3-14-00

MAR 15 '00 02:43PM ANAL LABS P.2/11

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Bulk Density Calculations

Log #s 991026-2, 991027-2, 000105-6, + 000107-5

See page 51, 53-56 for raw data

	WM:182		WM:183	
Log #	991026-2	991027-2	000105-6	000107-5
G.W. of Tube + Solids	17.107g	18.834g	19.896g	23.700g
T.W. of Tube	15.990g	16.312g	16.134g	16.932g
Weight of wet solids	1.117g	2.522g	3.772g	6.768g
Volume of Settled Solids	1.35ml	2.60ml	3.70ml	6.26ml
Moist Bulk Density Mass/Vol	0.83g/cc	0.97g/cc	1.02g/cc	1.08g/cc

Table of Moist Bulk Density - Settled Solids

Log #	991026-2	991027-2	000105-6	000107-5
G.W. of Tube + Solids	17.107g	18.834g	19.896g	23.700g
T.W. of Tube	15.990g	16.312g	16.134g	16.932g
Weight of wet Solids	1.117g	2.522g	3.772g	6.768g
Volume of ~~Settled~~ Centrifuged Solids	1.20ml	2.50ml	~~2.80ml~~ 3.60 ml	6.16ml
Centrifuged Bulk Density	0.93g/cc	1.01g/cc	~~1.34g/cc~~ 1.03 g/cc	1.10g/cc

Table of Bulk Density - Centrifuged wet solids

Note: Log 000107-5 the 3.7 ml mark corresponds to 6.26 ml actual volume (p 94 of LN-545). Table interpolation. The 6.16 ml volume was interpolated the same way from the 3.4 ml mark.

[illegible] 03.14.00

MAR 15 '00 02:43PM ANAL LABS P.3/11

63

Particle Density Calculations - Wet

WM:182-183 Log # 991026-2, 991027-2, 000105-6, 000117-5

Particle Density Calculations & Data Table

	WM:182		WM:183	
Log #	991026-2	991027-2	000105-6	000117-5
~~Calc~~ Sample + Tare + H_2O	23.062g	23.462g	23.505g	26.265g
Tare wt. sol. tube	15.990g	16.312g	16.124g	16.932g
Calc. - Sample + H_2O wt.	7.072g	7.150g	7.381g	9.333g
Wet sample wt.	1.117g	2.522g	3.772g	6.768g
Wt. of H_2O in tube	5.955g	4.628g	3.609g	2.565g
Calibrated G.W. Tube + H_2O	22.955g	23.220g	23.047g	~~8.503g~~ NA *
Tube T. wt.	15.990g	16.312g	16.124g	16.932g
Wt. of water in Cal. Tube	7.005g	6.908g	6.923g	~~5.938g~~ 8.503g
Cal H_2O wt. - H_2O in tube	1.050g	2.280g	3.314g	NA
Analysis Temperature	31°C	31°C	31°C	31°C
Density of H_2O @ Temp.	0.99534 g/cc	0.99534 g/cc	0.99534 g/cc	0.99534 g/cc
Calc. Vol. of Displaced H_2O @ temperature	1.0451 ml	2.291 ml	3.330 ml	5.9656 ml
density of wet solids	1.069 g/cc	1.101 g/cc	1.133 g/cc	1.134 g/cc

Note: * refers to LN-545 p99 calculated volume @ 20°C

The particle density based on Dry solid weights are less predictable & less useful. This is because the water of hydration has been removed from the weight of the sample. The Dry particle density calculations are provided on page 64.

[signature] 3-14-00

MAR 15 '00 02:44PM ANAL LABS P.4/11

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Particle Density Calculations - Dry

WM:182-183 Log #: 991026-2, 991027-2, 000105-6, 000117-5

Log #	991026-2	991027-2	000105-6	000117-5
	WM:182		WM:183	
G.W. - Tube, Spl + H2O	23.062g	23.462g	23.505g	26.265g
wt. of Dry Sample	0.092g	0.227g	0.295g	0.700g
T. wt. of Tube	15.990g	16.312g	16.312g	16.932g
Weight of H2O in Tb	6.980g	6.923g	6.898g	8.633g
Convert g to ml @ 1g/cc	6.980ml	6.923ml	6.898ml	8.633g
Cal Vol @ 7.0ml Mark	7.0ml	6.94ml	6.95ml	8.54ml
Vol of H2O in Tube	6.98ml	6.923ml	6.898ml	Neg. 8.633
Displaced Vol = Sample Vol	0.02ml	0.017ml	0.052ml	Negative Value
Spl Wt ÷ Sample Vol	4.60 g/cc	13.35 g/cc	5.67 g/cc	NOT CALCULATED

Note Sample 000117-5 solid particle density is not able to be calculated because the wt of the sample + water appears too high. The problem with this value is not able to be resolved.

[signature] 3-14-00

[signature]

MAR 20 '00 03:04PM ANAL LABS P.2/2

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Log #s 991026-2, 991027-2, 991108-1, 991108-2

(3-20-00)

UDS CALCULATION TABLE - WM-182

WEIGHT DESCRIPTION	991026-2	991027-2	991108-1	991108-2
VOA-1	27.005g	26.516g	27.100g	NA
VOA-2	26.881g	26.781g	26.679g	NA
VOA-3	26.827g	26.785g	26.603g	NA
VOA-4	26.508g	26.985g	27.328g	NA
500 ml PFE-#1	283.480g	387.419g	501.571g	522.185g
500 ml PFE-#2	553.938g	409.919g	387.491g	NA
Total wt. of Liq + Sol	944.639g	904.405g	996.772g	522.185g
SOLIDS - ~~Fines~~ Wet wt. (centrifuged/decanted)	(129.103g)	(119.811g)	(140.713g)	NOT DETERM.
TOTAL LIQ WT. - Wet Sol.	815.536g	784.594g	856.059g	
Specific GRAVITY	1.10268	1.11444	1.09700	1.09668
CALCULATED VOLUME	739.59 ml	704.03 ml	780.36	NA

SOLID WEIGHTS & FINAL UDS CALCULATIONS

Wet Solids wt.	129.103g	119.811g	140.713g	NA
Dry Solids wt. - Air dried	39.494g	38.538g	47.060g	NA
MOISTURE LOSS WT.	89.609g	81.273g	93.653g	NA
% MOISTURE CONTENT	69.41%	67.83%	66.56%	NA

CALC. H_2O VOL TO Be Added to H_2O Vol - above	89.609 ml	81.273 ml	93.653 ml	NA
New Calc. Total Vol.	829.199 ml	785.303 ml	874.01 ~~780.36~~ ml	NA
Dry solid weight	39.494g	38.538	47.060g	NA
U.D.S. Value g/L	47.63 g/L	49.07 g/L	53.84 g/L	NA

Note: weights of water loss assume a specific gravity of 1.0 (g/cc) This allows a direct conversion from grams to milliliters.

[signature] 3-20-00

MAR 21 '00 09:03AM ANAL LABS P.2/2

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Log H000228-1 WM:183 Composite 3-20-00

CALCULATION TABLE - PARTICLE DENSITY of AIR DRIED SOLIDS - WM:183 COMPOSITE

Parameter	Value	Reference Page of LN-354
G wt. of Sply Tube + H_2O	23.548g	p 66
Measured wt of Dry sample	1.179g	p 65
Wt. of Tube + Water	22.369 g	Calculated
Tare wt. of Tube	15.993g	p 65
Wt. of H_2O in Tube	6.376g	Calculated
Convert H_2O wt to Vol.	6.376 ml	Converted assuming 1.0g of
Calibrated Vol @ 7.0ml		H_2O = 1 ml or 1 cc
Mark	7.00ml	p 61
Volume of H_2O in Tube	6.376ml	Calculated
Displaced Volume = Sample		
Volume	0.624ml	Calculated
Sample wt. from above	1.179g	p 65
Sample wt ÷ Displaced Vol.	1.889g/cc	Calculated
Operating Temperature	30.8 °C	p 66
Density of H_2O @ Temp	0.99540g/cc	interpolated using Table 10-38
Particle Density @ Temp.	1.88 g/cc	of page 85, LN-545 Lab book

WM:183 Comp. BULK DENSITY CALCULATION TABLE

	Log H000228-1	Reference Page
Gross wt of Tube + Solids	18.700g	66
Tare wt. of Tube	15.993g	65
Weight of Wet Solids	2.707g	Calculated
Volume of settled Solids	2.33 - Interpolation based on Calibration	66 & 61
~~Moist~~ Moist Bulk Density Mass/Volume	1.16 g/cc	Calculated
Temperature in °C	30.8	66

[signature] 3-20-00

MAR 21 '00 09:02AM ANAL LABS P.1/2

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Log 000228-1 WM-183 COMPOSITE 3-21-00

WM-183 Composite DRY BULK DENSITY CALCULATION TABLE

PARAMETER	VALUE	Reference Page
Drum wt of tube + dry solids	17.172g	65
Tare weight of tube	15.993g	65
weight of dry solids	1.179g	65
volume of settled dry solids - measured	1.65ml	65
actual volume of solids based on calibration table - p61	1.64ml	61
air dry bulk density	0.72 g/cc	calculated

Gary M. Hurst 03-28-00

Post-it® Fax Note 7671

Date 3-21-00	# of pages ▶ 2
To ADAM POLUSKI	From Gary Hurst
Co./Dept.	Co.
Phone # 6-6100	Phone # 6-7837
Fax # 6-6803	Fax # 6-0067

MAR 27 '00 03:49PM ANAL LABS P.2/4

ALD-354

70

% INTERSTITIAL WATER HOLDUP CALCULATIONS

3-24-06	WM: 182		WM: 183		
	991026-2	991027-2	000105-6	000117-5	000228-1
Tube + SPL + H_2O wt.	23.062g	23.462g	22.505g	26.765g	23.548g
- Tube T.W.	15.990g	16.312g	16.124g	16.932g	15.993g
= Sample + H_2O wt.	7.072g	7.150g	7.381g	9.333g	7.555g
Vol of H_2O Filled Tube at Calib.	7.0ml	6.94ml	6.95ml	8.54ml	7.00ml
Vol. of Settled Sol.	1.35ml	2.60ml	3.70ml	6.26ml	2.33ml
Vol of H_2O above solids	5.65ml	4.34ml	3.25ml	2.28ml	4.67ml
Analysis Temp °C	31°C	31°C	31°C	31°C	30.8°C
H_2O Density at Temp.	0.99534g/cc	0.99534g/cc	0.99534g/cc	0.99534g/cc	0.99542
Wt. of H_2O above solids	5.624g	4.320g	3.235g	2.269g	4.649g
H_2O + SPL wt.	7.072g	7.150g	7.381g	9.333g	7.555g
- wt. of H_2O	5.624g	4.320g	3.235g	2.269g	4.649g
= SPL + H_2O HOLDUP	1.448g	2.830g	4.146g	7.064g	2.906g
SPL + water holdup	1.448g	2.830g	4.146g	7.064g	2.906g
- wet SPL	1.117g	2.523g	3.772g	6.768g	2.707g
= water Holdup wt	0.331g	0.308g	0.374g	0.296g	0.199g
H_2O Holdup wt.	0.331g	0.308g	0.374	0.296g	0.199g
SPL + holdup wt	1.448g	2.830g	4.146	7.064g	2.906g
= % H_2O Holdup	22.86%	10.88%	8.97%	4.19%	6.85%

Note: log 000228-1 is a composite of all WM: 183 samples.
Above calculations are for SEMI-WET SOLIDS

MAR 27 '00 03:50PM ANAL LABS P.3/4

ALO-754

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% INTERSTITIAL WATER HOLDUP CALCULATIONS

3-24-00

CENTRIFUGED WET SOLIDS

	WM-182		WM-183	
	991026-2	991027-2	000105-6	000117-5
Tube+Sol+H2O wt	23.062g	23.462g	23.585g	26.265g
-Tube Tare wt	15.990g	16.312g	16.124g	16.932g
Sol+H2O wt	7.072g	7.150g	7.381g	9.333g
Vol of H2O Filled Tube Calibr.	7.0ml	6.94ml	6.95ml	8.54ml
Vol of Cent. Sol.	1.20ml	2.50ml	3.60ml	6.16ml
Vol of H2O above solids	5.8ml	4.44ml	3.35ml	2.38ml
Analysis Temp °C	31°C	31°C	31°C	31°C
H2O Density at Temp	0.99534g/cc	0.99534g/cc	0.99534g/cc	0.99534g/cc
Wt of H2O above solids	5.773g	4.419g	3.334	2.369
H2O+Sol wt	7.072g	7.150g	7.381g	9.333g
-wt. of H2O	5.773g	4.419g	3.334g	2.369g
=Sol+H2O Holdup	1.299g	2.731g	4.047g	6.964g
=Sol+H2O Holdup	1.299g	2.731g	4.047g	6.964g
-wt of wet Sol	1.117g	2.523g	3.772g	6.768g
=g of H2O Holdup	0.182g	0.209g	0.275g	0.196g
H2O Holdup wt	0.182g	0.209g	0.275g	0.196g
÷sol+holdup wt	1.299g	2.731g	4.047g	6.964g
= % H2O Holdup	14.01%	7.65%	6.80%	2.81%

[signature] 3-27-00

MAR 27 '00 03:50PM ANAL LABS P.4/4

ALD-354

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03-27-00

% INTERSTITIAL WATER HOLDUP CALCULATION
BASED ON AIR-DRIED WM-183 COMPOSITE
& COMPARED TO WET SAMPLE WEIGHT

Log = 000228-1

			Reference Page
	Tube + Sample + H_2O wt.	23.548g	66
	- Tube Tare wt.	15.993g	65
	= Sample + H_2O wt.	7.555g	calculated
	Volume of H_2O Filled Tube at the calibration mark	7.00 ml	66+61
	- Volume of settled solids	2.33 ml - Calib. Interpol.	66+61
	= Vol. of H_2O Above Solids	4.67 ml	calculated
	Analysis Temp. °C	30.8°C 1.05	66
	H_2O Density @ Temp	0.99540 g/cc 1.2	interpolation from Table 10-28 of page 85, LN-545
	Weight of Water Abv. Solids	4.649g 5.604	
	Sample + H_2O weight	7.555g	calculated
	- wt. of H_2O	4.649g 5.604	calculated
	= Spl. + H_2O Holdup	2.906g 1.951	calculated
1.25 g/ml	- Slurry density Sample + water Holdup	2.906g 1.951	calculated
	- wet sample wt.	2.707g 2.707	page 66
	= water Holdup wt.	0.199g	calculated
	H_2O Holdup weight	0.199g	calculated
	÷ wet sample + Holdup wt.	2.906g	calculated
	= % H_2O Holdup of wet Spl	6.85%	calculated
	Sample + H_2O Holdup	2.906g	calculated
Gary M. Huntz	- Dry Sample weight	1.179g	65
	= water Holdup wt	1.727g	calculated
3-27-00	water Holdup % of Dry sample	59.43%	calculated

MAR 15 '00 02:44PM ANAL LABS P.5/11

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March 25, 1999 LDUA Meeting (cont'd)

320 hrs was approved for method development for Cl^- analysis of solids.

Gary H is supposed to check with Tom Brown regarding NIST particle size standards.

If possible, the WM:188 solids must be retained for cliff after analyses are complete on the RCRA package on 990301-6 & 990210-4.

Gary M. Huck 3-26-99

NOTE: The data tabulated on pages 135 and 136 summarize important values necessary to obtain % moisture content on fine solids and U.D.S. information for fine and coarse solids. The lab ID#s were unintentionally left out of the table.
The lab ID#s are as follows:

Log #	SAMPLE NAME	TYPE of SOLIDS	LAB ID #
990210-4	WM:188 SPL1	COARSE	9AH97
990210-4	WM:188 SPL1	FINE	9AI01
990210-4	WM:188 SPL2	COARSE	9AH98
990210-4	WM:188 SPL2	FINE	9AI02
990210-4	WM:188 SPL3	COARSE	9AH99
990210-4	WM:188 SPL3	FINE	9AI03
990301-6	WM:188 SPL4	COARSE	9AM74
990301-6	WM:188 SPL4	FINE	9AM75

Gary M. Huck 3-29-99

MAR 15 '00 02:45PM ANAL LABS P.6/11

135

990301-6 (WM:188-4) + 990310-4 (WM:188 1,2,3)

SOLIDS + LIQUIDS WEIGHT SUMMARY

WEIGHT DESCRIPTION	SAMPLE 1 (WM:188-1,2,3)	SAMPLE 2	SAMPLE 3	SAMPLE 4 (WM:188-4)
VOA-1	30.670	29.497	30.737	30.713
VOA-2	29.728	30.349	30.428	30.444
VOA-3	30.184	29.443	30.490	30.659
VOA-4	30.601	29.745	27.610	30.099
SVOL-FINES	NOT Alliquoted	398.798	408.266	413.126
ORIGINAL FINES	310.901	364.720	351.798	220.200
TOTAL WT. of LIQ + FINES	432.084	882.551	878.829	755.234
FINES (WET WT.)	(4.634)	(10.081)	(9.659)	(4.177)
TOTAL LIQ WT - WET FINES	427.450	872.470	869.170	751.057
SPECIFIC GRAVITY of SAMPLE	1.28583	1.28258	1.28141	1.27828
CALCULATED VOLUME	332.43 ml	680.25 ml	678.29 ml	587.553

SOLID WEIGHTS + UDS CALCULATIONS

FINES WET WT.	4.634	10.081	9.659	4.177
FINES DRY WT.	1.896	4.519	4.173	0.642
MOISTURE LOSS FINES	2.738	5.56	5.49	3.535
% MOISTURE CONTENT (FINES)	59.08	55.17	56.80	84.13
COARSE SOL. DRY WT.	0.455	0.376	1.681	0.038
TOTAL WT. of DRY SOLIDS	2.351	4.895	5.854	0.680
CALCULATED WATER VOL	+ 0.2 ml 3-29-00			
m EVAP ABSORB TO TTL VOL	2.738	5.56	5.49	3.54
CALCULATED TOTAL VOL.	335.17 ml	685.81 ml	683.78 ml	591.09 ml
÷ TOTAL WT. of DRY SOLIDS	2.351	4.895	5.854	0.680
= U.D.S. VALUE g/L	7.01 g/L	7.14 g/L	8.56 g/L	1.15 g/L

[signature] 3-29-00

(CONTINUED ON PAGE 136)

MAR 15 '00 02:46PM ANAL LABS P.7/11

136

990301-6 (WM:188-4) & 990210-4 WM:188 1,2,3

U.D.S. CALCULATIONS (CONTINUED)

	WM:188-1,2,3			WM:188-4
WTs & DESCRIPTION	SAMPLE 1	SAMPLE 2	SAMPLE 3	SAMPLE 4
CALC. TOTAL VOL of LIQUID	335.17 ml	685.81 ml	683.78	591.09
Dry weight of FINES	1.896g	4.519g	4.173g	0.642g
Dry weight of Coarse Sol.	0.455	0.376	1.681	0.038
U.D.S. Value - Coarse Sol.	1.36g/L	0.55g/L	2.46g/L	0.06g/L
U.D.S. Value Fine Solids	5.66g/L	6.59g/L	6.10g/L	1.09

Note: Water loss wts from page 135 assumed a specific gravity of 1.0. This allows a direct conversion from mls to grams & vise versa.

BULK DENSITY CALCULATIONS

TABLE of WEIGHTS & VOLUMES USED FOR BULK DENSITY

TYPE OF MEASUREMENT	REFERENCE PAGE #	VALUE	UNIT
Tare wt. of Sel. Tube	124	13.740g	grams
wt. of Sel. Tube + Wet Sample (Un-centrifuged)	130	21.563	grams
Settled Wet Volume of Solids	129	6.77	milliliters
Volume of Centrifuged Solids	130	4.72	milliliters
Weight of 0.1N HNO_3 Displaced	131 - NaCl #2	2.04	grams
Weight of Wet Cent. Solids	CALCULATED	5.783	grams
Weight of Solid + Tube - Displaced HNO_3	CALCULATED	2.04	grams

This tube is used for reference to calculation on pages 137 & 138

Gary M. Huesk

April 1, 1999

MAR 15 '00 02:46PM ANAL LABS P.8/11

137

990301-6 (WM-188-4) + 990210-4 (WM-188-1,2,3)

BULK DENSITY CALCULATIONS

MOIST BULK DENSITY (settled)

Moist Bulk Density-settled = (wt. of Tube + wt. of moist sample) − (Tube wt. of sel. Tube) / (settled wet volume of solids)

A wt. of Tube + wt. of moist sample needs to have the wt. of displaced 0.1M HNO_3 removal from this total wt since this value was not measured upon centrifugation + removal of all liquid.

2.05 mls of 0.1 M HNO_3 was displaced upon centrifugation and the Density of 0.1M HNO_3 @ 30°C is 0.9969 g/cc

page 131 Soa Note H_2 2.05 mls × 0.9969 g/cc = 2.04 g of HNO_3

21.563 g of solids, HNO_3, Tube − 2.04 g of HNO_3 = 19.523 g

19.523 g of Tube + moist solids − 13.740 g of Tube Tare wt = 5.783 g of wet solids

5.783 g of wet solids / 6.77 ml of settled solids = 0.85 g/cc Moist Bulk Density (settled)

[signature] 4-1-99

MAR 15 '00 02:46PM ANAL LABS P.9/11

138

990301-6 (WM:188-4) + 990210-4 (WM 188-1,2,3)

BULK DENSITY CALCULATIONS

MOIST BULK DENSITY (CENTRIFUGED)

MOIST BULK Density (centrifuged) = (wt. of Tube + wet solids) − (empty wt. of Sol Tube) / Volume of solids in Tube centrifuged

See NOTE #2 Page 171

2.05 mls of 0.1M HNO_3 was displaced upon centrifugation.
The density of 0.1M HNO_3 @ 20°C is 0.9969 g/cc
2.05 mls × 0.9969 g/cc = 2.04 g of 0.1M HNO_3

21.563 g (of solids, 0.1M HNO_3 + Tube) − 2.04 g (of 0.1M HNO_3)
= 19.523 g

19.523 g of Tube + Moist solids − 13.740 g of Tube Tare wt.
= 5.783 g of wet solids

5.783 g of wet solids / 4.72 mls of centrifuged wet solids = 1.22 g/cc Moist Bulk density (centrifuged)

[illegible] 4.1.99

MAR 15 '00 02:47PM ANAL LABS P.10/11

139

990301-6 (WM:188-4) + 990716-4 (WM:188-1,2,3)

TABLE of WEIGHTS, VOLUMES & DENSITY FOR PARTICLE DENSITY

TYPE OF MEASUREMENT	REFERENCE PAGE #	VALUE	UNIT
wt of Sol. Tube + 0.1M HNO_3 at mark	Calculated	20.623	grams
SAMPLE WT. - Dry	127	3.770g	grams
DENSITY of 0.1M HNO_3 @ 30°C	97	0.9969	g/cc
Gross wt. of Tube, Solids + HNO_3 - 0.1M at the ~~Siphoned~~ Calibrated mark	101	19.626	grams
Siphoned mark	~~0.0~~ 129	0.0	N/A
Weight of 0.1M HNO_3 above the Calibrated 1.0 mark	97	0.9969	grams
Gross wt of Tube, HNO_3 + Solids at 0 mark	129	21.888g	grams

Particle density was calculated as follows

Particle density = dry sample wt. / (wt. of Tube + HNO_3 at 0.0 mark) + (wt. of Dry Solids) − (g wt. of Tube, Solids + HNO_3 at Calc. mark)

Density of 0.1M HNO_3 @ 30°C

The calibrated weight of the Tube + 0.1M HNO_3 at the 1.0 mark is 19.626g. But the Tube was siphoned to the 0.0 mark instead of 1.0. That represents 1.0 mls more volume of 0.1M HNO_3 so 19.626g − (Calibrated wt. of Tube + HNO_3) + 0.9969g (1.0 ml HNO_3) = 20.623g of Tube + HNO_3 (0.1M) at the 0 mark.

20.623g Tube + 0.1M HNO_3
+ 3.770g Dry sample added
24.393g Total wt.

24.393g Total wt
− 21.888g g wt. of Tube, Solids + HNO_3 at mark
2.505g displaced wt.

[signature] 4.1.49

MAR 15 '00 02:47PM ANAL LABS P.11/11

140

990301-6 (WM: 188-4) 990210-4 (WM: 188-1,2,3

PARTICLE DENSITY CALCULATIONS (CONT.)

3.505g displaced wt / 0.9969 g/cc 0.1m HNO_3 @ 30°C = 2.513 mls of displaced volume

3.770g of solids (Dry) / 2.513 mls of displaced volume = 1.50 g/cc @ 30°C

[signature] 4-1-99

Aliquoting For ORGANIC ANALYSES - SOLIDS

Check wt. B.C #1 7.502 g passed P.C

PFE Cent Tube #	Gross wt	Tube wt (P.III)	Net wt
1	36.463g	31.103g	5.360g
2	32.269g	31.486g	0.783g

Sample #1 was split 4 ways As Follows

5.360g ÷ 4 Aliquots = 1.34g Theoretical split

Actual Splits were performed as Follows

EDF-015722-041

ENGINEERING DESIGN FILE

1. Project File No. 15722 2. Project/Task Tank Farm Closure

3. Subtask Process

4. Title: Surrogate Sludge for Tank Farm Closure Mockups

5. Summary: An effort to create a surrogate sludge material for tank farm closure mockups is discussed. Visual data from the Light Duty Utility Arm, and empirical data from tank farm samples are evaluated against a number of possible surrogate materials. This evaluation produced a **kaolin clay/ alum floc** as a recommended surrogate. **Hydrated gypsum** should be added to increase the settling rate. **Iron oxide should also be added (prior to flocculation)** as a pigment. The exact quantities of these materials need to be determined quantitatively in an analytical laboratory environment.

While the sludge initially exhibits good characteristics, sludge aging can produce some unwanted effects:

- After aging two to three weeks, the solids seemed to settle significantly faster and the yield stress properties seemed to degrade.
- After approximately three weeks the kaolin/alum sludge had some algae growth. Therefore, a fungicide may be added to prevent biological activity.

Therefore, if the mockups are performed immediately following sludge production (within one to two weeks) this degradation and biological activity should be minimized.

6. Distribution (complete package):

Distribution (summary package only):

7. Review (R) and Approval (A) Signatures: (Minimum reviews and approvals are listed. Additional reviews/approvals may be added as necessary.)

	R/A	Printed Name	Signature	Date
Author	R	Adam Poloski	Adam Poloski	10/23/00
Author	R	Michael Wilcox	Michael R. Wilcox	10/23/00
Technical Review	R	Edward Wagner	Edward Wagner	10/20/00
Requestor	A	Edward Anderson	Edward Anderson	10/30/00

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1 Introduction

Selection of a simulated solid surrogate to mimic the physical characteristics of sludge located in tank WM-182 and Tank WM-183 within the INTEC Tank Farm Facility (TFF) has been performed. This evaluation was based on TFF solids technical data acquired to date. It was determined that kaolin clay (pigmented with iron-oxide) flocculated by the addition of aluminum sulfate (alum) provides the basis for an effective surrogate. Calcium sulfate dihyrdate (hydrated gypsum) provides adjustment of settling rate and may provide refinement of particle size distribution. Quantitative work needs to be performed in order to develop final recipe ratios and parameters of the surrogate ingredients.

Mixed waste sludge needs to be removed from TFF tanks as part of the closure process to the maximum extent practical. The tanks will be closed in a phased approach with sludge (solids) being transferred to other TFF tanks in order to begin closure of the tanks as they are emptied. In order to manage the TFF solids, it desired to mimic the sludge for use in TFF closure mock-up work. The mock-up is planned to test processes and equipment such as sludge displacement by grout of varying slump rates, tank solids washing, and remote camera operation.

Development of a surrogate sludge and its use in TFF tank closure mock-up execution is useful for a variety of reasons:

- Provides for a measurement of the amount of sludge displaced from additions of grout of varying slump rates.
- Provides for a measurement of how the sludge is encapsulated or entrained within the grout.
- Provides for a measurement of cured grout/surrogate composite compressive strength.
- Provides a vehicle to measure the effectiveness of wash-ball tank operations on removing solids adhered to tank walls and solids suspension for removal via the steam inductor.
- Provides an arithmetic basis for sludge mass remaining in the tanks after washball and grouting operations to base radiological and hazardous source term calculations in support of TFF conceptual design closure.

2 Significant Factors

2.1 Visual Data

While not based on strict empirical data, visual observations of the sludge material provide a general understanding of the behavior of the solids. We have a great amount of video footage from the LDUA during inspections and sampling. A few of the more interesting scenes pertaining to the surrogate solids effort from the WM-182,WM-183 video collection

have been selected. These selections will be discussed and some conclusions will be drawn based on these photographs. The first set of images consists of the LDUA inspecting prior WM-182 sampling locations (see Figure 1). The photograph on the left shows one previous sample location. This sample location shows cracks on the surface of the sludge layer. The cracks seem to indicate that the solids have solid-like properties. The photograph on the right shows a different sample location. This image shows the surface cracking similar to the other sample location. Therefore, this property is not localized. The right image also shows a distinct cylindrical shape at the sampling location. Since the LDUA sample port is cylindrical and the sample depression did not crumble to an angle of repose, this image also shows that the sludge layer acts solid-like in nature.

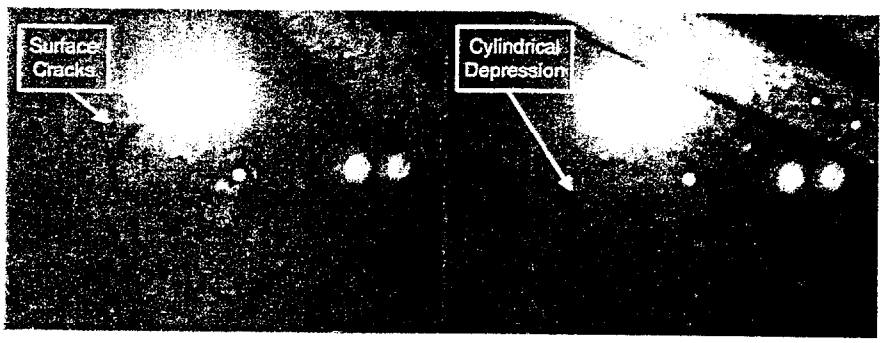

Figure 1: Inspection of Previous Sampling Locations (WM-182)

The second set of images consists of the LDUA inspecting a location where the sampler was previously moved through the WM-182 sludge layer (see Figure 2). The image on the right shows the original location where the sampler was placed in the sludge layer. Note the surface cracking is again present in this image. As the sampler was moved to the left, a wake developed behind the sampler. In this wake area, one can see relatively large solid clumps or agglomerates near the boundary of the wake area. Much smaller clumps are present in the center of the wake. This occurred because as the sampler was moved through the sludge layer large cracks would form near the wake boundary region. These cracks would eventually grow large enough to form large agglomerates. As these agglomerates move into the wake, larger shear rates are generated by the velocity gradient that break apart the agglomerates. Therefore, one could see the solid-like properties of the sludge under low shearing conditions at the wake boundary and fluid-like properties in the wake when the shear rates became large enough the break the agglomerates into smaller particles. Consequently, this material appears to act as a solid until a certain threshold is reached. At this point, the sludge begins to behave as a fluid. This is the definition of fluid dynamics property called a ***yield stress***. Sludges commonly possess this yield stress property.

Figure 3 shows a scene where the LDUA sampler was placed in the WM-182 sludge layer. As the sampler sat in the sludge layer, the LDUA mast was in the air above the tank. Gusts of wind oscillated the mast and in turn oscillated the sampler. As the sampler oscillated,

Figure 2: LDUA Sampler Moved Through The Sludge (WM-182)

an area of sludge around the sampler clearly oscillated with the sampler. While we could only observe the uppermost portion of the sludge layer, this situation demonstrates how the sludge layer possesses fluid-like properties.

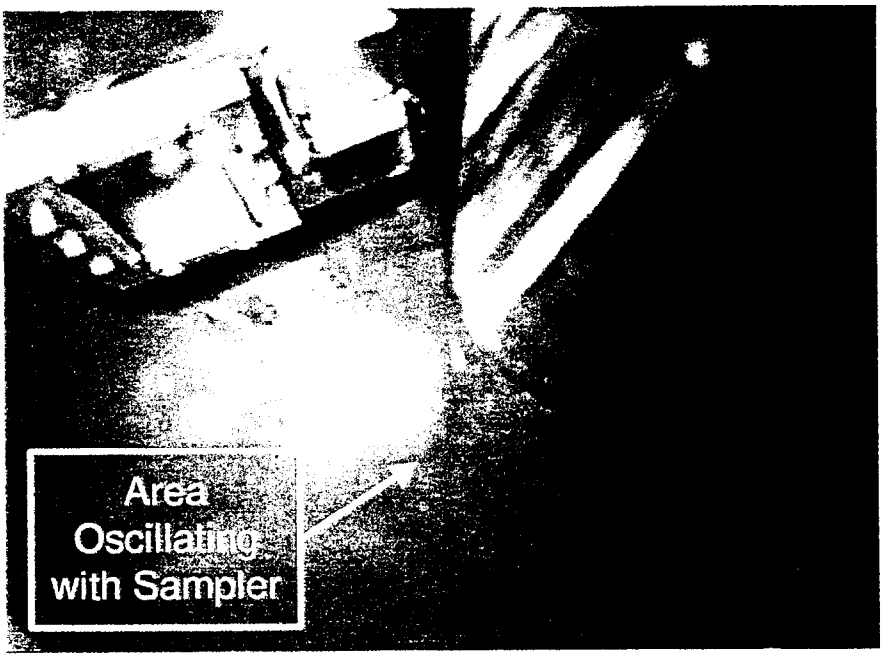

Figure 3: Sludge Layer Oscillating with Sampler (WM-182)

Figure 4 shows a scene where the LDUA sampler was taking a sample from the WM-182 sludge layer. As the sampling began, surface cracks (as previously discussed) could be seen forming. Near the end of the of the sampling a relatively large amount of agitated solids could be seen billowing out near the sampler. This situation can be interpreted as follows:

- The surface cracks are forming due to low shear stresses under the yield stress threshold.

As a result, the sludge particles act interdependently on each other and possess solid-like behavior.

- The billowy disturbance is generated due to larger shear forces that are above the yield stress threshold. As a result, the sludge particles act independently of each other and possess fluid-like behavior.

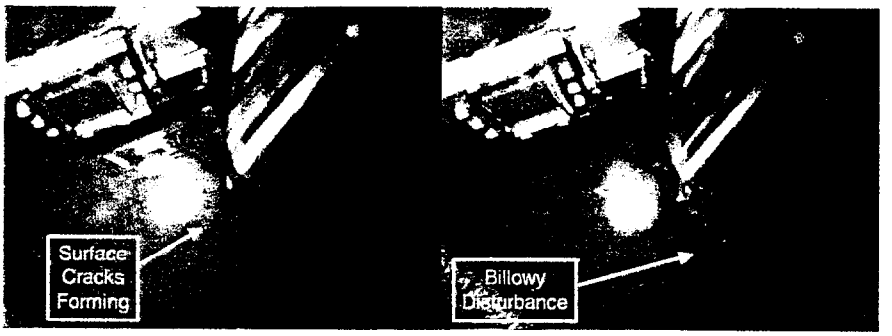

Figure 4: WM-182 Sludge Sampling

Figure 5 shows a scene where the LDUA sampler was taking a sample from the WM-183 sludge layer. The interesting feature in this scene is that while the WM-182 sludge layer was under a few inches of standing free liquid, the WM-183 sample location has no standing free liquid and the sludge layer is undersaturated. In this undersaturated condition the sludge layer appears to possess only fluid-like behavior. As the sampler is inserted, the sludge layer is pushed around the sampler in a fluid-like manner. When the sample is taken, no surface cracks form and the sludge could be likened to a thick mud.

Figure 5: WM-183 Sludge Sampling

Figure 6 shows the LDUA inspecting the WM-182 sludge. The images show particles floating on the surface of the standing liquid (see Figure 6). Under this layer of standing liquid one can see the settled sludge particles. This is interesting because previous sampling

activities of tank liquid in the transfer lines have shown a relatively large amount of solids in the tank farm liquid. Many people have assumed these solids were due to suspended solids in the tank farm liquid. This image shows that the majority of the solids have settled out and some particles are suspended on the surface of the liquid due to surface tension. Consequently, the assumption that relatively large amounts of suspended undissolved solids ($3\ \frac{g\ UDS}{L}$)in the tank farm liquid could be in error. The UDS concentration measurements are from liquid samples taken as the tank farm liquid was transferred from one tank to another via steam jet eductor. Figure 7 shows the sludge layer around a steam jet eductor in WM-183. As one can see, the steam jet not only transferred liquid but also entrained solids around the steam jet which may account for the large amount of "suspended" UDS.

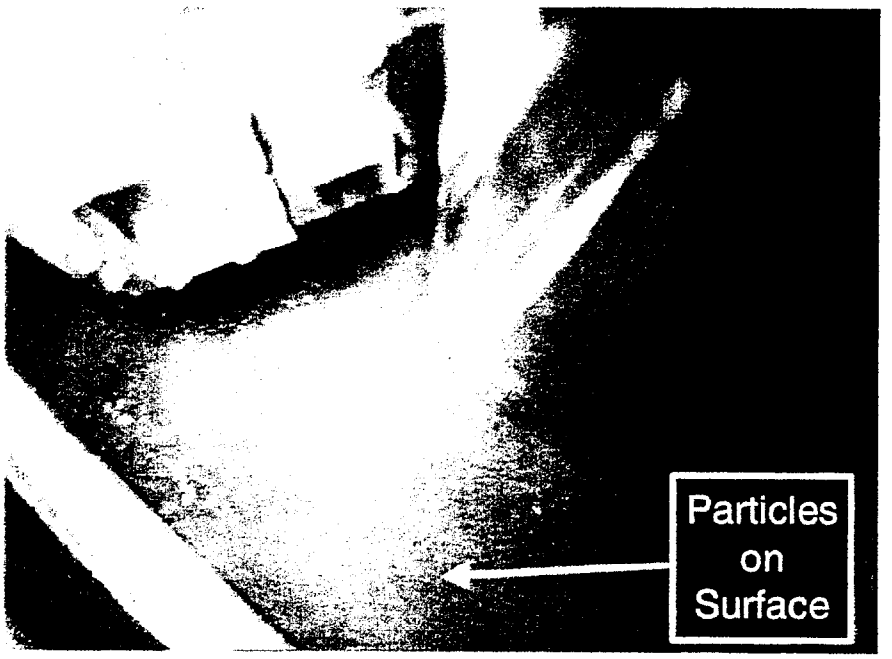

Figure 6: Particles Floating on Clear Liquid (WM-182)

One might argue that that once the depression around the steam jet is established the amount of entrained solids would be minimal. However, it seems that the required yield stress to agitate and move the solids is low and is met by simply transferring liquid from the tanks. Figure 8 shows the topology of the sludge layer in WM-183. After liquid was transferred from the tank, the topology of the sludge layer was significantly changed. This indicates that a significant amount of entrained solids could still be present after establishing a depression around the steam jet. If one used a different method to transfer the liquid, such as slowly removing the liquid from the top, the UDS concentration should be minimized.

Besides LDUA footage, a WM-182 sample was taken and placed in the RAL hot cell. Figure 9 shows this sample as it is tilted to one side. As one can see, the clear liquid top layer

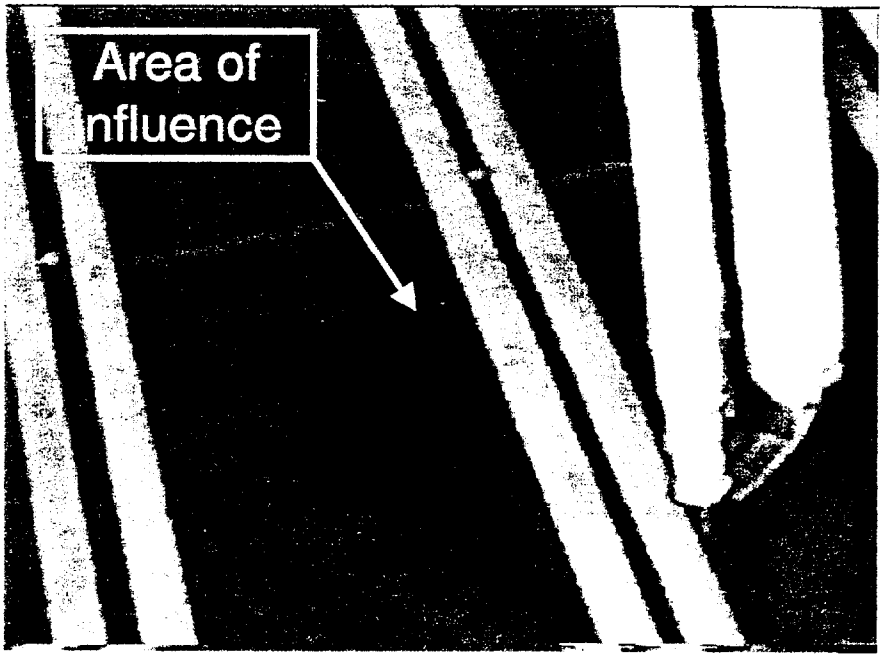

Figure 7: WM-183 Steam Jet

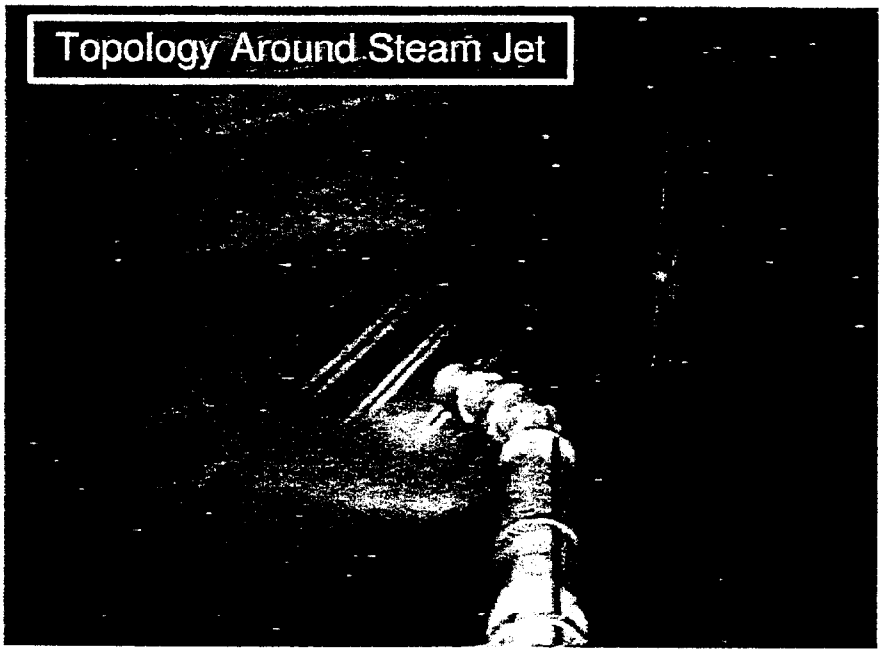

Figure 8: WM-183 Sludge Layer Topology

is fluid-like and moves with gravity. The sludge layer, however, is solid-like and remains in its settled configuration. This again is evidence of a yield stress property. As the bottle was tilted quickly from one side to another, the sludge particle would break apart and become agitated and billowy, thus clouding the clear liquid layer.

Figure 9: Tilting the WM-182 Hot Cell Sample

In conclusion, the visual data we have discussed above provides evidence for the following conclusions:

- The solids are electrostaticly attracted to each other. This attraction provides the observed yield stress phenomenon and solid-like behavior (surface cracks, tilted bottle, etc.).
- The electrostatic attraction is relatively weak and once these forces have been broken the particles act in a fluid-like manner. This explains the observed change in sludge layer topology, the wake behind the sampler, and the billowy disturbances.
- This electrostatic attraction is the driving force behind flocculation. Further evidence of the sludge being a floc will be presented below. See Appendix A for a brief discussion on flocculation.

2.2 Settling Type and Rate

For certain types of solid/liquid separation operations, an understanding of the dynamics involved in settling is essential. Perry's Chemical Engineers' Handbook [2] has a general discussion of various settling regimes:

> At low concentrations, the type of settling encountered is called particulate settling. Regardless of their nature, particles are sufficiently far apart to settle freely. Faster settling particles may collide with slower settling ones and, if they do not cohere, continue downward at their own specific rate. Those that do cohere will form floccules of a larger diameter that will settle at a rate greater than that of individual particles.
>
> There is a gradual transition from particulate settling into the zone-settling regime, where the particles are constrained to settle as a mass. The principal characteristic of this zone is that the settling rate of the mass, as observed in

batch tests, will be a function of the solids concentration (for any particular condition of flocculation, particle density, etc.).

The solids concentration ultimately will reach a level at which particle descent is restrained not only by the hydrodynamic forces but partially by mechanical support from the particles below; therefore, the weight of the particles in mutual contact can influence the rate of sedimentation of those at lower levels. This compression, as it is termed, will result in further solids concentration because of compaction of the individual floccules and partial filling of the interfloc voids by the deformed floccules. Accordingly, the rate of sedimentation in the compression regime is a function of both the solids concentration and the depth of pulp in this particular zone. As indicated in Figure 10, granular, nonflocculent particles may reach their ultimate solids concentration without passing through this regime.

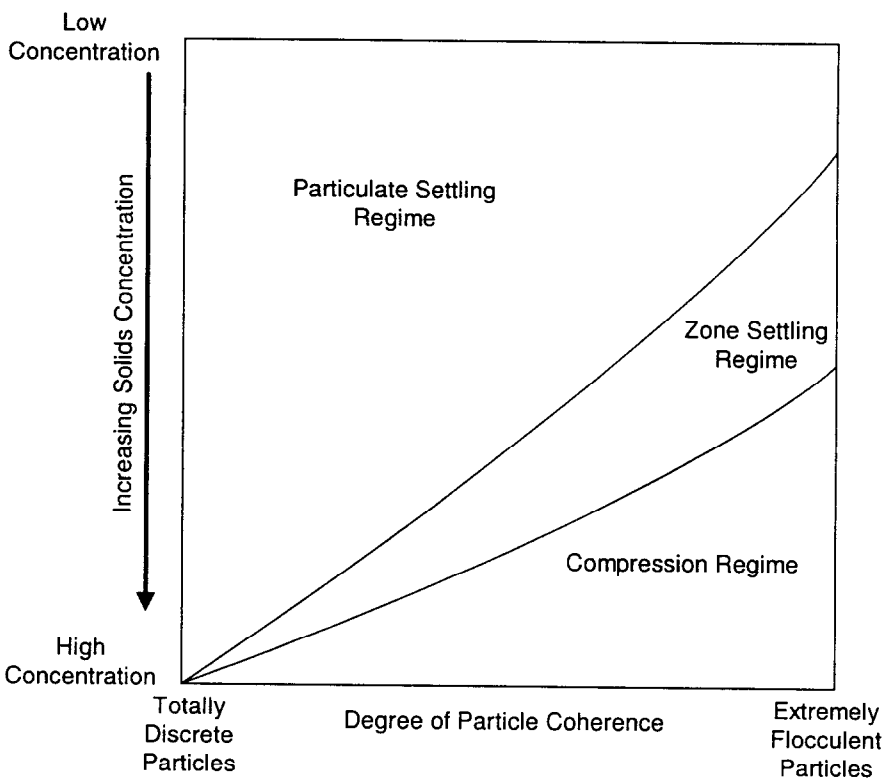

Figure 10: Settling Regimes

These types of settling are further discussed by Pierre and Ma [3]. In this paper, Pierre and Ma describe two types of settling, accumulation sedimentation, which is analogous to particulate settling, and flocculation sedimentation, which is analogous to zone/compression settling. These types of sedimentation are illustrated in Figure 11.

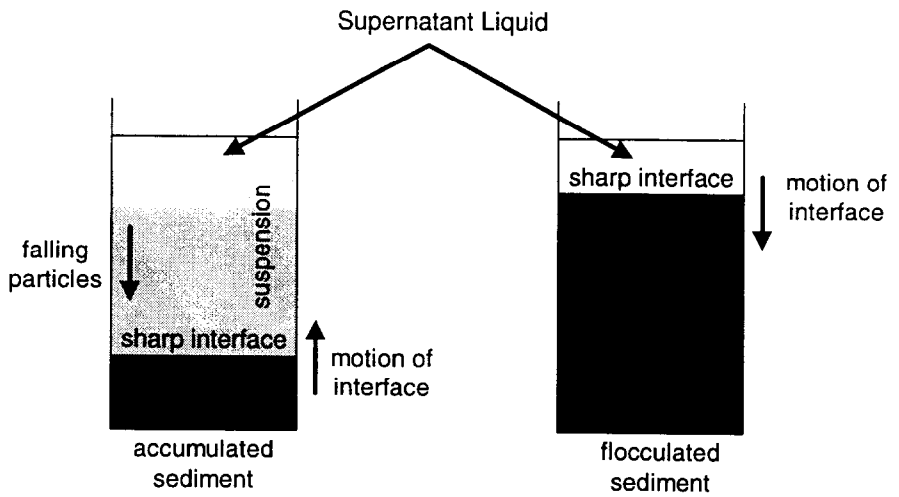

Figure 11: Accumulation Sedimentation and Flocculation Sedimentation

The WM-182 hot cell sludge sample was completely shaken and allowed to settle. Photographs were taken at various times after agitation. From the upper left photograph shown in Figure 12, one can see that we have a relatively high solids concentration. As a result, the degree of flocculation should be the determining factor in the type of settling that occurs. As time progresses after agitation, flocculation sedimentation or zone/compression settling is observed; indicating a relatively high degree of flocculation. From these pictures, we were able to scale the images to a similar sample bottle with a measured circumference and get the heights of the sample and settled sludge layer as a function of time. Nondimensionalizing the system involves using the following relation:

$$\text{Settled Solids Percent} = 100\% \times \frac{V_{\text{sample}} - V_t}{V_{\text{sample}} - V_\infty} \tag{1}$$

where,

V_{sample} is the total volume of the sample

V_t is the volume of the settled sludge layer at time t

V_∞ is the final settled volume of the sludge layer

From this equation, the plot shown in Figure 13 can be constructed. Note that there is no way to gauge the error involved in these data. Based on best professional judgment, a 20% error is assumed. A plot of the interface velocity as a function of time is shown in the same figure. From these photographs and plots, a slow flocculation sedimentation can be concluded.

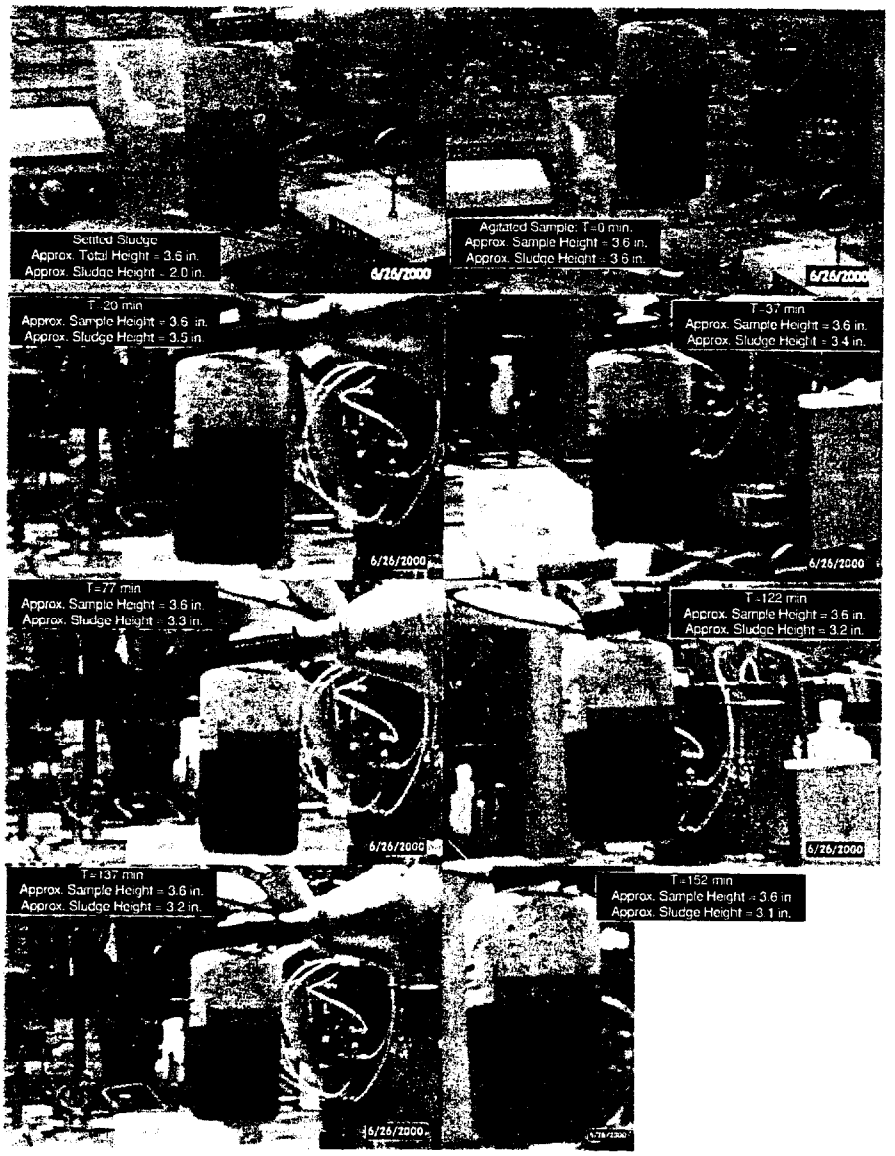

Figure 12: WM-182 Sludge Sample Settling Photographs

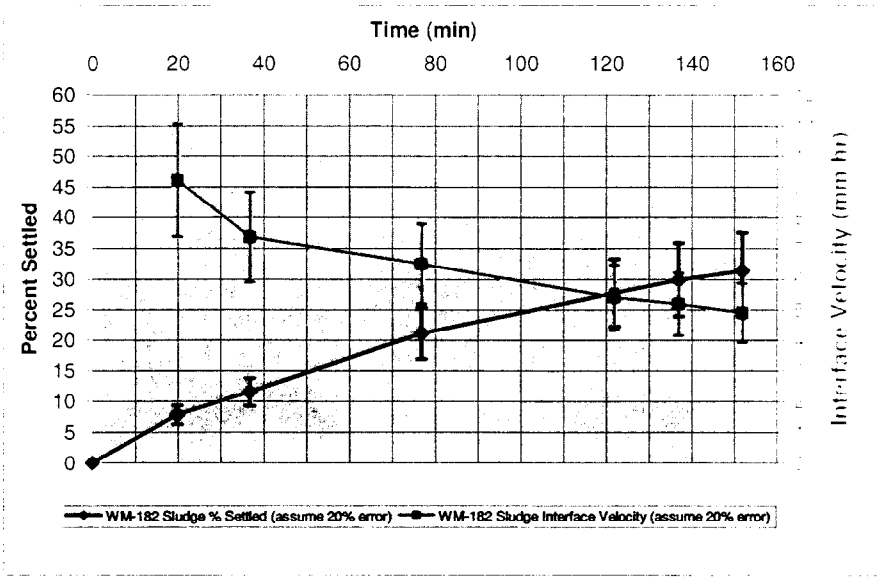

Figure 13: WM-182 Sludge Compression Settling Rate

2.3 Particle Size Distribution

A Horiba particle size analyzer was recently deployed in the RAL hot-cell. Several of the LDUA samples were analyzed using this particle size analyzer. The results of this analysis were compiled in "WM-182/183 Heel Slurry PSD Results Report" [5]. The particle size distribution (PSD) data in this report consists of two distributions for both WM-182 and WM-183. The first set of PSDs consists of data taken with the ultrasonic dispersion chamber turned off while the second set of data consists of PSDs with the ultrasonic dispersion chamber turned on. With the ultrasonic dispersion chamber off, the PSDs for both WM-182 and WM-183 were significantly shifted to the right (i.e. bigger particles, see Figure 14). This is expected since the ultrasonic dispersion chamber would disperse the floccules into their smaller "fundamental" component particles. For WM-182, the median sonicated particle size is approximately 8 μm. The WM-183 median sonicated particle size is approximately 12 μm. With the ultrasonic dispersion chamber off, the only thing to keep the particles from cohering to each other (i.e. flocculating) is the centrifugal recirculation pump (see Figure 15) which may or may not keep the system dispersed.

Perry's Chemical Engineers' Handbook [2] has a general discussion of interparticle attraction and particle size:

> Figure 10 illustrates the relationship between solids concentration, interparticle cohesiveness, and the type of sedimentation that may exist. "Totally discrete" particles include many mineral particles (usually greater than 20 μm), salt crystals, and similar substances that have little tendency to cohere. "Flocculent" particles generally will include those smaller than 20 μm (unless present in a

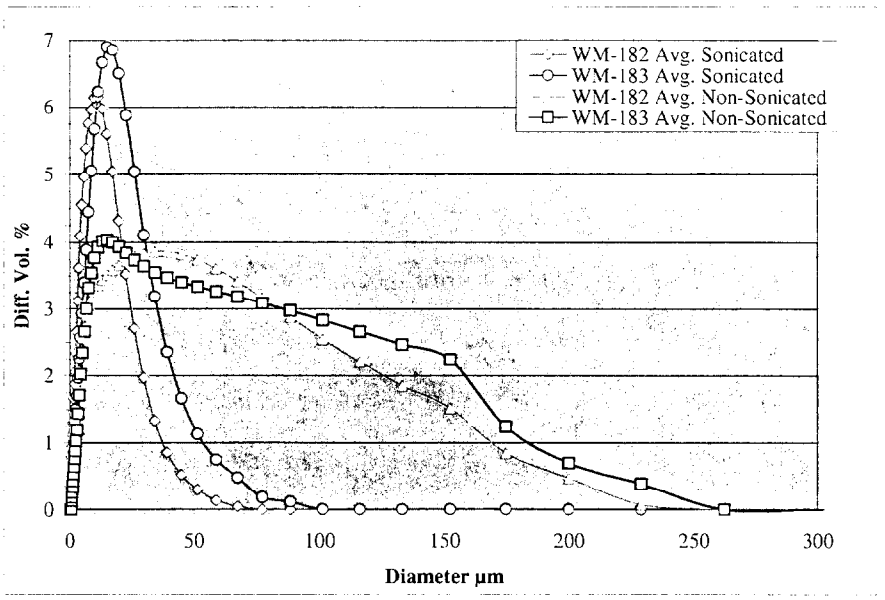

Figure 14: WM-182 and WM-183 Particle Size Distributions

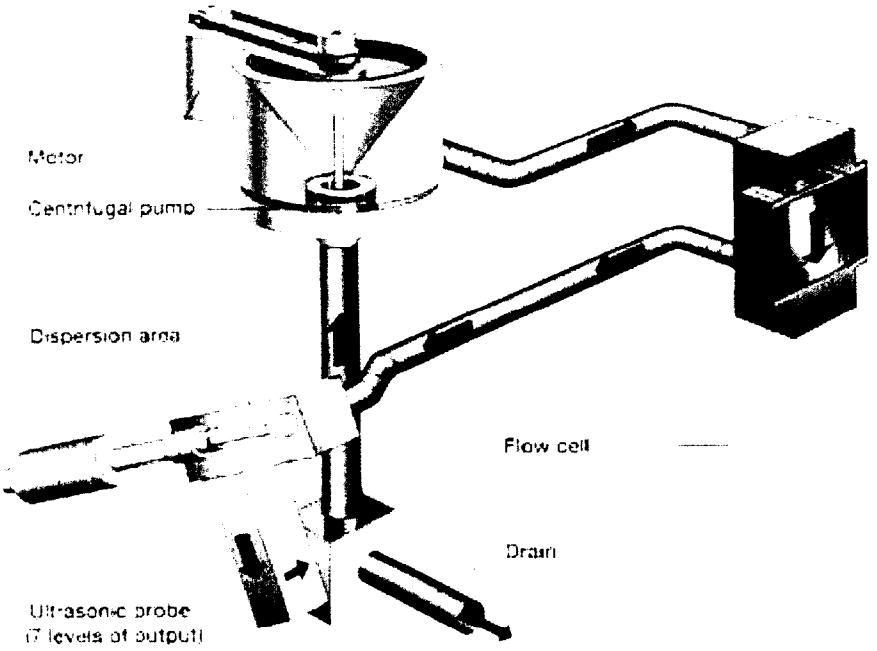

Figure 15: Horiba Sample Recirculation System

dispersed state due to surface charges), metal hydroxides, many chemical precipitates, and most organic substances other than true colloids.

If the "true" PSD is the non-sonicated case, the expected settling regime would be particulate settling due to the larger heavier particles and lack of cohesiveness. One would not expect the slow compression type settling that is observed. This again leads to the conclusion that flocculation could occur in the particle size analyzer and the sonicated PSD measures the smaller "fundamental" component particles in the sludge rather than floccules. Since these solids are believed to be formed by chemical precipitation in the tanks, the conclusion that the sludge is flocculent is supported by the quote given above at these particle sizes.

2.4 Sludge Density Measurements

The density of the solids are evaluated in an EDF written by Poloski [4]. The EDF reached the following conclusions:

- 75% interstitial liquid in sludge by volume
- 25% air-dried solids in sludge by volume
- 2.0 g/ml air-dried solids particle density

With the interstitial liquid SG (specific gravity) at approximately 1.2, the calculated tank farm sludge specific gravity would be 1.4.

Comparing these densities with other materials produces Figure 16. The solid materials shown in this graph are at the lower end of the density spectrum. Consequently, the sludge in the tank farm is relatively low-density. Since the oven-dried density of the solids was significantly higher than the air-dried density, the low density of the solids could be attributed to a large amount of hydrated water present in the crystalline structure of the particles.

Please note that these measurements involved air-drying the solids and then adding deionized water to reconstitute the sludge. Through this process, the interstitial liquid chemistry is significantly altered from the chemistry in the tank farm (e.g. pH, molar concentration of significant species, etc.). Changing the interstitial liquid chemistry can, in turn, change the solids surface chemistry. Changing the surface chemistry alters the so-called *zeta potential*, which is an indicator of how the solid particles interact with each other. Ultimately, the solids packing and interstitial liquid fraction can be significantly altered by the chemistry of the interstitial liquid (the particle density measurements should be unaffected). Even with this potential source of error, these RAL data are the best available tank farm sludge density data.

Changing the liquid phase composition can also alter settling type and rate. When the solids are washed (via washball) and transported to another tank, the ionic composition of the liquid should be significantly diluted. Further investigation on diluting the liquid phase and changes of settling type and rate of the solids should be a priority.

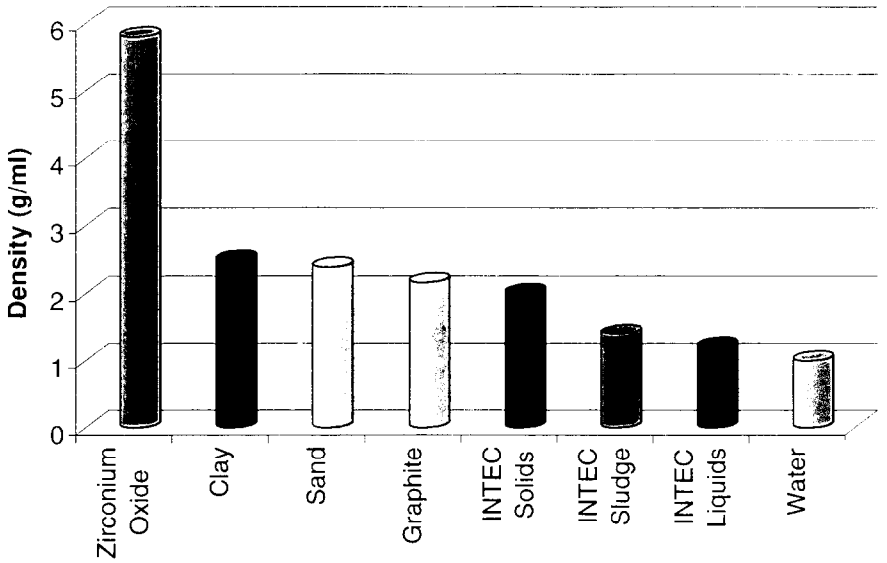

Figure 16: Density Comparison of Various Materials

2.5 Unknown Data and Risks

While the data discussed above provides a fairly comprehensive view of the many of the solids properties, we still do not have any empirical data on how the sludge will move when various degrees of force are applied. This empirical data would be very useful for the grout placement mockup because the grout applies a force to the sludge and displaces it. Being able to match these dynamic behaviors would allow for a much more accurate mockup.

Getting this empirical data would involve measuring the viscosity of the sludge under different conditions. Measuring the viscosity of the sludge would be achieved through the use of a viscometer. Currently, a viscometer is being prepared for deployment in the RAL hotcell for actual measurements of the sludge viscosity. Unfortunately, these data will be unavailable for this surrogate solids design effort. The high degree of variability between the viscosity of various materials under similar conditions is discussed below.

Most fluids are categorized as Newtonian. Newtonian fluids possess a linear relationship between shear stress (τ=force/area applied to fluid) and shear rate ($\frac{d_v}{d_y}$ = velocity profile of fluid). The slope of this linear relationship is referred to as the dynamic viscosity (μ) of the fluid. This relation is expressed in Figure 17.

When shear stress versus shear rate is measured and plotted a flow curve results. Flow curves are used to categorize fluids as one type of fluid or another. Fluids other than Newtonian are called non-Newtonian. Non-Newtonian fluids are fluids for which the relation between shear stress and shear rate is nonlinear or is linear but does not go through the origin (i.e. has a y-intercept other than zero). Often slurried material is categorized as a Non-Newtonian fluid. Flow curves for various types of fluids are shown in Figure 18.

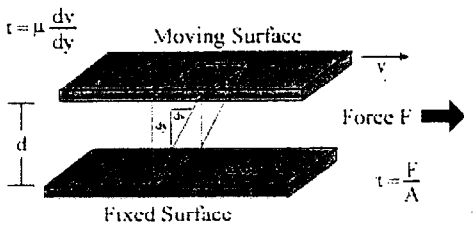

Figure 17: Definition of Viscosity

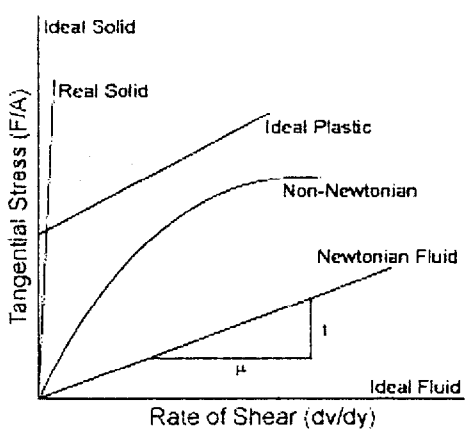

Figure 18: Flow Curves for Various Fluid Types

Examples of various materials and the type of fluid they are categorized are discussed below:

Newtonian (see Figure 19) Water, Most salt solutions in water, Light suspensions of dye, Kaolin (clay slurry), High-viscosity fuels, Gasoline, Kerosene, Most motor oils, Most mineral oils

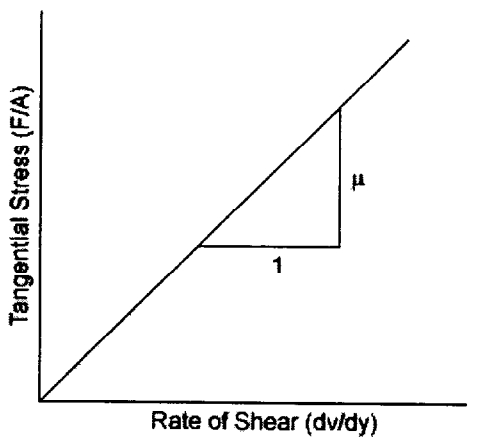

Figure 19: Newtonian Fluid Flow Curve

Yield Pseudoplastic/Bingham Plastic/Yield Dilatant (see Figure 20) Clay, Mud, Tar, Sewage sludge, Digested sewage, High concentrations of asbestine in oil, Thermoplastic polymer solutions

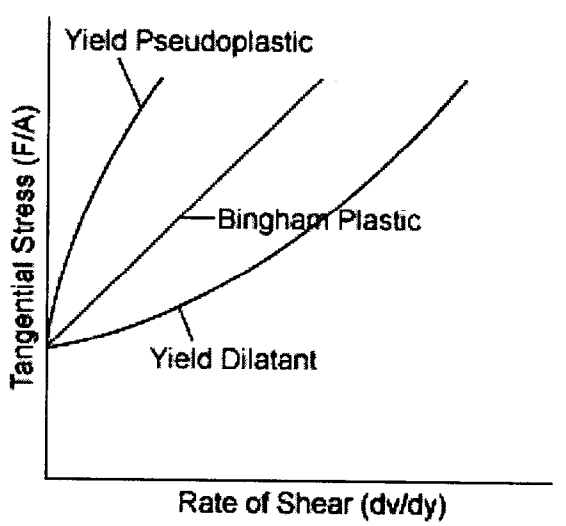

Figure 20: Flow Curves for Fluids with Yield Stresses

Pseudoplastic (see Figure 21) Sewage sludge, Paper pulp, Grease, Soap, Paint, Printer's ink, Starch, Latex solutions, Most emulsions

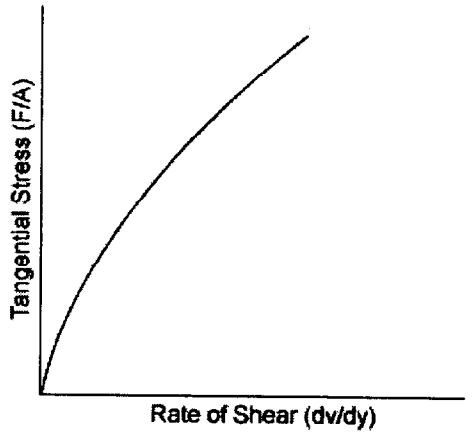

Figure 21: Pseudoplastic Flow Curve

Dilatant (see Figure 22) Feldspar, Mica, Clay, Beach sand, Quicksand, Starch in water

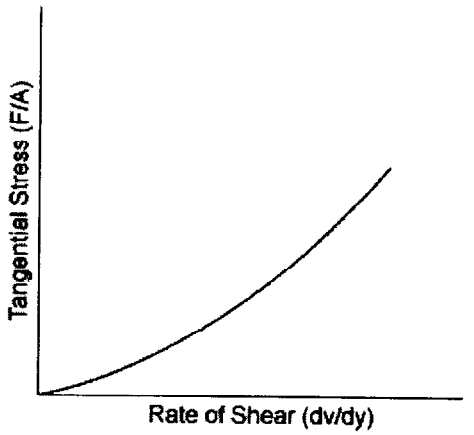

Figure 22: Dilatant Flow Curve

Thixotropic/Rheopectic (see Figure 23) Thixotropic – decreases viscosity over time/Rheopectic – increases viscosity over time, Inks, Most paints, Carboxymethyl cellulose, Silica gel, Greases, Asphalt, Starch, Bentonite, Gypsum solutions in water

As one can see, there is much variability in the behavior of these fluids. Since we do not have a flow curve for this the tank farm sludge there is an inherent risk that the surrogate sludge we use for mockups may not even be the same type of fluid. Consequently, we are

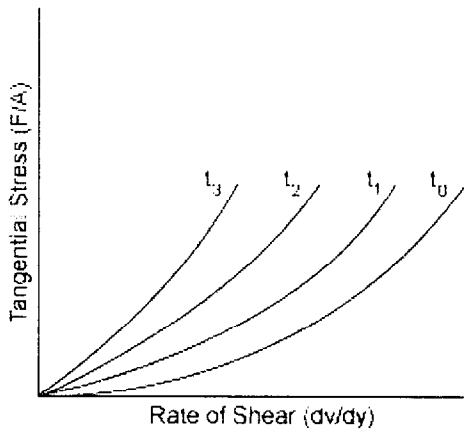

Figure 23: Time-Dependent Flow Curves

planning on creating a flow curve for our surrogate sludge prior to the mockup so when the tank farm sludge flow curve becomes available we can compare them. If the flow curves are significantly different, modifications to our surrogate sludge recipe could then be made.

2.6 Conclusions

In conclusion we are looking for a sludge with the properties listed in Table 1.

Significant Parameter	Tank Farm Solids
Low Yield Stress (from visual observations)	yes
Light, Billowy Sludge	yes
Flocculation Sedimentation	yes
Median Particle Size	8-12 micron
Particle Density	2.0 g/ml
Sludge Bulk Density	1.25 g/ml

Table 1: Significant Surrogate Selection Parameters for Tank Farm Sludge

3 Evaluated Surrogates

The surrogate sludge developed herein is based on limited measured physical and visual characteristics. It is desirous to develop a surrogate sludge that meets these characteristics, is inexpensive to produce, and minimizes industrial hygiene and environmental concerns.

Unfortunately, surrogate sludge development based on chemical characteristics could not be performed due to insufficient knowledge of chemical compound species within the TFF tanks.

Key technical parameters for determining the surrogate include the following (discussed above):

- remote video visual information during sampling operations within tanks WM-182 and WM-183
- solids settling rate of WM-183 sludge sample
- median particle size distribution
- particle (solids) and apparent (sludge) density

Based on limited analysis data from Tanks WM-182 and WM-183 samples, the liquid and solid (sludge) chemistry could not be estimated and an attempt to reconstruct a surrogate based on similar chemical species and viscosity could not be performed. The surrogate sludge was developed based on physical parameters - primarily video images displaying particle and rheological behavior, particle (solids) and apparent (sludge) density, solids settling rate, and median particle size distribution. Two Cole-Parmer rotational viscometers were purchased to determine shear rates as a function of shear stress. Unfortunately, the capability to use one these viscometers within the INTEC RAL Hot Cell has not been realized and there presently exists no viscosity (flow curve) data on TFF sludge. Viscosity measurements on surrogate sludge have not been made as there is no viscosity comparison criteria. It would be desirous to reasonably match the flow curve of the surrogate sludge to that of the actual sludge. This flow curve match would be particularly useful during grout displacement mock-up operations where one fluid (grout) flows into and interacts with another fluid (surrogate sludge).

It was envisioned that developing the surrogate sludge would entail adding a variety of materials to achieve these physical parameters as best as possible. A number of materials were examined during the investigation for surrogate development. Table 2 delineates the primary materials examined, marketing nomenclature, median particle size, density information, aimed surrogate uses, logistics issues, and particular health & safety issues. The types of materials for this investigation can be itemized into the following categories: minerals, clays, inorganic salts, polyelectrolytes, and bipolymers. The most important findings are addressed below.

3.1 Minerals

Several minerals were looked into as possible simulated sludge "building block" candidates due to their relatively low cost, chemically inert qualities, and environmentally friendly nature. However, success in finding a mineral meeting these criteria having a likeness to the actual sludge in median particle size, particle (solids) and apparent (sludge) density

Table 2: Evaluated Surrogate Materials

Material Category	Marketing Nomenclature	Median particle size (microns)	Specific gravity (particle density) and other densities	pH	Aimed surrogate uses	Logistics issues	Health & Safety issues (particular to the mock-up effort)
Mineral							
Talc	Pioneer 2606 lamellar 200 mesh talc from Zemex , sample from Suzorite Mineral Products P.O. Mineral products, Van Horn, TX 79855; (915)-283-2330	**16.5**	**2.8** Loose bulk (lb/ft3) = 32; Packed bulk (lb/ft3) = 64	**9.5**	Bulk inert body for surrogate	Straight-forward and relatively easily logistics of adding feed and mixing the talc in water is anticipated. A very small percentage of the talc (just a surface film) appears to be strongly hydrophobic and stays on top of the water. It may be desired to decant this top portion off for easier viewing "into the water".	Possible airborne crystalline silica in excessive dusting
Iron oxide	Sample from Lansco colors - (201)-307-5995. May be able to buy locally.	**99.9% smaller than 44 microns [920 Black ave.=.5 micron, 415 Red ave.=.2 micron]**	5.18		Colorant for surrogate	Excellent colorant of suitable particle size. There exists reds, yellows, browns, and black colors of "iron oxide". Red is chosen as it has the highest chroma of all colors. It is desirous to color the surrogate sludge such that it can be visibly distinguished from grout during solids displacement and within core samples. A .2% by volume delivered a strong color to the surrogate.	None
Silicon Carbide (Black)	Electro Abrasives Corp. 701 Willet Road Buffalo, NY 14218 (716)-822-2500	**20 range = 5.5 - 31**	**3.2**		Bulk body or filler for surrogate	Extreme packing by settling in water because of blocky sharp particle shape (abrasive)	Nuisance dust, abrasive to tissue
Aluminum oxide (white fused)	Electro Abrasives Corp. 701 Willet Road Buffalo, NY 14218 (716)-822-2501	**20**	**3.95**		Bulk body or filler for surrogate	Extreme packing by settling in water because of blocky sharp particle shape (abrasive)	Nuisance dust, abrasive to tissue
Aluminum oxide (brown fused)	Electro Abrasives Corp. 701 Willet Road Buffalo, NY 14218 (716)-822-2501	**20**	**3.95**		Bulk body or filler for surrogate	Extreme packing by settling in water because of blocky sharp particle shape (abrasive)	Nuisance dust, abrasive to tissue
Zirconium alumina	Electro Abrasives Corp. 701 Willet Road Buffalo, NY 14218 (716)-822-2502	Very coarse particle size (too large)	**4.3**		Bulk body or filler for surrogate	No sample evaluation	Uncertain
Titanium dioxide (anatase and rutile)	None found	Could not find close particle size manufactured	**3.89 & 4.25**		Bulk body or filler for surrogate	Particle sizes tailored for pigment and ceramic industry and were too small	Nuisance dust

Table 2: Evaluated Surrogate Materials-Cont.

Material Category	Marketing Nomenclature	Median particle size (microns)	Specific gravity (particle density) and other densities	pH	Aimed surrogate uses	Logistics issues	Health & Safety issues (particular to the mock-up effort)
Graphite	World Sales Headquarters Asbury Carbons, Inc. PO Box 144, Asbury, NJ 08802, (908)-537-2155, www.asbury.com	20	2.20-2.30		Bulk body for surrogate	Extreme hydrophobic nature and surface tension making mixing impossible and messy without perhaps proper wetting with wetting agent	Fire risk from powder, respirable dust
Barium Sulfate	Barimite, CIMBAR Performance Minerals, PO Office Box 250, Cartersville, GA 30120, (800) 852-6868, www.cimbar.com	Mean particle size available as 1.8, 2.5, 4.0, 9.0, 11.0, 50.0	4.5 Bulk dry loose and compacted densities vary widely with particle size- see company literature.	7	Bulk body or filler for surrogate. Can add as a percentage in the surrogate for conservatism due to very high particle density.	Inexpensive dense material and remote possibility of producing hazardous waste by generation of free Barium ions. Products represent group of naturally occurring unbleached products.	Possibility of producing hazardous waste by generation of free Barium ions?
Calcium Sulfate dihydrate (Hydrated Gypsum)	"Terra Alba #1", and "SNOW WHITE" United States Gypsum Company, 125 South Franklin Street, Chicago, Illinois 60606-4678, 1-800-621-9523	Terra Alba = 7, SNOW WHITE = 12	2.32 Loose bulk (lb/ft3) = 42; Packed bulk (lb/ft3) = 62	7.3 for a 10% slurry	Bulk body for surrogate. Weighting agent for clay/floc systems to speed settling rates.	Reasonable degree of packing in water - fair amount of stress to break solid when mixing, fairly quick settling time - with relatively clear supernate after 3 hours. Can be added to kaolin/iron oxide/alum mixture directly (before or after alum addition)	Possible airborne crystalline silica in excessive dusting
Calcium Carbonate	RO-40 & No. 8 White, LANSCO COLORS, 305 West Grand Ave., Montvale, NJ 07645, (201) 307-5855	25% retained on 74 micron wet screen and 44 mesh screen	2.71	9.0-9.5	Bulk body for surrogate	Fair degree of packing in water - fair amount of stress to break solid when mixing, fairly quick settling time - with relatively clear supernate after 3 hours.	None
Crystalline silica	Silica Quartzite, ARCO Hills, LLC., (208)-524-2657	200 mesh - all particles smaller than 74 microns	2.464	5.9	Bulk body or filler for surrogate	Uncertainties with particle size and the uncertainties associated with inhalation hazard of 100% crystalline silica.	Airborne crystalline silica in excessive dusting
Silica gel		Particle size uncertain - would have to be ground to match settling rate etc.	2.1	3-8 in aqueous slurry	Bulk body for surrogate	Particle size uncertain - would have to be ground to match settling rate etc.	Amorphous form so free of crystalline silica. However, the material has a moderate health rating. Inhalation causing dryness to mucous membranes, nose, and throat. Abrasion to eyes.

Table 2: Evaluated Surrogate Materials-Cont.

Material Category	Marketing Nomenclature	Median particle size (microns)	Specific gravity (particle density) and other densities	pH	Aimed surrogate uses	Logistics issues	Health & Safety issues (particular to the mock-up effort)
Diatomaceous silica	Diatomaceous Earth, DE (775) 352-1000	"Powder sized finer than 45 microns"	2 Dry density (lb/ft3) = 9.5-13.0	**7.0 -10.0 for a 10% slurry**	Bulk body for surrogate (A naturally occurring mineral derived form microscopic in size fossilized remains of marine diatoms).	Uncertainties with particle size and uncertainties associated with relative high crystalline silica. Very abrasive particle most likely not representative of sludge particle shape and dynamics.	Inhalation hazard. Uncertainties in the amount of crystalline silica.
Clay							
Wyoming Sodium Bentonite (Sodium Montmorillonite)	WYO-BEN, INC, P.O. Box 1979, Billings, Montana 59103	Varies, Standard 75-80% (% minus 74 microns), Fine grind (% minus 44 microns)	**2.45-2.55** Product bulk density around 55 lb/ft3	**8-10 (5% aqueous suspension)**	Seed for flocculent and body mass - Kaolin provides particles of anionic surface, which upon addition of flocculating agents such as Aluminum Sulfate, Ferric Sulfate, and Ferric Chloride destabilize and drop out of suspension much more quickly as larger particles.	Extreme control needed for mixing. Swelling clay in water (around 15X dry volume). Bentonite masses prone to gumming together. Gumming very much reduced with proper shearing, mixing, and hydration before bulk settling. Reasonably effective visual rheological characteristics. Floc size varies with variables not understood at this time.	Possible airborne crystalline silica in excessive dusting
Kaolin	WILKLAY FE, 325 Mesh Screen Residue, from Wilkinson kaolin Associates LTD., P.O. Box 306, Milledgeville Rd., Gordon, GA 31031; (912)-628-5301	**0.7**	**2.6**	**5.0 (28% solids)**	Seed for flocculent and body mass - Kaolin provides particles of anionic surface, which upon addition of flocculating agents such as Aluminum Sulfate, Ferric Sulfate, and Ferric Chloride destabilize and drop out of suspension much more quickly as larger particles.	Reasonable control needed for mixing. Non-swelling clay. Forms a typical clay film that may need a little physical pressure to clean completely off most surfaces.	Possible airborne crystalline silica in excessive dusting
Laponite (synthetic)	Southern Clay Products, Inc., 1212 Church Street, gonzales, TX 78529 (888)-Laponite or 830-672-2891		Bulk density = 0.7-1.3 kl/dm3 (packed)	**9.8 (2% dispersion in water)**	Gel characteristics to provide yield stress and provide thixotropic rheolgy and suspending power for adding known particle sizes of other materials Laponite is an entirely synthetic hectorite mineral which closely resembles the natural clay mineral hectorite (such as bentonite). Provides a clear gel unlike bentonite. Also possible seed for flocculent with addition of salts (particularly Laponite RD). Experiments in support of this assessment of adding aluminum sulfate into a laponite suspension produced a very lightweight sludge. Flocculated laponite produced opaque particles which settles very slowly.	Conventional mixer process control for mixing. Swelling clay but not prone to substantial gumming as bentonite. Very non-dense flocculent formed as a result of addition of alum. This floc may be difficult to separate in process.	Adding strong mineral acid may produce Lithium salts which may cause a RCRA concern (?). However, it does not contain free crystalline silica found as an impurity as in most other natural minerals.
Inorganic salt							
Aluminum Sulfate	Various	**NA**	1.69	**2.3+/-0.4 conc. aqueous solution**	Salt causing flocculation by diminishing zeta potential around clay particles	Relatively inexpensive salt that can be purchase either as liquid (usually 50 wt.%) or solid. Solution of Aluminum sulfate can have a pH as low as 1.9, but for use here should be well above the RCRA pH of 2.0 for any remaining liquid.	Harmful if swallowed or inhaled. Causes irritation to skin, eyes, and respiratory tract. Hazard minimized by purchasing in solution form. Precautions for splashing, eye potection, etc.

Table 2: Evaluated Surrogate Materials-Cont.

Material Category	Marketing Nomenclature	Median particle size (microns)	Specific gravity (particle density) and other densities	pH	Aimed surrogate uses	Logistics issues	Health & Safety issues (particular to the mock-up effort)
Ferric Sulfate	Various	**NA**	3.097 (Anhydrous)		Salt causing flocculation by diminishing zeta potential around clay particles	Known to form a gelatinous floc. Mixture of Ferric Sulfate and clays have not yet been prepared as part of this study due unavailability of Ferric Sulfate to date for this effort.	Harmful if swallowed or inhaled. Causes irritation to skin, eyes, and respiratory tract.
Ferrous Sulfate	Various	**NA**	1.9		Salt causing flocculation by diminishing zeta potential around clay particles	Known to form a gelatinous floc. Limited use of very low grade Ferrous Sulfate mixture. Mixture of Ferrous Sulfate and clays have not yet been prepared as part of this study due unavailability of Ferrous Sulfate to date for this effort.	Harmful if swallowed or inhaled. Causes irritation to skin, eyes, and respiratory tract.
Ferric Chloride	Various	**NA**	2.9		Salt causing flocculation by diminishing zeta potential around clay particles	Too corrosive for our use - formed a yellowish gel looking floc that may need to be examine if corrosive and health and safety issues are not an issue.	Very corrosive and an irritant. Not recommended for this effort due to health and corrosion hazard.
Magnesium Sulfate	Various	**NA**	1.67 (aqueous solution is neutral to slightly acidic)		Salt causing flocculation by diminishing zeta potential around clay particles	Produced a flocculent with kaolin clay but there was question whether the floc interparticle forces produces as positive rheological characteristics (visual yield stress, etc.) as with the trivalent aluminum sulfate.	None
Sodium Chloride	Various	**NA**	2.16	**6.7-7.3 (aqueous solution)**	Salt causing flocculation by diminishing zeta potential around clay particles	Produced a flocculent with kaolin clay but there was question whether the floc interparticle forces produces as positive rheological characteristics (visual yield stress, etc.) as with the trivalent aluminum sulfate.	None
Polyelectolyte							
many - Ciba Specialty Chemicals -(both cationic and anionic)	Ciba Specialty Chemicals Water Treatments, Inc. 2301 Wilroy Rd., Suffolk, VA 23439-0820 (757) 5380-3700	**NA**			Flocculation aid for dewatering, floc size, and increased floc settling. Available in non-ionic, anionic, and cationic. Product #455 (a low cationic ionic product) particularly produced very large fast settling floc with aluminum sulfate coagulated bentonite (also with iron oxide as colorant). Products #156 and #336 (anionic) were also tried with less successful results within the limited qualitative testing performed.	Must have proper preparation logistics established for making a concentrated polymer base stock. This consists of initially wetting the polymers with solvents of no or very little water such as ethanol, acetone, etc. This wetting process begins to "unravel" the long polymer chains without "gumming" the outer layers of the product particles causing inefficient dispersion in water because of the gum layer (poor water availability into the particle). This concentrate stock solution can then be diluted for uses as concentration needed. Must have adequately controlled mixing if to be used.	None - other than polymer wetting solvent management (relatively small amounts of ethanol, etc.)
Biopolymers							
Xanthan Gum	Kelzan AR Xanthan Gum, Kelco Biopolymers, 8355 Aero Drive, San Diego CA 92123 (800)-535-2687, www.kelco.com	**NA**		**7.2 1% solution**	Long chained polymers designed to directly change rheology characteristics of bulk mineral	Must have adequately controlled mixing if to be used. Biopolymer changed viscosity of hydrated gypsum in water to a lotion like consistency. Predicted same effect for talc, calcium carbonate, etc. Polyvalent cations may cause gelation at high pH.	Slipping hazard when wet

Table 2: Evaluated Surrogate Materials-Cont.

Material Category	Marketing Nomenclature	Median particle size (microns)	Specific gravity (particle density) and other densities	pH	Aimed surrogate uses	Logistics issues	Health & Safety issues (particular to the mock-up effort)
Welan Gum	K1A96 Welan Gum	**NA**			Long chained polymers designed to directly change rheology characteristics of bulk mineral	Must have adequately controlled mixing if to be used. Biopolymer changed viscosity of hydrated gypsum in water to a lotion like consistency. Predicted same effect for talc, calcium carbonate, etc. Polyvalent cations may cause gelation at high pH.	Slipping hazard when wet
Sodium carboxymethycelluiose	AQUALON 7H4 sodium carboxymethylcellulose, Hercules Incorporated, Aqualon Division P.O. Box 271, Hopewell, VA 23860-0271, (801)-541-4679.	**NA**		**6.5-8.5 1% solution**	Polymer potentialy used to directly change rheology characteristics of bulk mineral. An anionic water-soluble polymer derived from cellulose.	Must have adequately controlled mixing. Biopolymer changed viscosity of hydrated gypsum in water to a lotion like consistency. This product is considered hazardous according to the OSHA Hazard Communication Standard 29CFR1910.12000 due to the flammable dust potential.	Slipping hazard when wet. This product is considered hazardous according to the OSHA Hazard Communication Standard 29CFR1910.12000 due to the flammable dust potential.
Hydroxyethylcellulose	NATROSOL Hydroxyethylcellulose, hercules Incorporated, Hercules Plaza, 1313 North market Street, Wilmington, DE 19894-0001	**NA**		**6.0-8.5 1% solution**	Polymer potentially used to directly change rheolgy characteristics of bulk mineral. A nonionic water soluble polymer derived from cellulose. Like AQUALON cellulose gum (sodium carboxymethylcellulose), it is a cellulose ether, but it differs in that it is nonionic and its solutions are unaffected by cations.	Must have adequately controlled mixing. Biopolymer changed viscosity of hydrated gypsum in water to a lotion like consistency. This product is considered hazardous according to the OSHA Hazard Communication Standard 29CFR1910.12000 due to the flammable dust potential.	Slipping hazard when wet. This product is considered hazardous according to the OSHA Hazard Communication Standard 29CFR1910.12000 due to the flammable dust potential.

was not adequate. The relatively low particle (solids) density of 2.0 g/ml and apparent (sludge) density of 1.25 g/ml (based on density data discussed above) presented density match challenges. In the beginning stages of this evaluation, the actual sludge settling rate was not known. Since free-falling settling velocity (see above particulate settling regime discussion) is a function of particle shape and density, it was desirous to match particle size (around 20 microns for samples), particle and wetted bulk minerals densities to develop the main body of surrogate of whose rheological properties could be modified. It was hoped that these mineral particles would provide the basis for mimicking particle suspension and settling needed for turbulent wash-ball mock-up activities.

Minerals such as calcium carbonate, silicon carbide, aluminum oxide, proved to have high interparticle wetted packing and thus very high slurry/sludge (water and mineral) density slurries, very fast particle/zone settling regime rates, and little observed rheological similarities to the TFF sludge. Of the minerals samples evaluated, talc and hydrated gypsum were the most promising. However, the sludge (mineral and water mixed) densities were determined to be as high as around 2.4 g/ml and 2.2 g/ml respectively. Compared to some of the other minerals examined, these sludge densities were quite low. Relative to flocculated clays (performed later in the investigation), the use of minerals such as talc and hydrated gypsum did not have the observed yield-stress rheological characteristics similar to the TFF sludge (see Figure 1). Because mineral sludge densities and settling rates (see Figure 24) were high for talc and hydrated gypsum compared to the actual sludge, clay flocculated systems proved a more promising mechanism for developing the surrogate. Please note that the type of settling observed for these mineral based surrogates was accumulation settling (see Section 2.2). The settling curves for these mineral based surrogates are then based on the uppermost interface between the suspension and supernatant liquid. Even with this conservative basis the mineral based surrogates settled at a much faster rate than the tank farm sludge.

Iron oxide, having a desirable particle size distribution, served as surrogate pigmentation of pre-flocculated clays and was not meant to be used as a bulk surrogate solid substrate. Iron oxide is an excellent colorant for the surrogate sludge. There exists red, yellow, brown, and black colors of iron oxide. Black results in a colored surrogate nearly identical to the actual sludge. Red would be a desired color for surrogate used during grout displacement mock-up activities as it as the highest chroma of all colors. It is desirous to color the surrogate sludge such that it can be visibly distinguished from grout during solids displacement and within core samples. It was found that about 0.2% by volume of surrogate was adequate color the surrogate. Less colorant could be sufficient.

3.2 Clays

Because the particle size distribution of clays are at least partially into the colloidal range, clays as a bulk surrogate ingredient are not be desired. Colloidal sized particles (0.001 μm to 1 μm) are stable in solution (remain suspended) and cloud (visible obscure) clarity of solution. Wyoming Sodium Bentonite (Sodium montmorillonite), kaolin, and laponite are

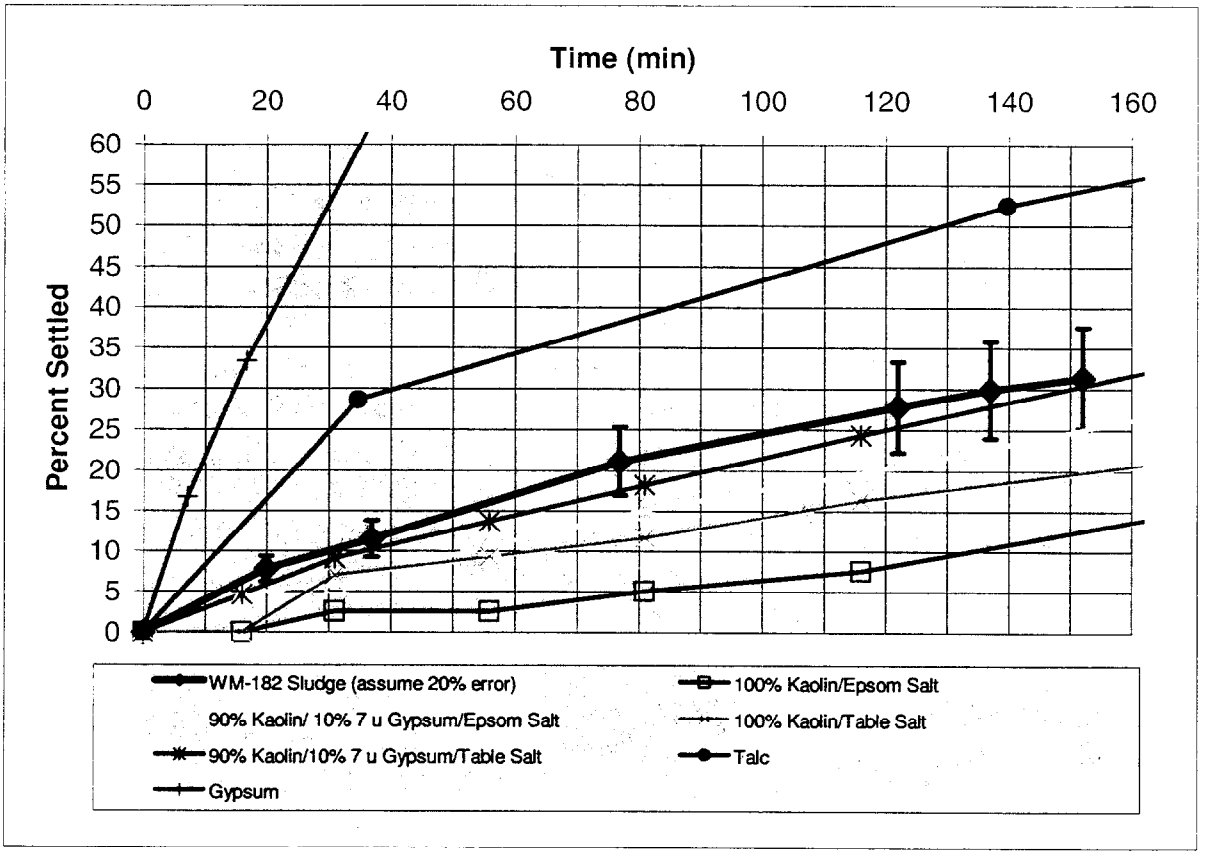

Figure 24: Evaluated Surrogate Settling Rates

clays that were examined for use as seeds for flocculation. In addition, laponite was also examined as a possible gelling agent for suspending particles. Bentonite and kaolin are opaque natural clays whereas laponite is a clear synthetic clay. Particles from these clays are anionic which upon the addition of flocculating agents become destabilized, increase in size out of the colloidal range, and settle out of solution. Bentonite and aluminum sulfate (alum) floc size appeared to vary greatly with salt-anion concentration and shear stress (mixing). The floc settled quite quickly resulting in a settled sludge that exhibited yield-stress rheological characteristics similar to the TFF sludge. Laponite, when flocculated with alum, produced an extremely non-dense (perhaps hard to manage) floc that would probably be of little use for the surrogate effort. This laponite base floc could perhaps be used as a percentage of another floc to decrease the overall sludge density. However, to use as a primary surrogate base the use laponite would not be acceptable. Kaolin clay flocculated with alum increased the median particle range from 0.7 μm (kaolin powder particles) to around 19 μm (kaolin/alum floc particles). These kaolin-based floc particles appeared to not agglomerate in lower shear rate conditions as did the bentonite and alum mixture. The settled flocculated kaolin clay was observed to exhibit yield-stress rheological characteristics very similar to the TFF sludge. Such similar observations between the actual sludge and kaolin/alum surrogate include:

- A "billowing" of particles from the top surface of the sludge upon slight disturbance
- Oscillation of the surrounding sludge from the point of disturbance similar to that of gelatinous material
- A relative rigidity of surrounding material directly near an area of sludge removal or relocation often leaving a "clumpy" appearance of the sludge
- A similar "cracking" appearance around an area of sludge removal or relocation.
- A similar settling appearance of zone/compression settling

These similarities will be discussed in greater detail in the next section.

3.3 Inorganic Salts

Trivalent, divalent and monovalent cations of salts were used to flocculate bentonite and kaolin. From the limited experiments performed to date, it appeared that the trivalent aluminum provided stronger yield stress characteristics than the did divalent magnesium (magnesium sulfate), and monovalent sodium (sodium chloride) with bentonite and kaolin. Therefore, the flocs created with epsom and table salts should not be considered for surrogate sludge. However, settling rate curves for these materials are shown in Figure 24.

3.4 Polyelectrolytes

It was desired to investigate the use of polyelectrolytes as flocculating aids to see if as a result of the flocculation process a desirable particle size and yield stress would be established. Many polyelectoytes samples were obtained from Ciba Specialty Chemicals (anionic, cationic, and non-ionic), three of which were tested with flocculated bentonite clay. Those chosen for this effort were Ciba MAGNAFLOC # 156 (anionic), # 336 (anionic), and # 455 (cationic). The use of these flocculent aids resulted in either no observed effect at the concentrations used or extremely large quickly settling rubber-like floc (up to 1.5 cm bridged floc) that did not show any interparticle behavior that would result in the observed TFF sludge yield stress characteristics. Upon further investigation and detailed lab work with the numerous polyelectroytes and also with the use of kaolin clay, it is possible that more promising results may be obtained. However, logistics issues probably make the use of polyelectrolytes unrealistic. Proper preparation logistics must be established for making a concentrated polymer base stock. This consists of initially wetting the polymers with solvents of no or very little water such as ethanol, acetone, etc. This wetting process begins to "unravel" the long polymer chains without "gumming" the outer layers of the product particles causing inefficient dispersion in water because of the gum layer (poor water availability into the particle). This concentrate stock solution can then be diluted for uses as concentration needed. Even though used small quantities relative to the mass to be flocculated, adequately controlled mixing must be established if polyelectolytes are to be used.

3.5 Biopolymers

Biopolymers are long chained polymers investigated to directly change rheological characteristics of bulk material commonly used in the food, pharmaceutical, and personal care formulations. Xanthan gum, Welan gum, Sodium carboxymethylcellulose (CMC) and Hydroxyethylcellulose are biopolymers that were mixed with the bulk inert mineral gypsum to investigate a likeness to the observed rheological behavior of the TTF sludge. In all cases the biopolymers changes the viscosity of hydrated gypsum in water to a lotion like consistency. These biopolymers, mixed with talc, calcium carbonate and other bulk minerals for this effort are anticipated to have the same effect. The mixtures did not exhibit the clumping, cracking yield stress characteristics of the observed TFF sludge. Also, the biopolymers require adequately controlled premixing preparation, the logistics of which make then an unlikely choice for the TFF mock-up. The bioploymers must be mixed very well before entry into the media in which they are to affect the rheology. In general, the use of biopolymer rheology modifiers with minerals did prove to be as effective because the mineral particles are entrained/restrained within the polymer substrate and the mixture of bulk material and the mixture tends to have a elastic viscosity characteristics such as lotion or syrup. The rheological characteristics thought to be caused by the attractive interparticle forces as displayed by flocculated clay systems could not be mimicked by the mineral biopolymer combination.

3.6 Conclusion

After evaluating the materials previously describe above, it was determined that kaolin clay (pigmented with iron-oxide) flocculated by the addition of aluminum sulfate (alum) provides the basis for an effective surrogate. A detailed comparison of kaolin/alum floc to tank farm sludge is given in the following section.

4 Recommended Surrogate

4.1 Visual Data

Visually, the kaolin/alum sludge exhibits the characteristics discussed in Section 2.1. First, we placed a tube in the kaolin/alum sludge layer (see Figure 25). Suction was then applied to the tube to mimic the LDUA sampling events. From this procedure, the following characteristics were realized:

- a cylindrical depression was created when the sludge is removed through the suction tube
- surface cracks formed around this depression
- some of the sludge was agitated and billowed into the liquid phase

Next, the sample tube was moved through the sludge layer (see Figure 26) in an attempt to mimic the similar WM-182 event discussed in Section 2.1. This motion created a wake behind the tube. From this wake, one can see a similar type of yield stress property where large sludge clumps were formed around the wake boundary.

Finally, a kaolin/alum sludge was placed in a bottle similar to the WM-182 sludge RAL sample bottle. Note that black iron oxide pigment was used. As the bottle was tipped to one side, a similar property to the WM-182 RAL sludge was observed, the sludge layer did not shift with gravity (see Figure 27).

In conclusion, the kaolin/alum sludge visually exhibits the low yield stress properties exhibited in the tank farm sludge.

4.2 Settling Type and Rate

The kaolin/alum based sludge was agitated and allowed to settle. A slow zone/compression regime was observed. Volumetric measurements were made and Equation 1 was used to compute the percent settled parameter. The results are shown in Figure 28. Note that six runs were performed and the kaolin/alum sludge settled consistently slower than the WM-182 observed rate. Since slower settling would result in a larger quantity of solids being transferred from the washball tank during the mockup, a faster settling sludge is required.

Because of its low density, hydrated gypsum at 7 μm and 12 μm was selected to be added to the kaolin/alum floc. Roughly measuring by volume, a 90% kaolin 10% hydrated

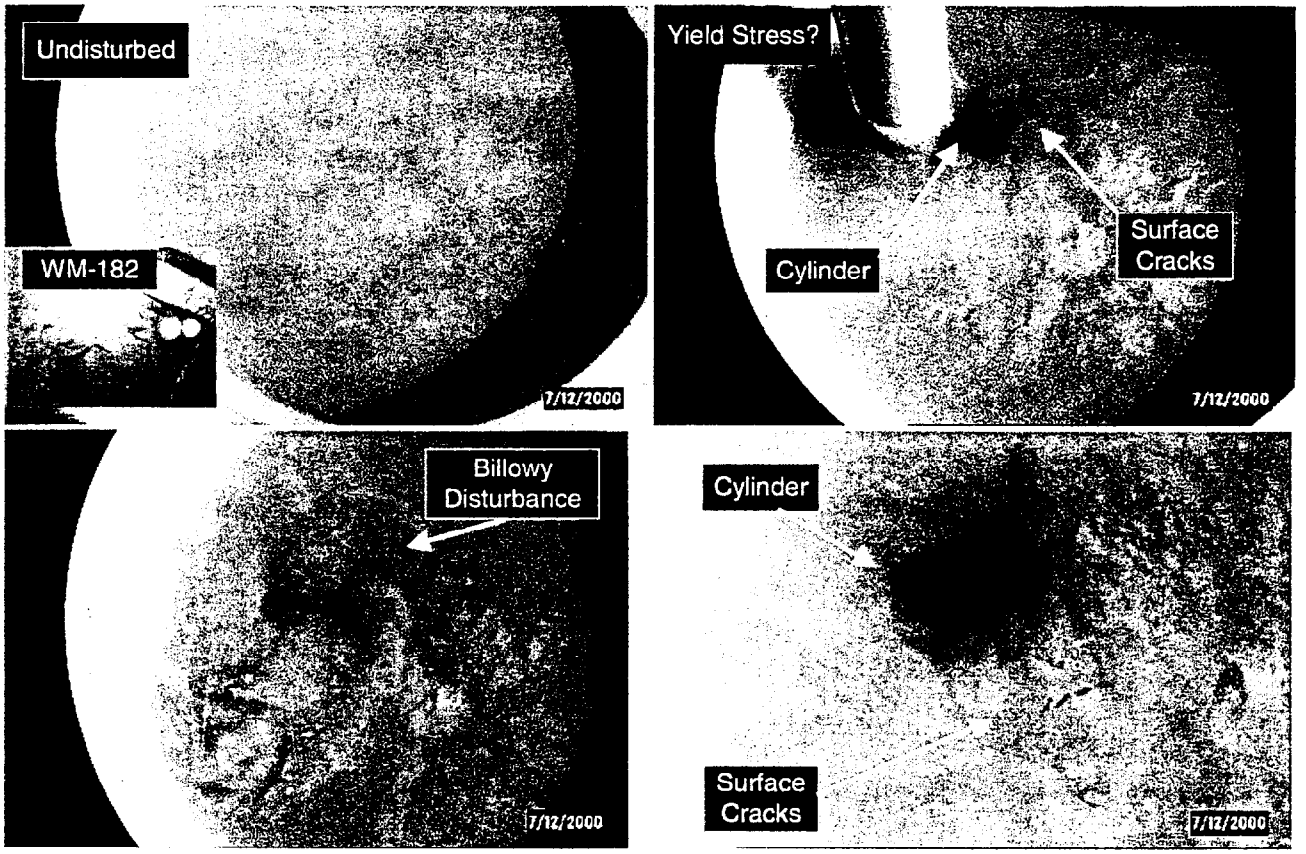

Figure 25: Sampling the Kaolin/Alum Sludge with a Suction Tube

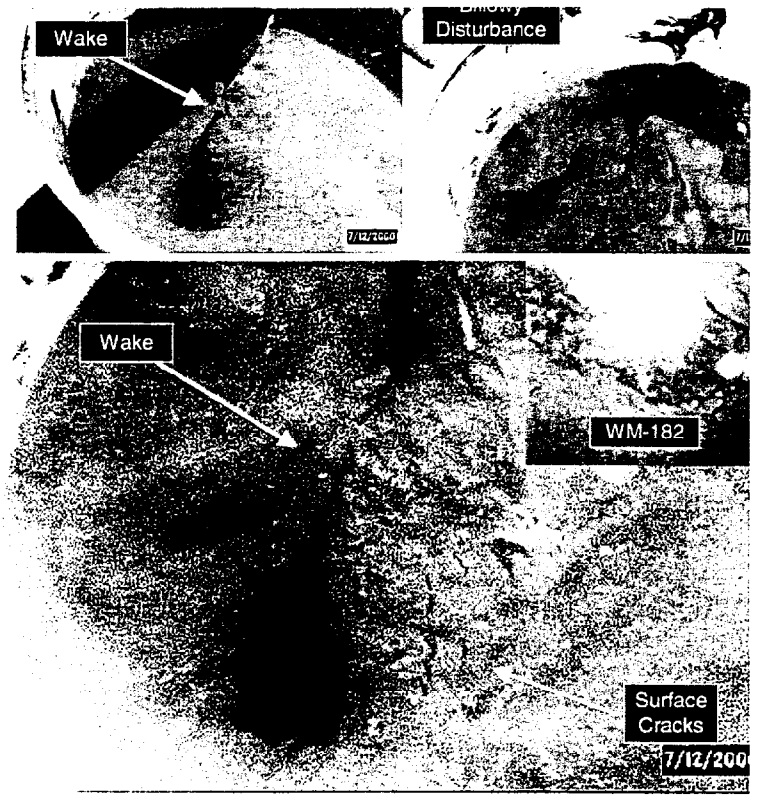

Figure 26: Moving the Suction Tube through the Kaolin/Alum Sludge

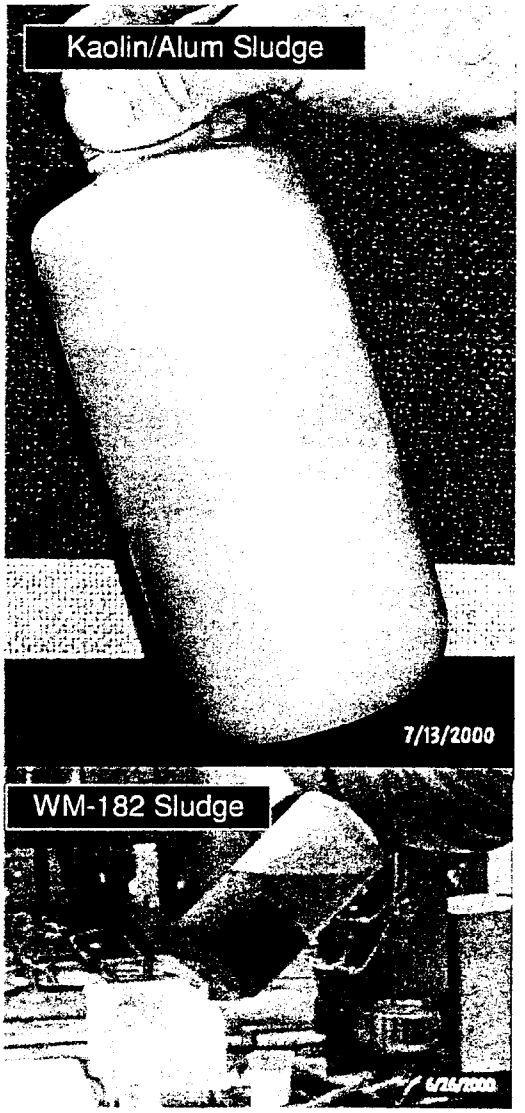

Figure 27: Tilting the Kaolin/Alum Sludge

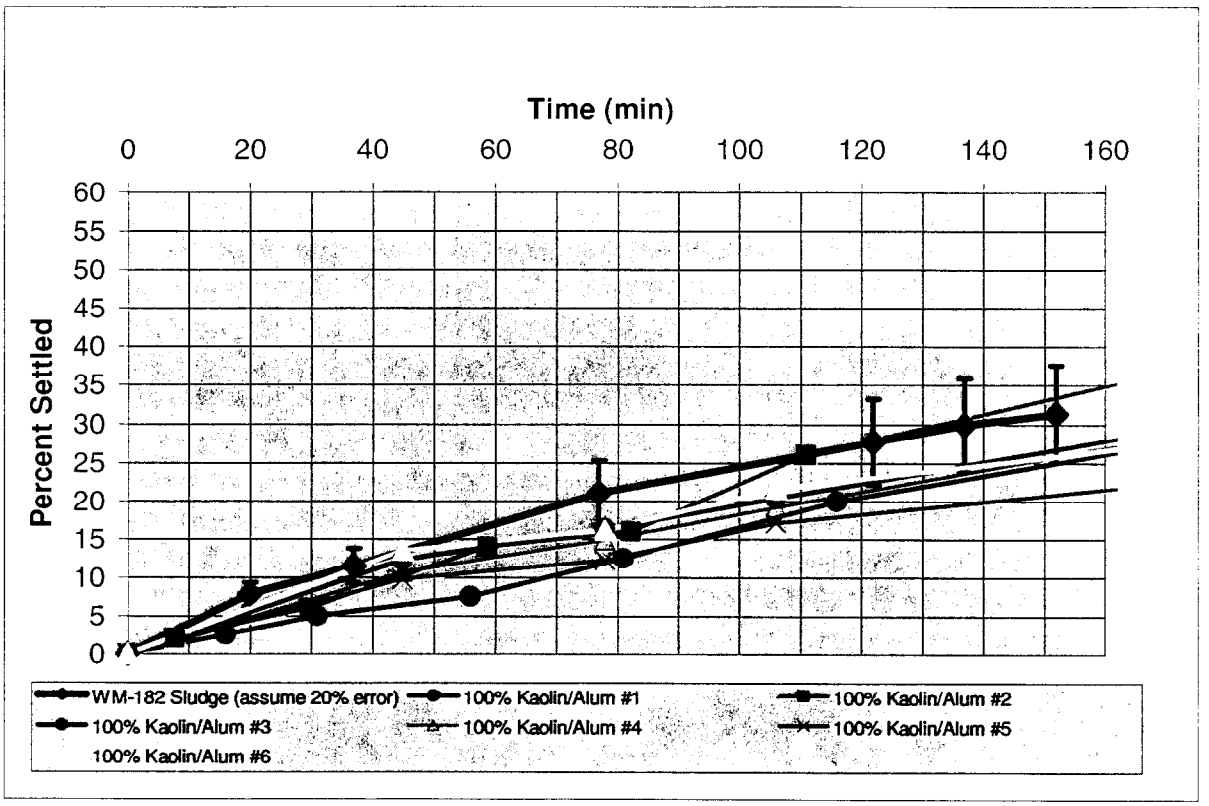

Figure 28: Kaolin/Alum Compression Settling Rate

gypsum slurry was prepared at both particle sizes. The sludge was agitated and allowed to settle. Volumetric measurements were made and Equation 1 was used to compute the percent settled parameter. The results are shown in Figure 29. These results show that the addition of a relatively small amount of gypsum acts as a settling agent and significantly reduces settling time. The addition of the hydrated gypsum also does not adversely effect the visual comparisons made above. However, bulk volumetric measurements of powders is yields poor repeatability due to variations in powder packing. Therefore, the exact amount of gypsum added to the surrogate recipe will be determined in the future on a mass basis when analytical balances become available.

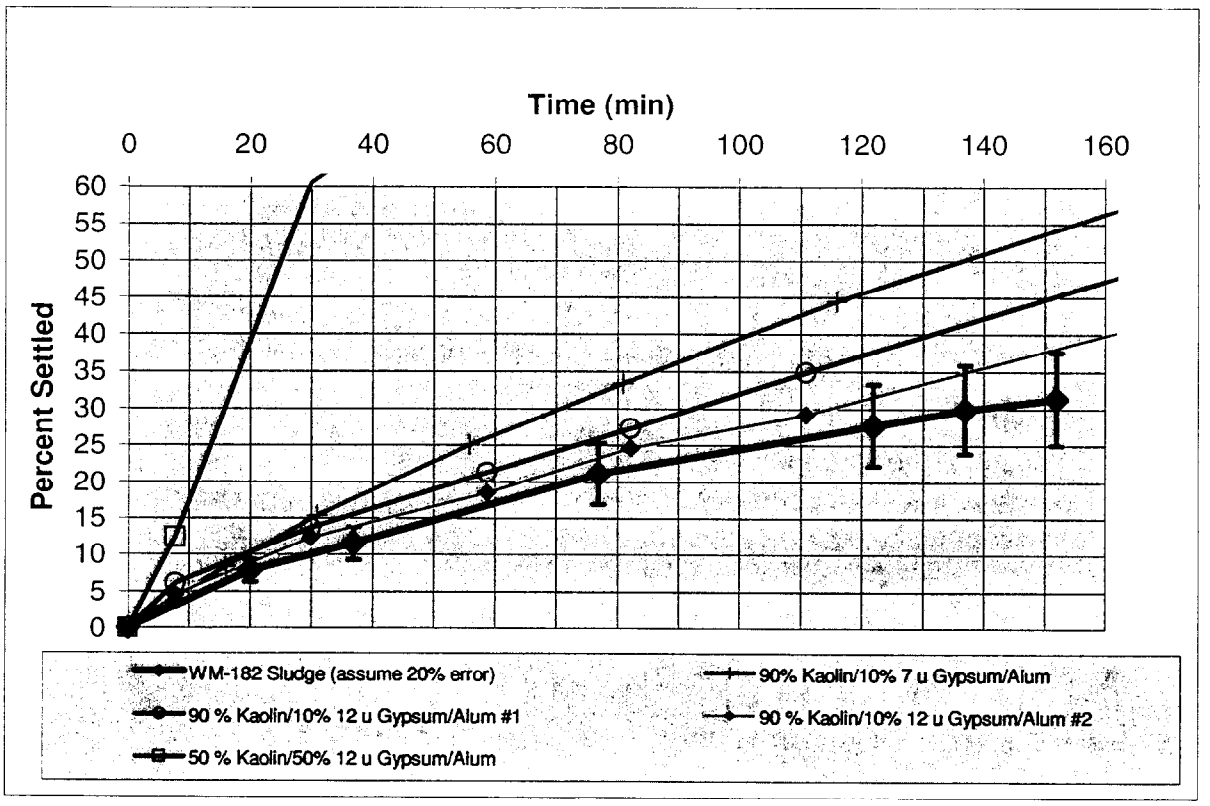

Figure 29: Kaolin/Alum/Gypsum Compression Settling Rate

Note that Iron Oxide was used in these sludges as a pigment. Adding Iron Oxide after the flocculating agent resulting in the pigment becoming one large mass and difficult to disperse. Therefore, the Iron Oxide pigment must be added before the flocculating agent (alum).

4.3 Particle Size Distribution

Since the particle size analyzer we used to make measurements on our candidate sludges consists of a mechanical agitator to keep the sludge dispersed (i.e. a Coulter counter), we

should compare fundamental particle size to fundamental particle size and our target PSD should be based on the sonicated data set. For WM-182, the median sonicated particle size is approximately 8 μm. The WM-183 median sonicated particle size is approximately 12 μm. The average particle size distribution for the kaolin/alum/iron oxide sludge (based on four runs) is shown with the sonicated WM-182 and WM-183 PSDs in Figure 30.

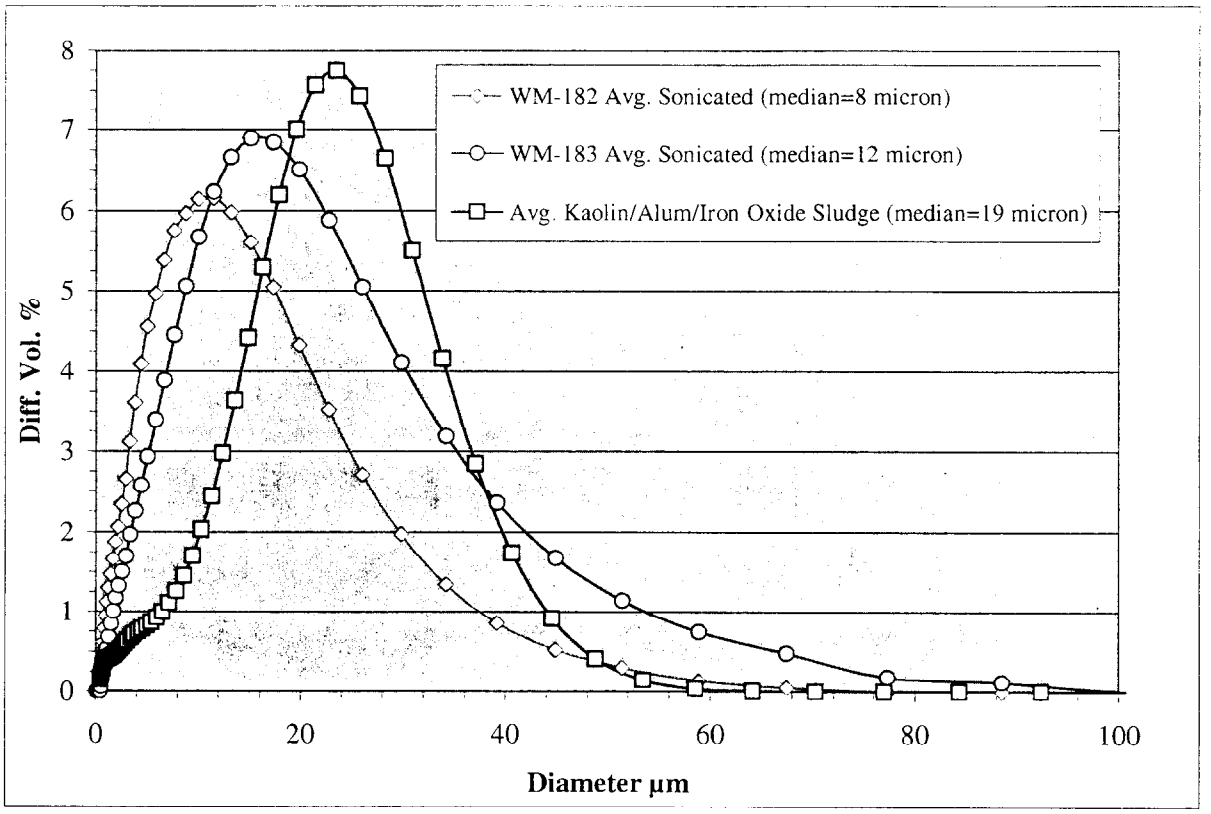

Figure 30: Kaolin/Alum/Iron Oxide Particle Size Distribution

In conclusion, the median particle size for the kaolin/alum/iron oxide sludge is relatively close to the WM-182 and WM-183 particle size medians.

4.4 Sludge Density Measurements

The particle density of kaolin is given in vendor data as 2.6 $\frac{g}{ml}$. Sludges typically have a interstitial liquid fraction in the range of 70% to 90% by volume. This range is consistent with rudimentary experiments with the kaolin/alum sludge of 75% to 86% interstitial liquid by volume. Using the more liberal 70% to 90% interstitial liquid range the expected sludge density should be in the range of 1.16 $\frac{g}{ml}$ to 1.48 $\frac{g}{ml}$. This range encompasses the tank farm

sludge density of 1.25 $\frac{g}{ml}$. A comparison of the expected kaolin/alum density values and the tank farm sludge density values are shown in Table 3.

Description	Tank Farm Sludge Parameter	Expected Surrogate Parameter	Units
Percent Interstial Liquid	75	70-90	%
Percent Solid Particles	25	10-30	%
Solids Particle Density	2.0	2.6	g/mL
Interstial Liquid Density	1.0	1.0	g/mL
Bulk Sludge Density	1.25	1.16-1.48	g/mL

Table 3: Expected Kaolin/Alum Densities

5 Conclusions

It was determined that kaolin clay (pigmented with iron-oxide) flocculated by the addition of aluminum sulfate (alum) provides the basis for an effective surrogate. Calcium sulfate dihyrdate (hydrated gypsum) provides effective adjustment of settling rate and particle size. Quantitative work needs to be performed in order to develop final recipe ratios of the surrogate solid ingredients. Because of the wide variation in dry apparent (bulk) densities (and therefore volumes) of many minerals/clays such as kaolin clay, it is desired to perform future recipe development based on mass measurements. To date, measurements have consisted of volume measurements and estimations. A comparison of the tank farm sludge and the kaolin/alum sludge is summarized in Table 4

Significant Parameter	Tank Farm Solids	Kaolin/Alum Sludge
Low Yield Stress (from visual observations)	yes	yes
Light, Billowy Sludge	yes	yes
Flocculation Sedimentation	yes	yes
Median Particle Size	8-12 micron	19 micron
Particle Density	2.0 g/ml	2.6 g/ml
Sludge Bulk Density	1.25 g/ml	1.16-1.48 g/ml

Table 4: Significant Surrogate Sludge Selection Parameters Comparison

Below is a summary list of the chosen surrogate benefits:

- The combined surrogate constituents can be percentaged to compare very closely to the settling rate and particle size distribution of the WM-183 actual sludge.
- No acidic or basic solution required as part of the process make-up (other than the coagulating agent Aluminum Sulfate which has mild acidic properties).
- Materials are inexpensive.

- Materials are safe to use.
- Generation of the surrogate sludge and disposal of the surrogate sludge will not be regulated as hazardous waste under the Resource Conservation & Recovery Act (RCRA).
- All materials can be mixed together in two steps. The kaolin, iron oxide, and gypsum are to be mixed in the first step to homogenize the mixture, followed by the alum addition. The mixing process is easy and can most likely be done with efficiency in a cement truck mixer. There are no special premixing requirements for preparing stock solutions.
- The particles in the material exhibit a particle size distribution similar to that of Tanks WM-182 and particularly WM-183 - the bounding tank for the simulated solids mock-up effort sludge depth and species denotation.
- The material exhibits a yield stress (based on visual observations) that matches the visual of the LDUA video footage of WM-182 and WM-183 sampling operations. The flocculated clays have provided more of the inter-particle forces needed for this behavior. The use of biopolymer rheology modifiers with minerals have not proven as effective as the mineral particles are entrained/restrained within the polymer substrate and the mixture of bulk material and the mixture tends to have a elastic viscosity characteristics such as lotion or syrup. More investigation may show different results.
- The mixed and then settled material results in two distinct phases, the sludge and the clear supernate.
- The mixture exhibits two settling characteristics as follows:
  - Upon complete disturbance of the sludge, the particles of such increased density (close proximity to one another) that a settling zone develops as the particles move in a defined horizontal layer enmasse as a moving filter capturing all particles via gravity settling. In this settling one may three distinct areas within a settling vessel - a clear supernate, a settling zone of particles, and the settled zone.
  - Upon partial disturbance of the sludge, the particles "billow" up from the sludge surface and then randomly settle until the supernate is clear. There is no distinct horizontal zone settling in this case.
- Material is easily colored with iron oxide of similar particle size. The color stays with the surrogate sludge (solids). The supernate remains clear. Red iron oxide is chosen over black, browns, and yellows for it has the highest chroma value and can be visually seen the easiest.

In addition, some of the issues associated with actually using this surrogate are discussed below:

- The beneficial properties of the sludge seem to deteriorate over time. After aging two to three weeks, the solids seemed to settle significantly faster and the yield stress properties seemed to degrade. Therefore, if the mockups are performed immediately following sludge production this degradation should be minimized.

- After approximately three weeks the kaolin/alum sludge had some algae growth. Therefore, a fungicide may be added to prevent biological activity.

- Please note that when washing occurs in the tank farm tanks, the interstitial liquid chemistry is significantly altered from dilution (e.g. pH, molar concentration of significant species, etc.). Changing the interstitial liquid chemistry can, in turn, change the solids surface chemistry. Changing the surface chemistry alters the so-called *zeta potential*, which is an indicator of how the solid particles interact with each other. Ultimately, the solids packing and interstitial liquid fraction can be significantly altered by the chemistry of the interstitial liquid. In addition, this dilution process can significantly alter the rheology of the sludge. Currently, the magnitude of these changes is unknown. Therefore, we have tried to match the sludge to the current tank farm conditions and no effort has been made to mimic this potential dynamic system.

References

[1] N.M. Gric and B.D. Lric. Flocculation: Theory and application. *Mine and Quarry Journal*, May 1978.

[2] Perry and Green. *Perry's Chemical Engineers' Handbook.* McGraw Hill, New York, 6th edition, 1984.

[3] A.C. Pierra and K. Ma. DLVO theory and clay aggregate architectures formed with $AlCl_3$. *Journal of the European Ceramic Society*, 19:1615–1622, 1999.

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A Flocculation Theory

Since the fundamental concept behind surrogate development involves flocculation, the following provides a brief introduction to some basic concepts of colloids, coagulation, and flocculation [1].

Many minerals, some organic pollutants, proteinaceous materials, some algae, and some bacteria are suspended in water as very small particles. Such particles, which have characteristics of both species in solution and larger particles in suspension, range in diameter from about 0.001 μm to about 1 μm. These particles are classified as colloids. Colloids may be classified as hydrophilic colloids, hydrophobic colloids, or association colloids. Hydrophobic colloids interact to a lesser extent with water and are stable because of their positive or negative electrical charges. The charged surface of the colloidal particle and the counter-ions that surround it compose an electrical double layer (adsorbed-ion layer and counter-ion layer), which causes the particles to repel each other. Colloidal particles are thus prevented from aggregating. Hydrophobic colloids are usually caused to settle from suspension by the addition small quantities of salts that contribute ions to solution. Clay particles are examples of hydrophobic colloids.

Destabilization of charged particles in water occurs as a result of the type of chemical (usually inorganic salts) causing coagulation. These salt ions reduce the electrostatic repulsion between particles to such a extent that the particles aggregate. Because of the double layer of electrical charge surrounding a charged particle, this aggregation mechanism is sometimes called double-layer compression. The selection of type and dosage of the chemical coagulant must be made by experimentation, most commonly with "jar tests." For this effort, 150 ml graduated beakers were primarily used to measure the volume of floc produced. Coagulation involves the reduction of this electrostatic repulsion, such that colloidal particles of identical materials may aggregate. Flocculation depends upon the presence of bridging compounds, which form chemically bonded links between colloidal particles and enmesh the particles in relatively large masses called floc networks.

Polyelectrolytes of both natural and synthetic origin may cause colloids to flocculate. Polyelectrolytes are polymers with a high formula weight, normally contain ionizable functional groups, are long enough for one end to adsorb onto one particle and the other end onto a second particle (bridging). Somewhat paradoxically, anionic polyelectolytes may flocculate negatively charged colloidal particles. The mechanism by which this occurs involves bridging between the colloidal particles by way of the polyelectrolytes anions. Strong chemical bonding has to be involved, since both the particles and the polyelectrolytes are negatively charged. The flocculation process induced by anionic polyelectrolytes is greatly facilitated by the presence of a low concentration of a metal ion capable of binding with the functional groups on the polyelectolyte. The positively charged metal ion serves to form a bridge between the negatively charged anionic polyelectrolytes and negatively charged functional groups on the colloidal particle surface. Acrylamide, polyacrylamides, polystyrene sulfonate, polyacrlyate, polyvinyl pyridium, and polyethylene amine are examples of synthetic polymers.

For a synthetic polyelectrolyte to function effectively, it must be released from its transported state to be available as a free dissolved and fully extended single molecule. Sophisticated modern polymers are supplied in solid form for reasons of economy and ease of transportation and storage with the solid having a particle size distribution around a centrally selected mean. Each particle is a hard packed tangle of long polymer chains similar to a ball of string. For the individual chains to be released they must firstly absorb water to begin to uncoil by hydrating and activating their repulsive ionic groups. Unfortunately, the wetted polymer on the outer surface of each particle forms initially into a highly viscous gel which resists the passage of the free water necessary for wetting the polymer in the center of the particle. Thus, this initial absorption of water is dependent on the particle size.

EDF-015722-043

ENGINEERING DESIGN FILE

1. Project File No. _____ 2. Project/Task INTEC Tank Farm Closure Project

3. Subtask Grout Qualification

4. Title: **Quality Assurance/Quality Control Plan for Grout**

5. Summary: This summary briefly defines the problem or activity to be addressed in the EDF, gives a summary of the activities performed in addressing the problem and states the conclusions, recommendations, or results arrived at from this task.

The purpose of this engineering design file (EDF) is to specify appropriate standards, inspections, sampling techniques, test procedures, and test frequencies associated with grout used for the INTEC Tank Farm Facility closures. This EDF is limited to Quality Assurance/Quality Control (QA/QC) as it pertains to grout materials, physical properties and delivery to the project site. This QA/QC plan does not address placement methods or grout properties after placement.

6. Distribution (complete package):

Distribution (summary package only):

7. Review (R) and Approval (A) Signatures: (Minimum reviews and approvals are listed. Additional reviews/approvals may be added as necessary.)

	R/A	Printed Name	Signature	Date
Author	R	Ray Schwaller	K J Poor for	5/30/00
Independent Verification	R	Kevin Poor	K J Poor	6/1/00
Requestor	A	Keith Quigley		
Requestor	A	Ed Anderson	E Anderson	6/1/00

INTEC Tank Farm Facility Closure
Draft Quality Assurance/Quality Control Plan for Grout

Purpose and Scope

The purpose of this engineering design file (EDF) is to specify appropriate standards, inspections, sampling techniques, test procedures, and test frequencies associated with grout used for the INTEC Tank Farm Facility closures. This EDF is limited to Quality Assurance/Quality Control (QA/QC) as it pertains to grout materials, physical properties and delivery to the project site. This QA/QC plan does not address placement methods or grout properties after placement.

Project Description

The INTEC facility (formerly ICPP) is located approximately 50 miles west of Idaho Falls, Idaho, and within the Idaho National Engineering and Environmental Laboratory. The INTEC facility houses the Tank Farm Facility (TFF), which contains underground tanks that were used to store radioactive and other liquid wastes from a variety of spent fuel processing activities.

The INTEC TFF includes eleven stainless steel tanks each having an approximate capacity of 300,000 gallons, with typical dimensions of 50 feet in diameter and 21 feet side walls (Palmer et al, 1999). The tanks are buried with the base of each approximately 45 feet below ground surface. Approximately 1.3 million gallons of liquid remain in the tanks at this time and an estimated one inch of solids has accumulated on the bottom of each.

The closure process for each tank includes removing most of the liquid waste, grouting of the tanks, vaults, and associated piping, and placing a final cover over the entire area upon completion. The period between the first tank closure and final closure of the area is expected to be a minimum of 20 years.

Upon closing individual tanks, the intermediate cover materials must be protective of human health and the environment. To meet closure requirements, each tank will be grouted with a Portland cement/fly ash based grout.

Grout Performance Objectives

The main purpose for using grout in the tank closures is to provide long-term structural stability of the waste under the expected disposal conditions. If the final waste form is structurally stable it will meet the following criteria (per 10 CFR Part 61):

- prevent excessive subsidence, settlement, or deformation
- minimize water infiltration
- prevent radionuclide release due to disintegration of the waste form
- minimize the likelihood of waste intrusion

As stated in 10 CFR 61.56(b):

"The requirements in this section are intended to provide stability of the waste. Stability is intended to ensure that the waste does not structurally degrade and affect overall stability of the site through slumping, collapse, or other failure of the disposal unit and thereby lead to water infiltration. Stability is also a factor in limiting exposure to an inadvertent intruder, since it provides a recognizable and nondispersible waste."

Another objective for using grout in the tank closure process is to provide a mechanical means for repositioning tank heels such that the residual waste is integrated into and/or encapsulated by the grout. To accomplish this objective, the grout must have the appropriate consistency and density to displace the waste. The grout must remain sufficiently flowable during placement.

The above objectives are, in various instances, mutually exclusive. In particular, increasing flowability is generally accompanied by a strength reduction and increased susceptibility to cracking. Based on the 1999 INTEC grouting mockups, it is understood flowability versus strength issues will be balanced by engineering the grout mix designs and placement sequencing.

Grout Mix Design

Two basic grout mixtures are proposed for the INTEC TFF closure. The first (pipe grout) is a mixture of Portland cement, fly ash, water, and water reducing admixtures. The second (tank grout or vault grout) is a mixture of Portland cement, fly ash, sand, water, and water reducing admixtures.

Specifications of proposed mix designs for the INTEC TFF Closure are provided in EDF-1464 (Bechtel, 2000). That EDF contains mix design descriptions, rationale for those designs, and a summary of grout strength data derived from recent tests.

Quality Assurance/Quality Control General Definitions

This section defines selected terms that are used through the remainder of this EDF. These terms are defined for purposes of presenting information in the sections to follow, and are not meant to supercede standard contractual language that may be associated with the INTEC TFF closure work.

For purposes of this QA/QC Plan, the following definitions apply:

Owner – The agent that is fiscally responsible for the INTEC TFF closure.

Contractor – The person, firm, or corporation with whom the Owner has entered into a written contract covering the INTEC TFF closure grouting work. The Contractor is responsible for implementing Quality Control.

Supplier – A manufacturer, supplier, or distributor having a direct contract with the Contractor, responsible for producing and delivering grout per the specifications.

Engineer – The Owner's representative responsible for preparing specifications and determining if the Contractor complies with those specifications. The Engineer is responsible for implementing Quality Assurance.

Specifications – Written technical descriptions of materials, equipment, construction systems, standards, and workmanship as applied to the grouting work. The Contractor is contractually responsible for complying with the project specifications.

In the context of waste containment facilities, the U.S. Environmental Protection Agency defines Quality Assurance and Quality Control for manufacturing and construction as follows (USEPA, 1993):

- *"Manufacturing Quality Control (MQC)*: A planned system of inspections that is used to directly monitor and control the manufacture of a material which is factory originated. MQC is normally performed by the manufacturer of...materials and is necessary to ensure minimum (or maximum) specified values in the manufactured product. MQC refers to measures taken by the manufacturer to determine compliance with the requirements for materials and workmanship as stated in certification documents and contract plans.

- *Manufacturing Quality Assurance (MQA)*: A planned system of activities that provides assurance that the materials were constructed as specified in the certification documents and contract plans. MQA includes manufacturing facility inspections, verifications, audits and evaluation of the raw materials and...products to assess the quality of the manufactured materials. MQA refers to measures taken by the MQA organization to determine if the manufacturer is in compliance with the product certification and contract plans for a project.

- *Construction Quality Control (CQC)*: A planned system of inspections that is used to directly monitor and control the quality of a construction project...Construction quality control is normally performed by the...contractor, and is necessary to achieve quality in the constructed or installed system. Construction quality control (CQC) refers to measures taken by the...contractor to determine compliance with the requirements for materials and workmanship as stated in the plans and specifications for the project.

- *Construction Quality Assurance (CQA)*: A planned system of activities that provides the owner and permitting agency assurance that the facility was constructed as specified in the design...Construction quality assurance includes inspections, verifications, audits, and evaluations of materials and workmanship necessary to determine and document the quality of the constructed facility. Construction quality assurance (CQA) refers to measures taken by the CQA organization to assess if the...contractor is in compliance with the plans and specifications for a project."

Manufacturing Quality Control

The Supplier (through the Contractor) shall provide and manufacture grout per the following requirements:

Cement, Sand, and Fly Ash

ASTM C 33 Standard Specification for Concrete Aggregates (for tank grout and vault grout)
ASTM C 94 Standard Specification for Ready-Mixed Concrete
ASTM C 150 Standard Specification for Portland Cement
ASTM C 618 Standard Specification for Coal Fly Ash or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete

Chemical Admixtures

ASTM C 494 Standard Specification for Chemical Admixtures for Concrete
ASTM C 1017 Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete

Manufacturing Quality Assurance

MQA will be conducted by the Engineer and generally includes the following:

- Review documentation stating the Supplier's qualifications, capabilities, licenses, certifications, etc.
- Periodic inspections of the manufacturing plant
- Verification that substantive requirements of the MQC standards are being met

- Independent sampling and testing of aggregates for moisture content

Construction Quality Control

The Contractor shall follow requirements of *ASTM C 94 Standard Specification for Ready-Mixed Concrete* for mixing and delivering grout to the project site. CQC procedures are normally established by the Contractor, and include activities such as delivery cycles, truck waiting time limitations, mixing revolutions, water and admixture measurements, and any other procedures that are used to consistently meet the project specifications.

Construction Quality Assurance

CQA activities conducted by the Engineer at the project site will consist of the following:

- Observe and record the Contractor's activities and CQC procedures
- Receive batch tickets, verify that each delivery meets project specifications
- Provide adequate grout samples for field and laboratory testing per applicable ASTM standards
- Field test grout per applicable ASTM standards
- Report field and laboratory test results to the Owner, provide recommendations as appropriate

The following ASTM standards shall be used for CQA:

Sampling Procedures

ASTM C 31/C 31M Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C 172 Standard Practice for Sampling Freshly Mixed Concrete

Grout Testing

ASTM C 143 Standard Test Method for Slump of Hydraulic Cement Concrete
ASTM C 939 Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method)
ASTM C 1064 Standard Test Method for Temperature of Freshly Mixed Portland-Cement Concrete

Periodic tests will be conducted at the Engineer's discretion to verify that the delivered grout used throughout the INTEC TFF closure project has compressive strength properties similar to preliminary design values and remains consistent over time. Tests on representative samples shall be conducted per *ASTM C 39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.*

Quality Assurance Testing Summary

This section provides a summary of the numbers and types of QA tests that are recommended for the INTEC TFF closure grouting project. The following QA tests and procedures are based on the concrete construction industry standards of practice, and should be defensible without placing excessive constraints or restrictions on the grouting project.

QA Test or Procedure	Standards	Frequency and Time, Other Notes
Review Supplier's qualifications	N/A	Once, prior to beginning work
Inspect batch plant	N/A	Quarterly (4 inspections per year) for the project duration, more frequently if grout inconsistencies are noted
Check compliance with manufacturing standards	ASTM C 33 ASTM C 94 ASTM C 150 ASTM C 494 ASTM C 618 ASTM C 1017	These checks will be performed as part of the batch plant inspections
Sample and test aggregates for moisture content	ASTM D 2216	One per week, representative sample collected from stockpile at batch plant and tested by a qualified laboratory
Observe and record Contractor's activities and QC procedures	N/A	Continuously through project duration, prepare daily logbooks, weekly reports, and monthly reports
Verify batch tickets	ASTM C 94	One per batch*, upon delivery
Measure grout temperature	ASTM C 1064	One per batch, upon delivery
Measure grout slump or time of efflux	ASTM C 143 ASTM C 939	One per batch, upon delivery (The method selected will be based on the criteria discussed in the recommendations section of this draft QA/QC plan.)
Collect grout test specimens	ASTM C 31/C 31M ASTM C 172	Collect 6 cylinders representative of a batch, and from the minimum number of batches needed to meet the compressive strength test frequencies as shown below. Field cure per applicable requirements.
Perform compressive strength tests	ASTM C 39	Tank grout and vault grout: Test cylinders collected from the same batch, per every 150 cubic yards placed or per day, whichever is more stringent. Break 2 cylinders at 7 days. Retain other samples for further testing, if determined necessary by the Engineer.

*In the table above, it is assumed that there is one batch per truck load.

Discussion

As described above, Quality Control is implemented by the Contractor and his Supplier. Quality Assurance is implemented by the Engineer, on behalf of the Owner. It is assumed that the project specifications will establish quantitative values for acceptance or rejection of batches that are delivered to the project site. The Engineer will perform the appropriate tests and notify the Owner of those test results. The Owner and Engineer will determine if adjustments to the batch can be made, such as the addition of water reducing admixtures. If the batch is flawed such that it cannot meet project specifications, the Owner should have the option to reject the batch at no expense to the Owner.

The water to cement ratio (or in this case, the water to cement plus fly ash ratio) is the chief factor for determining grout strength (Wang and Salmon, 1985). Therefore, careful measuring and testing of the mix during manufacturing and upon arrival at the job site is important to the final product. For structural concrete, if materials pass field tests but later testing shows the desired strength has not been attained, the product may be demolished and reconstructed. This cannot be done for the INTEC TFF Closure project, so grout materials must be thoroughly tested and verified prior to placement. If a batch yields lower compressive strength values than specified, it is an indicator of some problem in the production and delivery process, and work should be discontinued until the problem has been identified and resolved.

Due to the need for real-time physical characterization of the grout prior to placement, grout samples should be collected from the beginning of the truck discharge prior to placement. These samples should be tested for slump (ASTM C 143) and/or time of efflux (ASTM C 939). If grout test specimens are to be collected from the batch, a second grout sample should be collected from the middle of the batch per ASTM C 172. Temperature, slump, and/or time of efflux should be retested prior to molding test specimens.

Although is standard procedure to measure air content (ASTM C 231) in conjunction with field sampling concrete, in this case, air content measurements should be waived. This is for two reasons. Prior test data indicates a very low values of air content (Portage, 1999) for the proposed mix design and this is not expected to increase during the TFF closure. Also, entrained air is used to give concrete (or grout) freeze/thaw resistance, and frost is not anticipated in this design application.

Because the pipe grout represents a small percentage of the total grout quantity, CQA procedures are minimal. The tank and vault grout compressive strength test recommendations provided in this QA/QC plan follow ACI code requirements (ACI, 1999) for test frequencies of structural concrete. For most of the INTEC tanks, the frequency of tank grout compressive strength tests will occur at intervals of approximately one test per two feet of grout depth.

Recommendations

As stated in EDF-1464, a test more sensitive than slump is necessary to determine the flowability of the grout mixture. The slump test standard (ASTM C 143) specifically notes that "concretes having slumps greater than about 9 in. (230 mm) may not be adequately cohesive for this test to have significance. Caution should be exercised in interpreting such results."

Based on these statements, a test such as the flow cone method (ASTM C 939) may be more appropriate for measuring the flowability of the grout than the slump test. Further testing and development of correlations between the slump test and flow cone method should be conducted as part of the overall mix design process. The tests should be conducted within the anticipated range of water, cement, fly ash, and admixture proportions that may be encountered throughout the project.

Finally, the appropriate sections of this draft QA/QC plan should be modified and incorporated into the project specifications along with the grout mix design and pass/fail criteria. Although the Contractor is responsible for QC and the Engineer will implement QA, it is important that the Contractor understands the overall QA/QC program, due to cost and schedule implications to the Contractor and his Supplier.

References

American Concrete Institute, *Building Code Requirements for Reinforced Concrete*, ACI 318-99, Detroit, Michigan, 1999.

American Society for Testing and Materials:

ASTM C 31/C 31M Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C 33 Standard Specification for Concrete Aggregates
ASTM C 39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C 94 Standard Specification for Ready-Mixed Concrete
ASTM C 143 Standard Test Method for Slump of Hydraulic Cement Concrete
ASTM C 150 Standard Specification for Portland Cement
ASTM C 172 Standard Practice for Sampling Freshly Mixed Concrete
ASTM C 231 Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 494 Standard Specification for Chemical Admixtures for Concrete
ASTM C 618 Standard Specification for Coal Fly Ash or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
ASTM C 939 Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method)
ASTM C 1017 Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C 1064 Standard Test Method for Temperature of Freshly Mixed Portland-Cement Concrete
ASTM D 2216 Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock

Bechtel BWXT Idaho, LLC, Engineering Design File No. EDF-1464, INTEC Tank Farm Closure, Grout Mix Design, April 14, 2000.

Engineers Joint Contract Documents Committee, *Standard General Conditions of the Construction Contract*, Issued and Published Jointly by NSPE, ACEC, ASCE, and CSI, Approved and Endorsed by AGCA, Document No. 1910-8, 1990 Edition.

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U.S. Environmental Protection Agency, *Technical Guidance Document: Quality Assurance and Quality Control for Waste Containment Facilities*, Document No. EPA/600/R-93/182, Cincinnati, Ohio, September, 1993.

Wang, Chu-Kia and Salmon, Charles G., *Reinforced Concrete Design*, Fourth Edition, Harper & Row, Publishers, Inc., New York, NY, 1985.

ENGINEERING DESIGN FILE

1. Project File No. _____ 2. Project/Task INTEC TFF Closure

3. Subtask _____

4. Title: INTEC 300,000 Gallon Tank Grout Requirements for 10 CFR 61 Class C Limits

5. Summary:

The residual Tank Farm Facility (TFF) radionuclide inventory was evaluated to determine the classification of the waste according to the U.S. Nuclear Regulatory Commission's (NRC) 10 CFR 61.55 waste classification scheme. Contamination exists within the stainless-steel tanks and also in the sand pad beneath the tanks (i.e., sand pads beneath tanks WM-185 and WM-187).

The closure of the TFF and associated tank/vault systems will involve the cleaning and grouting of the tanks and vaults. During this process, the radionuclides contained in the tank heels and liquids will be incorporated into the grout matrix. A radionuclide inventory for the heels, liquid, and sand pads has been determined for use in the assessment of the TFF closure. This inventory was calculated based on process knowledge, sample analysis results, and conservative closure assumptions and is referred to as the "Bounding TFF Inventory" for this purposes of this report. This report presents the results of an evaluation of the required grout mixing depth required to ensure that residual radionuclide contamination (i.e., bounding TFF inventory) contained in the tanks is classified as Class C waste according to the 10 CFR 61.55 definition.

The analysis indicates that based on 5.6 feet of grout mixing and a grout density of 2.1 g cm^3, the residual "bounding TFF inventory" in the tanks (consisting of the heel and liquid) would be classified as Class C waste under 10 CFR 61.55 requirements. The analysis also indicates that the bounding sand pad inventory is Class C based on 10 CFR 61.55.

6. Distribution (complete package):

Distribution (summary package only):

7. Review (R) and Approval (A) Signatures: (Minimum reviews and approvals are listed. Additional reviews/approvals may be added as necessary.)

	R/A	Printed Name	Signature	Date
Author	R	David Thorne	K Poor for D Thorne	6/21/00
Independent Verification	R	Kevin Poor	K Poor	7/1/00
Requestor	A	[illegible]	[illegible]	7/1/00

1.0 INTRODUCTION

The residual Tank Farm Facility (TFF) radionuclide inventory was evaluated to determine the classification of the waste according to the U.S. Nuclear Regulatory Commission's (NRC) 10 CFR 61.55 waste classification scheme. Contamination exists within the stainless-steel tanks and also in the sand pad beneath the tanks (i.e., sand pads beneath tanks WM-185 and WM-187).

The closure of the TFF and associated tank/vault systems will involve the cleaning and grouting of the tanks and vaults. During this process, the radionuclides contained in the tank heels and liquids will be incorporated into the grout matrix. A radionuclide inventory for the heels, liquid, and sand pads has been determined for use in the assessment of the TFF closure. This inventory was calculated based on process knowledge, sample analysis results, and conservative closure assumptions and is referred to as the "Bounding TFF Inventory" for this purposes of this report. This report presents the results of an evaluation of the required grout mixing depth required to ensure that residual radionuclide contamination (i.e., bounding TFF inventory) contained in the tanks is classified as Class C waste according to the 10 CFR 61.55 definition.

2.0 NRC 10 CFR 61.55 CLASS C DETERMINATION

Waste classification for near surface disposal is provided by NRC in 10 CFR 61.55, "Waste Classification." The NRC concentration limits in 10 CFR 61.55 are for classification of waste as a particular type (Class A, B, C, or Greater Than Class C (GTCC)). The classification scheme from 10 CFR 61.55 is provided below:

2.1 10 CFR 61.55 Waste classification.

The following discussion is directly from 10 CFR 61.55:

(a) Classification of waste for near surface disposal. (1) *Considerations*. Determination of the classification of radioactive waste involves two considerations. First, consideration must be given to the concentration of long-lived radionuclides (and their shorter-lived precursors) whose potential hazard will persist long after such precautions as institutional controls, improved waste form, and deeper disposal have ceased to be effective. These precautions delay the time when long-lived radionuclides could cause exposures. In addition, the magnitude of the potential dose is limited by the concentration and availability of the radionuclide at the time of exposure. Second, consideration must be given to the concentration of shorter-lived radionuclides for which requirements on institutional controls, waste form, and disposal methods are effective.

(2) *Classes of waste*. (i) Class A waste is waste that is usually segregated from other waste classes at the disposal site. The physical form and characteristics of Class A waste must meet the minimum requirements set forth in §61.56(a). If Class A waste also meets the stability requirements set forth in §61.56(b), it is not necessary to segregate the waste for disposal.

(ii) Class B waste is waste that must meet more rigorous requirements on waste form to ensure stability after disposal. The physical form and characteristics of Class B waste must meet both the minimum and stability requirements set forth in §61.56.

(iii) Class C waste is waste that not only must meet more rigorous requirements on waste form to ensure stability but also requires additional measures at the disposal facility to protect against inadvertent intrusion. The physical form and characteristics of Class C waste must meet both the minimum and stability requirements set forth in §61.56.

(iv) Waste that is not generally acceptable for near-surface disposal is waste for which form and disposal methods must be different, and in general more stringent, than those specified for Class C waste. In the absense of specific requirements in this part, such waste must be disposed of in a geologic repository as defined in part 60 of this chapter unless proposals for disposal of such waste in a disposal site licensed pursuant to this part are approved by the Commission.

(3) Classification determined by long-lived radionuclides. If radioactive waste contains only radionuclides listed in Table 1, classification shall be determined as follows:

(i) If the concentration does not exceed 0.1 times the value in Table 1, the waste is Class A.

(ii) If the concentration exceeds 0.1 times the value in Table 1 but does not exceed the value in Table 1, the waste is Class C.

(iii) If the concentration exceeds the value in Table 1, the waste is not generally acceptable for near-surface disposal.

(iv) For wastes containing mixtures of radionuclides listed in Table 1, the total concentration shall be determined by the sum of fractions

Table 1 (10 CFR 61.55)

Radionuclide	Concentration curies per cubic meter
C-14	8
C-14 in activated metal	80
Ni-59 in activated metal	220
Nb-94 in activated metal	0.2
Tc-99	3
I-129	0.08
Alpha emitting transuranic nuclides with half-life greater than 5 years	[1]100
Pu-241	[1]3,500
Cm-242	[1]20,000

[1]Units are nanocuries per gram.

(4) Classification determined by short-lived radionuclides. If radioactive waste does not contain any of the radionuclides listed in Table 1, classification shall be determined based on the concentrations shown in Table 2. However, as specified in paragraph (a)(6) of this section, if radioactive waste does not contain any nuclides listed in either Table 1 or 2, it is Class A.

(i) If the concentration does not exceed the value in Column 1, the waste is Class A.

(ii) If the concentration exceeds the value in Column 1, but does not exceed the value in Column 2, the waste is Class B.

(iii) If the concentration exceeds the value in Column 2, but does not exceed the value in Column 3, the waste is Class C.

(iv) If the concentration exceeds the value in Column 3, the waste is not generally acceptable for near-surface disposal.

(v) For wastes containing mixtures of the nuclides listed in Table 2, the total concentration shall be determined by the sum of fractions rule

Table 2 (10 CFR 61.55)

Radionuclide	Concentration curies per cubic meter		
	Col. 1	Col. 2	Col. 3
Total of all nuclides with less than 5 year half-life	700	([1])	([1])
H-3	40	([1])	([1])
Co-60	700	([1])	([1])
Ni-63	3.5	70	700
Ni-63 in activated metal	35	700	7000
Sr-90	0.04	150	7000
Cs-137	1	44	4600

[1] There are no limits established for these radionuclides in Class B or C wastes. Practical considerations such as the effects of external radiation and internal heat generation on transportation, handling, and disposal will limit the concentrations for these wastes. These wastes shall be Class B unless the concentrations of other nuclides in Table 2 determine the waste to the Class C independent of these nuclides.

(5) Classification determined by both long- and short-lived radionuclides. If radioactive waste contains a mixture of radionuclides, some of which are listed in Table 1, and some of which are listed in Table 2, classification shall be determined as follows:

(i) If the concentration of a nuclide listed in Table 1 does not exceed 0.1 times the value listed in Table 1, the class shall be that determined by the concentration of nuclides listed in Table 2.

(ii) If the concentration of a nuclide listed in Table 1 exceeds 0.1 times the value listed in Table 1 but does not exceed the value in Table 1, the waste shall be Class C, provided the concentration of nuclides listed in Table 2 does not exceed the value shown in Column 3 of Table 2.

(6) Classification of wastes with radionuclides other than those listed in Tables 1 and 2. If radioactive waste does not contain any nuclides listed in either Table 1 or 2, it is Class A.

(7) The sum of the fractions rule for mixtures of radionuclides. For determining classification for waste that contains a mixture of radionuclides, it is necessary to determine the sum of fractions by dividing each nuclide's concentration by the appropriate limit and adding the resulting values. The appropriate limits must all be taken from the same column of the same table. The sum of the fractions for the column must be less than 1.0 if the waste class is to be determined by that column. Example: A waste contains Sr-90 in a concentration of 50 Ci/m^3. and Cs-137 in a concentration of 22 Ci/m^3. Since the concentrations both exceed the values in Column 1, Table 2,

they must be compared to Column 2 values. For Sr-90 fraction 50/150=0.33; for Cs-137 fraction, 22/44=0.5; the sum of the fractions=0.83. Since the sum is less than 1.0, the waste is Class B.

(8) *Determination of concentrations in wastes*. The concentration of a radionuclide may be determined by indirect methods such as use of scaling factors which relate the inferred concentration of one radionuclide to another that is measured, or radionuclide material accountability, if there is reasonable assurance that the indirect methods can be correlated with actual measurements. The concentration of a radionuclide may be averaged over the volume of the waste, or weight of the waste if the units are expressed as nanocuries per gram.

2.2 Use of the 10 CFR 61.55 Waste Classification

The classification of the TFF residual radionuclide inventory involves the use of 10 CFR 61.55(a)5 along with the sum of fractions rule described in 10 CFR 61.55(a)7. The TFF inventory contains both long and short-lived radionuclides in a mixture, some of which are listed in both 10 CFR 61.55 Table 1 and Table 2. In addition, since the residual waste contains a mixture of radionuclides, the sum of fractions rule described in 10 CFR 61.55(a)7 must also be evaluated.

3.0 TFF Residual Source Inventory

The radionuclide inventory for the heels, liquid, and sand pads has been determined for use in the assessment of the TFF closure. This inventory was calculated based on process knowledge, sample analysis results, and conservative closure assumptions and is referred to as the "Bounding TFF Inventory" for this purposes of this report. The "bounding TFF inventory" is currently being documented and is presented in Table 3.

Table 3. Bounding TFF Inventory (Curies).

Nuclide	Liquid	Solids	Total	Sand
H-3	9.30E-04	2.90E-02	2.99E-02	8.10E-01
Be-10	3.50E-08	2.70E-05	2.70E-05	1.20E-07
C-14	1.60E-03	3.10E-05	1.63E-03	4.80E-06
Co-60	5.10E-03	1.40E+00	1.41E+00	7.70E-03
Ni-63	1.80E-03	6.60E+01	6.60E+01	0.00E+00
Se-79	2.60E-03	2.00E+00	2.00E+00	1.70E-02
Kr-81	5.00E-12	3.80E-09	3.81E-09	5.70E-10
Kr-85	3.10E-01	2.40E+02	2.40E+02	3.60E+01
Rb-87	9.90E-09	7.60E-06	7.61E-06	1.10E-06
Sr-90	4.90E+00	1.30E+04	1.30E+04	1.40E+03
Y-90	1.80E+01	1.40E+04	1.40E+04	1.50E+03
Zr-93	7.40E-04	5.70E-01	5.71E-01	8.60E-02
Nb-93m	6.30E-04	4.80E-01	4.81E-01	7.30E-02
Nb-94	2.90E-04	8.50E+00	8.50E+00	9.20E-07
Tc-98	7.80E-10	6.00E-07	6.01E-07	2.70E-08
Tc-99	2.00E-03	1.00E+01	1.00E+01	5.70E-01
Rh-102	5.20E-07	3.90E-04	3.91E-04	2.10E-07
Ru-106	4.10E-05	2.00E+00	2.00E+00	1.60E-08
Rh-106	2.70E-03	2.00E+00	2.00E+00	1.60E-08

Table 3 (continued). Bounding TFF Inventory (Curies).

Nuclide	Liquid	Solids	Total	Sand
Pd-107	9.90E-06	7.50E-03	7.51E-03	7.00E-09
Ag-108	1.40E-11	1.00E-08	1.00E-08	0.00E+00
Ag-108m	1.50E-10	1.10E-07	1.10E-07	0.00E+00
Ag-109m	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cd-109	3.30E-19	2.60E-16	2.60E-16	3.90E-17
Ag-110	2.90E-11	2.20E-08	2.20E-08	1.70E-19
Ag-110m	9.90E-20	7.60E-17	7.61E-17	1.10E-17
Cd-113m	3.80E-03	2.90E+00	2.90E+00	7.30E-02
In-115	2.90E-14	2.20E-11	2.20E-11	5.40E-13
Sn-119m	5.40E-11	4.10E-08	4.11E-08	3.90E-19
Sn-121m	9.20E-05	7.00E-02	7.01E-02	2.10E-03
Te-123	1.30E-16	1.00E-13	1.00E-13	1.00E-15
Sb-125	1.30E-03	1.80E+02	1.80E+02	1.00E-02
Te-125m	2.60E-03	2.00E+00	2.00E+00	2.50E-03
Sn-126	3.30E-04	2.50E-01	2.50E-01	1.50E-02
Sb-126	4.60E-05	3.50E-02	3.50E-02	2.10E-03
Sb-126m	3.30E-04	2.50E-01	2.50E-01	1.50E-02
I-129	3.10E-06	1.00E-02	1.00E-02	9.50E-04
Cs-134	3.10E-02	1.60E+01	1.60E+01	1.50E-03
Cs-135	3.90E-04	3.00E-01	3.00E-01	1.50E-02
Cs-137	1.40E+01	1.10E+04	1.10E+04	1.60E+03
Ba-137m	1.40E+01	1.00E+04	1.00E+04	1.50E+03
La-138	7.40E-14	5.70E-11	5.71E-11	8.60E-12
Ce-142	1.00E-08	7.80E-06	7.81E-06	1.20E-06
Ce-144	1.40E-05	2.80E+00	2.80E+00	1.10E-10
Pr-144	4.30E-05	3.30E-02	3.30E-02	5.70E-11
Pr-144m	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nd-144	5.00E-13	3.80E-10	3.81E-10	5.70E-11
Pm-146	2.00E-05	1.50E-02	1.50E-02	1.60E-04
Sm-146	9.20E-11	7.00E-08	7.01E-08	9.80E-10
Pm-147	4.50E-01	3.40E+02	3.40E+02	3.20E-01
Sm-147	3.30E-09	2.50E-06	2.50E-06	3.80E-07
Sm-148	9.70E-15	7.40E-12	7.41E-12	4.10E-13
Sm-149	3.10E-15	2.40E-12	2.40E-12	1.70E-13
Eu-150	8.00E-09	6.10E-06	6.11E-06	7.00E-08
Sm-151	5.50E-01	4.20E+02	4.21E+02	2.50E+01
Eu-152	1.10E-03	8.10E-01	8.11E-01	2.20E-02
Gd-152	5.40E-16	4.10E-13	4.11E-13	1.30E-14
Gd-153	1.10E-21	8.50E-19	8.51E-19	1.30E-19
Eu-154	3.90E-02	3.80E+00	3.84E+00	2.00E+00
Eu-155	1.10E-02	5.20E+01	5.20E+01	3.10E-01
Ho-166m	1.50E-08	1.20E-05	1.20E-05	2.80E-07
Tm-171	4.50E-13	3.50E-10	3.50E-10	8.90E-16
Tl-207	7.40E-08	5.60E-05	5.61E-05	5.70E-06
Tl-208	5.80E-07	4.40E-04	4.41E-04	2.90E-07
Tl-209	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 3 (continued). Bounding TFF Inventory (Curies).

Nuclide	Liquid	Solids	Total	Sand
Pb-209	1.50E-10	1.10E-07	1.10E-07	6.70E-09
Pb-210	6.80E-09	5.20E-06	5.21E-06	6.40E-07
Pb-211	7.40E-08	5.60E-05	5.61E-05	5.70E-06
Pb-212	2.00E-06	1.50E-03	1.50E-03	7.90E-07
Pb-214	1.80E-08	1.40E-05	1.40E-05	1.80E-06
Bi-210m	5.60E-23	4.30E-20	4.31E-20	2.90E-23
Bi-210	6.80E-09	5.20E-06	5.21E-06	6.40E-07
Bi-211	7.40E-08	5.60E-05	5.61E-05	5.70E-06
Bi-212	2.00E-06	1.50E-03	1.50E-03	7.90E-07
Bi-213	1.50E-10	1.10E-07	1.10E-07	6.70E-09
Bi-214	1.80E-08	1.40E-05	1.40E-05	1.80E-06
Po-210	6.80E-09	5.20E-06	5.21E-06	6.40E-07
Po-211	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Po-212	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Po-213	1.50E-10	1.10E-07	1.10E-07	6.70E-09
Po-214	1.80E-08	1.40E-05	1.40E-05	1.80E-06
Po-215	7.40E-08	5.60E-05	5.61E-05	5.70E-06
Po-216	2.00E-06	1.50E-03	1.50E-03	0.00E+00
Po-218	1.80E-08	1.40E-05	1.40E-05	1.80E-06
At-217	1.50E-10	1.10E-07	1.10E-07	6.70E-09
Rn-219	7.40E-08	5.60E-05	5.61E-05	5.70E-06
Rn-220	2.00E-06	1.50E-03	1.50E-03	7.90E-07
Rn-222	1.80E-08	1.40E-05	1.40E-05	1.80E-06
Fr-221	1.50E-10	1.10E-07	1.10E-07	6.70E-09
Fr-223	1.20E-08	8.90E-06	8.91E-06	7.90E-08
Ra-223	7.40E-08	5.60E-05	5.61E-05	5.70E-06
Ra-224	2.00E-06	1.50E-03	1.50E-03	7.90E-07
Ra-225	1.50E-10	1.10E-07	1.10E-07	6.70E-09
Ra-226	1.80E-08	1.40E-05	1.40E-05	1.80E-06
Ra-228	2.30E-13	1.70E-10	1.70E-10	2.60E-11
Ac-225	1.50E-10	1.10E-07	1.10E-07	6.70E-09
Ac-227	7.40E-08	5.60E-05	5.61E-05	5.70E-06
Ac-228	1.20E-13	9.00E-11	9.01E-11	0.00E+00
Th-227	7.40E-08	5.60E-05	5.61E-05	5.70E-06
Th-228	2.00E-06	1.50E-03	1.50E-03	7.90E-07
Th-229	1.50E-10	1.10E-07	1.10E-07	6.70E-09
Th-230	1.50E-06	1.10E-03	1.10E-03	1.60E-04
Th-231	5.40E-06	4.10E-03	4.11E-03	3.20E-05
Th-232	2.50E-13	1.90E-10	1.90E-10	2.90E-11
Th-234	5.40E-06	4.10E-03	4.11E-03	1.80E-06
Pa-231	1.20E-07	9.40E-05	9.41E-05	9.80E-06
Pa-233	7.40E-04	5.70E-01	5.71E-01	1.60E-03
Pa-234m	5.40E-06	4.10E-03	4.11E-03	1.80E-06
Pa-234	6.80E-09	5.20E-06	5.21E-06	2.40E-09
U-232	2.00E-06	1.50E-03	1.50E-03	2.50E-07
U-233	8.30E-09	6.30E-06	6.31E-06	1.00E-07

Table 3 (continued). Bounding TFF Inventory (Curies).

Nuclide	Liquid	Solids	Total	Sand
U-234	3.10E-05	1.60E-01	1.60E-01	4.80E-03
U-235	7.20E-06	6.00E-04	6.07E-04	3.20E-05
U-236	7.60E-06	7.10E-04	7.18E-04	7.60E-05
U-237	3.70E-06	2.80E-03	2.80E-03	1.50E-05
U-238	1.00E-05	2.70E-04	2.80E-04	1.80E-06
U-240	1.70E-13	1.30E-10	1.30E-10	7.00E-14
Np-235	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Np-236	1.50E-10	1.10E-07	1.10E-07	1.70E-08
Np-237	1.20E-04	6.60E-03	6.72E-03	1.30E-03
Np-238	2.00E-08	1.50E-05	1.50E-05	3.10E-08
Np-239	5.40E-05	4.10E-02	4.11E-02	6.00E-06
Np-240m	1.70E-13	1.30E-10	1.30E-10	7.00E-14
Pu-236	1.60E-06	1.20E-03	1.20E-03	3.80E-09
Pu-238	2.60E-02	4.50E+01	4.50E+01	6.70E-01
Pu-239	3.40E-03	3.40E+00	3.40E+00	7.60E-02
Pu-240	5.80E-04	2.00E+00	2.00E+00	3.00E-02
Pu-241	3.90E-02	1.10E+02	1.10E+02	6.00E-01
Pu-242	1.10E-05	3.70E-03	3.71E-03	2.30E-06
Pu-243	1.20E-19	9.00E-17	9.01E-17	1.40E-17
Pu-244	1.70E-13	1.30E-10	1.30E-10	7.00E-14
Am-241	2.70E-03	2.00E+00	2.00E+00	1.70E-01
Am-242m	6.70E-06	5.10E-03	5.11E-03	6.40E-06
Am-242	6.70E-06	5.10E-03	5.11E-03	6.00E-06
Am-243	5.40E-05	4.10E-02	4.11E-02	6.00E-06
Cm-242	5.70E-06	4.30E-03	4.31E-03	5.10E-06
Cm-243	7.80E-06	6.00E-03	6.01E-03	4.40E-07
Cm-244	5.20E-04	3.90E-01	3.91E-01	1.80E-05
Cm-245	7.60E-08	5.80E-05	5.81E-05	1.60E-09
Cm-246	5.00E-09	3.80E-06	3.81E-06	3.80E-11
Cm-247	5.60E-15	4.30E-12	4.31E-12	1.40E-17
Cm-248	6.00E-15	4.60E-12	4.61E-12	4.10E-18
Cf-249	4.50E-15	3.50E-12	3.50E-12	0.00E+00
Cf-250	4.30E-15	3.30E-12	3.30E-12	0.00E+00
Cf-251	7.00E-17	5.40E-14	5.41E-14	0.00E+00
Cf-252	0.00E+00	0.00E+00	0.00E+00	0.00E+00

4.0 TFF Tank Source Inventory Class C Calculations

The residual inventory provided above was used to evaluate the source inventory against the Class C limits according to the requirements of 10 CFR 61.55. The following assumptions were required to calculate the appropriate Class C Limit based upon either activity per unit volume of waste or activity per unit mass of waste:

1. Each waste tank has a radius of 25 feet (7.62 m)
2. The area of each tank was determined by Area = πr^2 = 182.4 m^2
3. The depth of grout mixing is 1.71 m (5.6 ft)
4. The volume of grout mixing is 311 m^3 (10990 ft^3)
5. The bulk density of the grout is 2.1 x 10^6 g/m^3 (2.1 g/cm^3)

Comparison of the "bounding TFF inventory" to the class C limits of 10 CFR 61.55 Table 1 are provided in Table 4, while comparison to the Class C limits of 10 CFR Table 2 are provided in Table 5.

Table 4. Bounding TFF Inventory Comparison to 10 CFR 61.55 Table 1 Class C Limits.

Nuclide	Half-life (yr)	Bounding Tank (Ci)	Tank Ci/m^3	Tank nCi/g	10 CFR 61.55 Table 1[a]	Fraction of Limit
C-14	5730	1.6E-03	5.2E-06		8.0E+00	6.5E-07
Nb-94	2.03E+04	8.5E+00	2.7E-02		2.0E-01	1.4E-01
Tc-99	2.13E+05	1.0E+01	3.2E-02		3.0E+00	1.1E-02
I-129	1.57E+07	1.0E-02	3.2E-05		8.0E-02	4.0E-04
Np-237	2.14E+06	6.7E-03	2.2E-05	1.0E-02	1.0E+02	1.0E-04
Pu-238	87.75	4.5E+01	1.4E-01	6.9E+01	1.0E+02	6.9E-01
Pu-239	24131	3.4E+00	1.1E-02	5.2E+00	1.0E+02	5.2E-02
Pu-240	6537	2.0E+00	6.4E-03	3.1E+00	1.0E+02	3.1E-02
Pu-241	14.4	1.1E+02	3.5E-01	1.7E+02	3.5E+03	4.8E-02
Pu-242	3.76E+05	3.7E-03	1.2E-05	5.7E-03	1.0E+02	5.7E-05
Pu-244	8.26E+07	1.3E-10	4.2E-13	2.0E-10	1.0E+02	2.0E-12
Am-241	432.2	2.0E+00	6.4E-03	3.1E+00	1.0E+02	3.1E-02
Am-242m	152	5.1E-03	1.6E-05	7.8E-03	1.0E+02	7.8E-05
Am-243	7380	4.1E-02	1.3E-04	6.3E-02	1.0E+02	6.3E-04
Cm-242	163.2	4.3E-03	1.4E-05	6.6E-03	2.0E+04	3.3E-07
Cm-243	28.5	6.0E-03	1.9E-05	9.2E-03	1.0E+02	9.2E-05
Cm-244	18.11	3.9E-01	1.3E-03	6.0E-01	1.0E+02	6.0E-03
Cm-245	8500	5.8E-05	1.9E-07	8.9E-05	1.0E+02	8.9E-07
Cm-246	4750	3.8E-06	1.2E-08	5.8E-06	1.0E+02	5.8E-08
Cm-247	1.56E+07	4.3E-12	1.4E-14	6.6E-12	1.0E+02	6.6E-14
Cm-248	3.39E+05	4.6E-12	1.5E-14	7.1E-12	1.0E+02	7.1E-14
Cf-249	350.6	3.5E-12	1.1E-14	5.4E-12	1.0E+02	5.4E-14
Cf-250	13.08	3.3E-12	1.1E-14	5.0E-12	1.0E+02	5.0E-14
Cf-251	900	5.4E-14	1.7E-16	8.3E-14	1.0E+02	8.3E-16
Sum of Fractions						*1.00E+00*

a Note that the Table 2 values from 10 CFR 61.55 are in units of Ci/m3 for C-14, Nb-94 , Tc-99 and I-129. The units for all remaining radionuclides in this table are nCi/g.

Table 5. Bounding TFF Inventory Comparison to 10 CFR 61.55 Table 2 Class C Limits.

Nuclide	Half-life (yr)	Bounding Tank (Ci)	Tank Ci/m^3	10 CFR 61.55 Table 2	Fraction of Limit
Ni-63	100.1	6.6E+01	2.1E-01	7.0E+02	3.0E-04
Sr-90	28.6	1.3E+04	4.2E+01	7.0E+03	6.0E-03
Cs-137	30.17	1.1E+04	3.5E+01	4.6E+03	7.7E-03
Sum of Fractions					*1.4E-02*

4.1 Interpretation

The above analysis indicates that based on 5.6 feet of grout mixing and a grout density of 2.1 g cm^3, the residual "bounding TFF inventory" in the tanks (consisting of the heel and liquid) would be classified as Class C waste under 10 CFR 61.55 requirements. Two radionuclides, Nb-94 and Pu-238, are greater than 0.1 times the value of 10 CFR 61.55 Table 1 values, but do not exceed the value in 10 CFR 61.55 Table 1. Therefore, the waste is classified as Class C since the nuclides shown in Table 5 do not exceed the values listed in 10 CFR 61.55 Table 2 column 3. The sum of fraction rule indicates that the sum of 1.0 is not exceeded for either 10 CFR 61.55 Table 1 or Table 2 radionuclides in a mixture.

5.0 TFF Sand Pad Source Inventory Class C Calculations

The residual inventory provided in Section 2 for the sand pad was used to evaluate the inventory against the Class C limits according to the requirements of 10 CFR 61.55. The following assumptions were required to calculate the appropriate Class C Limit based upon either activity per unit volume of waste or activity per unit mass of waste:

1. The sand pad is 23.39 m^3 (826 ft^3) (Staiger MDS-07099 1999)
2. The sand pad mass is 4.13 x 10^7 g (Staiger MDS-07099 1999)

Comparison of the "bounding sand pad inventory" to the class C limits of 10 CFR 61.55 Table 1 are provided in Table 6, while comparison to the Class C limits of 10 CFR Table 2 are provided in Table 7.

5.1 Interpretation

The above analysis indicates that the bounding sand pad inventory is Class C based on 10 CFR 61.55. One radionuclides, Pu-238, is greater than 0.1 times the value of 10 CFR 61.55 Table 1 value, but do not exceed the value in 10 CFR 61.55 Table 1. Therefore, the waste is classified as Class C since the nuclides shown in Table 6 do not exceed the values listed in 10 CFR 61.55 Table 2 column 3. The sum of fraction rule indicates that the sum of 1.0 is not exceeded for either 10 CFR 61.55 Table 1 or Table 2 radionuclides in a mixture. The sand pad analysis does not take into account any mixing of the radionuclides with the grout in the vault. This is appropriate since the sand is isolated from the vault system and grout is not expected to mix with the sand.

Table 5. Bounding Sand Pad Inventory Comparison to 10 CFR 61.55 Table 1 Class C Limits.

Nuclide	Half-life (yr)	Bounding Tank (Ci)	Sand Pad Ci/m^3	Sand Pad nCi/g	10 CFR 61.55 Table 1[a]	Fraction of Limit
C-14	5730	4.8E-06	2.1E-07		8.0E+00	2.6E-08
Nb-94	2.03E+04	9.2E-07	3.9E-08		2.0E-01	2.0E-07
Tc-99	2.13E+05	5.7E-01	2.4E-02		3.0E+00	8.1E-03
I-129	1.57E+07	9.5E-04	4.1E-05		8.0E-02	5.1E-04
Np-237	2.14E+06	1.3E-03	5.6E-05	3.2E-02	1.0E+02	3.2E-04
Pu-238	87.75	6.7E-01	2.9E-02	1.6E+01	1.0E+02	1.6E-01
Pu-239	24131	7.6E-02	3.2E-03	1.8E+00	1.0E+02	1.8E-02
Pu-240	6537	3.0E-02	1.3E-03	7.3E-01	1.0E+02	7.3E-03
Pu-241	14.4	6.0E-01	2.6E-02	1.5E+01	3.5E+03	4.2E-03
Pu-242	3.76E+05	2.3E-06	9.8E-08	5.6E-05	1.0E+02	5.6E-07
Pu-244	8.26E+07	7.0E-14	3.0E-15	1.7E-12	1.0E+02	1.7E-14
Am-241	432.2	1.7E-01	7.3E-03	4.1E+00	1.0E+02	4.1E-02
Am-242m	152	6.4E-06	2.7E-07	1.6E-04	1.0E+02	1.6E-06
Am-243	7380	6.0E-06	2.6E-07	1.5E-04	1.0E+02	1.5E-06
Cm-242	163.2	5.1E-06	2.2E-07	1.2E-04	2.0E+04	6.2E-09
Cm-243	28.5	4.4E-07	1.9E-08	1.1E-05	1.0E+02	1.1E-07
Cm-244	18.11	1.8E-05	7.7E-07	4.4E-04	1.0E+02	4.4E-06
Cm-245	8500	1.6E-09	6.8E-11	3.9E-08	1.0E+02	3.9E-10
Cm-246	4750	3.8E-11	1.6E-12	9.2E-10	1.0E+02	9.2E-12
Cm-247	1.56E+07	1.4E-17	6.0E-19	3.4E-16	1.0E+02	3.4E-18
Cm-248	3.39E+05	4.1E-18	1.8E-19	9.9E-17	1.0E+02	9.9E-19
Cf-249	350.6	0.0E+00	0.0E+00	0.0E+00	1.0E+02	0.0E+00
Cf-250	13.08	0.0E+00	0.0E+00	0.0E+00	1.0E+02	0.0E+00
Cf-251	900	0.0E+00	0.0E+00	0.0E+00	1.0E+02	0.0E+00
Sum of Fractions						*2.42E-01*

a Note that the Table 2 values from 10 CFR 61.55 are in units of Ci/m3 for C-14, Nb-94 , Tc-99 and I-129. The units for all remaining radionuclides in this table are nCi/g.

Table 6. Bounding Sand Pad Inventory Comparison to 10 CFR 61.55 Table 2 Class C Limits.

Nuclide	Half-life (yr)	Bounding Tank (Ci)	Sand Pad Ci/m^3	10 CFR 61.55 Table 2	Fraction of Limit
Ni-63	100.1	0.0E+00	0.0E+00	7.0E+02	0.0E+00
Sr-90	28.6	1.4E+03	6.0E+01	7.0E+03	8.6E-03
Cs-137	30.17	1.6E+03	6.8E+01	4.6E+03	1.5E-02
Sum of Fractions					*2.3E-02*

6.0 Conclusion

The analysis indicates that based on 5.6 feet of grout mixing and a grout density of 2.1 g cm^3, the residual "bounding TFF inventory" in the tanks (consisting of the heel and liquid) would be classified as Class C waste under 10 CFR 61.55 requirements. The analysis also indicates that the bounding sand pad inventory is Class C based on 10 CFR 61.55.

ENGINEERING DESIGN FILE

1. Project File No. _____ 2. Project/Task INTEC Tank Farm Closure Project

3. Subtask Regulatory Analysis

4. Title: TFF closure regulatory analysis

5. Summary: This summary briefly defines the problem or activity to be addressed in the EDF, gives a summary of the activities performed in addressing the problem and states the conclusions, recommendations, or results arrived at from this task.

The attachment accompanying this EDF identifies the applicable RCRA/CERCLA regulatory requirements and DOE 435.1. The EDF assess the conceptual design and proposed closure process with respect to each requirement. The EDF identifies and describe how the proposed process meets or does not meet each requirement. Where the proposed process does not meet a requirement or where the process/requirement relationship is "grey", the EDF makes recommendations for the position the project should take in negotiations with the regulators. The EDF utilized prior deliverables to develop the assessment, primarily the TFF Closure Approach document and 80% HWMA/RCRA Closure Plan.

6. Distribution (complete package):

Distribution (summary package only):

7. Review (R) and Approval (A) Signatures: (Minimum reviews and approvals are listed. Additional reviews/approvals may be added as necessary.)

	R/A	Printed Name	Signature	Date
Author	R	Kevin Poor/Lisa Matis	K J Poor	6/1/00
Independent Verification	R	Nick Stanisich	K J Poor for	6/12/00
Requestor	A	Ed Anderson	E Anderson	6/12/00
Requestor	A	Keith Quigley	Est for Keith Quigley	6/12/00

Assessment of Regulatory Drivers for Idaho Nuclear Technology and Engineering Center Tank Farm Facility Closure Conceptual Design

Introduction

This document identifies the principle regulatory drivers for the closure of the Idaho Nuclear Technology and Engineering Center (INTEC) Tank Farm Facility (TFF) and briefly describes how each driver affects the project. The assessment of regulatory drivers is limited to hazardous waste management facility closure requirements under the Resource Conservation and Recovery Act (RCRA)/Hazardous Waste Management Act (HWMA) [for the remainder of this document referred to as RCRA] and the provisions of DOE Order 435.1 "Radioactive Waste Management" relevant to closure of deactivated high-level waste (HLW) management facilities. The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process being implemented by the INEEL Environmental Restoration (ER) program is included in the assessment to the extent closure and post-closure requirements under RCRA or DOE Order 435.1 will be addressed through actions that are carried out under the ER program rather than the TFF closure project.

Existing information from the conceptual design currently in-progress, and from the proposed closure process for the TFF were assessed against each of the regulatory drivers. The assessment was based on documentation available as of May 2000. The primary references were the *INTEC TFF Tanks WM-182 and WM-183 Closure Study* (Spaulding et al. 1998) and related engineering design files (EDFs), the *Idaho Nuclear Technology and Engineering Center Tank Farm Facility Conceptual DOE and HWMA/RCRA Closure Approach* (Portage 2000a), and the *Idaho Hazardous Waste Management Act/Resource Conservation and Recovery Act Closure Plan for Idaho Nuclear Technology and Engineering Center Tanks WM-182 and WM-183* (Portage 2000b).

Background

In January 1990, the U.S. Environmental Protection Agency (EPA) issued a Notice of Noncompliance (NON) for the INTEC TFF. The NON was primarily based on storing mixed (radioactive and hazardous) waste in tanks without adequate secondary containment. The resulting Consent Order (CO) was signed in 1992. The NONCO provides schedules for either bringing the TFF into compliance with secondary containment requirements or ceasing use of the tanks. In addition, the NONCO requires that a RCRA closure plan covering at least one of the tank systems be submitted by December 31, 2000. Tanks WM-182 and WM-183 have been identified as Phase 1 of the TFF closure to be addressed in that initial RCRA closure plan.

The Federal Facility Agreement and Consent Order (FFA/CO) and its associated Action Plan (DOE 1991a, b) describe the conduct of CERCLA remedial activities at the INEEL. The FFA/CO provides the procedural framework and schedule under which the INEEL ER Program will address contamination resulting from past releases at the TFF through the CERCLA process. RCRA closure of a tank system would generally include removal or decontamination of materials contaminated with hazardous waste or hazardous waste constituents to

the extent necessary to protect human health and the environment. For the TFF, the "remove or decontaminate" standard will not be applied to media (soils, groundwater) outside the tank systems that may have been contaminated as a result of past releases. The TFF soils have been designated OU 3-14. Any remediation to address hazardous wastes or hazardous waste constituents associated with those soils will be determined through the CERCLA process.

DOE recently issued its Record of Decision (ROD) for Operable Unit 3-13, listed in the FFA/CO as the "WAG 3 Comprehensive Remedial Investigation (RI)/Feasibility Study (FS)." The ROD (DOE 1999) addressed remedies for seven groups of WAG 3 release sites, including an interim action of "institutional controls with surface water control" for the Tank Farm soils. The interim action is intended to reduce direct radiation exposure and the potential for leaching and transport of contaminants to the perched water or the Snake River Plain aquifer until a final remedy is selected. As part of its decision for the "Soils Under Buildings and Structures" (Group 2 of the units comprising OU 3-13), DOE included post-closure monitoring and maintenance requirements for the Waste Calcining Facility (WCF), which had been closed under RCRA. These requirements will be addressed under the OU 3-13 ROD as ARARs. Post-closure care of the WCF will be incorporated in the post-ROD monitoring plan for OU 3-13. The ROD states that additional sites being closed under RCRA (e.g., the TFF) will be handled in the same manner as the WCF (i.e., address post-closure monitoring and maintenance requirements as ARARs, address substantive requirements of 40 CFR 264.310 (closure to landfill standards) in CERCLA 5-year reviews, and incorporate these requirements into the post-ROD monitoring plan).

The TFF will be closed under the RCRA requirements for interim status facilities. RCRA standards for closure are found at 40 CFR Part 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities" [These standards are adopted by reference in Idaho Administrative Procedures Act (IDAPA) 16.01.05.009.]. Within 40 CFR Part 265, the specific requirements are found at Subpart J, Tank Systems and Subpart G, Closure and Post-closure Care. These tank system and general closure requirements invoke additional interim status provisions (e.g., Section 264.310 for closure and post-closure care of landfills, groundwater monitoring provisions of Subpart F). RCRA closure standards are applicable to the hazardous constituents associated with the mixed wastes managed in the TFF. Radioactive constituents are addressed by DOE Orders pursuant to the Atomic Energy Act.

The TFF will be closed under the requirements of DOE Order 435.1 and the associated Manual (M 435.1-1) and Implementation Guide (G 435.1-1). The DOE requirements for closure of deactivated HLW management facilities are specified in Section II.U of DOE M 435.1-1. In conjunction with the closure of TFF under DOE Order 435.1, any residual material remaining in the TFF when the closure activities are completed must meet the requirements for the waste incidental to reprocessing evaluation process set forth in Section II.B of DOE M 435.1-1.

Summary of Regulatory Driver Assessment

Table 1 documents the evaluation of the TFF closure project against the RCRA requirements for closure of hazardous waste management facilities in 40 CFR Part 265 and the closure requirements for deactivated high-level waste facilities/sites under DOE Order 435.1. RCRA closure requirements are addressed by EPA guidance that describe what the Agency views as acceptable methods of compliance. EPA policy statements and guidance were included in the evaluation where such documents provide insight into closure requirements not explicitly addressed by the regulations.

Where possible, the evaluation indicates whether the proposed TFF closure process meets or does not meet each RCRA or DOE Order 435.1 requirement. When the proposed process does not meet a requirement, or where the relationship between the closure process and regulatory requirement is subject to interpretation, the table provides recommendations for future negotiations with the regulators to clarify how the requirement will be applied in the context of TFF closure.

The assessment of the conceptual design was based on the *INTEC TFF Tanks WM-182 and WM-183 Closure Study* (Spaulding et al. 1998, referred to as the "Closure Study") and EDFs generated to date as part of the TFF Closure Conceptual Design, currently in progress. The Conceptual Design is scheduled for completion by the end of this fiscal year. The assessment of the closure approach was based on the *Idaho Nuclear Technology and Engineering Center Tank Farm Facility Conceptual DOE and HWMA/RCRA Closure Approach* (Portage 200a, referred to as the "Closure Approach") and the *Idaho Hazardous Waste Management Act/Resource Conservation and Recovery Act Closure Plan for Idaho Nuclear Technology and Engineering Center Tanks WM-182 and WM-183* (Portage 2000b, referred to as the "Closure Plan").

Conclusions

The following summarizes general conclusions from the regulatory driver assessment.

The performance standards for TFF closure (i.e., the "remove and decontaminate" standard under RCRA and the technical and economic practicability standard for an incidental waste determination under DOE Order 435.1) are somewhat subjective and will be defined during closure design. Compliance with these requirements must be demonstrated through consideration of a reasonable range of alternatives. The evaluation of alternatives should include a cost/benefit analysis where the "cost" includes additional resources (dollars, occupational radiological exposure, secondary wastes, etc.) needed to achieve an incremental benefit (i.e., reduction in the level of residual hazardous constituents and radioactivity associated with the closed TFF). The proposed closure method must reflect a defensible balance of these considerations.

Waste removal and decontamination efforts should be implemented to the maximum extent technically and economically practical, and not be based on convenience or limited by achieving performance objectives. In general, the TFF closure activities appear to represent a reasonable effort to remove waste and decontaminate the

tank systems. The conceptual design documents shall include the rationale for many of the proposed activities. Where options exist, the Conceptual Design will include an alternatives analysis delineating how the proposed method was selected. For example, the primary decontamination solution is water. The reason for selecting water over alternatives such as an acidic decontamination solution are not currently described. Use of heat or pressurized sprays to facilitate the decontamination are similarly not described. Documentation supporting the proposed closure methods should be developed in parallel with the design effort. Such documentation could include literature reviews to identify techniques successful in similar applications and mock-up testing to evaluate techniques under simulated TFF closure conditions.

The residual material in the TFF at closure may exceed the Class C limits defined in 10 CFR 61.55, Waste Classification. If that occurs, DOE must demonstrate via performance assessment that allowing the residual material to be left in place is consistent with the performance objectives for LLW or TRU waste disposal (as appropriate). The closure project assumes the TFF residuals can be managed as LLW based on meeting the Class LLW limits specified in 10 CFR 61.55.

References:

DOE (U.S. Department of Energy) 1991a, Federal Facility Agreement and Consent Order for the Idaho National Engineering Laboratory, State of Idaho Department of Health and Welfare, the U.S. Environmental Protection Agency Region 10, and the U.S. Department of Energy Idaho Field Office, December 4, 1991.

DOE (U.S. Department of Energy) 1991b, Action Plan for Implementation of the Federal Facility Agreement for the Idaho National Engineering Laboratory, State of Idaho Department f Health and Welfare, the U.S. Environmental Protection Agency Region 10, and the U.S. Department of Energy Idaho Field Office, December 4, 1991.

DOE (U.S. Department of Energy) 1999, Final Record of Decision Idaho Nuclear Technology and Engineering Center Operable Unit 3-13, Idaho National Engineering Laboratory, Idaho Falls, Idaho, DOE/ID-10660, Revision 0, October.

Portage, 2000a, *Idaho Nuclear Technology and Engineering Center Tank Farm Facility Conceptual DOE and HWMA/RCRA Closure Approach,* INEEL/EXT-99-01066, Draft Final, March.

Portage, 2000b, *Idaho Hazardous Waste Management Act/Resource Conservation and Recovery Act Closure Plan for Idaho Nuclear Technology and Engineering Center Tanks WM-182 and WM-183*, 80 Percent Draft, April.

Spaulding, B.C., M.M. Chadwick, K.D. McAllister, L.C. Tuott, and S.K. Evans, 1998, *INTEC TFF Tanks WM-182 and WM-183 Closure Study*, INEEL/EXT-98-00913, Lockheed Martin Idaho Technologies Company, September.

Table 1 - Regulatory Analysis for the Tank Farm Facility (TFF) Closure Project
Recommendations for Compliance & Implementation of Regulatory Requirements

Citation	Description of Requirement	Compliance Method/Comments
40 CFR 265, Subpart G - Closure and Post-Closure		
Sec. 265.110 Applicability	Except as Sec. 265.1 provides otherwise: (a) Sections 265.111 through 265.115 (which concern closure) apply to the owners and operators of all hazardous waste management facilities; and (b) Sections 265.116 through 265.120 (which concern post-closure care) apply to the owners and operators of: (1) All hazardous waste disposal facilities; (2) Waste piles and surface impoundments for which the owner or operator intends to remove the wastes at closure to the extent that these sections are made applicable to such facilities in Sec. 265.228 or Sec. 265.258; (3) Tank systems that are required under Sec. 265.197 to meet requirements for landfills; and (4) Containment buildings that are required under Sec. 265.1102 to meet the requirement for landfills. (c) Section 265.121 applies to owners and operators of units that are subject to the requirements of 40 CFR 270.1(c)(7) and are regulated under an enforceable document (as defined in 40 CFR 270.1(c)(7)). (d) The Regional Administrator may replace all or part of the requirements of this subpart (and the unit-specific standards in Sec. 265.111(c)) applying to a regulated unit (as defined in 40 CFR 264.90), with alternative requirements for closure set out in an approved closure or post-closure plan, or in an enforceable document (as defined in 40 CFR 270.1(c)(7)), where the Regional Administrator determines that: (1) A regulated unit is situated among solid waste management units (or areas of concern), a release has occurred, and both the regulated unit and one or more solid waste management unit(s) (or areas of concern) are likely to have contributed to the release, and (2) It is not necessary to apply the closure requirements of this subpart (and/or those referenced herein) because the alternative	Met - Sections 265.111 through 265.115 are applicable to TFF closure. Sections 265.116 through 265.120 would be applicable in the event the TFF is required to meet the closure requirements for landfills.

Citation	Description of Requirement	Compliance Method/Comments
	requirements will protect human health and the environment, and will satisfy the closure performance standard of Sec. 265.111 (a) and (b).	
Sec. 265.111 Closure performance standard	The owner or operator must close the facility in a manner that: (a) Minimizes the need for further maintenance, and (b) Controls, minimizes or eliminates, to the extent necessary to protect human health and the environment, post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated run-off, or hazardous waste decomposition products to the ground or surface waters or to the atmosphere, and (c) Complies with the closure requirements of this subpart, including, but not limited to, the requirements of Secs. 265.197, 265.228, 265.258, 265.280, 265.310, 265.351, 265.381, 265.404, and 264.1102.	Clarification Needed - The closure performance standard for tanks WM-182 and WM-183 is not well defined. Examples include: • Section 3 of the Closure Plan identifies cleanup levels that will be used to determine whether clean closure has been achieved. Because closure of WM-182 and WM-183 constitutes a partial closure of the TFF, the plan states that a determination whether the clean closure standard has been met will be based on the residual remaining in all of the TFF tanks after closure. It is unclear whether the performance standard identified in the plan (i.e., 10^{-4} total residual risk for carcinogenic constituents and hazard index less than 1 for non-carcinogens) is applicable to the two tank systems or the entire TFF. If the closure performance standard identified in the plan is applicable to the entire TFF, a method should be identified for allocating that standard to the groupings covered by specific closure plans (i.e., what portion of that standard may be consumed by the WM-182 and WM-183 group). The proposed closure activities (see Figure 6-1) include comparison of tank-specific analysis results to performance criteria. Without an allocation scheme, such comparisons would be impossible. • The Closure Plan is generally limited to the hazardous constituents associated with the TFF waste. This is not always the case (e.g., discussion of radionuclides in abandoned piping in Section 4.1). The risk calculation methodology referenced

Citation	Description of Requirement	Compliance Method/Comments
		in the closure performance standard includes both hazardous and radioactive constituents (see groundwater modeling approach in Section A.5). The Closure Approach (e.g., Figure 7) is clear regarding the disposition of hazardous constituents under RCRA and radionuclides under DOE O 435.1. A clear distinction should also be maintained in the RCRA Closure Plan. • Performance measures that will be used to assert that no hazardous waste remains in the tank systems are not defined (e.g., concentrations less than toxicity characteristic (TC) levels, where applicable; pH greater than 2). The Closure Plan should clearly state the relevant closure performance standards. Inconsistencies in the inclusion/exclusion of radionuclides in the risk calculations to demonstrate conformance to the closure standard should be resolved.
Sec. 265.112 Closure plan; amendment of plan	(a) *Written plan.* By May 19, 1981, or by six months after the effective date of the rule that first subjects a facility to provisions of this section, the owner or operator of a hazardous waste management facility must have a written closure plan. Until final closure is completed and certified in accordance with Sec. 265.115, a copy of the most current plan must be furnished to the Regional Administrator upon request, including request by mail. In addition, for facilities without approved plans, it must also be provided during site inspections, on the day of inspection, to any officer, employee, or representative of the Agency who is duly designated by the Administrator.	Met - In accordance with the NONCO, INEEL will submit a written closure plan addressing the first phase of TFF closure (WM-182 and WM-183) by December 31, 2000. Written closure plans for the remainder of the TFF will be submitted as the tank systems are taken out of service. [The remainder of the requirements are assessed with respect to the Closure Plan covering the WM-182 and WM-183 tank systems.]
	(b) *Content of plan.* The plan must identify steps necessary to perform partial and/or final closure of the facility at any point during its active life. The closure plan must include, at least: (1) A description of how each hazardous waste management unit at the facility will be closed in accordance with Sec. 265.111; and	Met – The Closure Plan provides a conceptual description of the closure of the WM-182 and WM-183 tank systems.

Citation	Description of Requirement	Compliance Method/Comments
	(2) A description of how final closure of the facility will be conducted in accordance with Sec. 265.111. The description must identify the maximum extent of the operation which will be unclosed during the active life of the facility; and	Final closure of the TFF will include eleven 300,000 to 318,000 gallon tanks (WM-180 through WM-190), four inactive 30,000-gallon tanks (WM-103 through WM-106), the associated vaults, ancillary equipment (piping, pumps, valve boxes), abandoned piping, and those ancillary tanks identified in the 1998 Voluntary Consent Order. The RCRA Closure Plan is limited to partial closure of the first grouping (WM-182 and WM-183). The current closure documentation does not address development of RCRA closure plans for additional TFF groupings. Overall TFF closure activities will be described in the DOE Tier 1 closure plan scheduled for completion in March 2001.
	(3) An estimate of the maximum inventory of hazardous wastes ever on-site over the active life of the facility and a detailed description of the methods to be used during partial and final closure, including, but not limited to methods for removing, transporting, treating, storing or disposing of all hazardous waste, identification of and the type(s) of off-site hazardous waste management unit(s) to be used, if applicable; and	Met – The Closure Plan (Sections 13.4 and 13.5) provides an operational history for the subject tanks, including the maximum waste inventory during the operational period.
	(4) A detailed description of the steps needed to remove or decontaminate all hazardous waste residues and contaminated containment system components, equipment, structures, and soils during partial and final closure including, but not limited to, procedures for cleaning equipment and removing contaminated soils, methods for sampling and testing surrounding soils, and criteria for determining the extent of decontamination necessary to satisfy the closure performance standard; and	Clarification Needed - The Closure Plan describes the conceptual design for the tank system closure effort. Note that the TFF closure excludes Tank Farm soils contaminated as a result of past releases, which are being addressed under CERCLA as OU 3-14. The relationship of these two activities should be clarified. For example, the Plan should indicate how the residual risk associated with the closed tank systems would be aggregated with risks posed by other sources such as OU 3-14 in determining compliance with the performance objectives. The proposed closure standard (e.g., 10^{-4} residual cancer risk) is a reasonable opening position. However, it may be necessary to accept a lower limit for the TFF closure to allow for other sources and contaminants (e.g., radionuclides) that are not addressed by the risk calculations.

Citation	Description of Requirement	Compliance Method/Comments
	(5) A detailed description of other activities necessary during the partial and final closure period to ensure that all partial closures and final closure satisfy the closure performance standards, including, but not limited to, groundwater monitoring, leachate collection, and run-on and run-off control; and	Met - The ROD for OU 3-13 includes interim measures for the Tank Farm soils group including diversion channels to control surface water run-on, grading and sealing to minimize precipitation infiltration, and improved building exterior drainage to divert water away from contaminated areas. No additional measures are anticipated in conjunction with the TFF closure.
	(6) A schedule for closure of each hazardous waste management unit and for final closure of the facility. The schedule must include, at a minimum, the total time required to close each hazardous waste management unit and the time required for intervening closure activities which will allow tracking of the progress of partial and final closure. (For example, in the case of a landfill unit, estimates of the time required to treat or dispose of all hazardous waste inventory and of the time required to place a final cover must be included.); and	Met - Section 6 of the Closure Plan provides a schedule for closure of tanks WM-182 and WM-183. Figure 6 includes planning and pre-closure activities that are prerequisites to closure of the two tank systems. A schedule for closure of the six groupings comprising the TFF is provided as Table 3 in the Closure Approach.
	(7) An estimate of the expected year of final closure for facilities that use trust funds to demonstrate financial assurance under Sec. 265.143 or Sec. 265.145 and whose remaining operating life is less than twenty years, and for facilities without approved closure plans.	NA - The TFF is owned and operated by the U.S. Government and is therefore exempt from the financial assurance requirements.
	(8) For facilities where the Regional Administrator has applied alternative requirements at a regulated unit under Secs. 265.90(f), 265.110(d), and/or 265.140(d), either the alternative requirements applying to the regulated unit, or a reference to the enforceable document containing those alternative requirements.	NA - The TFF closure is not expected to seek alternative requirements for groundwater monitoring or closure and post-closure care.
	(c) *Amendment of plan.* The owner or operator may amend the closure plan at any time prior to the notification of partial or final closure of the facility. An owner or operator with an approved closure plan must submit a written request to the Regional Administrator to authorize a change to the approved closure plan. The written request must include a copy of the amended closure plan for approval by the Regional Administrator. (1) The owner or operator must amend the closure plan whenever:	Met - Section 10 of the Closure Plan provides for modifications to the WM-182 and WM-183 RCRA closure plan for the circumstances specified in Section 265.112(c).

Citation	Description of Requirement	Compliance Method/Comments
	(i) Changes in operating plans or facility design affect the closure plan, or (ii) There is a change in the expected year of closure, if applicable, or (iii) In conducting partial or final closure activities, unexpected events require a modification of the closure plan. (iv) The owner or operator requests the Regional Administrator to apply alternative requirements to a regulated unit under Secs. 265.90(f), 265.110(d), and/or 265.140(d).	
	(2) The owner or operator must amend the closure plan at least 60 days prior to the proposed change in facility design or operation, or no later than 60 days after an unexpected event has occurred which has affected the closure plan. If an unexpected event occurs during the partial or final closure period, the owner or operator must amend the closure plan no later than 30 days after the unexpected event. These provisions also apply to owners or operators of surface impoundments and waste piles who intended to remove all hazardous wastes at closure, but are required to close as landfills in accordance with Sec. 265.310.	Met - Section 10 of the Closure Plan provides for amendments to the WM-182 and WM-183 RCRA closure plan consistent with the timeframes specified in Section 265.112(c).
	(3) An owner or operator with an approved closure plan must submit the modified plan to the Regional Administrator at least 60 days prior to the proposed change in facility design or operation, or no more than 60 days after an unexpected event has occurred which has affected the closure plan. If an unexpected event has occurred during the partial or final closure period, the owner or operator must submit the modified plan no more than 30 days after the unexpected event. These provisions also apply to owners or operators of surface impoundments and waste piles who intended to remove all hazardous wastes at closure but are required to close as landfills in accordance with Sec. 265.310. If the amendment to the plan is a Class 2 or 3 modification according to the criteria in Sec. 270.42, the modification to the plan will be approved according to the procedures in Sec. 265.112(d)(4).	Met - Section 10 of the Closure Plan provides for modifications to the WM-182 and WM-183 RCRA closure plan consistent with the timeframes specified in Section 265.112(c).

Citation	Description of Requirement	Compliance Method/Comments
	(4) The Regional Administrator may request modifications to the plan under the conditions described in paragraph (c)(1) of this section. An owner or operator with an approved closure plan must submit the modified plan within 60 days of the request from the Regional Administrator, or within 30 days if the unexpected event occurs during partial or final closure. If the amendment is considered a Class 2 or 3 modification according to the criteria in Sec. 270.42, the modification to the plan will be approved in accordance with the procedures in Sec. 265.112(d)(4).	Met - Section 10 of the Closure Plan provides for modifications to the WM-182 and WM-183 RCRA closure plan upon request from the regulatory authority.
	(d) *Notification of partial closure and final closure.* (1) The owner or operator must submit the closure plan to the Regional Administrator at least 180 days prior to the date on which he expects to begin closure of the first surface impoundment, waste pile, land treatment, or landfill unit, or final closure if it involves such a unit, whichever is earlier. The owner or operator must submit the closure plan to the Regional Administrator at least 45 days prior to the date on which he expects to begin partial or final closure of a boiler or industrial furnace. The owner or operator must submit the closure plan to the Regional Administrator at least 45 days prior to the date on which he expects to begin final closure of a facility with only tanks, container storage, or incinerator units. Owners or operators with approved closure plans must notify the Regional Administrator in writing at least 60 days prior to the date on which he expects to begin closure of a surface impoundment, waste pile, landfill, or land treatment unit, or final closure of a facility involving such a unit. Owners or operators with approved closure plans must notify the Regional Administrator in writing at least 45 days prior to the date on which he expects to begin partial or final closure of a boiler or industrial furnace. Owners or operators with approved closure plans must notify the Regional Administrator in writing at least 45 days prior to the date on which he expects to begin final closure of a facility with only tanks, container storage, or incinerator units.	Met - RCRA Closure Plan for WM-182 and WM-183 will be submitted in December 2000 in accordance with the NONCO. This submittal date is greater than 45 days before the expected start date for the TFF closure activities (see schedule provided as Figure 6-1 of the Closure Plan).
	(2) The date when he "expects to begin closure" must be either: (i) Within 30 days after the date on which any hazardous waste management unit receives the known final volume of hazardous wastes, or, if there is a reasonable possibility that the hazardous	Met - There is no reference to the date the subject tanks received their final volume of hazardous waste in relation to the schedule for closure. However, the submittal of the Closure Plan is directed by the

Citation	Description of Requirement	Compliance Method/Comments
	waste management unit will receive additional hazardous wastes, no later than one year after the date on which the unit received the most recent volume of hazardous waste. If the owner or operator of a hazardous waste management unit can demonstrate to the Regional Administrator that the hazardous waste management unit or facility has the capacity to receive additional hazardous wastes and he has taken, and will continue to take, all steps to prevent threats to human health and the environment, including compliance with all interim status requirements, the Regional Administrator may approve an extension to this one-year limit; or (ii) For units meeting the requirements of Sec. 265.113(d), no later than 30 days after the date on which the hazardous waste management unit receives the known final volume of nonhazardous wastes, or if there is a reasonable possibility that the hazardous waste management unit will receive additional nonhazardous wastes, no later than one year after the date on which the unit received the most recent volume of nonhazardous wastes. If the owner or operator can demonstrate to the Regional Administrator that the hazardous waste management unit has the capacity to receive additional nonhazardous wastes and he has taken, and will continue to take, all steps to prevent threats to human health and the environment, including compliance with all applicable interim status requirements, the Regional Administrator may approve an extension to this one-year limit.	NONCO and is assumed to be satisfactory to the regulatory authorities.
	(3) The owner or operator must submit his closure plan to the Regional Administrator no later than 15 days after: (i) Termination of interim status except when a permit is issued simultaneously with termination of interim status; or (ii) Issuance of a judicial decree or final order under section 3008 of RCRA to cease receiving hazardous wastes or close.	NA - Timeframe for submission of closure plans is dictated by the NONCO.
	(4) The Regional Administrator will provide the owner or operator and the public, through a newspaper notice, the opportunity to submit written comments on the plan and request modifications to the plan no later than 30 days from the date of the notice. He will also, in	Met - Requirements address procedures for review and approval of the closure plan by the regulatory authority.

Citation	Description of Requirement	Compliance Method/Comments
	response to a request or at his own discretion, hold a public hearing whenever such a hearing might clarify one or more issues concerning a closure plan. The Regional Administrator will give public notice of the hearing at least 30 days before it occurs. (Public notice of the hearing may be given at the same time as notice of the opportunity for the public to submit written comments, and the two notices may be combined.) The Regional Administrator will approve, modify, or disapprove the plan within 90 days of its receipt. If the Regional Administrator does not approve the plan he shall provide the owner or operator with a detailed written statement of reasons for the refusal and the owner or operator must modify the plan or submit a new plan for approval within 30 days after receiving such written statement. The Regional Administrator will approve or modify this plan in writing within 60 days. If the Regional Administrator modifies the plan, this modified plan becomes the approved closure plan. The Regional Administrator must assure that the approved plan is consistent with Secs. with 265.111 through 265.115 and the applicable requirements of subpart F of this part, Secs. 265.197, 265.228, 265.258, 265.280, 265.310, 265.351, 265.381, 265.404, and 264.1102. A copy of the modified plan with a detailed statement of reasons for the modifications must be mailed to the owner or operator.	
	(e) *Removal of wastes and decontamination or dismantling of equipment.* Nothing in this section shall preclude the owner or operator from removing hazardous wastes and decontaminating or dismantling equipment in accordance with the approved partial or final closure plan at any time before or after notification of partial or final closure.	Met -TFF pre-closure phase activities include spray washing the tanks, flushing tanks, and cleaning piping. Such actions are consistent with Section 112(e).
Sec. 265.113 Closure; time allowed for closure	(a) Within 90 days after receiving the final volume of hazardous wastes, or the final volume of nonhazardous wastes if the owner or operator complies with all applicable requirements in paragraphs (d) and (e) of this section, at a hazardous waste management unit or facility, or within 90 days after approval of the closure plan, whichever is later, the owner or operator must treat, remove from the unit or facility, or dispose of on-site, all hazardous wastes in accordance with the approved closure plan. The Regional Administrator may approve a	Met - Section 9 of the Closure Plan states that "partial closure activities are anticipated to begin within 90 days after use of each group of TFF tanks is discontinued." Depending on the schedule for initiation of closure activities, the start of closure may be associated with approval of the RCRA Closure Plan, not the discontinuation of use of the tanks.

Citation	Description of Requirement	Compliance Method/Comments
	longer period if the owner or operator demonstrates that: (1)(i) The activities required to comply with this paragraph will, of necessity, take longer than 90 days to complete; or (ii)(A) The hazardous waste management unit or facility has the capacity to receive additional hazardous wastes, or has the capacity to receive non-hazardous wastes if the facility owner or operator complies with paragraphs (d) and (e) of this section; and (B) There is a reasonable likelihood that he or another person will recommence operation of the hazardous waste management unit or the facility within one year; and (C) Closure of the hazardous waste management unit or facility would be incompatible with continued operation of the site; and (2) He has taken and will continue to take all steps to prevent threats to human health and the environment, including compliance with all applicable interim status requirements.	
	(b) The owner or operator must complete partial and final closure activities in accordance with the approved closure plan and within 180 days after receiving the final volume of hazardous wastes, or the final volume of nonhazardous wastes if the owner or operator complies with all applicable requirements in paragraphs (d) and (e) of this section, at the hazardous waste management unit or facility, or 180 days after approval of the closure plan, if that is later. The Regional Administrator may approve an extension to the closure period if the owner or operator demonstrates that: (1)(i) The partial or final closure activities will, of necessity, take longer than 180 days to complete; or (ii)(A) The hazardous waste management unit or facility has the capacity to receive additional hazardous wastes, or has the capacity to receive non-hazardous wastes if the facility owner or operator complies with paragraphs (d) and (e) of this section; and (B) There is reasonable likelihood that he or another person will recommence operation of the hazardous waste management	Conditionally Met - Section 9 of the Closure Plan indicates that an extension of the 180-day closure time period would likely be needed. Since the Closure Plan includes a schedule (see Section 6) for the closure of WM-182 and WM-183 that exceeds the 180-day period authorized in 265. 113(b), it may be appropriate to focus the discussion in Section 9 to the specific tank systems and to incorporate the extension request into the plan.

Citation	Description of Requirement	Compliance Method/Comments
	unit or the facility within one year; and (C) Closure of the hazardous waste management unit or facility would be incompatible with continued operation of the site; and (2) He has taken and will continue to take all steps to prevent threats to human health and the environment from the unclosed but not operating hazardous waste management unit or facility, including compliance with all applicable interim status requirements.	
	(c) The demonstrations referred to in paragraphs (a)(1) and (b)(1) of this section must be made as follows: (1) The demonstrations in paragraph (a)(1) of this section must be made at least 30 days prior to the expiration of the 90-day period in paragraph (a) of this section; and (2) The demonstration in paragraph (b)(1) of this section must be made at least 30 days prior to the expiration of the 180-day period in paragraph (b) of this section, unless the owner or operator is otherwise subject to the deadlines in paragraph (d) of this section.	Met – Section 9 of the Closure Plan calls for any closure extension request to be submitted at least 30 days prior to the expiration of the 90-day or 180-day periods specified in 265.113(a) and 265.113(b).
Sec. 265.114 Disposal or decontamination of equipment, structures and soils	During the partial and final closure periods, all contaminated equipment, structures and soil must be properly disposed of, or decontaminated unless specified otherwise in Secs. 265.197, 265.228, 265.258, 265.280, or 265.310. By removing all hazardous wastes or hazardous constituents during partial and final closure, the owner or operator may become a generator of hazardous waste and must handle that hazardous waste in accordance with all applicable requirements of part 262 of this chapter.	Met - Section 8 of the Closure Plan describes the management of closure-generated waste. The RCRA generator standards (40 CFR Part 262) applicable to hazardous or mixed waste generated as a result of TFF closure activities are not detailed as part of this assessment.
Sec. 265.115 Certification of closure	Within 60 days of completion of closure of each hazardous waste surface impoundment, waste pile, land treatment, and landfill unit, and within 60 days of completion of final closure, the owner or operator must submit to the Regional Administrator, by registered mail, a certification that the hazardous waste management unit or facility, as applicable, has been closed in accordance with the specifications in the approved closure plan. The certification must be signed by the owner or operator and by an independent registered professional engineer. Documentation supporting the independent registered professional engineer's certification must be	Met – Section 11 of the Closure Plan describes the certification process. Note that Section 11 and the closure schedule (Figure 6-1) do not indicate the timing for submittal of the closure certification. While certifications will be provided for each partial closure (e.g., specific tank system(s)), it is not expected that the IDEQ will approve closure certification until after final closure of the entire TFF is completed.

Citation	Description of Requirement	Compliance Method/Comments
	furnished to the Regional Administrator upon request until he releases the owner or operator from the financial assurance requirements for closure under Sec. 265.143(h).	
Sec. 265.116 Survey plat	No later than the submission of the certification of closure of each hazardous waste disposal unit, an owner or operator must submit to the local zoning authority, or the authority with jurisdiction over local land use, and to the Regional Administrator, a survey plat indicating the location and dimensions of landfill cells or other hazardous waste disposal units with respect to permanently surveyed benchmarks. This plat must be prepared and certified by a professional land surveyor. The plat filed with the local zoning authority, or the authority with jurisdiction over local land use must contain a note, prominently displayed, which states the owner's or operator's obligation to restrict disturbance of the hazardous waste disposal unit in accordance with the applicable subpart G regulations.	Met – Section 11 of the Closure Plan includes the submission of a survey plat, if required under §265.116. A survey plat will be provided for each partial closure (e.g., specific tank system(s)) or after final closure of the entire TFF is completed if closure under landfill standards occurs.
Sec. 265.117 Post-closure care and use of property.	(a)(1) Post-closure care for each hazardous waste management unit subject to the requirements of Secs. 265.117 through 265.120 must begin after completion of closure of the unit and continue for 30 years after that date. It must consist of at least the following: (i) Monitoring and reporting in accordance with the requirements of subparts F, K, L, M, and N of this part; and (ii) Maintenance and monitoring of waste containment systems in accordance with the requirements of subparts F, K, L, M, and N of this part. (2) Any time preceding closure of a hazardous waste management unit subject to post-closure care requirements or final closure, or any time during the post-closure period for a particular hazardous waste disposal unit, the Regional Administrator may: (i) Shorten the post-closure care period applicable to the hazardous waste management unit, or facility, if all disposal units have been closed, if he finds that the reduced period is sufficient to protect human health and the environment (e.g., leachate or ground-water monitoring results, characteristics of the hazardous waste, application of advanced technology, or alternative disposal, treatment, or re-use techniques indicate that the hazardous waste management unit or facility is secure);	Met - Section 7.2.2 of the Closure Plan describes monitoring and maintenance during the post-closure period, if required.

Citation	Description of Requirement	Compliance Method/Comments
	(ii) Extend the post-closure care period applicable to the hazardous waste management unit or facility, if he finds that the extended period is necessary to protect human health and the environment (e.g., leachate or groundwater monitoring results indicate a potential for migration of hazardous wastes at levels which may be harmful to human health and the environment).	
	(b) The Regional Administrator may require, at partial and final closure, continuation of any of the security requirements of Sec. 265.14 during part or all of the post-closure period when: (1) Hazardous wastes may remain exposed after completion of partial or final closure; or (2) Access by the public or domestic livestock may pose a hazard to human health.	Met - Section 3 of the Closure Approach indicates that a security force is expected to be in place for the next 100 years to prevent access to INEEL facilities without proper clearance, training, or escort and controls to limit the potential for unacceptable exposures.
	(c) Post-closure use of property on or in which hazardous wastes remain after partial or final closure must never be allowed to disturb the integrity of the final cover, liner(s), or any other components of the containment system, or the function of the facility's monitoring systems, unless the Regional Administrator finds that the disturbance: (1) Is necessary to the proposed use of the property, and will not increase the potential hazard to human health or the environment; or (2) Is necessary to reduce a threat to human health or the environment.	Met - Any post-closure controls will be implemented through the INEEL land use plan (see Section 4.2.1 of the Closure Approach).
	(d) All post-closure care activities must be in accordance with the provisions of the approved post-closure plan as specified in Sec. 265.118.	Met - Contingent landfill closure and post-closure care is provided for in Section 7 of the Closure Plan.
Sec. 265.118 Post-closure plan; amendment of plan	(a) *Written plan.* By May 19, 1981, the owner or operator of a hazardous waste disposal unit must have a written post-closure plan. An owner or operator of a surface impoundment or waste pile that intends to remove all hazardous wastes at closure must prepare a post-closure plan and submit it to the Regional Administrator within 90 days of the date that the owner or operator or Regional Administrator determines that the hazardous waste management unit or facility must be closed as a landfill, subject to the requirements of Secs. 265.117 through 265.120.	Met - Contingent landfill closure and post-closure care is provided for in Section 7 of the Closure Plan.

Citation	Description of Requirement	Compliance Method/Comments
	(b) Until final closure of the facility, a copy of the most current post-closure plan must be furnished to the Regional Administrator upon request, including request by mail. In addition, for facilities without approved post-closure plans, it must also be provided during site inspections, on the day of inspection, to any officer, employee or representative of the Agency who is duly designated by the Administrator. After final closure has been certified, the person or office specified in Sec. 265.118(c)(3) must keep the approved post-closure plan during the post-closure period.	Met - Contingent landfill closure and post-closure care is provided for in Section 7 of the Closure Plan.
	(c) For each hazardous waste management unit subject to the requirements of this section, the post-closure plan must identify the activities that will be carried on after closure of each disposal unit and the frequency of these activities, and include at least: (1) A description of the planned monitoring activities and frequencies at which they will be performed to comply with subparts F, K, L, M, and N of this part during the post-closure care period; and (2) A description of the planned maintenance activities, and frequencies at which they will be performed, to ensure: (i) The integrity of the cap and final cover or other containment systems in accordance with the requirements of subparts K, L, M, and N of this part; and (ii) The function of the monitoring equipment in accordance with the requirements of subparts F, K, L, M, and N of this part; and (3) The name, address, and phone number of the person or office to contact about the hazardous waste disposal unit or facility during the post-closure care period. (4) For facilities subject to Sec. 265.121, provisions that satisfy the requirements of Sec. 265.121(a)(1) and (3). (5) For facilities where the Regional Administrator has applied alternative requirements at a regulated unit under Secs. 265.90(f), 265.110(d), and/or 265.140(d), either the alternative requirements that apply to the regulated unit, or a reference to the enforceable document containing those requirements.	Met - Contingent landfill closure and post-closure care is provided for in Section 7 of the Closure Plan.
	(d) *Amendment of plan.* The owner or operator may amend the post-	Met - Contingent landfill closure and post-closure care

Citation	Description of Requirement	Compliance Method/Comments
	closure plan any time during the active life of the facility or during the post-closure care period. An owner or operator with an approved post-closure plan must submit a written request to the Regional Administrator to authorize a change to the approved plan. The written request must include a copy of the amended post-closure plan for approval by the Regional Administrator. (1) The owner or operator must amend the post-closure plan whenever: (i) Changes in operating plans or facility design affect the post-closure plan, or (ii) Events which occur during the active life of the facility, including partial and final closures, affect the post-closure plan. (iii) The owner or operator requests the Regional Administrator to apply alternative requirements to a regulated unit under Secs. 265.90(f), 265.110(d), and/or 265.140(d). (2) The owner or operator must amend the post-closure plan at least 60 days prior to the proposed change in facility design or operation, or no later than 60 days after an unexpected event has occurred which has affected the post-closure plan. (3) An owner or operator with an approved post-closure plan must submit the modified plan to the Regional Administrator at least 60 days prior to the proposed change in facility design or operation, or no more than 60 days after an unexpected event has occurred which has affected the post-closure plan. If an owner or operator of a surface impoundment or a waste pile who intended to remove all hazardous wastes at closure in accordance with Sec. 265.228(b) or Sec. 265.258(a) is required to close as a landfill in accordance with Sec. 265.310, the owner or operator must submit a post-closure plan within 90 days of the determination by the owner or operator or Regional Administrator that the unit must be closed as a landfill. If the amendment to the post-closure plan is a Class 2 or 3 modification according to the criteria in Sec. 270.42, the modification to the plan will be approved according to the procedures in Sec. 265.118(f). (4) The Regional Administrator may request modifications to the plan under the conditions described in paragraph (d)(1) of this section. An owner or operator with an approved post-closure plan must submit the modified plan no later than 60 days of the request from	is provided for in Section 7 of the Closure Plan.

Citation	Description of Requirement	Compliance Method/Comments
	the Regional Administrator. If the amendment to the plan is considered a Class 2 or 3 modification according to the criteria in Sec. 270.42, the modifications to the post-closure plan will be approved in accordance with the procedures in Sec. 265.118(f). If the Regional Administrator determines that an owner or operator of a surface impoundment or waste pile who intended to remove all hazardous wastes at closure must close the facility as a landfill, the owner or operator must submit a post-closure plan for approval to the Regional Administrator within 90 days of the determination.	
	(e) The owner or operator of a facility with hazardous waste management units subject to these requirements must submit his post-closure plan to the Regional Administrator at least 180 days before the date he expects to begin partial or final closure of the first hazardous waste disposal unit. The date he "expects to begin closure" of the first hazardous waste disposal unit must be either within 30 days after the date on which the hazardous waste management unit receives the known final volume of hazardous waste or, if there is a reasonable possibility that the hazardous waste management unit will receive additional hazardous wastes, no later than one year after the date on which the unit received the most recent volume of hazardous wastes. The owner or operator must submit the post-closure plan to the Regional Administrator no later than 15 days after: (1) Termination of interim status (except when a permit is issued to the facility simultaneously with termination of interim status); or (2) Issuance of a judicial decree or final orders under section 3008 of RCRA to cease receiving wastes or close.	Met - Contingent landfill closure and post-closure care is provided for in Section 7 of the Closure Plan.
	(f) The Regional Administrator will provide the owner or operator and the public, through a newspaper notice, the opportunity to submit written comments on the post-closure plan and request modifications to the plan no later than 30 days from the date of the notice. He will also, in response to a request or at his own discretion, hold a public hearing whenever such a hearing might clarify one or more issues concerning a post-closure plan. The Regional Administrator will give public notice of the hearing at least 30 days before it occurs.	Met - Provides general administrative requirements only

Citation	Description of Requirement	Compliance Method/Comments
	(Public notice of the hearing may be given at the same time as notice of the opportunity for the public to submit written comments, and the two notices may be combined.) The Regional Administrator will approve, modify, or disapprove the plan within 90 days of its receipt. If the Regional Administrator does not approve the plan he shall provide the owner or operator with a detailed written statement of reasons for the refusal and the owner or operator must modify the plan or submit a new plan for approval within 30 days after receiving such written statement. The Regional Administrator will approve or modify this plan in writing within 60 days. If the Regional Administrator modifies the plan, this modified plan becomes the approved post-closure plan. The Regional Administrator must ensure that the approved post-closure plan is consistent with Secs. 265.117 through 265.120. A copy of the modified plan with a detailed statement of reasons for the modifications must be mailed to the owner or operator.	
	(g) The post-closure plan and length of the post-closure care period may be modified any time prior to the end of the post-closure care period in either of the following two ways: (1) The owner or operator or any member of the public may petition the Regional Administrator to extend or reduce the post-closure care period applicable to a hazardous waste management unit or facility based on cause, or alter the requirements of the post-closure care period based on cause. (i) The petition must include evidence demonstrating that: (A) The secure nature of the hazardous waste management unit or facility makes the post-closure care requirement(s) unnecessary or supports reduction of the post-closure care period specified in the current post-closure plan (e.g., leachate or ground-water monitoring results, characteristics of the wastes, application of advanced technology, or alternative disposal, treatment, or re-use techniques indicate that the facility is secure), or (B) The requested extension in the post-closure care period or alteration of post-closure care requirements	Met - Provides general administrative requirements only

Citation	Description of Requirement	Compliance Method/Comments
	is necessary to prevent threats to human health and the environment (e.g., leachate or ground-water monitoring results indicate a potential for migration of hazardous wastes at levels which may be harmful to human health and the environment). (ii) These petitions will be considered by the Regional Administrator only when they present new and relevant information not previously considered by the Regional Administrator. Whenever the Regional Administrator is considering a petition, he will provide the owner or operator and the public, through a newspaper notice, the opportunity to submit written comments within 30 days of the date of the notice. He will also, in response to a request or at his own discretion, hold a public hearing whenever a hearing might clarify one or more issues concerning the post-closure plan. The Regional Administrator will give the public notice of the hearing at least 30 days before it occurs. (Public notice of the hearing may be given at the same time as notice of the opportunity for written public comments, and the two notices may be combined.) After considering the comments, he will issue a final determination, based upon the criteria set forth in paragraph (g)(1) of this section. (iii) If the Regional Administrator denies the petition, he will send the petitioner a brief written response giving a reason for the denial. (2) The Regional Administrator may tentatively decide to modify the post-closure plan if he deems it necessary to prevent threats to human health and the environment. He may propose to extend or reduce the post-closure care period applicable to a hazardous waste management unit or facility based on cause or alter the requirements of the post-closure care period based on cause. (i) The Regional Administrator will provide the owner or operator and the affected public, through a newspaper notice, the opportunity to submit written comments within	

Citation	Description of Requirement	Compliance Method/Comments
	30 days of the date of the notice and the opportunity for a public hearing as in paragraph (g)(1)(ii) of this section. After considering the comments, he will issue a final determination. (ii) The Regional Administrator will base his final determination upon the same criteria as required for petitions under paragraph (g)(1)(i) of this section. A modification of the post-closure plan may include, where appropriate, the temporary suspension rather than permanent deletion of one or more post-closure care requirements. At the end of the specified period of suspension, the Regional Administrator would then determine whether the requirement(s) should be permanently discontinued or reinstated to prevent threats to human health and the environment.	
Sec. 265.119 Post-closure notices	(a) No later than 60 days after certification of closure of each hazardous waste disposal unit, the owner or operator must submit to the local zoning authority, or the authority with jurisdiction over local land use, and to the Regional Administrator, a record of the type, location, and quantity of hazardous wastes disposed of within each cell or other disposal unit of the facility. For hazardous wastes disposed of before January 12, 1981, the owner or operator must identify the type, location and quantity of the hazardous wastes to the best of his knowledge and in accordance with any records he has kept.	Met – Section 11 of the Closure Plan includes the submission of a record of the type, location, and quantity of hazardous waste disposed in any TFF components, if required under §265.119. Such notice will be provided for each partial closure (e.g., specific tank system(s)) or after final closure of the entire TFF is completed if required.
	(b) Within 60 days of certification of closure of the first hazardous waste disposal unit and within 60 days of certification of closure of the last hazardous waste disposal unit, the owner or operator must: (1) Record, in accordance with State law, a notation on the deed to the facility property--or on some other instrument which is normally examined during title search--that will in perpetuity notify any potential purchaser of the property that: (i) The land has been used to manage hazardous wastes; and (ii) Its use is restricted under 40 CFR subpart G regulations; and (iii) The survey plat and record of the type, location, and	See Section 265.119(a).

Citation	Description of Requirement	Compliance Method/Comments
	quantity of hazardous wastes disposed of within each cell or other hazardous waste disposal unit of the facility required by Secs. 265.116 and 265.119(a) have been filed with the local zoning authority or the authority with jurisdiction over local land use and with the Regional Administrator; and (2) Submit a certification signed by the owner or operator that he has recorded the notation specified in paragraph (b)(1) of this section and a copy of the document in which the notation has been placed, to the Regional Administrator.	
	(c) If the owner or operator or any subsequent owner of the land upon which a hazardous waste disposal unit was located wishes to remove hazardous wastes and hazardous waste residues, the liner, if any, and all contaminated structures, equipment, and soils, he must request a modification to the approved post-closure plan in accordance with the requirements of Sec. 265.118(g). The owner or operator must demonstrate that the removal of hazardous wastes will satisfy the criteria of Sec. 265.117(c). By removing hazardous waste, the owner or operator may become a generator of hazardous waste and must manage it in accordance with all applicable requirements of this chapter. If the owner or operator is granted approval to conduct the removal activities, the owner or operator may request that the Regional Administrator approve either: (1) The removal of the notation on the deed to the facility property or other instrument normally examined during title search, or (2) The addition of a notation to the deed or instrument indicating the removal of the hazardous waste.	NA - Post-closure care, if required, will be implemented under the CERCLA program.
Sec. 265.120 Certification of completion of post-closure care	No later than 60 days after the completion of the established post-closure care period for each hazardous waste disposal unit, the owner or operator must submit to the Regional Administrator, by registered mail, a certification that the post-closure care period for the hazardous waste disposal unit was performed in accordance with the specifications in the approved post-closure plan. The certification must be signed by the owner or operator and an independent registered professional engineer. Documentation supporting the independent registered professional engineer's certification must be furnished to the Regional Administrator	NA - Post-closure care, if required, will be implemented under the CERCLA program.

Citation	Description of Requirement	Compliance Method/Comments
	upon request until he releases the owner or operator from the financial assurance requirements for post-closure care under Sec. 265.145(h).	
Sec. 265.121 Post-closure requirements for facilities that obtain enforceable documents in lieu of post-closure permits	(a) Owners and operators who are subject to the requirement to obtain a post-closure permit under 40 CFR 270.1(c), but who obtain enforceable documents in lieu of post-closure permits, as provided under 40 CFR 270.1(c)(7), must comply with the following requirements: (1) The requirements to submit information about the facility in 40 CFR 270.28; (2) The requirements for facility-wide corrective action in Sec. 264.101 of this chapter; (3) The requirements of 40 CFR 264.91 through 264.100.	NA - Post-closure care, if required, will be implemented under the CERCLA program.
	(b)(1) The Regional Administrator, in issuing enforceable documents under Sec. 265.121 in lieu of permits, will assure a meaningful opportunity for public involvement which, at a minimum, includes public notice and opportunity for public comment: (i) When the Agency becomes involved in a remediation at the facility as a regulatory or enforcement matter; (ii) On the proposed preferred remedy and the assumptions upon which the remedy is based, in particular those related to land use and site characterization; and (iii) At the time of a proposed decision that remedial action is complete at the facility. These requirements must be met before the Regional Administrator may consider that the facility has met the requirements of 40 CFR 270.1(c)(7), unless the facility qualifies for a modification to these public involvement procedures under paragraph (b)(2) or (3) of this section. (2) If the Regional Administrator determines that even a short delay in the implementation of a remedy would adversely affect human health or the environment, the Regional Administrator may delay compliance with the requirements of paragraph (b)(1) of this section and implement the remedy immediately. However, the Regional Administrator must assure involvement of the public at the earliest opportunity, and, in all cases, upon making the decision that additional remedial action is not needed at the facility. (3) The Regional Administrator may allow a remediation initiated prior	NA - Post-closure care, if required, will be implemented under the CERCLA program.

Citation	Description of Requirement	Compliance Method/Comments
	to October 22, 1998 to substitute for corrective action required under a post-closure permit even if the public involvement requirements of paragraph (b)(1) of this section have not been met so long as the Regional Administrator assures that notice and comment on the decision that no further remediation is necessary to protect human health and the environment takes place at the earliest reasonable opportunity after October 22, 1998.	
40 CFR 265, Subpart H - Financial Requirements		
Sec. 265.140 Applicability	(a) The requirements of Secs. 265.142, 265.143 and 265.147 through 265.150 apply to owners or operators of all hazardous waste facilities, except as provided otherwise in this section or in Sec. 265.1. (b) The requirements of Secs. 265.144 and 265.146 apply only to owners and operators of: (1) Disposal facilities; (2) Tank systems that are required under Sec. 264.197 of this chapter to meet the requirements for landfills; and (3) Containment buildings that are required under Sec. 265.1102 to meet the requirements for landfills. (c) States and the Federal government are exempt from the requirements of this subpart. (d) The Regional Administrator may replace all or part of the requirements of this subpart applying to a regulated unit with alternative requirements for financial assurance set out in the permit or in an enforceable document (as defined in 40 CFR 270.1(c)(7)), where the Regional Administrator: (1) Prescribes alternative requirements for the regulated unit under Sec. 265.90(f) and/or 265.110(d), and (2) Determines that it is not necessary to apply the requirements of this subpart because the alternative financial assurance requirements will protect human health and the environment.	Met - The TFF is owned and operated by the U.S. Government and is therefore exempt from the financial assurance requirements.
40 CFR 265, Subpart J -Tank Systems		
Sec. 265.197(a) Closure and post-closure care	At closure of a tank system, the owner or operator must remove or decontaminate all waste residues, contaminated containment system components (liners, etc.), contaminated soils, and structures and equipment contaminated with waste, and manage them as hazardous	Clarification Needed - Section 4 of the Closure Plan and the Closure Study describes the activities that will be undertaken to remove or decontaminate all hazardous waste residues. The following summarizes

Citation	Description of Requirement	Compliance Method/Comments
	waste, unless Sec. 261.3(d) of this Chapter applies. The closure plan, closure activities, cost estimates for closure, and financial responsibility for tank systems must meet all of the requirements specified in subparts G and H of this part.	the activities for specific TFF components: Abandoned piping – The TFF closure encompasses piping that is no longer actively in use. However, this piping is not being addressed under the current phase of TFF Closure (WM-182 & WM-183). Documentation of decontamination performed prior to abandonment is not available. However, it is likely that decontamination was performed in order to reduce the radiation fields experienced by workers performing the abandonment work. The piping was cut and capped at both ends, providing limited opportunity for further removal of contamination. A conservative estimate of residual contamination will be used to assess conformance with the closure performance standard. Confirmation should be sought from DEQ that no further action regarding abandoned piping would be acceptable. Ancillary equipment – The proposed decontamination method for ancillary equipment (e.g., process waste lines, piping encasements, vessel off-gas system lines, valve boxes) consists of a "triple rinse." With the exception of process waste lines (for which the initial rinse uses an acidic decontamination solution), the rinses will be performed using water. Low-strength acid was included as an option in the Closure Study for decontaminating certain components (e.g., stainless steel liners in valve boxes). The Closure Study (section 5.2.1) assumes that the decontamination solution volume will be sufficient to decontaminate the pipe surfaces that have come in contact with waste. The Closure Plan does not prescribe sampling and analyses of the rinsates or the residuals in equipment as an indication of the effectiveness of the

Citation	Description of Requirement	Compliance Method/Comments
		decontamination. The Closure Approach (Section 6.1.2) includes sampling of the decontamination solutions used to clean ancillary equipment, where possible. It is unclear whether the triple rinse is assumed to achieve the "remove and decontaminate" standard or whether sampling and analysis will be performed to confirm that the decontamination of ancillary equipment was effective. It would be preferable to seek DEQ acceptance of triple rinsing as an acceptable decontamination method without limitations on the amount or characteristics of any residual in the ancillary equipment (other than inclusion of the source term for ancillary equipment in calculations for conformance to the overarching risk-based closure standards). The Closure Study (see Section 8.4 for valve boxes) includes provisions for heating the decontamination solution. Circumstances under which heated decontamination solution would be used should be identified. The Closure Study (Section 8.3) identifies the single acidic decontamination flush/two water decontamination flush protocol as a standard practice defined in INTEC operating procedures. A supporting rationale for deviating from this protocol (e.g., use of water as the sole decontamination solution for some components of the TFF) should be provided. <u>Tanks</u> – Tanks WM-182 and WM-183 will be decontaminated using a low-pressure water spray. The steam jets would be used to remove as much of the remaining material as possible. The initial grout layer will be emplaced to displace as much of the remaining tank heel as possible. A supporting rationale for the

Citation	Description of Requirement	Compliance Method/Comments
		proposed decontamination method should be developed that includes the reasons why alternate decontamination methods (e.g., high-pressure water spray, high-temperature water spray, steam) were not selected as part of the TFF Closure Conceptual Design currently in progress.. Section 8 of the Closure Plan describes the management of closure-generated waste. These wastes are primarily liquids that will be managed within the INTEC liquid radioactive waste management system (PEWE, portions of the TFF that are not yet closed). The RCRA waste identification (40 CFR Part 261) and generator standards (40 CFR Part 262) applicable to hazardous or mixed waste generated as a result of TFF closure activities are not detailed as part of this assessment. A potential concern with the closure approach is the transfer of decontamination solutions and tank heels into fewer tanks as closure of the TFF progresses. More information is needed to determine whether sufficient liquid waste storage capacity will be available. In addition, the amount of solids associated with the tank heels will increase as the heel from one tank is transferred to another tank to be closed at a later date. This material may be difficult to remove using the existing equipment (steam jets) as proposed for the first tank closures. Alternate heel management methods may be needed to respond to the changes in heel composition in later closures.
Sec. 265.197(b) Closure and post-closure care	If the owner or operator demonstrates that not all contaminated soils can be practicably removed or decontaminated as required in paragraph (a) of this section, then the owner or operator must close the tank system and perform post-closure care in accordance with the closure and post-closure care requirements that apply to landfills (Sec. 265.310) In addition, for the purposes of closure, post-closure, and financial responsibility, such a tank system is then considered to be a landfill, and	Met - Section 3 of the Closure Plan indicates that closure and post-closure care requirements under Sec. 265.310 would be implemented if the clean closure performance standard cannot be achieved. [Note that the disposition of contaminated soils (OU 3-14) associated with the TFF is not addressed by the RCRA closure. The requirement for a landfill closure and

Citation	Description of Requirement	Compliance Method/Comments
	the owner or operator must meet all of the requirements for landfills specified in subparts G and H of this part.	post-closure care would be invoked if the residual contamination within the tank systems failed to achieve the "remove and decontaminate" standard.]
Sec. 265.197(c) Closure and post-closure care	If an owner or operator has a tank system which does not have secondary containment that meets the requirements of Sec. 265.193(b) through (f) and which is not exempt from the secondary containment requirements in accordance with Sec. 265.193(g), then, (1) The closure plan for the tank system must include both a plan for complying with paragraph (a) of this section and a contingent plan for complying with paragraph (b) of this section. (2) A contingent post-closure plan for complying with paragraph (b) of this section must be prepared and submitted as part of the permit application. (3) The cost estimates calculated for closure and post-closure care must reflect the costs of complying with the contingent closure plan and the contingent post-closure plan, if these costs are greater than the costs of complying with the closure plan prepared for the expected closure under paragraph (a) of this section. (4) Financial assurance must be based on the cost estimates in paragraph (c)(3) of this section. (5) For the purposes of the contingent closure and post-closure plans, such a tank system is considered to be a landfill, and the contingent plans must meet all of the closure, post-closure, and financial responsibility requirements for landfills under subparts G and H of this part.	Met – The TFF tank systems do not have secondary containment that meets the requirements of Sec. 265.193(b) through (f). The Closure Plan includes both the proposed closure activities to achieve the "remove and decontaminate" standard and a commitment for contingent landfill closure and post-closure care. The TFF is owned and operated by the U.S. Government and is therefore exempt from the financial assurance requirements.
40 CFR 265, Subpart N – Landfills		
Sec. 265.310 Closure and post-closure care	(a) At final closure of the landfill or upon closure of any cell, the owner or operator must cover the landfill or cell with a final cover designed and constructed to: (1) Provide long-term minimization of migration of liquids through the closed landfill; (2) Function with minimum maintenance; (3) Promote drainage and minimize erosion or abrasion of the cover; (4) Accommodate settling and subsidence so that the cover's integrity is maintained; and	Conditionally Met – This requirement is invoked by Sec. 265.197(b) if the "remove and decontaminate" standard cannot be achieved. Section 7.1 of the Closure Plan includes the five elements required under Sec. 265.310(a). Sections 7.2 and 7.3 address landfill closure and post-closure care requirements and the integration of those requirements with ongoing CERCLA remediation activities.

Citation	Description of Requirement	Compliance Method/Comments
	(5) Have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present.	
	(b) After final closure, the owner or operator must comply with all post-closure requirements contained in Secs. 265.117 through 265.120 including maintenance and monitoring throughout the post-closure care period. The owner or operator must: (1) Maintain the integrity and effectiveness of the final cover, including making repairs to the cover as necessary to correct the effects of settling, subsidence, erosion, or other events; (2) Maintain and monitor the leak detection system in accordance with Secs. 264.301(c)(3)(iv) and (4) of this chapter and 265.304(b), and comply with all other applicable leak detection system requirements of this part; (3) Maintain and monitor the ground-water monitoring system and comply with all other applicable requirements of subpart F of this part; (4) Prevent run-on and run-off from eroding or otherwise damaging the final cover; and (5) Protect and maintain surveyed benchmarks used in complying with Sec. 265.309.	Conditionally Met – This requirement is invoked by Sec. 265.197(b) if the "remove and decontaminate" standard cannot be achieved. Section 7.2 of the Closure Plan includes the five elements required under Sec. 265.310(b). The Closure Plan indicates that these post-closure care activities would be integrated with those activities required by the Record of Decision for OU 3-13. The ROD acknowledges that post-closure monitoring and maintenance of the WCF (another RCRA closure) will be incorporated into the post-ROD monitoring plan for OU 3-13. The ROD also states that additional INTEC sites closed under RCRA will be handled in the same manner as the WCF.
40 CFR 265, Subpart F – Ground-Water Monitoring		
Sec. 265.90 Applicability	(a) Within one year after the effective date of these regulations, the owner or operator of a surface impoundment, landfill, or land treatment facility which is used to manage hazardous waste must implement a groundwater monitoring program capable of determining the facility's impact on the quality of ground water in the uppermost aquifer underlying the facility, except as Sec. 265.1 and paragraph (c) of this section provide otherwise (b) Except as paragraphs (c) and (d) of this section provide otherwise, the owner or operator must install, operate, and maintain a groundwater monitoring system which meets the requirements of Sec. 265.91, and must comply with Secs. 265.92 through 265.94. This groundwater monitoring program must be carried out during the active life of the facility, and for disposal facilities, during the post-closure care period as well. (c) All or part of the groundwater monitoring requirements of this	Met - The groundwater monitoring provisions of Subpart F are invoked by Sec. 265.310(b)(3) if the "remove and decontaminate" standard cannot be achieved. Section 7.2.1 of the Closure Plan acknowledges the requirement to implement a groundwater monitoring program within 1 year of a determination that a portion of the TFF will require closure as a landfill in accordance with Sec 265.310. The Closure Plan indicates that an alternate groundwater monitoring system (as provided for in Sec. 265.90(d)) may be needed to account for other potential sources of groundwater contamination not associated with the TFF. The design and implementation of the TFF groundwater monitoring

Citation	Description of Requirement	Compliance Method/Comments
	subpart may be waived if the owner or operator can demonstrate that there is a low potential for migration of hazardous waste or hazardous waste constituents from the facility via the uppermost aquifer to water supply wells (domestic, industrial, or agricultural) or to surface water. This demonstration must be in writing, and must be kept at the facility. This demonstration must be certified by a qualified geologist or geotechnical engineer and must establish the following: (1) The potential for migration of hazardous waste or hazardous waste constituents from the facility to the uppermost aquifer, by an evaluation of: (i) A water balance of precipitation, evapotranspiration, runoff, and infiltration; and (ii) Unsaturated zone characteristics (i.e., geologic materials, physical properties, and depth to ground water); and (2) The potential for hazardous waste or hazardous waste constituents which enter the uppermost aquifer to migrate to a water supply well or surface water, by an evaluation of: (i) Saturated zone characteristics (i.e., geologic materials, physical properties, and rate of groundwater flow); and (ii) The proximity of the facility to water supply wells or surface water. (d) If an owner or operator assumes (or knows) that groundwater monitoring of indicator parameters in accordance with Secs. 265.91 and 265.92 would show statistically significant increases (or decreases in the case of pH) when evaluated under Sec. 265.93(b), he may install, operate, and maintain an alternate groundwater monitoring system (other than the one described in Secs. 265.91 and 265.92). If the owner or operator decides to use an alternate groundwater monitoring system he must: (1) Within one year after the effective date of these regulations, submit to the Regional Administrator a specific plan, certified by a qualified geologist or geotechnical engineer, which satisfies the requirements of Sec. 265.93(d)(3), for an alternate ground-water monitoring system; (2) Not later than one year after the effective date of these regulations, initiate the determinations specified in Sec. 265.93(d)(4);	system would be integrated with CERCLA remedial actions at INTEC.

Citation	Description of Requirement	Compliance Method/Comments
	(3) Prepare and submit a written report in accordance with Sec. 265.93(d)(5); (4) Continue to make the determinations specified in Sec. 265.93(d)(4) on a quarterly basis until final closure of the facility; and (5) Comply with the recordkeeping and reporting requirements in Sec. 265.94(b). (e) The ground-water monitoring requirements of this subpart may be waived with respect to any surface impoundment that (1) Is used to neutralize wastes which are hazardous solely because they exhibit the corrosivity characteristic under Sec. 261.22 of this chapter or are listed as hazardous wastes in subpart D of part 261 of this chapter only for this reason, and (2) Contains no other hazardous wastes, if the owner or operator can demonstrate that there is no potential for migration of hazardous wastes from the impoundment. The demonstration must establish, based upon consideration of the characteristics of the wastes and the impoundment, that the corrosive wastes will be neutralized to the extent that they no longer meet the corrosivity characteristic before they can migrate out of the impoundment. The demonstration must be in writing and must be certified by a qualified professional. (f) The Regional Administrator may replace all or part of the requirements of this subpart applying to a regulated unit (as defined in 40 CFR 264.90), with alternative requirements developed for groundwater monitoring set out in an approved closure or post-closure plan or in an enforceable document (as defined in 40 CFR 270.1(c)(7)), where the Regional Administrator determines that: (1) A regulated unit is situated among solid waste management units (or areas of concern), a release has occurred, and both the regulated unit and one or more solid waste management unit(s) (or areas of concern) are likely to have contributed to the release; and (2) It is not necessary to apply the requirements of this subpart because the alternative requirements will protect human health and the environment. The alternative standards for the	

Citation	Description of Requirement	Compliance Method/Comments
	regulated unit must meet the requirements of 40 CFR 264.101(a).	
Sec. 265.91 Groundwater monitoring system	(a) A groundwater monitoring system must be capable of yielding groundwater samples for analysis and must consist of: (1) Monitoring wells (at least one) installed hydraulically upgradient (i.e., in the direction of increasing static head) from the limit of the waste management area. Their number, locations, and depths must be sufficient to yield ground-water samples that are: (i) Representative of background ground-water quality in the uppermost aquifer near the facility; and (ii) Not affected by the facility; and (2) Monitoring wells (at least three) installed hydraulically downgradient (i.e., in the direction of decreasing static head) at the limit of the waste management area. Their number, locations, and depths must ensure that they immediately detect any statistically significant amounts of hazardous waste or hazardous waste constituents that migrate from the waste management area to the uppermost aquifer. (3) The facility owner or operator may demonstrate that an alternate hydraulically downgradient monitoring well location will meet the criteria outlined below. The demonstration must be in writing and kept at the facility. The demonstration must be certified by a qualified ground-water scientist and establish that: (i) An existing physical obstacle prevents monitoring well installation at the hydraulically downgradient limit of the waste management area; and (ii) The selected alternate downgradient location is as close to the limit of the waste management area as practical; and (iii) The location ensures detection that, given the alternate location, is as early as possible of any statistically significant amounts of hazardous waste or hazardous waste constituents that migrate from the waste management area to the uppermost aquifer. (iv) Lateral expansion, new, or replacement units are not	Met - The groundwater monitoring provisions of Subpart F are invoked by Sec. 265.310(b)(3) if the "remove and decontaminate" standard cannot be achieved. Section 7.2.1 of the Closure Plan acknowledges the requirement to implement a groundwater monitoring program within 1 year of a determination that a portion of the TFF will require closure as a landfill in accordance with Sec 265.310. The Closure Plan indicates that an alternate groundwater monitoring system (as provided for in Sec. 265.90(d)) may be needed to account for other potential sources of groundwater contamination not associated with the TFF. The design and implementation of the TFF groundwater monitoring system would be integrated with CERCLA remedial actions at INTEC.

Citation	Description of Requirement	Compliance Method/Comments
	eligible for an alternate downgradient location under this paragraph. (b) Separate monitoring systems for each waste management component of a facility are not required provided that provisions for sampling upgradient and downgradient water quality will detect any discharge from the waste management area. (1) In the case of a facility consisting of only one surface impoundment, landfill, or land treatment area, the waste management area is described by the waste boundary (perimeter). (2) In the case of a facility consisting of more than one surface impoundment, landfill, or land treatment area, the waste management area is described by an imaginary boundary line which circumscribes the several waste management components. (c) All monitoring wells must be cased in a manner that maintains the integrity of the monitoring well bore hole. This casing must be screened or perforated, and packed with gravel or sand where necessary, to enable sample collection at depths where appropriate aquifer flow zones exist. The annular space (i.e., the space between the bore hole and well casing) above the sampling depth must be sealed with a suitable material (e.g., cement grout or bentonite slurry) to prevent contamination of samples and the ground water.	
Sec. 265.92 Sampling and analysis	This section provides requirements for obtaining and analyzing samples from the installed groundwater monitoring system.	Met - Sampling and analyses requirements would be incorporated in the TFF groundwater monitoring program.
Sec. 265.93 Preparation, evaluation, and response	This section provides minimum requirements for the groundwater quality assessment program.	Met - Section 7.2.1 of the Closure Plan acknowledges the requirement to outline the groundwater quality assessment program within 1 year of a determination that a portion of the TFF will require closure as a landfill in accordance with Sec 265.310. The content of the assessment program would be consistent with the specifications in Sec. 265.93.
Sec. 265.94 Recordkeeping and reporting	This section provides recordkeeping and reporting requirements for groundwater monitoring information.	Met - Recordkeeping and reporting requirements would be incorporated in the groundwater monitoring program. Per Table 1 of the Closure Approach, post-

Citation	Description of Requirement	Compliance Method/Comments
		closure records for the TFF would be maintained by the CERCLA program.
EPA Memorandum "Risk-Based Clean Closure" from E. Cotsworth, Office of Solid Waste, to RCRA Senior Policy Advisors Regions I-X, March 16, 1998		
Reaffirming Risk-Based Clean Closure Standards	EPA generally considers protective media cleanup standards for human health to mean constituent concentrations that result in the total residual risk from any medium to an individual exposed over a lifetime falling in a range from 10^{-4} to 10^{-6}, with the cumulative carcinogenic risk not to exceed 10^{-4} and a preference for cleanup standards at the more protective end of the risk range. For non-carcinogenic effects, EPA generally interprets protective cleanup standards to mean constituent concentrations that an individual could be exposed to on a daily basis without appreciable risk of deleterious effect during a lifetime; the hazard index generally should not exceed 1. Cleanup to standards that are consistent with these risk-reduction goals will generally be adequate to satisfy the closure performance standard and the "remove and decontaminate" standard.	Met - Although the EPA risk-based closure guidance is not cited in the Closure Plan, statements in Sections 3 and A.2 are generally consistent with this memorandum. [Note the Plan cites earlier EPA guidance such as the NCP and Subpart S proposal, that are consistent with the more recent EPA guidance specific to risk-based clean closure.] There is some internal inconsistency between Section 3 and Appendix A. The following concerns were noted: • Section 3 of the Closure Plan states the closure performance objective of less than 10^{-4} for "total residual risk from a medium to an individual exposed over a lifetime." Note that the EPA guidance specifies 10^{-4} for the cumulative carcinogenic risk not the risk from any medium. (the latter is expected to fall in the range of 10^{-4} to 10^{-6}). • Section 3 of the Closure Plan states that the performance standard for non-carcinogenic constituents will be based on the hazard quotient (the ratio of a single substance exposure level to its reference dose for a specified time period) not exceeding 1. The EPA guidance indicates that the hazard index (sum of the hazard quotients for individual constituents) should not exceed 1. The EPA guidance for non-carcinogens is accurately reflected in Section A.2. The closure performance standard should be corrected.
	In the March 19, 1987 notice (52 FR 8704), EPA interpreted the regulations governing closure by removal and the "remove and decontaminate" standards to require consideration of the possibility of	Clarification Needed - The Closure Plan does not address contamination limits for environmental media such as the MCLs for groundwater.

Citation	Description of Requirement	Compliance Method/Comments
	cross-media contamination so that, for example, facility owners/operators would have to show that remaining levels of hazardous constituents in soil would not migrate from the soil to air, surface water, or groundwater in excess of EPA-approved concentrations (e.g., maximum contaminant levels, ambient water quality standards).	
Clarification of the Acceptability of Fate and Transport Modeling	In the 1987 notice, EPA required that demonstrations of compliance with regulations governing closure by removal and the "remove and decontaminate" standard be conservative in the sense that they eliminate the uncertainties associated with contaminant fate and transport (52 FR 8707). EPA revised its interpretation of the remove or decontaminate" standard in a memo from Elliot Laws and Steve Herman to RCRA/CERCLA National Policy Managers (September 24, 1996) to allow limited use of fate and transport modeling during closure. This revision was based on the experience EPA has gained using fate and transport modeling since 1987. Under the new Agency interpretation, fate and transport models may be used to support clean closure determinations by modeling the potential for residual contamination in one medium to migrate to and contaminate other media.	Clarification Needed - Section A.4 of the Closure Plan refers to the original FR notice (52 FR 8707), which concluded that arguments for "clean closure" based on fate and transport analyses would not be acceptable. The use of fate and transport modeling in the TFF closure should be based on the 1996 EPA memorandum, not the 1987 interim status closure standards rulemaking. Portions of Appendix A of the Closure Plan include more than WM-182 and WM-183, but not the entire TFF. Section A.5.1 refers to the conceptual model for 11 tanks. The TFF includes four 30,000-gallon tanks and ancillary equipment in addition to the eleven 300,000-gallon tanks. The conceptual model should address all components of the TFF. Only two tanks (WM-182 and WM-183) are the subject of the current plan. Clarification is needed regarding the scope of the risk calculations (the entire TFF or just WM-182 and WM-183). If the modeling includes the entire TFF, clarification is needed regarding the application of the results to defining the closure standards for tanks WM-182 and WM-183.
New Interpretation Regarding Non-Residential Exposure Assumptions	EPA now interprets closure regulations to allow appropriate use of non-residential exposure assumptions when identifying the amount of decontamination necessary to satisfy the "remove and decontaminate" standard. Using non-residential exposure assumptions to identify the amount of decontamination necessary to satisfy the "remove and decontaminate" standard does not affect any other closure requirements. This means, for clean closure, facility owners/operators must still remove all hazardous wastes and liners. In addition, just like any other clean	Clarification Needed - Appendix A does not provide a consistent rationale for the exposure scenarios considered in the risk assessment. • Section A.1 states the tanks are to be clean closed to risk-based standards using a residential scenario. • Section A.3 indicates that no residential

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	closure, a decontamination level based on non-residential exposure assumptions must be achieved throughout the closing unit and any areas affected by releases from the closing unit. It also must ensure that environmental receptors are adequately protected and that no unacceptable transfer of contamination from one medium to another (e.g., soil to groundwater) will occur. Issues associated with protecting environmental receptors and preventing unacceptable cross-media transfer may prohibit approval of clean closure based on non-residential exposure assumptions when such closure might otherwise be appropriate. Moreover, although some additional increment of contamination may be allowed to remain in media through application of non-residential exposure assumptions, as during any clean closure, owners and operators may not rely on physical barriers (such as fences or slurry walls) to ensure protection of human health and the environment. When a facility is also undergoing RCRA corrective action or another type of site-wide cleanup, non-residential exposure assumptions used during clean closure must be consistent with the exposure assumptions being applied in the corrective action (or other) cleanup. The Agency emphasizes that non-residential exposure assumptions should not be used unless there is a reasonable degree of confidence that future land use will conform to those assumptions. EPA believes this confidence would typically be based on the existence of long-term controls over land use.	development will be allowed on the INEEL during the next 100 years. • Section A.4 states that the risk assessment modeling will use a non-residential exposure scenario. The Plan should be modified to be consistent in identifying the exposure assumptions used to estimate residual risk. The text in Section A.6 is nearly identical to that in the EPA guidance, except that "residential" (the exposure scenario selected for analysis) has been substituted "non-residential" (the subject of the EPA guidance) in three places. The argument (based on the EPA guidance) was meant to support use of non-residential exposure assumptions. It cannot be converted to support residential exposure assumptions by simply exchanging the words. An appropriate rationale for the use of residential exposure assumptions should be provided in the Closure Plan. Section A.6.1 states that the future residential scenario was chosen for the TFF closure. It also states that groundwater ingestion is the only complete pathway. However, the conceptual site model (Figure A-6-1) does not identify the groundwater pathway as complete for a future residential receptor. These inconsistencies should be resolved.
EPA Memorandum "Coordination Between RCRA Corrective Action and Closure and CERCLA Site Activities" from S. Herman, Office of Enforcement and Compliance Assurance, and E. Laws, Office of Solid Waste and Emergency Response, to RCRA/CERCLA National Policy Advisors Regions I-X, September 24, 1996		
Coordination Between Programs	Craft CERCLA or RCRA decision documents so that cleanup responsibilities are divided. CERCLA and RCRA decision documents do not have to ensure that the entire facility be cleaned up under one or the other program. For example, at some facilities being cleaned up under CERCLA, the RCRA units (regulated or solid waste) are	Met - Under the FFA/CO, the CERCLA program will manage previous releases of waste to the environment outside of the TFF (i.e., releases to soil or groundwater, external contamination of structures). HWMA/RCRA program will manage the

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	physically distinct and could be addressed under RCRA. In these cases, the CERCLA decision documents can focus CERCLA activities on certain units or areas, and designate others for action under RCRA. When units are deferred from CERCLA to RCRA, the CERCLA program should include a statement (e.g., in a ROD or memorandum submitted to the administrative record) that successful completion of these activities would eliminate the need for further cleanup under CERCLA at those units. Similarly, when units or areas are deferred from RCRA to CERCLA, RCRA permits or orders can reference the CERCLA cleanup process and state that complying with the terms of the CERCLA requirements would satisfy the requirements of RCRA. Agreements on coordination of cleanup programs should be fashioned to prevent revisiting of decisions and should be clearly incorporated and cross-reference into existing or new agreements, permit, or orders.	decontamination or removal of waste from the tanks, vaults, and ancillary equipment (including abandoned piping) associated with the TFF. Responsibility for capping, monitoring, and long-term maintenance, if required, will be under CERCLA. Residual contamination resulting from TFF closure cannot adversely impact the cumulative risk (See CERCLA and 435.1 composite analysis requirements). Coordination with ongoing CERCLA evaluations and agreements for transfer of post-closure responsibilities to the ER Program will be needed. The CERCLA program managers would need to agree to the TFF Closure Plan stipulating that the CERCLA ROD would address the RCRA requirements as ARARs. The deferral from RCRA to CERCLA must be agreeable to the regulatory agencies (State of Idaho and EPA).
RCRA Closure and Post-closure	Some of the most significant RCRA/CERCLA integration issues are associated with coordination of requirements for closure of RCRA regulated units with other cleanup activities. RCRA regulated units are subject to specific standards for operation, characterization of releases, groundwater corrective action and closure. Coordination of these standards with other remedial activities can be challenging. At the present time, the dual regulatory structure for RCRA closure and other cleanup activities remains in place. There are several approaches program implementors can use to reduce inconsistency and duplication of effort when implementing RCRA closure requirements during CERCLA cleanups or RCRA corrective actions. For example, a cleanup plan for a CERCLA operable unit that physically encompasses a RCRA regulated unit could be structured for concurrent compliance with CERCLA and the RCRA closure and post-closure requirements. At some sites, inconsistent cleanup levels have been applied for removal and decontamination (clean closure) of regulated units and for site-wide remediation under CERCLA or RCRA corrective action. Where this has	Met - The proposed risk-based closure of the TFF is consistent with EPA guidance for integration of RCRA-regulated unit closures with site-wide RCRA corrective action or CERCLA remediation programs.

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	happened, clean closure levels have generally been set at background levels while, at the same time, cleanup levels have been higher, risk-based concentrations. To avoid this inconsistency and to better coordinate between different regulatory programs, EPA encourages the use risk-based levels when developing clean closure standards. EPA's position on the use of background and risk-based levels as clean closure standards was published at 52 FR 8704-8709, March 19, 1987. That FR notice states that clean closure levels are to be based on health-based levels approved by the Agency. If no EPA-approved level exists then background concentrations may be used or the site owner may submit sufficient data to allow EPA to determine what the health-based level should be.	
DOE M 435.1-1 Radioactive Waste Management Manual		
Section I.2.E(2) Site Closure Plans	The Deputy Assistant Secretary for Waste Management and the Deputy Assistant Secretary for Environmental Restoration are responsible for: (2) Site Closure Plans. Reviewing and approving closure plans and other closure documentation for deactivated high-level waste facilities/sites and issuing authorization for closure activities to proceed.	Met - The Closure Approach (see Executive Summary) calls for the TFF closure to be initiated upon receipt of authorization to proceed with the DOE closure plans by the DOE Deputy Assistant Secretary for Waste Management.
Section I.2.F(5) Environmental Restoration, Decommissioning, and Other Cleanup Waste.	Field Element Managers are responsible for: (5) Environmental Restoration, Decommissioning, and Other Cleanup Waste. Ensuring the management and disposal of radioactive waste resulting from environmental restoration activities, including decommissioning, meet the substantive requirements of DOE O 435.1, Radioactive Waste Management, and this Manual. Environmental restoration activities using the CERCLA process (in accordance with Executive Order 12580) may demonstrate compliance with the substantive requirements of DOE O 435.1, Radioactive Waste Management, and this Manual (including the Performance Assessment and performance objectives, as well as the Composite Analysis) through the CERCLA process. However, compliance with all substantive requirements of DOE O 435.1 not met through the CERCLA process must be demonstrated.	Met - The Closure Approach (see Table 2) establishes the INEEL ER Program responsibility for demonstrating that environmental restoration activities are compliant with substantive requirements of DOE O 435.1.

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	Environmental restoration activities which will result in the off-site management and disposal of radioactive waste must meet the applicable requirements of DOE O 435.1, Radioactive Waste Management, and this Manual for the management and disposal of those off-site wastes. Field Elements performing environmental restoration activities involving development and management of radioactive waste disposal facilities under the CERCLA process shall: (a) Submit certification to the Deputy Assistant Secretary for Environmental Restoration that compliance with the substantive requirements of DOE O 435.1 have been met through application of the CERCLA process; and (b) Submit the decision document, such as the Record of Decision, or any other document that serves as the authorization to dispose, to the Deputy Assistant Secretary for Environmental Restoration for approval.	
Section I.2.F(8) Closure Plans	Field Element Managers are responsible for: (8) Closure Plans. Ensuring development, review, approval, and implementation of closure plans for radioactive waste management facilities in accordance with the applicable requirements in the waste-type chapters of this Manual.	Met - The Closure Approach (see Table 2) establishes the DOE-ID responsibility for developing and implementing a formal review and approval process for closure plans and other closure documentation prior to submission to DOE HQ. DOE-ID is also assigned responsibility for approval of waste incidental to reprocessing determinations in consultation with EM and NRC, as appropriate.
Section II.B Waste Incidental to Reprocessing	Waste resulting from reprocessing spent nuclear fuel that is determined to be incidental to reprocessing is not high-level waste, and shall be managed under DOE's regulatory authority in accordance with the requirements for transuranic waste or low-level waste, as appropriate. When determining whether spent nuclear fuel reprocessing plant wastes shall be managed as another waste type or as high-level waste, either the citation or evaluation process described below shall be used: (1) Citation. Waste incidental to reprocessing by citation includes spent nuclear fuel reprocessing plant wastes that meet the description included in the Notice of Proposed Rulemaking (34 FR 8712) for proposed	Conditionally Met - The Closure Approach proposes to close the TFF in accordance with RCRA risk-based closure standards and DOE LLW disposal performance objectives. The *INTEC TFF Waste Incidental to Reprocessing Determination Report* (dated April 28, 2000) provides a crosswalk of the 10 CFR 61 performance objectives and DOE M 435.1 requirements (see Appendix A). The report concludes that the LLW disposal performance objectives in Chapter IV of DOE M 435.1 are comparable to those in 10 CFR 61. Conformance to the requirements of

Citation	Description of Requirement	Compliance Method/Comments
	Appendix D, 10 CFR Part 50, Paragraphs 6 and 7. These radioactive wastes are the result of reprocessing plant operations, such as, but not limited to: contaminated job wastes including laboratory items such as clothing, tools, and equipment. (2) Evaluation. Determinations that any waste is incidental to reprocessing by the evaluation process shall be developed under good record-keeping practices, with an adequate quality assurance process, and shall be documented to support the determinations. Such wastes may include, but are not limited to, spent nuclear fuel reprocessing plant wastes that: (a) Will be managed as low-level waste and meet the following criteria: 1. Have been processed, or will be processed, to remove key radionuclides to the maximum extent that is technically and economically practical; and 2. Will be managed to meet safety requirements comparable to the performance objectives set out in 10 CFR Part 61, Subpart C, Performance Objectives; and 3. Are to be managed, pursuant to DOE's authority under the Atomic Energy Act of 1954, as amended, and in accordance with the provisions of Chapter IV of this Manual, provided the waste will be incorporated in a solid physical form at a concentration that does not exceed the applicable concentration limits for Class C low-level waste as set out in 10 CFR 61.55, Waste Classification; or will meet alternative requirements for waste classification and characterization as DOE may authorize. (b) Will be managed as transuranic waste and meet the following criteria: 1. Have been processed, or will be processed, to remove key radionuclides to the maximum extent that is technically and economically practical; and 2. Will be incorporated in a solid physical form and meet alternative	Section II.B(2)(a) for the tank system residuals to be managed as LLW will be demonstrated through the performance assessment as indicated in Section 4.2.3 of the Closure Approach. At this time, there is insufficient information to determine whether the TFF closure will be consistent with the requirements of Section II.B(2)(a). Potential concerns regarding the proposed TFF closure strategy include: • II.B(2)(a)(1) - Key radionuclides to be considered in the incidental waste determination are identified in the Table 4-1 of the INTEC TFF WIR Determination Report. Demonstration that these radionuclides have been removed to the extent technically and economically practical is not yet reflected in the TFF closure documentation, but is being developed as part of the conceptual design. The demonstration should include cost/benefit information for alternate key radionuclide removal techniques to support a conclusion that the proposed WM-182 and WM-183 closures constitute the limits of what is technically and economically practical at this time. The Closure Plan (Sections 4.2 and 4.2.5) refers to the determination of a decontamination factor for the tank residuals. Consideration should be given to using the decontamination factor to justify the extent of key radionuclide removal. Meeting performance objectives should not be the sole criterion for terminating the waste removal and decontamination effort. Previous incidental waste determinations provide insight into the level of key radionuclide removal that should be acceptable:

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	requirements for waste classification and characteristics, as DOE may authorize; and 3. Are managed pursuant to DOE's authority under the Atomic Energy Act of 1954, as amended, in accordance with the provisions of Chapter III of this Manual, as appropriate.	– NRC concluded that DOE would have removed the largest practical amount of total site activity attributable to HLW if the low-level waste fraction contained 2 to 3% of the key radionuclides that originally entered the Hanford tanks.[1] – NRC concluded that the DOE methodology for removal of key radionuclides from the SRS HLW tanks was acceptable.[2] The technique proposed as technically and economically practical is expected to remove 98 to 99% of the total radioactivity and 99% of the volume of the waste. • II.B(2)(a)(2) - A performance assessment will be completed to determine whether the performance objectives for LLW disposal facilities in DOE M 435.1-1 can be achieved. The performance objectives and points of compliance for the assessment are not described in the TFF closure documentation. In addition to those performance objectives specified in Section IV.P(1) of DOE M 435.1-1, the assessment would be expected to consider other performance measures such as the SDWA MCL for radionuclides as specified in 40 CFR 141 (and incorporated in State of Idaho regulations IDAPA 16.01.08.050).[3] The 4 mrem/yr limit for beta and gamma emitting radionuclides in drinking water would be more limiting than the all pathways dose limits

[1] Letter from R. M. Bernero, NRC, to J. Lytle, Denial of Petition for Rulemaking from the States of Washington and Oregon Regarding Classification of Radioactive Waste at Hanford, March 2, 1993.
[2] SECY-99-284, Classification of Savannah River Residual Tank Waste as Incidental, December 15, 1999.
[3] See DOE G 435.1-1 regarding performance standards applicable to closure actions (page II-201) and INTEC TFF WIR Determination Report (Final Review Draft, April 28, 2000)

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		prescribed in DOE M 435.1-1, Section IV.P(1), since groundwater has been identified as the only complete exposure pathway. • II.B(2)(a)(3) - The addition of grout to the tank serves two purposes: (1) to push the waste toward the removal system and reduce the amount of residual remaining at closure and (2) to solidify the remaining heel at a concentration less than the Class C limits set out in 10 CFR 61.55. Comparisons to the Class C limits are expected to use concentration averaging over a reasonable volume of the solidified grout. The grout formulation for the waste push is engineered to be immiscible with the residual to push the liquid toward the steam jet suction. Grout used for stabilization would be engineered for other attributes (e.g., self-leveling, ability to incorporate free liquids). Some of the desired attributes for the grout appear to be mutually exclusive. Mock-up testing must be used to support the selection of grout formulation and placement techniques that adequately serve both purposes. Section 4.3.1 of the Closure Plan identifies a combined volume for the first and second grout layers of 145 yd^3 as the target volume for stabilizing the heel. The rationale for this target volume should be provided. If concentration averaging is not sufficient to bring the residual below the Class C limits, alternate classification requirements may be proposed based on the specific characteristics and configuration of the TFF residuals.
Section II.U Closure	The following requirements for closure of deactivated high-level waste facilities and sites are in addition to those in Chapter I of this Manual. 1) Decommissioning. Deactivated high-level waste facilities/sites	Met - The TFF closure will follow the closure process described in Section II.U(3), closure of deactivated HLW facilities in accordance with an approved closure plan.

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	shall meet the decommissioning requirements of DOE O 430.1A, Life-Cycle Asset Management and the requirements of DOE 5400.5, Radiation Protection of the Public and the Environment, for release; or 2) CERCLA Process. Deactivated high-level waste facilities/sites shall be closed in accordance with the CERCLA process as described in Section I.2.F.(5); or 3) Closure. Deactivated high-level waste facilities/sites shall be closed in accordance with an approved closure plan as specified below. Residual radioactive waste present in facilities to be closed shall satisfy the waste incidental to reprocessing requirements of this Chapter.	
Section II.U(3)(a) Facility/Site Closure Plans	A closure plan shall be developed for each deactivated high-level waste facility/site being closed that defines the approach and plans by which closure of each facility within the site is to be accomplished. This plan shall be completed and approved prior to the initiation of physical closure activities, and updated periodically to reflect current analysis and status of individual facility closure actions. The plan shall include, at a minimum, the following elements: 1. Identification of the closure standards/performance objectives to be applied from Chapter III or IV, as appropriate; 2. A strategy for allocating waste disposal facility performance objectives from the closure standards identified in the closure plan among the facilities/units to be closed at the site; 3. An assessment of the projected performance of each unit to be closed relative to the performance objectives allocated to each unit under the closure plan; 4. An assessment of the projected composite performance of all units to be closed at the site relative to the performance objectives and closure standards identified in the closure plan; and	Conditionally Met - The Closure Approach describes the content of the DOE Closure Plans (see Section 4.2.1). The prescribed content is consistent with the requirements set forth in DOE M 435.1-1. The Tier 1 and Tier 2 Closure Plans are scheduled for completion in June 2001 and December 2001, respectively. When available, the plans must be evaluated against the information requirements of Section II.U(3)(a).

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	5. Any other relevant closure controls including a monitoring plan, institutional controls, and land use limitations to be maintained in the closure activity.	
DOE G 435.1-1, Implementation Guide for Use with DOE M 435.1-1, Chapter II, High-Level Waste Requirements		
DOE G 435.1-1 Section II.U, page II-193 Waste Incidental to Reprocessing	Material remaining in a deactivated high-level waste management facility that meets the requirements in Section II.B for the Citation or Evaluation processes can be included in the closure process, as discussed in this guidance, and managed as either low-level waste or transuranic waste. If it does not meet the criteria for determining that the waste is incidental to reprocessing, then the residual waste must be managed as high-level waste. As discussed in the guidance for Section II.A, Definition of High-Level Waste, DOE plans to dispose of high-level waste in a geologic repository consistent with the Nuclear Waste Policy Act of 1982, as amended. This plan was outlined in Secretary Hodel's letter to President Reagan (DOE, 2/6/85), in which the Secretary recommended that "the Department proceed with plans and actions to dispose of defense waste in a commercial repository." President Reagan's finding, in accordance with Section 8 of the Nuclear Waste Policy Act of 1982, as amended (Presidential memo, 4/30/85), found no basis to do otherwise and the Department has since implemented plans to dispose high-level waste in a geologic repository consistent with the Nuclear Waste Policy Act of 1982, as amended. Thus, any residual radioactive material remaining in deactivated high-level waste management facilities must meet the waste incidental to reprocessing evaluation process requirements for a high-level waste closure activity to continue under these requirements.	Met - The Closure Approach proposes to close the TFF in accordance with RCRA risk-based closure standards and DOE LLW disposal performance objectives. The *INTEC TFF Waste Incidental to Reprocessing Determination Report* (dated April 28, 2000) provides a crosswalk of the 10 CFR 61 performance objectives and DOE M 435.1 requirements (see Appendix A). The report concludes that the LLW disposal performance objectives in Chapter IV of DOE M 435.1 are comparable to those in 10 CFR 61. Conformance to the requirements of Section II.B(2)(a) for the tank system residuals to be managed as LLW will be demonstrated through the performance assessment as indicated in Section 4.2.3 of the Closure Approach.
DOE G 435.1-1 Section II.U, page II-196 Facility/Site Closure Plans	For each deactivated high-level waste facility or site, a closure plan must be developed. The general purpose of closure plans is to define the approach that will be taken for ensuring the long-term protection of the public and the environment from the closure of deactivated high-level waste facilities containing residual low-level or transuranic wastes. Included as part of this approach are the purpose and objectives of the closure action and general discussion of how the specific closure action fits within other past, and planned, closure actions. The closure plan	Conditionally Met - The Closure Approach describes the content of the DOE Closure Plans (see Section 4.2.1). The prescribed content is consistent with the requirements set forth in DOE M 435.1-1. The Tier 1 and Tier 2 Closure Plans are scheduled for completion in June 2001 and December 2001, respectively. When available, the plans must be evaluated against the information

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	should also address the three phases that a facility closure may experience. These are: (1) operational or interim closure; (2) final facility closure; and (3) institutional closure. Operational, or interim closure, includes those activities that are conducted to stabilize a deactivated high-level waste facility, but do not include the final actions necessary to support minimal, long-term maintenance. Final closure activities include those activities that complete the physical activities necessary for the closure of the facility/site but do not include long-term institutional control activities. Institutional control closure follows final closure and includes the actions and measure necessary to ensure long-term stability of the site such as monitoring and land use limitations. The closure plan needs to address all activities to be performed during and following deactivation of a facility, including decommissioning, with emphasis on those activities required to minimize the need for long-term maintenance and maximize the stability of the closed facility. As with the closure of low-level waste disposal facilities, a period of active institutional control of 100 years is normally assumed during which access is controlled, and monitoring and custodial maintenance is performed. However, longer periods of institutional control may be assumed when justification is provided in documented plans that describe long-term site land use or site remediation. Closure plans need to include the conceptual/preliminary designs and approaches to be taken for each step in the closure process and should be coordinated with the monitoring plan (see discussion below) for the closure facility or site. The closure plan provides the details for accomplishing the closure requirements included in the design. The plan needs to be specific to the facility or site closure action, the characteristics of the site, and the residual wastes in the deactivated facility. The plan should provide a discussion of applicable DOE, Federal, State, and local closure requirements. A discussion of each activity to be performed during each phase of the closure process, and the relationship between the activities to achieve the desired result of	

Citation	Description of Requirement	Compliance Method/Comments
	minimum maintenance and long-term stability are to be provided. The methods for accomplishing each of the closure activities are to be provided for each phase of the closure, including those methods to be employed to minimize infiltration of water into the closed site and the final landscape. As part of this discussion, the plan needs to explain how contaminant migration will be controlled in the near-term and the long-term. A description of the cover designs for the closed units and their intended performance is included. Features of the plan which address the minimization of erosion by wind and water are also described, along with features to prevent intrusion into the closed unit by plants and animals. The closure plan includes a summary description of how the activities to be performed will place the facility into a configuration which will allow the performance objectives identified (see requirement in Section II.U(3)(a)(3)) to be met in both the short-term and the long-term. The schedule for completing facility closure accompanies this presentation. The schedule is to show each phase of closure and the preparation and approval of related documents and permits, such as the final assessment of projected performance, projected composite performance of all units to be closed at the site, safety analysis report, RCRA permit, or State approvals. The closure plan also addresses corrective actions to be taken at each stage of the closure process. For example, it includes the elements of an inspection program, the inspection methods to be used, and the criteria to be used for initiating corrective actions. Specific corrective actions should be included for the occurrence of subsidence or the indication of contaminant migration. Other corrective actions to address potential issues such as uncontrolled facility or site access, natural phenomena, failure of monitoring equipment, ponding of water or excessive infiltration, erosion, or the presence of undesirable flora or fauna should also be included. The relationship between corrective actions to ensure compliance with the performance objectives and the monitoring program need to be clearly identified.	

Citation	Description of Requirement	Compliance Method/Comments
	As required by Section II.U(3)(a), each deactivated high-level waste facility or site, as defined in this guidance, shall have a plan that is complete and approved, as specified by the requirements in Sections I.2.F(8) and I.2.E(2), prior to physical closure activities. This requirement is intended to reduce the risk of committing a significant amount of resources to a closure action before the closure plan has been reviewed and approved by the appropriate levels of management. As explained in the guidance to these two sections, closure plans are expected to be two-tier documents (i.e., their development and review/approval are expected to be conducted in two phases). This multi-phase process is considered necessary because it is recognized that much of the data needed to fulfill all the requirements in Section II.U(3)(a) are not available initially, but become available as engineering data and/or other documents/permits are developed. However, Headquarters' review and approval is primarily focused on the first tier plans from which subsequent plans are developed. The first tier plan, which is to be approved by the Deputy Assistant Secretaries for Waste Management and/or Environmental Restoration (Section I.2.E(2)), is intended to define and bound the parameters of a closure action(s). This level of closure plan should include, at a minimum, the following topics: • closure methodology; • schedules and assumptions; • site or individual closure standards/performance objectives; • allocation of closure standard/performance objective budgets to individual facilities/sites; • assessment (preliminary) of the projected performance of each unit to be closed relative to the allocated performance objectives; • assessment (preliminary) of the projected composite performance of all units to be closed at the site; • alternatives (if any); • waste characterization data; • closure controls plans; and • stakeholder concerns.	

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	While it is recognized that the availability of some of the above information may be limited and therefore, preliminary, it is necessary to ensure that a credible, bounding review can be conducted by DOE Headquarters. The second tier of the closure plan, which is to be approved by the Field Element Manager, or designee, should provide the detailed information related to a specific unit or facility closure action that is bounded by the analyses contained in the first tier plan. The lower tier closure documentation should demonstrate that the performance objectives identified in the upper tier documentation can be met and maintained. As explained in the guidance to Sections I.2.E(2) and I.2.F(8), the first tier closure documentation should be approved by the Deputy Assistant Secretaries for Waste Management and/or Environmental Restoration before remedial action activities commence. However, design and field survey work can proceed prior to approval of a closure plan, particularly in the case where the data are needed to support elements required in the closure plan. Additionally, once the DOE Headquarters review/approval is gained on the first tier documentation and an authorization to proceed is issued, additional DOE Headquarters approvals are not required provided the bounding conditions defined in the approved first tier plan are not exceeded. Once approved, closure plans are to be updated periodically, to reflect revised analysis and the status of individual facility closure actions that are part of a site closure. The closure plan is a living document that is updated through the operational life of the closure activities with specific information about the contents and actions of interim closures and other information necessary (e.g., monitoring locations) to support final closure. As discussed below, it is imperative that the relationship between the analysis conducted in the assessment of the projected performance of each unit (Section II.U(3)(a)(3)) and the assessment of the projected composite performance of all units (Section II.U(3)(a)(4)) be kept in mind as the closure activities commence. Any information that is incorporated into a closure plan or any changes made to the	

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	closure activities of a facility that impacts the analysis in either of these assessments should be incorporated into them as soon as possible so that the extent of their impact on the closure can be known and any required changes can be made effective as soon as possible.	
DOE G 435.1-1 Section II.U, page II-200	Following is a brief discussion of each of the closure plan elements identified in Section II.U(3)(a)(1) through (5). 1. Identification of closure standards/performance objectives to be applied from Chapter III or IV, as appropriate; As discussed in the guidance to Section II.B, Waste Incidental to Reprocessing, residual waste in deactivated high-level waste facilities that remains as part of the facility's closure may be managed as either low-level waste or transuranic waste. Following is a discussion on identifying the appropriate radiological closure standards/performance objectives for each case. Low-level waste. For deactivated high-level waste facilities or sites that are closed as low-level waste sites, the disposal facility performance objectives in DOE M 435.1-1, Section IV.P(1) should be met. As discussed in guidance Section IV.P(1), these performance objectives provide criteria to be used in a disposal facility performance assessment that define the desired level of protection of the public and the environment from disposed low-level waste. The analyses in the performance assessment demonstrate there is a reasonable expectation that when actually measured, compliance with actual protection requirements will be easily achieved. A discussion on the performance objectives can be found in Section IV.P(1). Transuranic waste. For deactivated high-level waste facilities or sites that are closed as transuranic waste sites, the applicable performance objectives/requirements are contained in 40 CFR Part 191, Environmental Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Waste, as identified in the guidance to DOE M 435.1-1, Section III.P, Disposal. Within this regulation, Subpart B, Environmental Standards for Disposal,	See DOE M 435.1-1, Section II.U

Citation	Description of Requirement	Compliance Method/Comments
	contains the applicable requirements at 40 CFR 191.13, Containment Requirements; 191.14, Assurance Requirements; 191.15, Individual Protection Requirements; 191.16, Ground Water Protection Requirements; and 191.17, Alternative Provisions for Disposal. The discussion contained in guidance to Section III.P provides additional information on the applicability of 40 CFR Part 191 to the disposal of transuranic waste at a non-Waste Isolation Pilot Plant (WIPP) site. As acknowledged in the guidance to Section III.P, DOE needs to develop 40 CFR Part 191 compliance criteria for the disposal of transuranic waste at sites, other than WIPP. The term transuranic waste as used in the above discussion is consistent with the definition provided in DOE M 435.1-1, Section III.A, Definition of Transuranic Waste. Therefore, residual waste remaining in a deactivated high-level waste facility must meet the definition in Section III.A in order for it to be closed as a transuranic waste disposal site. If, for example, the waste meets one of the three exceptions included at Section III.A, it is not considered transuranic waste under the closure requirements. In addition to the radiological standards discussed above, there may be nonradiological air, groundwater and surface-water standards that are applicable to the closure action. Identification of such standards includes needs to be included during the development of a closure plan, and included in the plan. These standards may include state and local, as well as other Federal standards such as inorganic contaminant standards, contained in the Safe Drinking Water Act (40 CFR 141.62). To identify these standards, it is recommended that a performance standards evaluation process, similar to the CERCLA criteria for the identification of ARARs, be considered.	
DOE G 435.1-1 Section II.U, page II-201	2. A strategy for allocating waste disposal facility performance objectives from the closure standards identified in the closure plan among the facilities/units to be closed at the site; Included in the closure plan is the strategy/method for apportioning the performance objectives/closure standards identified in Section	See DOE M 435.1-1, Section II.U

Citation	Description of Requirement	Compliance Method/Comments
	II.U(3)(a)(1) to each of the facilities/units to be closed at the site. This strategy defines how facility or unit-specific performance objectives are, or will be, established based upon the overall site performance objectives. The strategy or methodology provides reasonable assurance that the overall performance objectives will not be exceeded by either the summation of the individual facility closure actions or by future closure activities. Additionally, the method recognizes that constituents of concern (radionuclides or chemicals) from various facilities or areas may impact compliance points at different times due to varying closure scenarios and geological conditions. The performance standards for the closure of a deactivated high-level waste facility are concentration or dose limits for specific radiological or chemical constituents released to the environment. These standards apply to various environmental media, at different points of compliance, at various periods during or after closure.	
DOE G 435.1-1 Section II.U, page II-202	3. An assessment of the projected performance of each unit to be closed relative to the performance objectives allocated to each unit under the closure plan; With the allocation of overall performance objectives or closure standards to individual facilities, an assessment of the projected performance of each facility or unit compared to these objectives needs to be prepared. As discussed above, the residual material in a deactivated high-level waste facility may be managed as either low-level waste or transuranic waste. Following is a discussion on preparing an assessment of projected performance for each of these waste types. Low-level waste. For deactivated high-level waste facilities or sites that are to be closed as low-level waste sites, the requirements for a radiological performance assessment for low-level waste disposal sites, in Section IV.P(2) of DOE M 435.1-1, are to be met. As discussed in the guidance to this section, the objectives of a performance assessment are to ensure that all aspects of low-level waste disposal are evaluated in an assessment to provide reasonable assurance that the performance objectives will be met. All of the elements of a low-level waste	See DOE M 435.1-1, Section II.U

Citation	Description of Requirement	Compliance Method/Comments
	performance assessment provided in the requirement in Section IV.P(2) are considered appropriate for this type of a deactivated high-level waste closure activity. The applicable review and approval requirements for the closure plan, which includes an assessment of performance, are included in Section I.2.E(2). A complete discussion on the preparation of a low-level waste disposal facility performance assessment can be found in the guidance to Section IV.P(2). Transuranic waste. Deactivated high-level waste facilities or sites that are to be managed as transuranic waste disposal sites must demonstrate compliance with 40 CFR Part 191. Details on the criteria for reviewing and approving 40 CFR Part 191 performance assessments are included in the guidance to Section III.P.	
DOE G 435.1-1 Section II.U, page II-203	4. An assessment of the projected composite performance of all units to be closed at the site relative to the performance objectives and closure standards identified in the closure plan; With assessments of the projected performance of each facility or unit completed relative to the performance objectives allocated to each unit (Section II.U(3)(a)(3)), an assessment of the projected composite performance of all the applicable units to be closed needs to be prepared. The objective of such an assessment is to ensure that the potential dose to hypothetical members of the public from the cumulative residual radioactive material that is likely to remain on a DOE site is reasonably expected to not exceed the dose limits for protection of the public. Low-level waste or transuranic waste disposal is not the only DOE activity that will leave residual radioactive material on a DOE site when operations have ceased. Environmental activities will be conducted to mitigate releases from former operations such as disposal of liquid radioactive waste to soil columns, but will not generally result in the removal of all of the radioactive material. Also facilities currently operating that involve the use of or handling of radioactive material or radioactive waste will eventually be closed and their closure may leave some residual radioactive material.	Conditionally Met - Section 4.2.4 of the Closure Approach describes the composite analysis. At this time, the TFF closure documentation does not describe the universe of potential sources to be included in the composite analysis or any assumptions regarding source terms for those sources that are not yet characterized or for which closure actions have not been determined (e.g., other TFF tank systems, Tank Farm soils, bin sets, NWCF).

Citation	Description of Requirement	Compliance Method/Comments
	The assessment of the projected composite performance of all units/facilities to be closed at a site that are relevant to the performance objectives/closure standards identified in a closure plan, is considered a reasonably conservative assessment of the cumulative impacts from all the current and planned closure facilities/units. The composite analysis provides a suggestion of what could conceivably happen if DOE did not act to protect public health and safety and provides information that DOE can use for planning. For example, the results of the composite analysis can assist DOE in identifying those sources that most significantly contribute to the total projected dose and decide on priorities for remediation, or decide on closure alternatives for active or inactive closure sites. Hazard implications for some sources may be so low that little needs to be done beyond land control, minor maintenance, and monitoring. The requirements and guidance to DOE M 435.1-1, Section IV.P(3), Composite Analysis, provide additional information on the development of an assessment of composite performance. In addition, the assessment of the projected performance of all units to be closed relative to the closure plan needs to be reviewed and updated as appropriate to keep the analysis current. Such updates should be performed to ensure the assumptions and parameters are appropriate to maintain the validity and effectiveness of the controls that are applied to the closure site. The guidance for DOE M 435.1-1, Section IV.P(4), Performance Assessment and Composite Analysis Maintenance, provides additional information on maintaining the composite analysis.	
DOE G.435.1-1 Section II.U, page II-204	5. Any other relevant closure controls including a monitoring plan, institutional controls, and land use limitations to be maintained in the closure activity. The final required element of a closure plan is to include those closure controls that are needed to ensure that the primary health and environmental protection requirements needed are put in place. These controls are to include, at a minimum, a monitoring plan, institutional controls, and limits of land use. Each of these is discussed below.	Conditionally Met - Section 4.2.1 of the Closure Approach describes the content of the DOE Closure Plans. It states that the Closure Plans will cover three phases: (1) operational or interim closure, (2) final facility closure, and (3) institutional closure. It is expected that the interim closure phase will occur as a RCRA action. Final closure is expected to occur as a CERCLA action in conjunction with remedial actions for OU 3-14. Institutional closure is expected to occur

Citation	Description of Requirement	Compliance Method/Comments
		through the implementation of the INEEL Land Use Plan, use restrictions and maintenance of previous closure actions. The DOE Closure Plan would include a monitoring plan, institutional controls, and land-use limitations. These closure documents are not yet available for review to determine whether the content is consistent with the requirements of Section II.U of DOE M435.1-1.
Monitoring Plan	The closure plan addresses the post closure activities to be undertaken to ensure health and environment protection requirements are met. One of the elements that is considered key is the development and implementation of a monitoring plan. Such a plan needs to identify the monitoring activities that are to be conducted after the closure is completed. This plan includes a location map of the monitoring wells or monitoring points that are considered necessary, the data that are to be collected, and actions that will be taken in response to the results of the monitoring activities. Also, the monitoring plan defines the inspection program and the inspection methods to be used, and describes the criteria to be used for initiating corrective actions. Specific corrective actions need to be included for the occurrence of subsidence or the indication of contaminant migration. Other corrective actions to address potential issues, such as uncontrolled site access, natural phenomena, failure of monitoring equipment, ponding of water or excessive infiltration, erosion, or the presence of undesirable flora or fauna, need to be included. The relationship between corrective actions and the monitoring program needs to be clearly identified.	Conditionally Met - Section 4.2.1.1 of the Closure Approach describes the content of the Tier 1 DOE Closure Plan. It states that the plan will address corrective action at each stage of the closure process and include all elements of the inspection program, methods of inspection, and criteria for initiating corrective action. Specific corrective actions will be included for contaminant migration, flooding and other natural phenomena, failure of monitoring equipment, excessive infiltration, erosion, and presence of undesirable flora or fauna. The relationship between corrective actions to ensure compliance with performance objectives and the monitoring program will be clearly identified. These closure documents are not yet available for review to determine whether the content is consistent with the requirements of Section II.U of DOE M 435.1-1.
Institutional Controls and Land Use Limitations	The intent of this requirement is to ensure that institutional control will continue at the closed site until it can be released and that local land use records appropriately record the use of the land as a closed radioactive waste facility/site. These actions provide additional protection against misuse of the land in the future and the possibility of an inadvertent intrusion. Documentation of institutional control and land use assumptions for a closed facility or site that is to be managed as a low-level waste disposal site should meet the requirements of DOE M 435.1-1, Section IV.Q(2),	Clarification Needed - DOE M 435.1-1 Section IV.Q(2) (c) requires that institutional control measures be integrated into land use and stewardship plans and programs, and continue until the facility can be released pursuant to DOE Order 54005. Section 4.2.1 of the Closure Approach indicates that institutional closure will occur through implementation of INEEL land use plan, use restrictions, and continued maintenance of previous closure actions.

Citation	Description of Requirement	Compliance Method/Comments
	paragraphs (c) and (d) and follow the corresponding guidance. Similarly, closed facilities or sites that are to be managed as a transuranic waste disposal site are to meet similar requirements. As with a low-level waste disposal site, the closure plan should identify the necessary activities to be performed to ensure protection of public health and the environment. Compliance with these requirements is demonstrated by successful closure and supporting documentation, e.g., decommissioning documentation, CERCLA documentation, or closure plan, which provides a reasonable expectation that the proposed closure conditions will achieve stability of the closed facility/site, reduce the need for active maintenance, and be protective of worker and public health and the environment.	DOE M 435.1-1 Section IV.Q(2) (d) requires that the location of the facility be filed with local authorities responsible for land use and zoning. Section 11 of the Closure Plan includes submission of a "Notice in Deed" and survey plat in accordance with 40 CFR 265.116 if any TFF components are closed to landfill standards. That commitment would not necessarily be sufficient to address the requirement of Section IV.Q(2)(d). Radioactive material could remain in place subject to DOE M 435.1-1 even though the TFF components achieve a risk-based RCRA closure that exempts the facility from the 40 CFR 265.116 requirement.
DOE M 435.1-1 Section IV.P(1) Performance Objectives	LLW disposal facilities shall be sited, designed, operated, maintained, and closed so that a reasonable expectation exists that the following performance objectives will be met for waste disposed after September 26, 1988: (a) Dose to representative members of the public shall not exceed 25mrem (0.25mSv) in a year total effective dose equivalent from all exposure pathways, excluding the dose from radon and its progeny in air. (b) Dose to representative members of the public via the air pathway shall not exceed 10 mrem (0.10 mSv) in a year total effective dose equivalent, excluding the dose from radon and its progeny. (c) Release of radon shall be less than an average flux of 20 pCi/m2/s (0.74Bq/m2/s) at the surface of the disposal facility. Alternatively, a limit of 0.5 pCi/l (0.0185 Bq/l) of air may be applied at the boundary of the facility.	Clarification Needed - The Closure Approach does not identify the performance objectives for the performance assessment.

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HLW-105 -11

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2.	**Document Date:**	09/29/2000
3.	**Document Title (or description):**	INTEC Tank farm facility closure Conceptual Design Report, Project File No. 015722, Book 6, Volume 2, EDF's
4.	**Addressee Name and Organization:**	N/A
5.	**Author Name and Organization:**	Keith Quigley/BBWI
6.	**Key Words:**	QA Record, EDF-015722-034,EDF-015722-035,EDF-015722-036,EDF-015722-037,EDF-015722-038,EDF-015722-039,EDF-015722-040,EDF-015722-041,EDF-015722-042,EDF-015722-043, EDF-015722-044,EDF-015722-045

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HLW-105 -11

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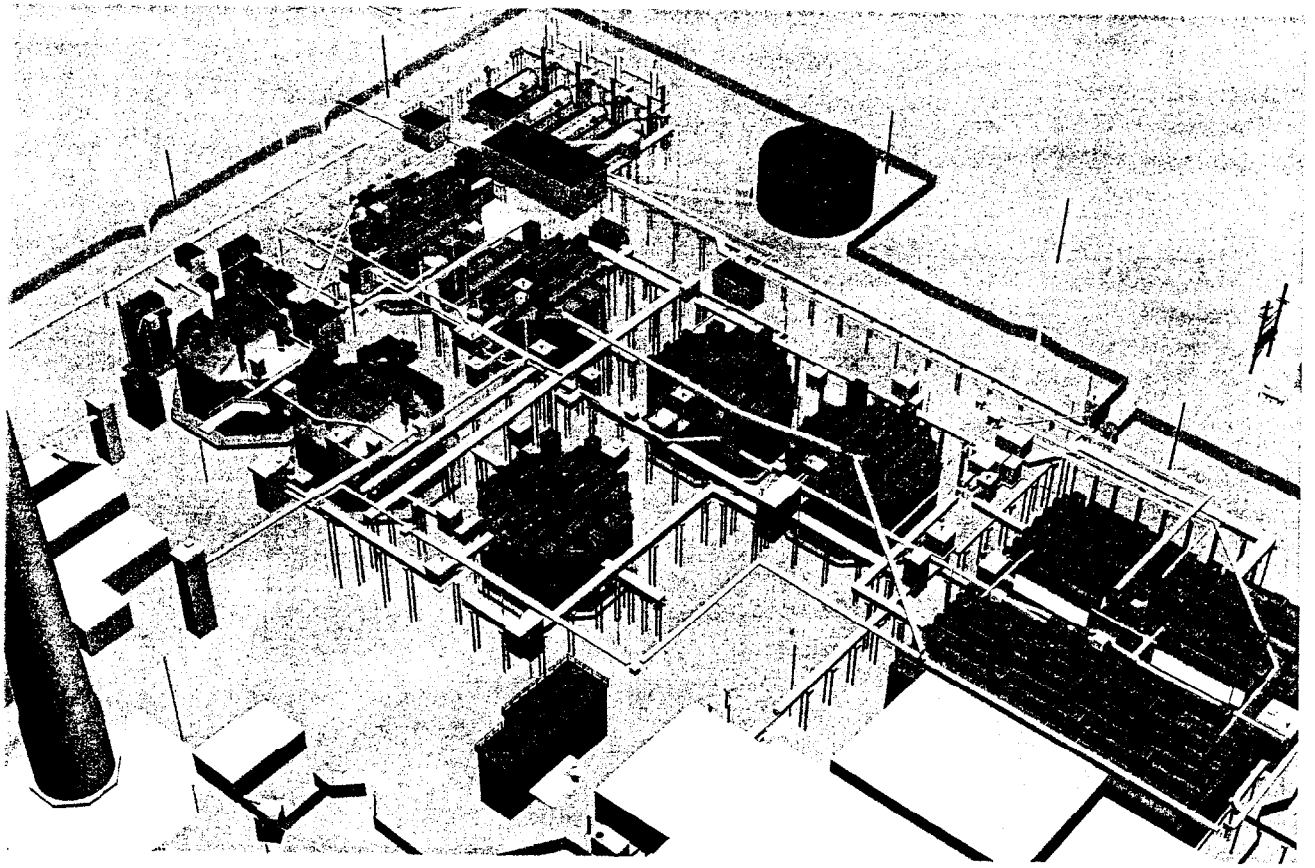
Project File: 015722

CONCEPTUAL DESIGN REPORT

BOOK 6: EDFs

Volume 3 of 3



INTEC TANK FARM FACILITY CLOSURE

INEEL
Idaho National Engineering & Environmental Laboratory
BECHTEL BWXT IDAHO, LLC

INTEC TANK FARM CLOSURE CONCEPTUAL DESIGN REPORT

BOOK 1 GENERAL (Two Volumes)

Book 1 consists of design requirements, design descriptions, general project information, and summaries of EDFs. Book one provides an overall summary of the project and the approach to Tank Farm Closure. Where an EDF covers a subject in more detail, the EDF is referenced. EDFs reside in BOOK 6.

BOOK 2 JUSTIFICATION DOCUMENT

Book 2 provides the details and justification for the closure process selected for the INTEC Tank Farm. It includes an alternatives assessment and cost benefit analysis.

BOOK 3 MODELING AND ANIMATIONS (Two Volumes)

Book 3 consists of the 3D Model of the Tank Farm and various views of the model. In addition the closure sequence for WM-182 & WM-183 has been animated utilizing the 3D Model; and has been transferred to VHS tape. 3D views of each of the major closure steps are provided.

BOOK 4 MOCK-UPS (Two Volumes)

Book 4 provides details on the past, present, and future proof of process activities. Mock-up test plans, subcontracts, current data, and drawings are included.

BOOK 5 DRAWINGS

Book 5 contains the underground drawings, design drawings for equipment and systems, and four fully annotated 3D views of each of the Tanks.

BOOK 6 EDFS (Three Volumes)

Book 6 contains all of the EDFs developed under the Conceptual Design (FY 99 & 00). The EDFs are summarized throughout BOOK 1. EDFs developed prior to the Conceptual Design are not included, but are available upon request.

BOOK 7 LINE LISTS

Book 7 contains a complete set of underground drawings for the Tank Farm and a complete line list for all pipelines within the Tank Farm. The Line List is subdivided into sections referenced to the specific Tank to which the line is associated. In addition, abandoned line drawings and associated lines lists are provided.

BOOK 8 PHOTOS

Book 8 is a small subset of Tank Farm Photos and Mock-up Photos. An extensive photo library has been developed within the HLW Program and is available.

ENGINEERING DESIGN FILES
Volume 3 of 3

EDF-15722-046	Sand Pad Contamination Analysis	Adam Poloski	7/21/00
EDF-15722-047	Wash Pump Analysis	Adam Poloski	7/21/00
EDF-1464	INTEC Tank Farm Closure Mix Design	S. A. Jensen	3/31/00
EDF-1437	Waste Transfer Sequence	Dennis Heyen	6/14/00
EDF-1114	Base-Case Risk Evaluation for Residual Inventories in the Tank Farm Facility	P. D. Ritter	5/10/99
EDF-1195	Compatibility of Using LDUA for Remote Sampling	S. M. Berry	8/4/99
EDF-1187	Electrical Loads	K. E. Wells	7/20/99

EDF-015722-046

ENGINEERING DESIGN FILE

1. Project File No. 15722 2. Project/Task Tank Farm Closure

3. Subtask Process

4. Title: Sandpad Contamination Analysis

5. Summary: This EDF evaluates the contamination of sand present in vaults located in the INTEC Tank Farm Facility (TFF). Since a contamination event in approximately 1962 the sand in the vault system has been repeatedly saturated and drained from annual runoff/snowmelt. Based on partition coefficient data for nuclides on sand this situation was simulated. The simulation results reveal that most of the contamination species adsorbs onto the sand media. Subsequent washings remove very little of the contaminates. However, due to decay of a relatively short-lived species Cs-137 to Ba-137m and the fact that Cesium adsorbs readily on sand while Barium does not, the washings may have removed a relatively large amount of Barium over the past four decades. This liquid is removed from a vault sump. The liquid drainage should be of a relatively high activity since Ba-137m, which does not bind to the sand, is in secular equilibria with Cs-137, which binds to the sand and is believed to be relatively high activity in the initial contamination. However, after the liquid has been removed from the vault, the liquid phase activity will decay very rapidly on the order of a few hours (Ba-137m has a short half-life). The simulation shows that the resulting liquid drainage (after years of sandpad saturation and draining) would have a Ba-137 concentration of approximately 60 mg/l for WM-185 and 43 mg/l for WM-187. While this concentration is below the RCRA characteristic hazard limit of 100 mg/l for Barium, **the potential for exceeding the RCRA Barium Toxicity Limit exists**. However, many assumptions were made in this report and other mechanisms could have occurred to reduce the amount of contamination in the sandpad. The only way to verify the contamination of the sandpad is through sampling and analysis.

6. Distribution (complete package):

Distribution (summary package only):

7. Review (R) and Approval (A) Signatures: (Minimum reviews and approvals are listed. Additional reviews/approvals may be added as necessary.)

	R/A	Printed Name	Signature	Date
Author	R	Adam Poloski	Adam Poloski	10/23/00
Technical Review	R	Edward Wagner	Edward Wagner	10/20/00
Requestor	A	Edward Anderson	Edward Anderson	10/23/00

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1 Introduction

The tanks in the Tank Farm Facility (TFF) consist of a stainless steel tank that provides primary containment and an outer concrete vault system that provides secondary containment. Commercial grade sand was placed underneath the stainless steel tank and above the croncrete vault (see Figure 1). This sand pad supports the tank and prevents it from shifting. If liquid enters this sandpad area, it may be removed by use of a drain-sump system. The sand is contained by a octagonal concrete curb. The tank was then placed on the octagon such that some of the sand is not covered by the circular tank.

Since the tanks are located outside, they are subject to the effects of rainwater and snowmelt. Typically, the vault area would recieve annual rainwater and snowmelt. The sump system would then be used to remove the water from the sand pad.

However, in approximately 1962, the sand pad in tanks WM-185, WM-187, and WM-188 became contaminated when high level liquid waste spilled into the vaults. It is also believed that a significant amount of rainwater was present in the vaults at this time. In the years subsequent to the contamination, approximately 35 rainwater saturation and sump removal events have occurred. Therefore, the purpose of this EDF is to evaluate the amount of radioactive contamination currently in the tank sandpad.

2 Theory

The purpose of this section is to evaluate how the radionuclides will absorb to the sand in the sandpad after multiple washings with snowmelt and approximately 35 years of radioactive decay. The adsorption of molecules on the surface of a particle can be described mathematically through the following equation [1]:

$$K_d = \frac{S}{C} \tag{1}$$

Where,

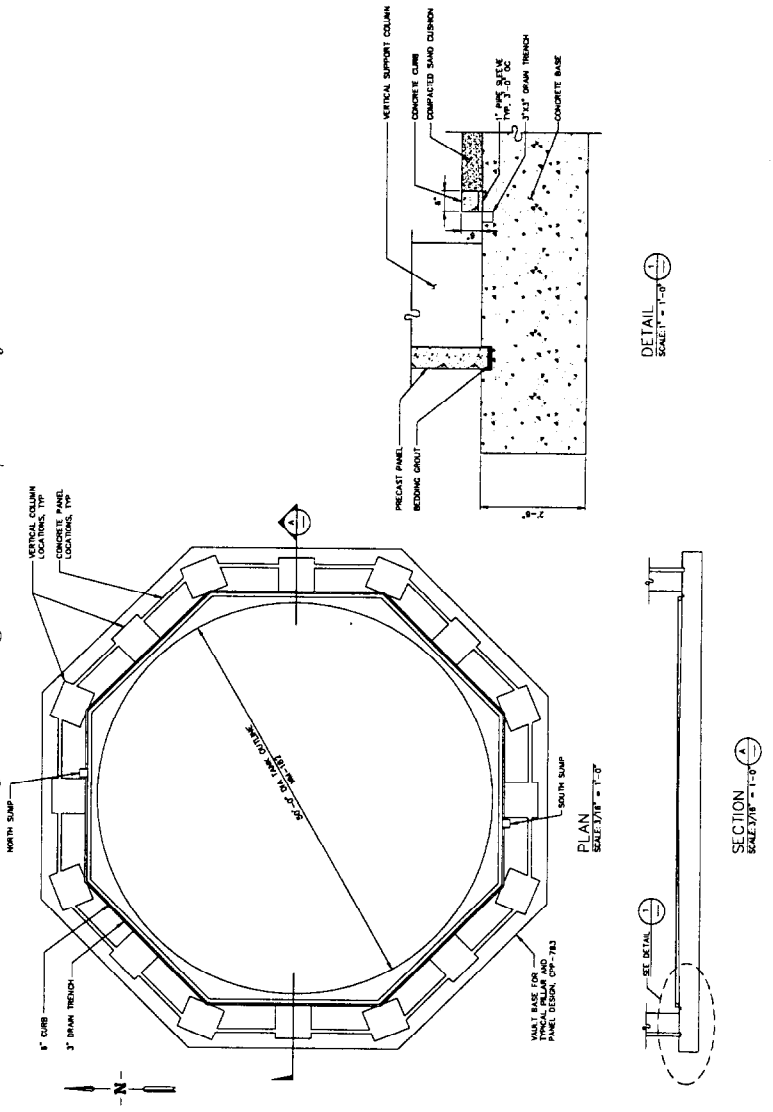
S = mass of contaminant adsorbed per unit mass of solid material

C = mass of contaminant in solution per unit volume of solute

K_d = distribution coefficient

Several limitations must be kept in mind when using K_d to model sorption. First, this model assumes that an infinite number of adsorption sites exist on the solid particle surface. This implies that there is no upper limit to the amount of material adsorbed onto the solid particles. For dilute solutions, this is a valid assumption since the number of sorption sites will be significantly larger than the amount of contaminant in solution.

Figure 1: Diagram of Tank/Vault System



Secondly, this model is only valid under the laboratory conditions at which an experiment is conducted. In a laboratory, controls can be implemented to achieve reproducible results. Several mechanisms exist such that slight deviations from experimental conditions could result in orders of magnitude difference. These mechanisms include:

- Ion Exchange
- Nonspecifiec Adsorption
- Specific Adsorption
- Precipitation
- Organic Complexation
- Colloid Formation

The factors that influence these mechanisms include the following:

- Differences in Solid Material Characteristics
  - Different types of active sites
  - Different amount of surface area
- Differences in Solution Characteristics
  - pH
  - Eh
  - Temperature
  - Dissolved organic content
  - Cation consituents/concentation
  - Anion consituents/concentation

Therefore, it is undesirable to apply generalized laboratory partition coefficient data to real situations that deviate from the laboratory conditions. It would be much more desirable to perform in-situ tests in the field and use this partition coefficient data. However, often one cannot perform such tests and must use laboratory data. In these situations, one must use care to find partition coefficients that closely mimic the real system. Consequently, researchers have published generalized partition coefficient data for a variety of soil types. Since the sandpad consists of commercial grade sand, generalized partition coefficients for sand should provide the best available sorption data outside of performing laboratory tests to mimic the conditions in the sandpad.

Sheppard and Thibault [5] have found these K_d data in various media for numerous radionuclides. These data are shown in Table 1. The data shown for Barium are taken from Eichholz and Whang [2].

Armed with the following data about the tank vault system,

Table 1: Summary of Mean K_d values ($mL\ g^{-1}$) by Soil Type

	Soil Type			
Species	***Sand***	***Clay***	***Loam***	***Organic***
Ac	450	2400	1500	5400
Ag	90	180	120	15000
Am	1900	8400	9600	112000
Be	250	1300	800	3000
Bi	100	600	450	1500
Br	15	75	50	180
C	5	1	20	70
Ca	5	50	30	90
Cd	80	560	40	800
Ce	500	20000	8100	3300
Cm	4000	6000	18000	6000
Co	60	550	1300	1000
Cr	70	1500	30	270
Cs	280	1900	4600	270
Fe	220	165	800	600
Hf	450	2400	1500	5400
Hg	100	100	100	100
Ho	250	1300	800	3000
I	1	1	5	25
K	15	75	55	200
Mn	50	180	750	150
Mo	10	90	125	25
Nb	160	900	550	2000
Ni	400	650	300	1100
Np	5	55	25	1200
P	5	35	25	90
Pa	550	2700	1800	6600
Pb	270	550	16000	22000
Pd	55	270	180	670
Po	150	3000	400	7300
Pu	550	5100	1200	1900
Ra	500	9100	36000	2400
Rb	55	270	180	670
Re	10	60	40	150
Ru	55	800	1000	66000
Sb	45	250	150	550
Se	150	740	500	1800
Si	35	180	110	400
Sm	245	1300	800	3000
Sn	130	670	450	1600
Sr	15	110	20	150
Ta	220	1200	900	3300
Tc	0.1	1	0.1	1
Te	125	720	500	1900
Th	3200	5800	3300	89000
U	35	1600	15	410
Y	170	1000	720	2600
Zn	200	2400	1300	1600
Zr	600	3300	2200	7300

- volume of sand present in the vault
- void fraction of the sand
- amount of runoff water the vault is filled with initially and annually
- composition and volume of the contaminant liquid entering the vault

One can calculate the amount of contamination remaining in the vaults after repeated runoff washings. This issue has been investigated previously by Kimmitt [3] with K_d values gathered from soil data. Consequently, this work reexamines Kimmitt's calculations with partition coefficient data for sand rather than soil (see Column 1 of Table 1) and a comprehensive evaluation of decay effects.

3 Analysis

Based on drawings of the tank vault system (see Figure 1), approximately 826 cubic feet of sand are present in each vault. This volume of sand has a void fraction of 0.34, resulting in an interstitial space of 281 cubic feet. It is assumed that the sandpad is 30% saturated with water at the time of the initial contamination event (with radionuclides concentrations given by Dan Staiger, see Table 2). This 30% value is due to surface tension.

Table 2: Summary of Initial Contamination Concentrations

	Activity (Ci/ml)		
Radionuclide	**WM-185**	**WM-187**	**K_d (mL/g)**
Ac-225	3.08E-15	2.19E-15	450
Am-241	7.56E-08	5.36E-08	1900
Cs-137	4.90E-04	3.48E-04	280
I-129	4.20E-10	2.98E-10	1
Np-237	7.00E-10	4.96E-10	5
Pa-233	7.00E-10	4.96E-10	550
Pu-238	2.66E-07	1.89E-07	550
Pu-239	3.36E-08	2.38E-08	550
Pu-240	1.34E-08	9.53E-09	550
Ra-225	3.08E-15	2.19E-15	500
Ra-226	1.30E-12	9.25E-13	500
Sr-90	4.48E-04	3.18E-04	15
Tc-99	2.52E-07	1.79E-07	0.1
Th-229	3.08E-15	2.19E-15	3200
Th-230	6.86E-11	4.87E-12	3200
U-234	2.10E-09	1.49E-09	35

Liquid contamination enters through the anular region between the tank wall and vault wall. The liquid would then spill over the concrete curb and into the sandpad region.

Depending on how the flow rate and the grade of the tank/concrete curb, the sandpad may fill completely with liquid, displacing the air in the sand void spaces, or air may be trapped under the tank and only part of the sandpad would be contaminated. For the purpose of this EDF the former situation will be assumed.

With the contamination saturating sandpad void void spaces. The sandpad remains in saturated long enough for the contaminates to diffuse through the surface tension liquid. At this point, the the entire liquid phase is well–mixed or homogeneous. The liquid and solid phases come to an equilibrium relation governed by the partition coefficient relation described above. Please note, that depending on the flow rate through the sandpad and transient absorption behavior of the contaminates on the sand, more contamination may be present near the edges of the sandpad than near the center. Since these dynamics are unknown only equilibrium conditions will be examined here. The only way to be sure about the extend of the contamination is to take sand samples at various intervals from the center of the tank to the concrete curb. Nuclear decay is also occurring during this period. The liquid phase is then removed through the sump at the bottom of the vault. It is also assumed that 30% of the liquid phase remains in the sandpad due to surface tension. From this point, the sandpad is annually saturated and washed with runoff. Figure 2 depicts this runoff washing cycle.

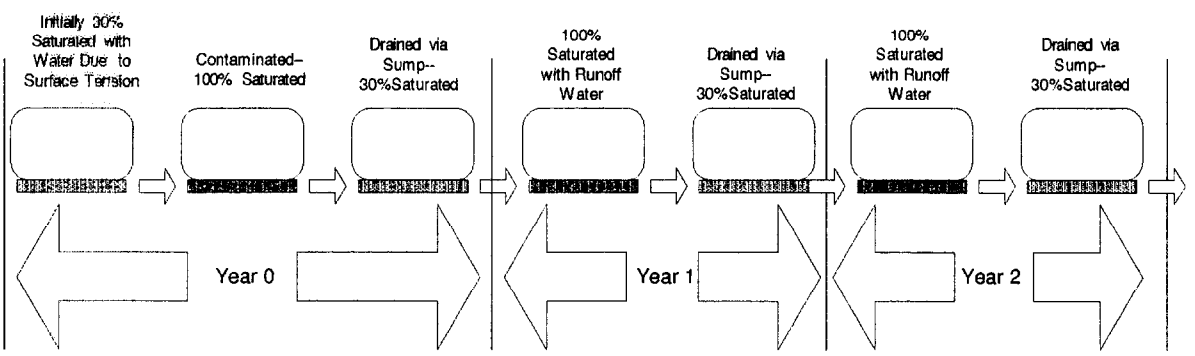


Figure 2: Runoff/Washing Cycle

The effect of these multiple washings on WM-185 and WM-187 are shown in Figures 3 and 4. When the total activity of the entire vault system is considered, the Figures 5 and 6 can be constructed. When the total mass of contaminates in the entire vault system is considered, the Figures 7 and 8 can be constructed.

By the year 2000, approximately 37 washings have occurred and the amount of nuclides remaining in the sandpad system for tanks WM-185 and WM-187 are shown in Tables 3 and 4 respectively (grouped by decay chain).

Tables 3 and 4 show that the activity in the of the sand and liquid phases are comparable and significant. The high activity level of the sand phase is due to the relatively large amount of ^{137}Cs present in the sand. The high activity level of the liquid phase is due to the relatively large amount of ^{137m}Ba (a daughter of ^{137}Cs) present in the liquid.

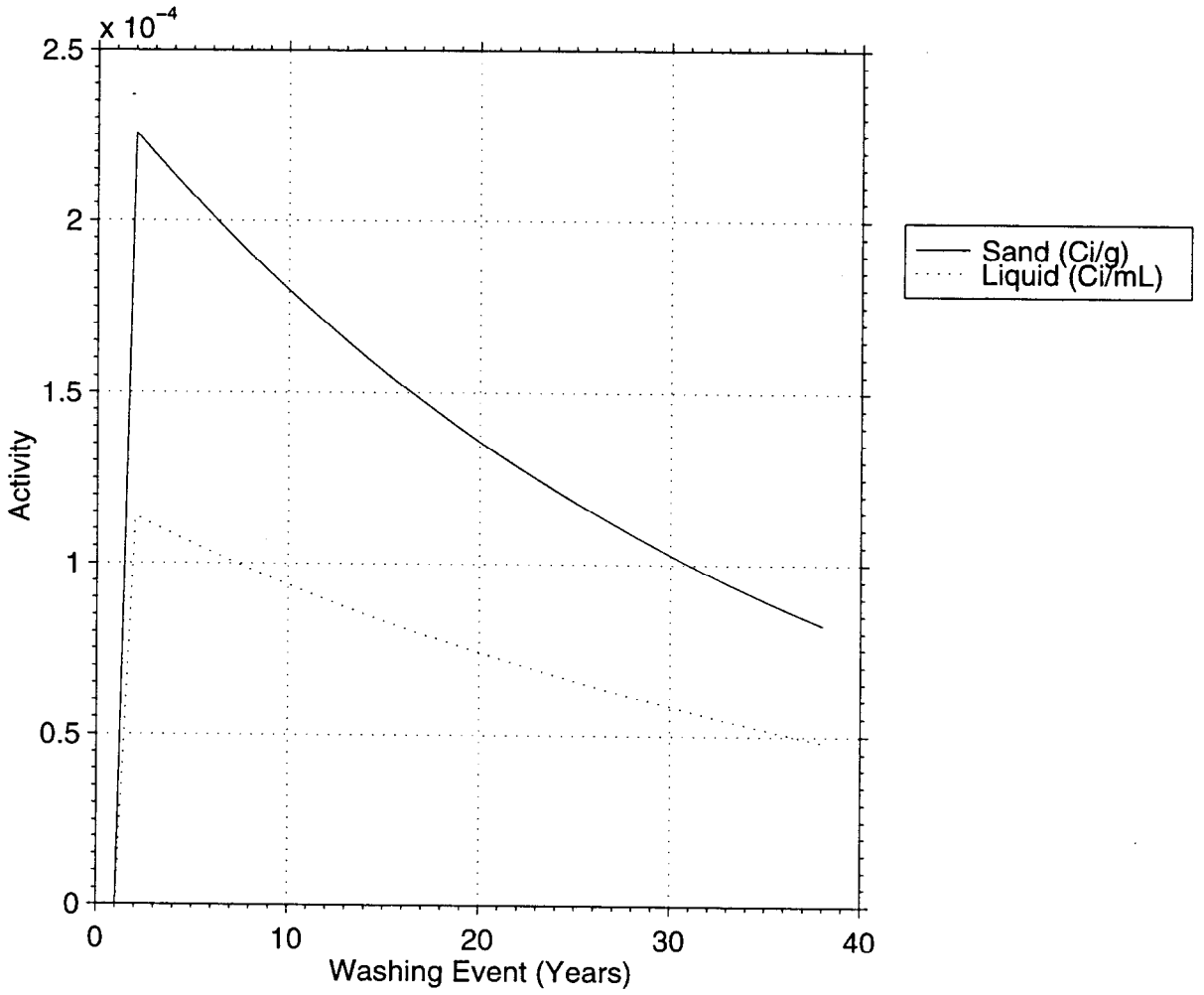


Figure 3: Effect of Decay and Runoff on Activity Levels in WM-185 Vault

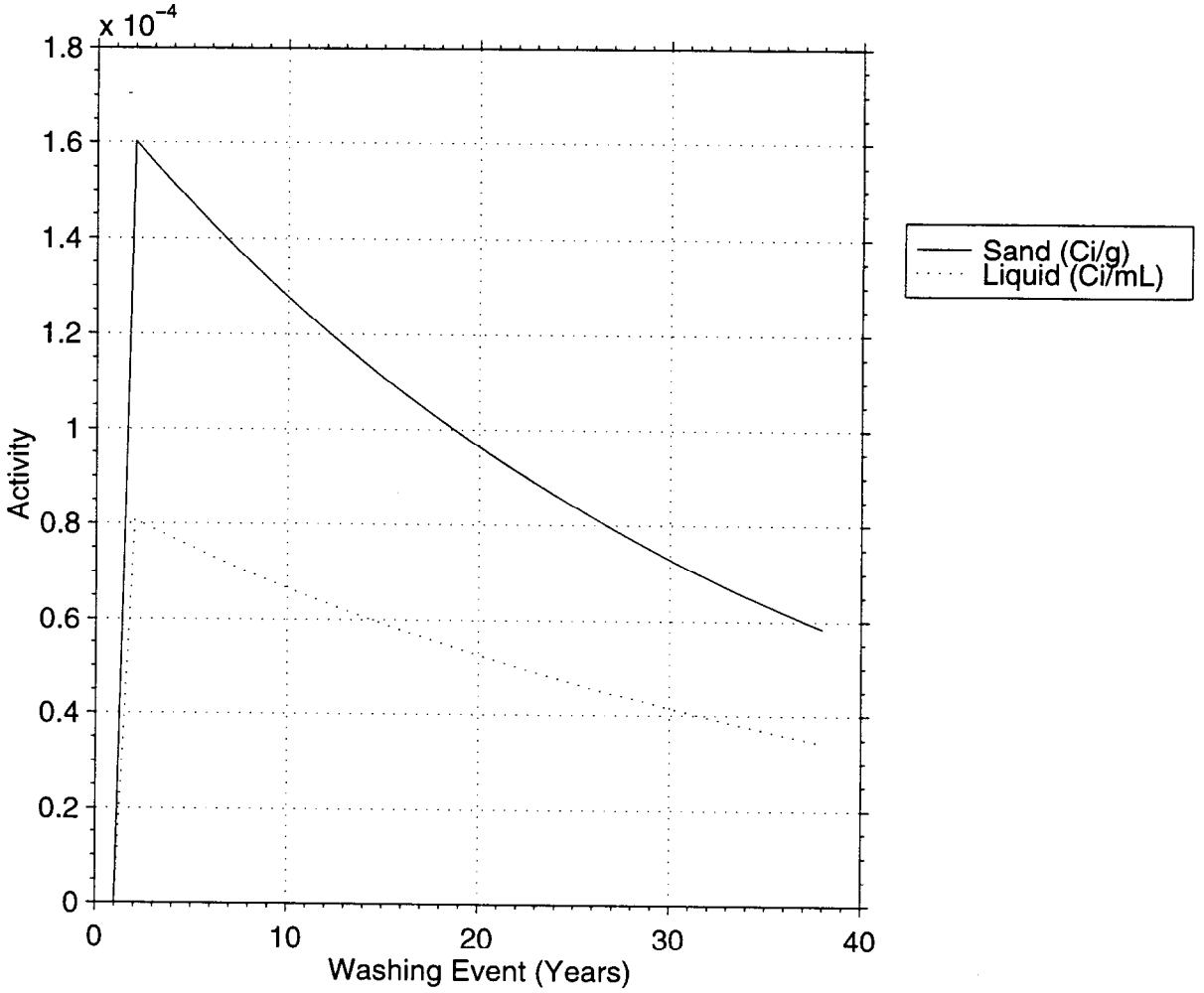


Figure 4: Effect of Decay and Runoff on Activity Levels in WM-187 Vault

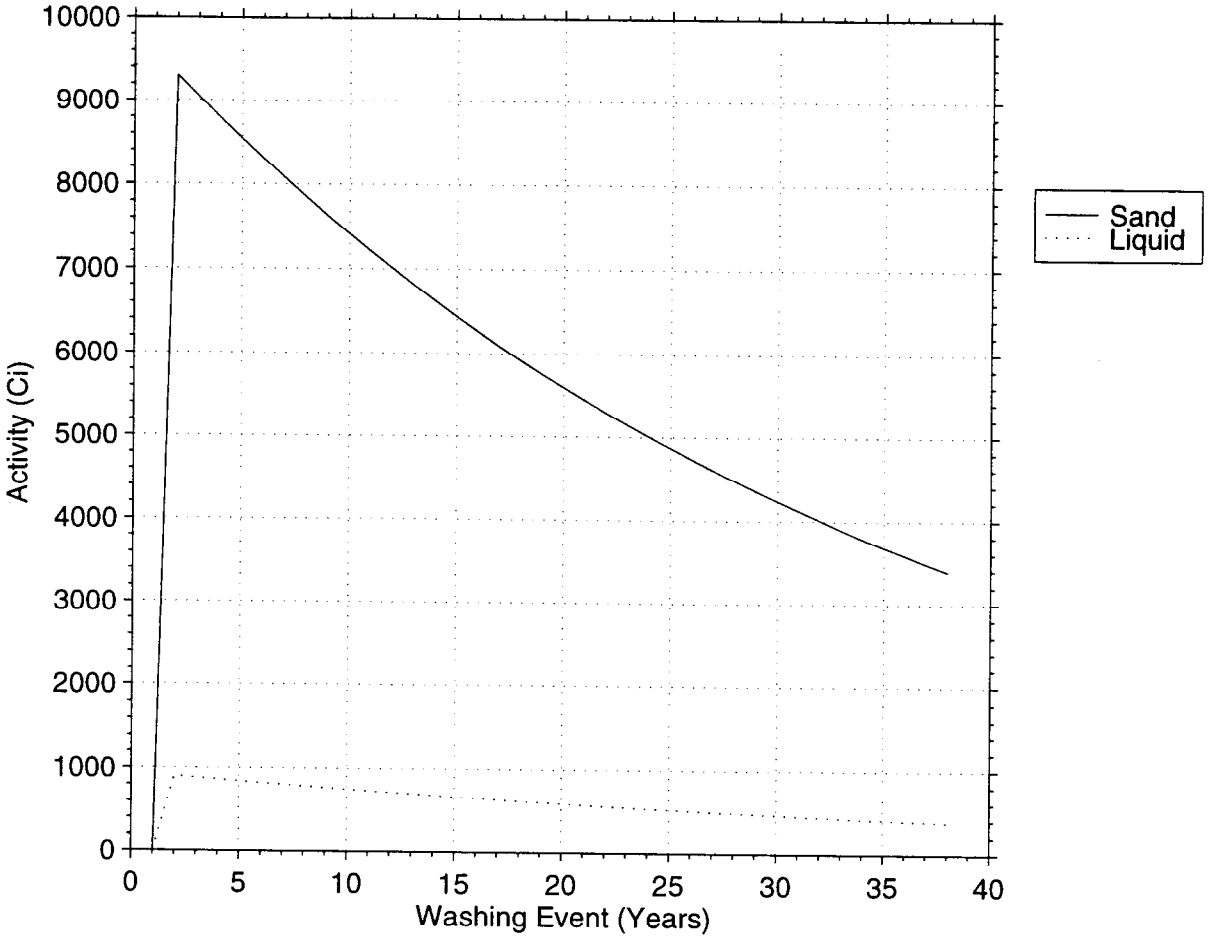


Figure 5: Effect of Decay and Runoff on Total Activity in WM-185 Vault

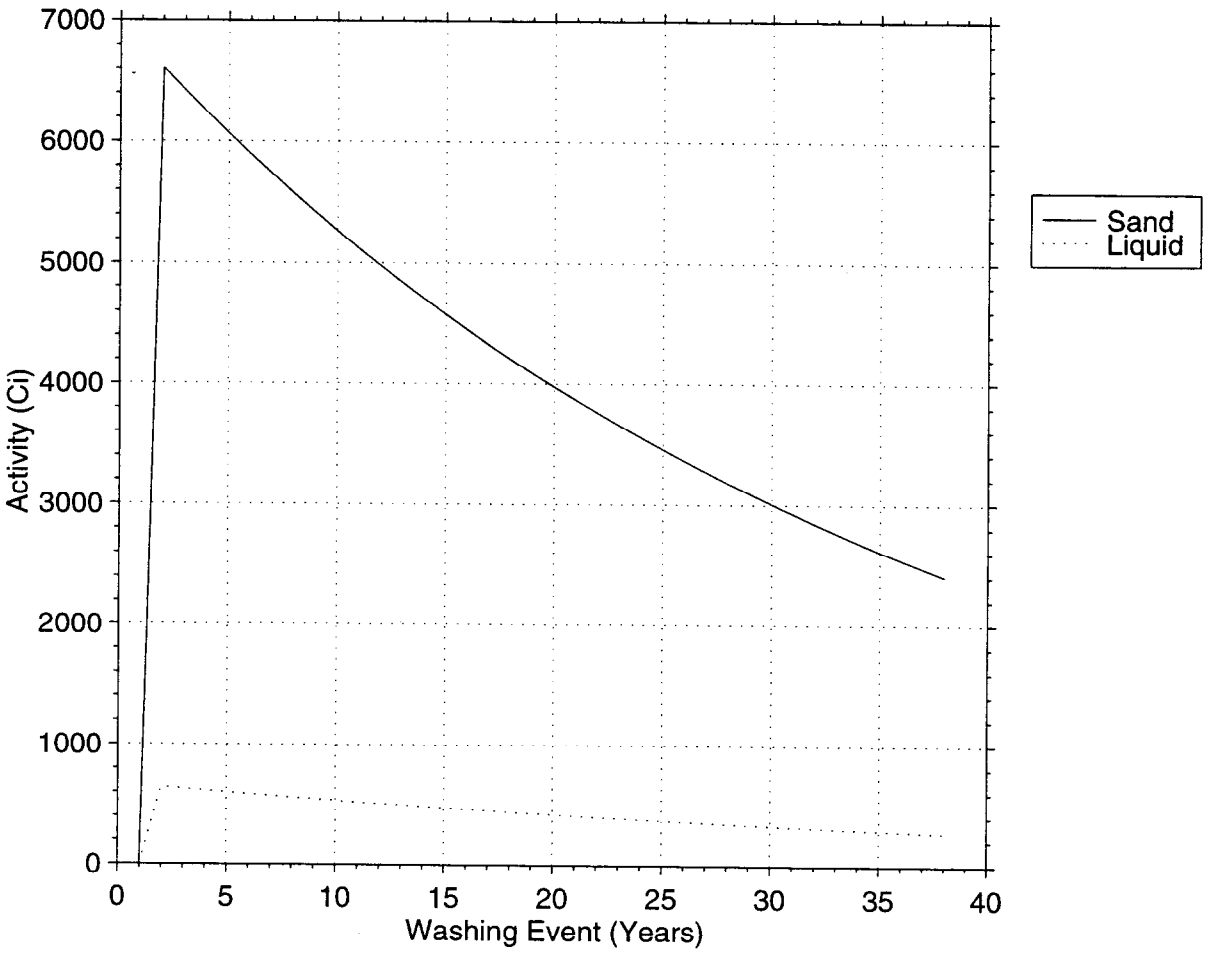


Figure 6: Effect of Decay and Runoff on Total Activity in WM-187 Vault

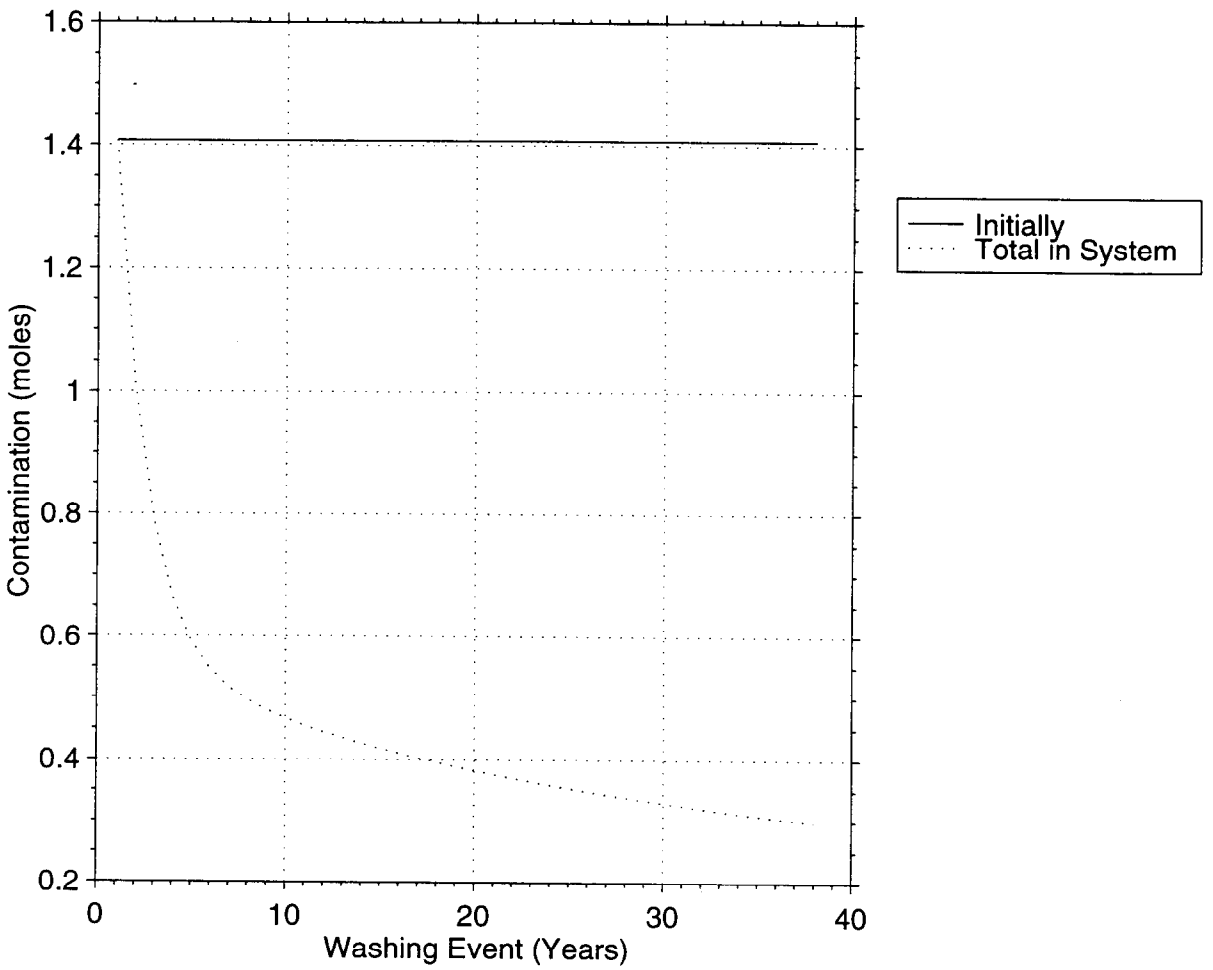


Figure 7: Effect of Decay and Runoff on Contamination Level in WM-185 Vault

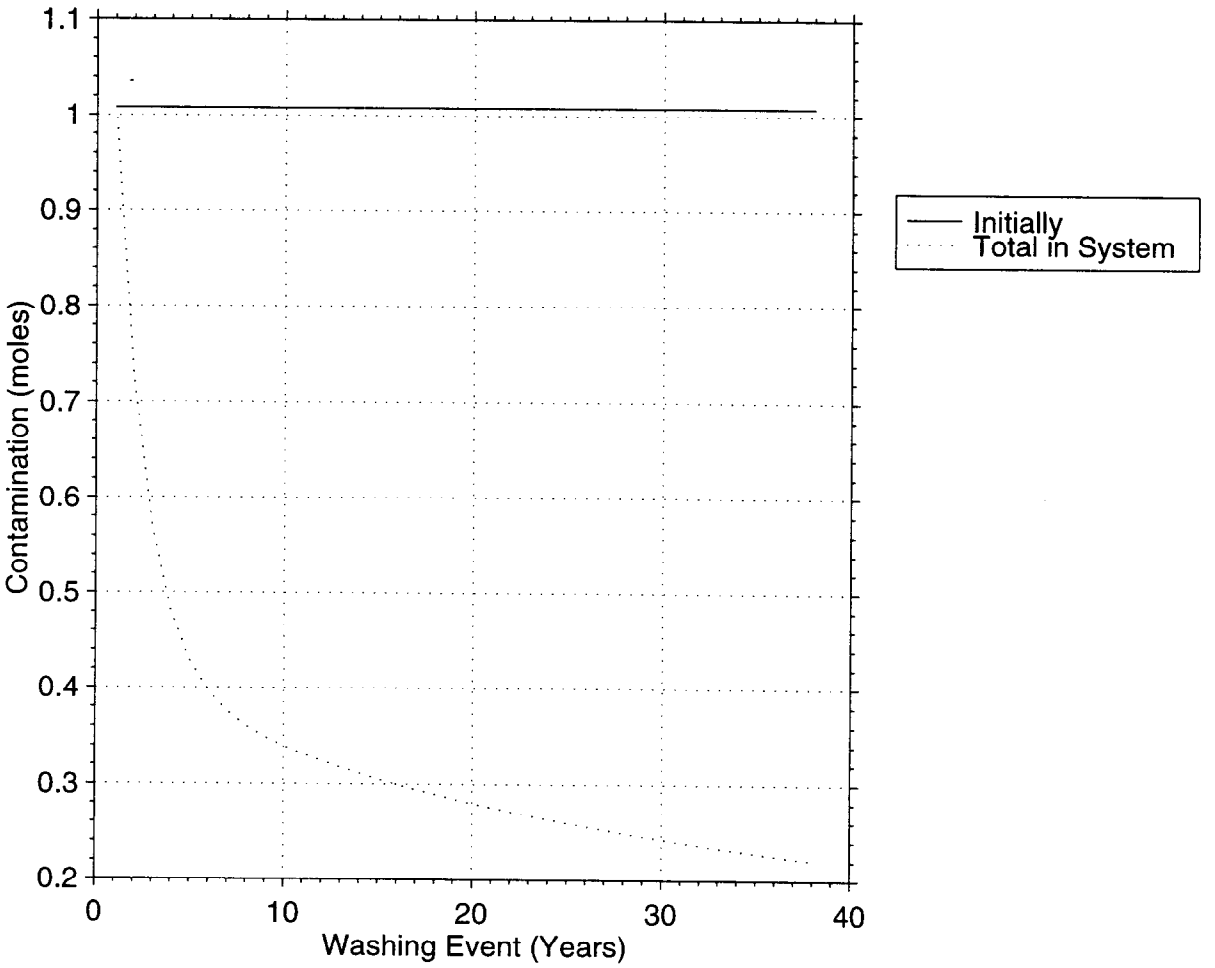


Figure 8: Effect of Decay an d Runoff on Contamination Level in WM-187 Vault

Table 3: Nuclides Remaining in WM-185 Vault System

Nuclide	Sand Activity Ci/g	Liquid Activity Ci/mL	Sand Composition mg/kg	Liquid Composition g/ml	Half-life	Units	Kd ml/g	% Desorbed per washing
Sr-90	1.78E-05	1.19E-06	1.29E+02	8.57E+00	28.79	years	15	1.27%
Y-90	1.80E-05	1.06E-07	3.30E-02	1.94E-04	64.00	hours	170	0.11%
Zr-90	0.00E+00	0.00E+00	2.25E+02	3.75E-01	stable		600	0.03%
Tc-99	2.51E-18	2.51E-17	1.47E-07	1.47E-06	211,100	years	0.1	65.86%
Ru-99	0.00E+00	0.00E+00	1.29E-02	2.35E-04	Stable		55	0.35%
I-129	6.29E-13	6.29E-13	3.56E+00	3.56E+00	15,700,000	years	1	16.17%
Xe-129	0.00E+00	0.00E+00	0.00E+00	1.47E-06	stable		n/a	100.00%
Cs-137	2.78E-05	9.92E-08	3.21E+02	1.15E+00	30.17	years	280	0.07%
Ba-137m	1.88E-05	4.69E-05	3.48E-05	8.71E-05	2.55	min	0.5	27.84%
Ba-137	0.00E+00	0.00E+00	2.40E+01	6.00E+01	stable		0.5	27.84%
Pu-238	2.66E-08	4.83E-11	1.55E+00	2.82E-03	87.70	years	550	0.04%
U-234	2.49E-10	7.10E-12	3.99E+01	1.14E+00	245,500	years	35	0.55%
Th-230	9.34E-12	2.92E-15	4.53E-01	1.41E-04	75,380	years	3200	0.01%
Ra-226	3.18E-13	6.37E-16	3.22E-04	6.43E-07	1,600	years	500	0.04%
Rn-222	0.00E+00	1.65E-12	0.00E+00	1.07E-08	3.82	days	n/a	100.00%
Po-218	3.18E-13	2.12E-15	1.14E-12	7.62E-15	3.10	min	150	0.13%
Pb-214	3.18E-13	1.18E-15	9.70E-12	3.59E-14	26.80	min	270	0.07%
Bi-214	3.18E-13	3.18E-15	7.19E-12	7.19E-14	19.90	min	100	0.19%
Po-214	3.18E-13	2.12E-15	9.91E-20	6.60E-22	164.30	microsec	150	0.13%
Pb-210	1.75E-13	6.48E-16	2.29E-06	8.48E-09	22.30	years	270	0.07%
Bi-210	1.75E-13	1.75E-15	1.41E-09	1.41E-11	5.01	days	100	0.19%
Po-210	1.72E-13	1.15E-15	3.83E-08	2.56E-10	138.38	days	150	0.13%
Pb-206	0.00E+00	0.00E+00	1.29E-06	4.79E-09	stable		270	0.07%
Pu-239	4.49E-09	8.17E-12	7.24E+01	1.32E-01	24,110	years	550	0.04%
U-235	1.53E-16	4.37E-18	7.07E-02	2.02E-03	703,800,000	years	35	0.55%
Th-231	1.54E-16	4.80E-20	2.89E-13	9.03E-17	25.52	hours	3200	0.01%
Pa-231	6.13E-20	1.12E-22	1.30E-09	2.36E-12	32,760.00	years	550	0.04%
Ac-227	1.85E-20	4.12E-23	2.56E-13	5.69E-16	21.77	years	450	0.04%
Th-227	1.85E-20	5.77E-24	6.00E-16	1.88E-19	18.72	days	3200	0.01%
Ra-223	1.84E-20	3.68E-23	3.59E-16	7.18E-19	11.44	days	500	0.04%
Rn-219	0.00E+00	9.53E-20	0.00E+00	7.33E-21	3.96	s	n/a	100.00%
Po-215	1.84E-20	1.22E-22	6.23E-25	4.16E-27	1.78	ms	150	0.13%
Pb-211	1.84E-20	6.81E-23	7.44E-19	2.76E-21	36.10	min	270	0.07%
Bi-211	1.84E-20	1.84E-22	4.41E-20	4.41E-22	2.14	min	100	0.19%
Tl-207	0.00E+00	9.53E-20	0.00E+00	5.00E-19	4.77	min	n/a	100.00%
Pb-207	0.00E+00	0.00E+00	0.00E+00	0.00E+00	stable		270	0.07%
Pu-240	1.79E-09	3.25E-12	7.87E+00	1.43E-02	6,564	years	550	0.04%
U-236	1.83E-15	5.23E-17	2.83E-02	8.07E-04	23,420,000	years	35	0.55%
Th-232	1.72E-24	5.37E-28	1.57E-08	4.89E-12	14,050,000,000	years	3200	0.01%
Ra-228	1.12E-24	2.25E-27	4.12E-18	8.24E-21	5.75	years	500	0.04%
Ac-228	1.12E-24	2.50E-27	5.03E-22	1.12E-24	6.15	hours	450	0.04%
Th-228	9.46E-25	2.96E-28	1.15E-18	3.60E-22	1.91	years	3200	0.01%
Ra-224	9.45E-25	1.89E-27	5.93E-21	1.19E-23	3.66	days	500	0.04%
Rn-220	0.00E+00	4.90E-24	0.00E+00	5.31E-24	55.60	s	n/a	100.00%
Po-216	9.44E-25	6.29E-27	2.62E-27	1.75E-29	0.15	s	150	0.13%
Pb-212	9.44E-25	3.50E-27	6.79E-22	2.52E-24	10.64	hours	270	0.07%
Bi-212	9.43E-25	9.43E-27	6.44E-23	6.44E-25	60.55	min	100	0.19%
Po-212	9.44E-25	6.29E-27	5.30E-34	3.53E-36	0.30	microsec	150	0.13%
Pb-208	0.00E+00	0.00E+00	0.00E+00	0.00E+00	stable		270	0.07%
Am-241	9.60E-09	5.05E-12	2.79E+00	1.47E-03	432.20	years	1900	0.01%
Np-237	3.53E-11	7.06E-12	5.02E+01	1.00E+01	2,144,000	years	5	3.71%
Pa-233	3.67E-11	6.67E-14	1.76E-06	3.21E-09	26.97	days	550	0.04%
U-233	9.08E-15	2.60E-16	9.42E-04	2.69E-05	159,200	years	35	0.55%
Th-229	4.33E-16	1.35E-19	2.03E-06	6.36E-10	7,340	years	3200	0.01%
Ra-225	4.33E-16	8.66E-19	1.11E-11	2.22E-14	14.90	days	500	0.04%
Ac-225	4.33E-16	9.62E-19	7.46E-12	1.66E-14	10.00	days	450	0.04%
Fr-221	0.00E+00	2.24E-15	0.00E+00	1.29E-14	4.90	min	n/a	100.00%
At-217	4.33E-16	9.62E-19	2.69E-19	5.97E-22	32.30	ms	450	0.04%
Bi-213	4.32E-16	4.32E-18	2.23E-14	2.23E-16	45.59	microsec	100	0.19%
Po-213	4.32E-16	2.88E-18	3.43E-24	2.29E-26	4.20	microsec	150	0.13%
Pb-209	4.33E-16	1.60E-18	9.38E-14	3.48E-16	3.25	hours	270	0.07%
Bi-209	0.00E+00	0.00E+00	6.16E-09	6.16E-11	Stable		100	0.19%
Total	8.23E-05	4.83E-05	8.77E+02	8.50E+01				

Table 4: Nuclides Remaining in WM-187 Vault System

Nuclide	Sand Activity Ci/g	Liquid Activity Ci/mL	Sand Composition mg/kg	Liquid Composition mg/l	Half-life	Units	Kd ml/g	% Desorbed per washing
Sr-90	1.26E-05	8.41E-07	9.13E+01	6.09E+00	28.79	years	15	1.27%
Y-90	1.28E-05	7.51E-08	2.34E-02	1.38E-04	64.00	hours	170	0.11%
Zr-90	0.00E+00	0.00E+00	1.60E+02	2.66E-01	stable		600	0.03%
Tc-99	1.78E-18	1.78E-17	1.04E-07	1.04E-06	211,100	years	0.1	65.86%
Ru-99	0.00E+00	0.00E+00	9.19E-03	1.67E-04	Stable		55	0.35%
I-129	4.46E-13	4.46E-13	2.52E+00	2.52E+00	15,700,000	years	1	16.17%
Xe-129	0.00E+00	0.00E+00	0.00E+00	1.04E-06	stable		n/a	100.00%
Cs-137	1.97E-05	7.05E-08	2.28E+02	8.14E-01	30.17	years	280	0.07%
Ba-137m	1.33E-05	3.33E-05	2.47E-05	6.19E-05	2.55	min	0.5	27.84%
Ba-137	0.00E+00	0.00E+00	1.71E+01	4.26E+01	stable		0.5	27.84%
Pu-238	1.89E-08	3.43E-11	1.10E+00	2.00E-03	87.70	years	550	0.04%
U-234	1.76E-10	5.04E-12	2.83E+01	8.09E-01	245,500	years	35	0.55%
Th-230	7.21E-13	2.25E-16	3.49E-02	1.09E-05	75,380	years	3200	0.01%
Ra-226	1.33E-13	2.65E-16	1.34E-04	2.68E-07	1,600	years	500	0.04%
Rn-222	0.00E+00	6.88E-13	0.00E+00	4.47E-09	3.82	days	n/a	100.00%
Po-218	1.33E-13	8.83E-16	4.76E-13	3.18E-15	3.10	min	150	0.13%
Pb-214	1.33E-13	4.91E-16	4.04E-12	1.50E-14	26.80	min	270	0.07%
Bi-214	1.32E-13	1.32E-15	3.00E-12	3.00E-14	19.90	min	100	0.19%
Po-214	1.33E-13	8.83E-16	4.13E-20	2.75E-22	164.30	microsec	150	0.13%
Pb-210	8.69E-14	3.22E-16	1.14E-06	4.21E-09	22.30	years	270	0.07%
Bi-210	8.67E-14	8.67E-16	6.99E-10	6.99E-12	5.01	days	100	0.19%
Po-210	8.60E-14	5.73E-16	1.91E-08	1.28E-10	138.38	days	150	0.13%
Pb-206	0.00E+00	0.00E+00	7.28E-07	2.70E-09	stable		270	0.07%
Pu-239	3.18E-09	5.79E-12	5.13E+01	9.32E-02	24,110	years	550	0.04%
U-235	1.08E-16	3.09E-18	5.01E-02	1.43E-03	703,800,000	years	35	0.55%
Th-231	1.09E-16	3.40E-20	2.05E-13	6.40E-17	25.52	hours	3200	0.01%
Pa-231	4.35E-20	7.90E-23	9.19E-10	1.67E-12	32,760.00	years	550	0.04%
Ac-227	1.31E-20	2.92E-23	1.81E-13	4.03E-16	21.77	years	450	0.04%
Th-227	1.31E-20	4.08E-24	4.25E-16	1.33E-19	18.72	days	3200	0.01%
Ra-223	1.30E-20	2.60E-23	2.54E-16	5.09E-19	11.44	days	500	0.04%
Rn-219	0.00E+00	6.75E-20	0.00E+00	5.19E-21	3.96	s	n/a	100.00%
Po-215	1.30E-20	8.67E-23	4.42E-25	2.94E-27	1.78	ms	150	0.13%
Pb-211	1.30E-20	4.82E-23	5.27E-19	1.95E-21	36.10	min	270	0.07%
Bi-211	1.30E-20	1.30E-22	3.12E-20	3.12E-22	2.14	min	100	0.19%
Tl-207	0.00E+00	6.75E-20	0.00E+00	3.54E-19	4.77	min	n/a	100.00%
Pb-207	0.00E+00	0.00E+00	0.00E+00	0.00E+00	stable		270	0.07%
Pu-240	1.27E-08	2.31E-11	5.60E+01	1.02E-01	6,564	years	550	0.04%
U-236	1.30E-14	3.72E-16	2.01E-01	5.74E-03	23,420,000	years	35	0.55%
Th-232	1.22E-23	3.82E-27	1.11E-07	3.48E-11	14,050,000,000	years	3200	0.01%
Ra-228	8.00E-24	1.60E-26	2.93E-17	5.86E-20	5.75	years	500	0.04%
Ac-228	8.00E-24	1.78E-26	3.58E-21	7.95E-24	6.15	hours	450	0.04%
Th-228	6.73E-24	2.10E-27	8.19E-18	2.56E-21	1.91	years	3200	0.01%
Ra-224	6.72E-24	1.34E-26	4.22E-20	8.43E-23	3.66	days	500	0.04%
Rn-220	0.00E+00	3.48E-23	0.00E+00	3.78E-23	55.60	s	n/a	100.00%
Po-216	6.71E-24	4.47E-26	1.86E-26	1.24E-28	0.15	s	150	0.13%
Pb-212	6.71E-24	2.49E-26	4.83E-21	1.79E-23	10.64	hours	270	0.07%
Bi-212	6.71E-24	6.71E-26	4.58E-22	4.58E-24	60.55	min	100	0.19%
Po-212	6.71E-24	4.47E-26	3.77E-33	2.51E-35	0.30	microsec	150	0.13%
Pb-208	0.00E+00	0.00E+00	0.00E+00	0.00E+00	stable		270	0.07%
Am-241	6.81E-09	3.58E-12	1.98E+00	1.04E-03	432.20	years	1900	0.01%
Np-237	2.50E-11	5.01E-12	3.56E+01	7.11E+00	2,144,000	years	5	3.71%
Pa-233	2.60E-11	4.72E-14	1.25E-06	2.27E-09	26.97	days	550	0.04%
U-233	6.44E-15	1.84E-16	6.67E-04	1.91E-05	159,200	years	35	0.55%
Th-229	3.08E-16	9.62E-20	1.45E-06	4.52E-10	7,340	years	3200	0.01%
Ra-225	3.08E-16	6.15E-19	7.90E-12	1.58E-14	14.90	days	500	0.04%
Ac-225	3.08E-16	6.84E-19	5.30E-12	1.18E-14	10.00	days	450	0.04%
Fr-221	0.00E+00	1.59E-15	0.00E+00	9.18E-15	4.90	min	n/a	100.00%
At-217	3.08E-16	6.84E-19	1.91E-19	4.25E-22	32.30	ms	450	0.04%
Bi-213	3.07E-16	3.07E-18	1.59E-14	1.59E-16	45.59	microsec	100	0.19%
Po-213	3.07E-16	2.05E-18	2.44E-24	1.62E-26	4.20	microsec	150	0.13%
Pb-209	3.08E-16	1.14E-18	6.67E-14	2.47E-16	3.25	hours	270	0.07%
Bi-209	0.00E+00	0.00E+00	4.38E-09	4.38E-11	Stable		100	0.19%
Total	5.85E-05	3.43E-05	6.73E+02	6.05E+01				

When one examines the partition coefficient data for these two nuclides, a significant difference exists. The K_d value for ^{137}Cs in sand is 280 $mL\ g^{-1}$ while the K_d value for ^{137m}Ba in sand is 0.4 $mL\ g^{-1}$. The percent of contaminant adsorbed onto the sand follows the following equation:

$$\text{Percent Sorbed} = 100 - \frac{100V_l}{K_d M_s + V_l} \tag{2}$$

Where,

V_l = volume of liquid in sandpad (7,950,000 ml)

M_s = mass of sand in the sandpad (41,200,000 g)

K_d = distribution coefficient

This function is shown in Figure 9. As one can see, the amount of contaminate adsorbed varies greatly between the values of $K_d = 0.001$ and $K_d = 1$. Even at a relatively low K_d of 100, nearly all of the contaminant is adsorbed in the sand. This is due to the geometry of the vault system. When using units consistent with the given K_d values, an order of magnitude difference exists between the mass of sand present in the vault system (41,200,000 g sand) and the amount of liquid present in the sandpad at saturation (7,950,000 ml). Consequently, there is so much sand that only species with a very low K_d (at K_d = 10ml g^{-1} over 98% of the species are adsorbed) can pass through in the liquid phase in significant amounts.

If one considers the effect of repeatedly saturating and draining the contaminated sandpad with deionized water (i.e. washing). The following relation can be derived:

$$\text{Percent Released} = 100 - \frac{100K_d M_s}{K_d M_s + V_l} \tag{3}$$

Where,

V_l = volume of liquid in sandpad (7,950,000 ml)

M_s = mass of sand in the sandpad (41,200,000 g)

K_d = distribution coefficient

This function is shown in Figure 10. As one can see, once the contaminates are adsorbed, extremely low K_d (i.e. below K_d = 10 ml g^{-1}) values are needed to remove significant amounts of contaminant.

Therefore, one has to look for situations in a decay chain where a high K_d (i.e. over K_d = 10 ml g^{-1}) species is initially adsorbed on the sand and decays to a species with a low K_d (i.e. below K_d = 10 ml g^{-1}) is then washed and removed in a significant quantity. From Tables 3 and 4, we see that this situation does exist.

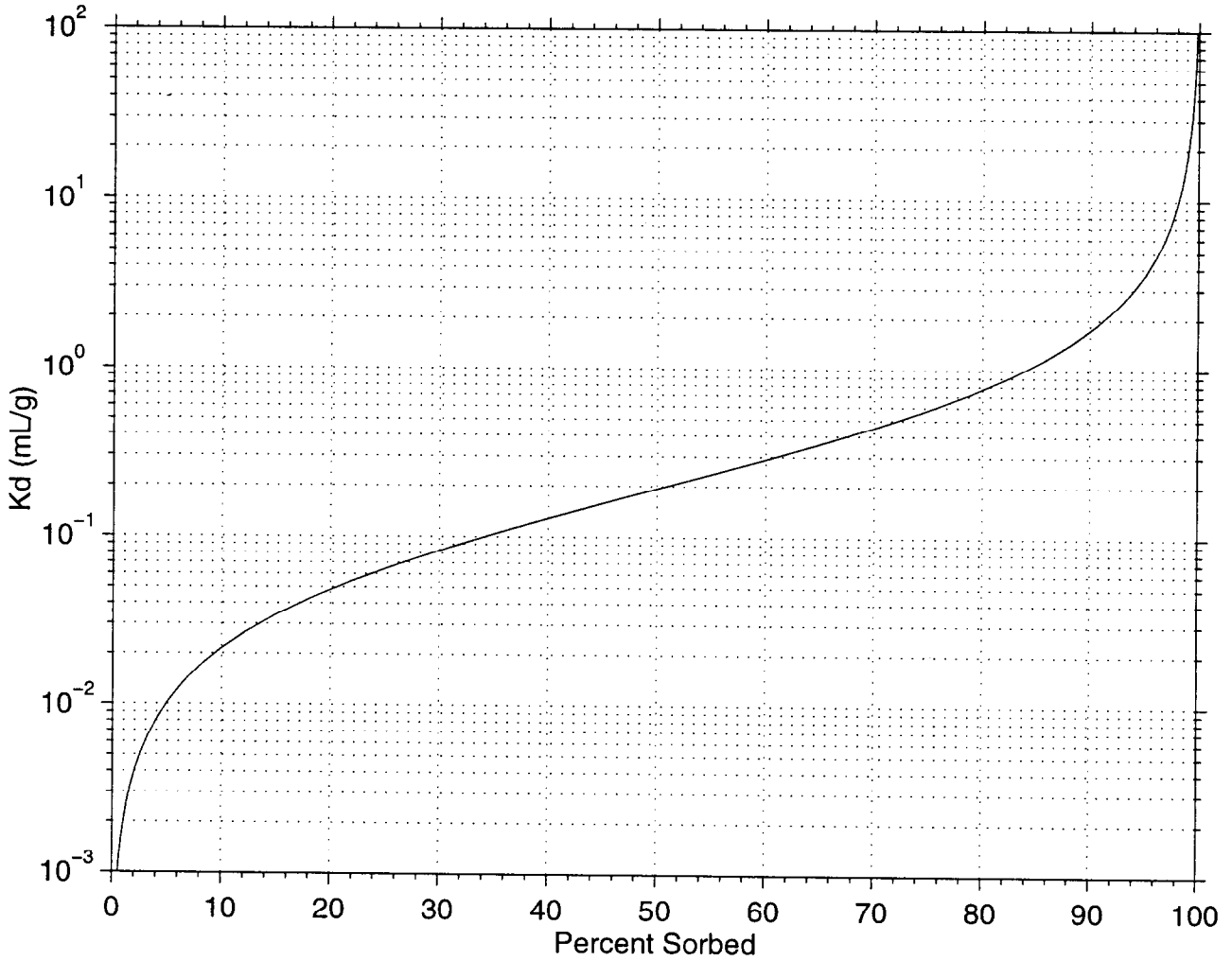


Figure 9: Sensitivity of Percent Sorbed to K_d

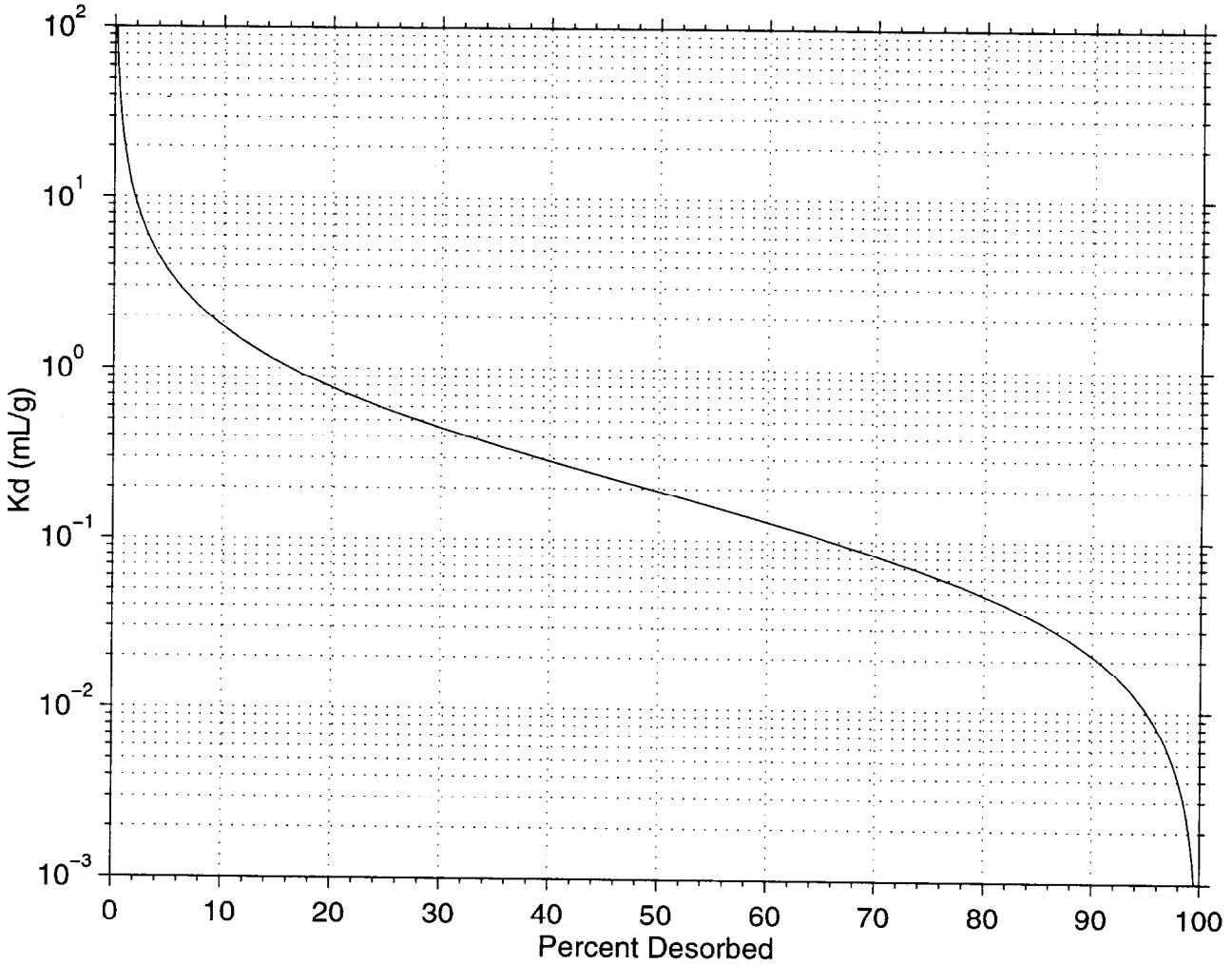


Figure 10: Sensitivity of Washing to K_d

For the case of Cesium decaying to Barium, most of the Cesium present in the initial contamination event sorbed on the sand (due to high K_d value). As the ^{137}Cs decays on the sand (relatively fast with a half-life of 30 years), it forms ^{137m}Ba. Barium has the chemical property of a low K_d value and some of it is released into the liquid phase (approximately 30% of the Barium is released per washing). The metastable Barium then decays to stable ^{137}Ba at a fast rate (half-life of 2.55 min) and remains in the liquid phase as stable Barium. This is very significant because ^{137}Cs has orders of magnitude more activity than other species present in the initial contamination (see Table 2).

The case of ^{241}Am decaying to ^{237}Np represents a similar situation. However, ^{237}Np still has a high enough K_d (5 ml g^{-1}) that only a very large quantity of water could remove the contamination (approximately 4% of the ^{237}Np is released per washing).

The other decay chains contain species that the distribution coefficient is not known. In our simulations, these K_d values were assumed to be zero (i.e. any water would remove all of the particular species). Fortunately, these nuclides are daughters of long-lived species and have relatively short half-lives. Therefore, these nuclides exist in very low concentrations. These nuclides also have decay products with relatively large K_d values. Therefore, even with this liberal assumption the vault system would have to be constantly flushed with water for billions of years for the nuclides to be removed through this route.

When the liquid in the vault is purged, a high-activity liquid is removed. This high-activity liquid may trip various process alarms in the tank farm. This is consistent with data given by tank farm operations personnel. At this point it is beneficial to evaluate the activity of the liquid removed from the WM-185 and WM-187 vault systems at various times (see Figures 11 and 12) It is now apparent that most of the activity in the liquid phase is due to ^{137m}Ba, which decays rapidly. Consequently, the liquid activity reduces an order of magnitude in approximately 30 minutes. The activity of the liquid from this point forward is due to nuclides with a longer half-life. Hence, the liquid activity will remain at that level for quite some time.

4 Conclusion

Our investigation revealed the following:

- The sensitivity analysis (see Figure 9) shows that at a K_d of 10 $\frac{\text{ml}}{\text{g}}$ over 98% of the contaminates are absorbed. Since most of the contaminates have a K_d significantly greater than this level, we can expect most of the species to remain adsorbed to the sand despite multiple washings.

- A situation exists where a short-lived species (^{137}Cs) adsorbs on the sand surface. As the Cesium decays into ^{137m}Ba, it is released in to the liquid phase. This metastable Barium species has a very short half-life and has an activity nearly as large as its parent ^{137}Cs. When the liquid phase is drained from the vault system, the metastable Barium is removed. Since Cesium was the primary contaminant involved in these

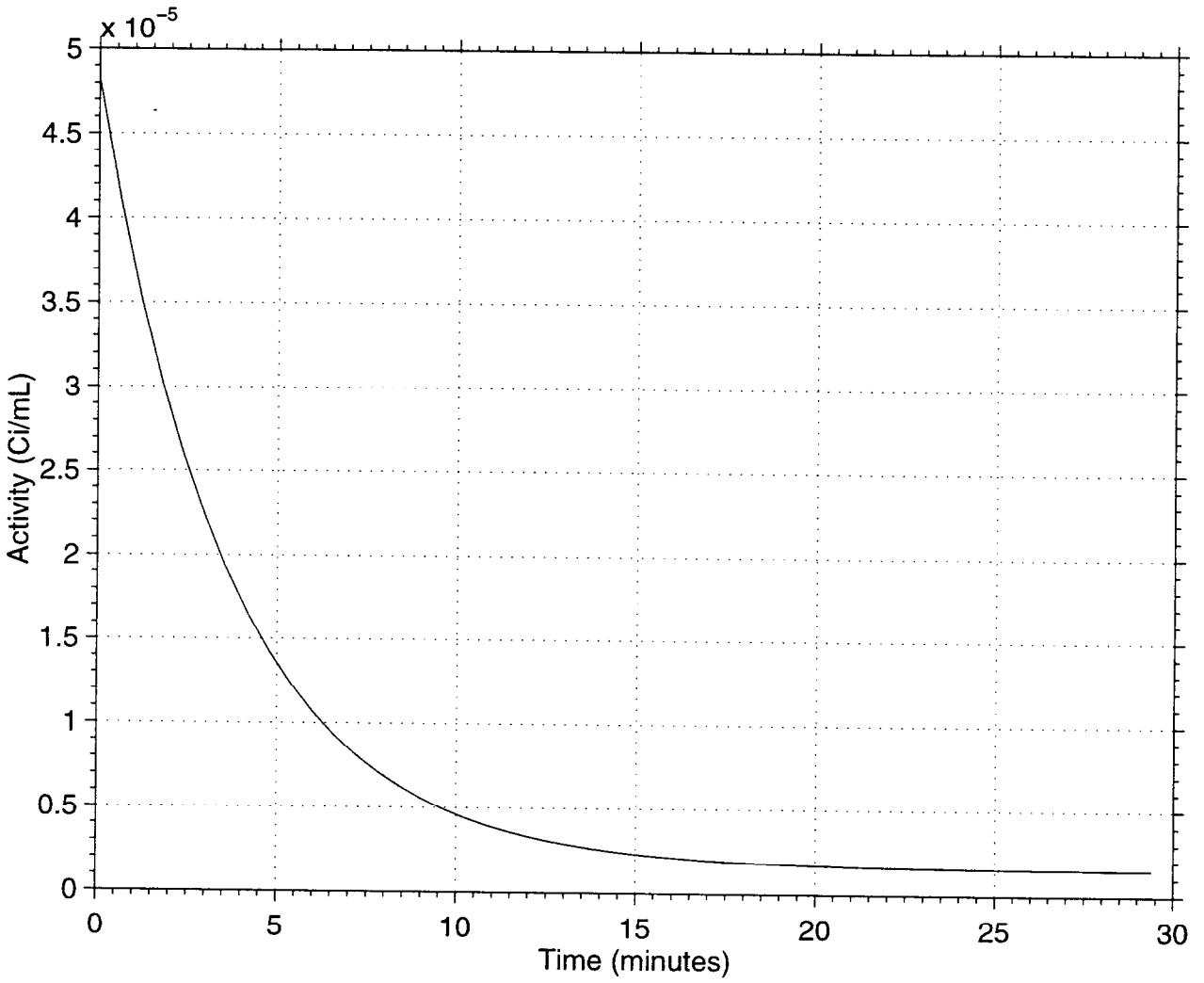


Figure 11: Activity of Liquid Purged from WM-185 Vault at Various Times

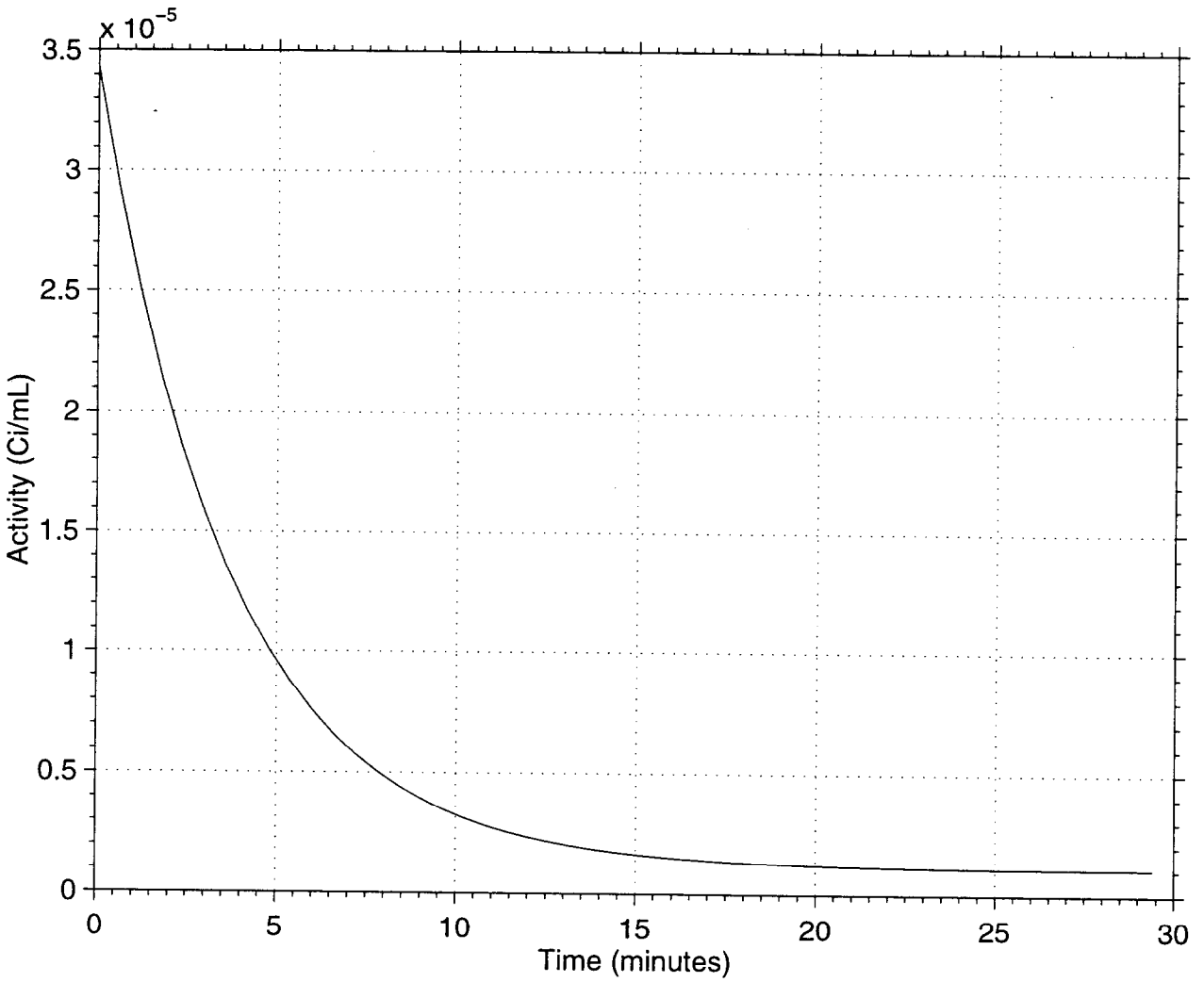


Figure 12: Activity of Liquid Purged from WM-187 Vault at Various Times

contamination events, the liquid phase has a relatively high activity. However, this activity is short-lived and decays to a much lower level in a few hours.

- If the sand remains saturated with water for a significant period of time, the total concentration of Barium in the system will grow due to decay. As this concentration grows the corresponding quantity of Barium absobed on the sand will also increase by the equation $K_d S = C$. Since the total amount of radioactive Barium remains relatively constant, the change in sorption capacity may lower the amount of radioactive Barium leached from the system. Therefore, under some circumstances, the total activity of the liquid may be significantly higher than previous instances with no additional contamination added to the system. Liquid activity may not be a good indication of the extent of contamination due to this variation.

- After 38 years of decay and washing a significant amount of the Cesium in the original contamination has been removed as Barium. The simulation shows that the Barium concentration in the liquid drainage should be approximately 60 mg/l for WM-185 and 43 mg/l for WM-187. While this concentration is below the RCRA characteristic hazard limit of 100 mg/l for Barium, the potential for exceeding the RCRA Barium Toxicity Limit exists. If the sandpad is washed for several hundred more years, a significant amount of Barium should continue to be removed.

- As part of our investigation, vault characterization data was discovered from sump sampling activities in the 1970's (see Table 5). As expected this data confirms that a relatively high activity liquid phase was present in vaults WM-185 and WM-187. However, these data also indicate that vaults WM-182, WM-183, WM-184, WM-188 may have also been significantly contaminated [6]. These vaults may have been contaminated through drainlines that connect valveboxes to the vaults as a secondary containment system [4].

- Recently, Dan Staiger used his process knowledge to estimate the total activity of a tank at time of closure. This report was intended to be used as an upper bound source term. For this reason, the activity levels for the contaminated sandpad in the Staiger report are conservative and the total activity of his bounding case is several orders of magnitude higher than this EDF. Although the Staiger report does not attempt to model the sandpad washing discussed above, this EDF shows that nearly all of the contaminates are absorbed on the sand and will not be removed with repeated washing, thus validating Staiger's estimates. Please note that Staiger's estimates for the activity of ^{90}Sr, ^{90}Y, ^{137}Cs, and ^{137m}Ba account for 98.90% of the total estimate. This EDF predicts that the activities of these nuclides in the sandpad would amount to 99.95% of the total activity. The difference is attributed to the fact that the Plutonium activity used in the Staiger report are much higher than in this EDF. Of these nuclides, only ^{137m}Ba has a small enough K_d value to be released in the liquid due to washing. Approximately 25% of the total activity in Staiger's report and this EDF is attributed

Table 5: Historical Vault Liquid Activity, Ci/ml

Tank	Date	Co-60	Nb-95	Zr-95	Ru-106	Sb-125	Cs-134	Cs-137	Ce-144	Eu-154	Location
WM-182	10/30/1973						7.57E-08	2.09E-05	1.25E-07	9.65E-08	South Sump
	10/13/1975	4.44E-10						2.78E-10			n/a
WM-183	5/17/1974	1.59E-07	4.16E-07	3.05E-06	1.34E-05		1.26E-05	6.97E-05	8.05E-05	9.97E-07	South Sump
WM-184	10/19/1973							2.95E-09			Soth Sump
WM-185	9/5/1973						4.38E-07	2.49E-05	1.63E-06	7.38E-08	South Sump
	12/30/1976					6.27E-06	1.85E-05	4.37E-04		4.16E-06	South Riser
WM-187	8/23/1974	1.19E-08					3.49E-07	5.49E-06			North Sump
	7/7/1975	1.40E-09	3.91E-09	2.26E-09	4.77E-08	1.74E-08	1.06E-07	1.61E-06	3.20E-07	8.65E-09	North Sump
	8/13/1976						2.49E-08	6.42E-07			North Sump
WM-188	11/3/1972							2.95E-08			n/a
	11/10/1972							2.89E-08			n/a
	7/8/1975	6.90E-10	4.98E-09	3.25E-09	1.32E-07	5.01E-08	4.22E-08	3.18E-07	6.95E-07	1.02E-08	South Sump
	8/13/1976	3.23E-10					1.24E-08	1.49E-07	7.38E-09	3.72E-10	South Sump
	4/24/1979						5.14E-08	1.14E-06			n/a
WM-189	8/31/1973							5.00E-10			n/a
	1/16/1974	Cs-137 < 0.04 dps/ml									Cold Sump
	2/1/1974	none detected									Cold Sump
	3/25/1974						5.41E-12	5.68E-11			Cold Sump
	5/14/1974						5.41E-12	5.41E-11			Cold Sump
	7/18/1974						1.89E-11	2.32E-10			Cold Sump
	4/28/1975	none detected									Cold Sump
	5/22/1975							2.15E-11			Cold Sump
	6/12/1975							5.16E-11			Cold Sump
	8/19/1975						4.32E-12	7.24E-11			Cold Sump
	3/22/1976							7.69E-10			Cold Sump
WM-190	7/2/1973	none dectected									Cold Sump
	9/26/1973	none dectected									
	12/26/1973	none dectected									Cold Sump
	1/28/1974	none dectected									Cold Sump
	3/14/1974	none dectected									Cold Sump
	4/25/1974	none dectected									Cold Sump
	3/11/1975	none dectected									Cold Sump
	3/25/1975	none dectected									Cold Sump
	3/28/1975							9.73E-11			Cold Sump
	3/30/1975	none dectected									n/a
	4/28/1975							4.14E-12			Cold Sump
	5/22/1975							6.78E-12			Cold Sump
	6/12/1975							9.43E-12			Cold Sump
	7/18/1975	none dectected									Cold Sump
	3/17/1976	none dectected									n/a

to ^{137m}Ba. In short, Saiger's assumption of all of the contamination remaining in the sandpad seems reasobable with the Cesium to Barium decay chain being the siginificant execption.

- This report attempts to use the best available literature data to gain insight on the partitioning of chemical species in the tank vault sandpad. For a number of reasons discussed above, application of this data typically yields unreliable results. To gain a better understanding of the contamination in the sandpad, sorption experiments on sand media similiar to that in the sandpad could be conducted in a laboratory environment. A higher level of reliability can be achieved by analyzing multiple sandpad samples. These samples could be either the sand itself or water could be introduced in the tank vault and liquid samples could be taken from the vault sump system. These samples could then be analyzed for a number of radioactive and RCRA species.

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EDF-015722-047

ENGINEERING DESIGN FILE

1. Project File No. 15722 2. Project/Task Tank Farm Closure

3. Subtask Process

4. Title: Wash/Pump Simulation

5. Summary: This EDF attempts to simulate the effects of the various washball washing/tank preparation steps just prior to grouting. With a goal of raising the tank heel pH to above 2.0, the amount of washwater added to the system was 37,000 gal for WM-182 and 66,000 gal for WM-183 for constant volume washing. Adding a control system that keeps a 2 in height of water throughout the washing results in a washwater volume of 30,000 gal for WM-182 and 35,000 gal for WM-183. To minimize the amount of washwater added to the tanks, one would need to apply a control law that kept the agitated phase solids concentration just below the level needed to plug the transfer lines. Currently, we do not know this concentration. However, this is something that may be investigated during the planned tank washing mockup. During these mockups, we also hope to obtain some tank washing results that could be used to fit the key parameters in this model. Please note, all of the simulations resulted in a final slurry layer height of 1.0 in or below. With this height of solids in the tanks, the amount of grout needed to produce a class C waste is estimated at a 5.6 ft. layer. This grout volume is very dependent on the Pu-238 activity in the solids (the total liquid phase activity has little effect). Also, an estimate for the total amount of TRU solids, HLW glass, or class C grout produced if the solids are dried, vitrified, or grouted is discussed. At the lower end, approximately 600, 55 gal drums of dried TRU solids would be need to be disposed at WIPP. 340, 0.7 cubic meter HLW glass canisters would need to be disposed at the national repository. While 42,000, 55 gal drums of class C grout would need to be disposed at a LLW disposal site. Again these numbers are highly dependent on Pu-238 activity and the solids in the other tanks should be fully characterized to refine these data. Finally, an evaluation of the cost versus performance of adding an additional decontamination step is performed. This step involved using a robotic arm similar to the LDUA to remove half the remaining activity from the tank farm after using the washball. This additional step creates an enormous cost while removing a relatively small amount of activity.

6. Distribution (complete package):

Distribution (summary package only):

7. Review (R) and Approval (A) Signatures: (Minimum reviews and approvals are listed. Additional reviews/approvals may be added as necessary.)

	R/A	Printed Name	Signature	Date
Author	R	Adam Poloski	Adam Poloski	10/30/00
Technical Review	R	Edward Wagner	Edward Wagner	10/30/00
Requestor	A	Edward Anderson	Edward Anderson	10/31/00

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1 Washball Simulation

This section will attempt to quantify the amount of solids remaining in WM-182 and WM-183 after performing the various tank washing/preparation steps and just prior to grout placement under conservative assumptions. The various tank-washing steps have a goal of increasing the tank heel to a pH above 2.0. Our goal is to create a model that can be adjusted to various real-world (i.e. mockup) results to give a good approximation of the effect of operating the washball on the tank system. A couple of washing regimes will be tested in order to reduce the total amount of new liquid added to the tank farm system.

1.1 Washball Simulation: Theory

Estimating the amount of solids that will leave the system during prewash/wash operations involves creating a model for the tank system (see Figure 1). The model consists of three tanks, one representing the solids in the slurry phase, one representing the liquid in the slurry phase, and one representing the remaining liquid in the tank. During wash ball operation the solid phase is agitated and the solids enter the liquid phase. Simultaneously, the solids in the liquid phase are settling into the slurry phase such that the liquid fraction in the slurry phase consists of liquid from the liquid phase.

1.1.1 Washball Simulation: Balance on Tank 1

Overall Balance We begin by using the general mass balance equation:

$$Accumulation = In - Out \tag{1}$$

The mass of solids in tank 1 is:

$$m_1 = V_1 \rho_1 \tag{2}$$

where,

V_1 is the volume of the solids in the slurry

ρ_1 is the density of the solids

Differentiating with respect to time yields:

$$\frac{\mathrm{d}m_1}{\mathrm{d}t} = \rho_1 \frac{\mathrm{d}V_1}{\mathrm{d}t} \tag{3}$$

The above equation represents the *Accumulation* term. The *In* term is due to the settling of solids and is should be proportional to the concentration of solids in the liquid phase.

$$In = K_1 A_2 \tag{4}$$

where,

K_1 is a proportionality term (discussed later)

A_2 is the concentration of the solids in tank 2

The *Out* term is due to the agitation of the solids and is should be proportional to the volume of the slurry in the tank.

$$Out = K_2 V_1 \tag{5}$$

where,

K_2 is a proportionality term (discussed later)

Substituting all of these terms leads to the following differential equation:

$$\boxed{\frac{\mathrm{d}V_1}{\mathrm{d}t} = \frac{K_1}{\rho_1} A_2 - \frac{K_2}{\rho_1} V_1} \tag{6}$$

1.1.2 Washball Simulation: Balance on Tank 2

Overall Balance Again we use the mass balance equation (see Equation 1). The accumulation term in this instance is shown below:

$$m_2 = V_2 \rho_2 \tag{7}$$

where,

V_2 is the volume of the liquid phase

ρ_2 is the density of the liquid phase

Differentiating with respect to time yields:

$$\frac{\mathrm{d}m_2}{\mathrm{d}t} = \rho_2 \frac{\mathrm{d}V_2}{\mathrm{d}t} + V_2 \frac{\mathrm{d}\rho_2}{\mathrm{d}t} \tag{8}$$

The above equation represents the *Accumulation* term. The *In* term is due to the in flow and the agitation of the slurry.

$$In = \rho_{in} \nu_{in} + K_2 V_1 + \psi K_2 V_1 \tag{9}$$

where,

ρ_{in} density of the inflow (water)

ψ the mass ratio of liquids to solids in the slurry phase

ψ can be related to the volume fraction of liquid in the slurry through the following equation:

$$\psi = \frac{\phi}{1-\phi}\frac{\rho_{in}}{\rho_1} \tag{10}$$

where,

ϕ volume fraction of liquid in the slurry

In the above equation and throughout this EDF, we assume that the density of the liquid is close to that of water.

The Out term is due to the settling of the solids and the outlet flow:

$$Out = \rho_2\nu_{out} + K_1A_2 + \psi K_1A_2 \tag{11}$$

where,

ν_{out} represents the outflow

Substituting all of these terms leads to the following differential equation:

$$\rho_2\frac{\mathrm{d}V_2}{\mathrm{d}t} + V_2\frac{\mathrm{d}\rho_2}{\mathrm{d}t} = (1+\psi)K_2V_1 + \rho_{in}\nu in - (1+\psi)K_1A_2 - \rho_2\nu_{out} \tag{12}$$

At this point we need to find an expression for the average density of tank 2. We begin by assuming the density of water is close to that of the liquid in the tank. With this assumption we can use the following expression for a binary system:

$$\frac{1}{\rho_2} = \frac{X_A}{\rho_1} + \frac{1-X_A}{\rho_{in}} \tag{13}$$

where,

X_A weight fraction of solids in liquid phase

$$X_2 = \frac{A_2}{\rho_2} \tag{14}$$

At this point we can solve for ρ_2:

$$\rho_2 = \rho_{in} + \left(1 - \frac{\rho_{in}}{\rho_1}\right)A_2 \tag{15}$$

or,

$$\rho_2 = \rho_{in} + \Delta\rho A_2 \tag{16}$$

So this equation relates the density of the liquid phase to the concentration of solids in the liquid phase. Taking the derivative with respect to time yields:

$$\frac{\mathrm{d}\rho_2}{\mathrm{d}t} = \Delta\rho\frac{\mathrm{d}A_2}{\mathrm{d}t} \tag{17}$$

Substituting this derivative into the differential equation we previously derived gives,

$$\boxed{(\rho_{in} + \Delta\rho A_2)\frac{\mathrm{d}V_2}{\mathrm{d}t} + \Delta\rho V_2\frac{\mathrm{d}A_2}{\mathrm{d}t} = (1+\psi)K_2V_1 - (1+\psi)K_1A_2 + \rho_{in}\nu_{in} - (\rho_{in} + \Delta\rho A_2)\nu_{out}} \tag{18}$$

Solids Balance Mass of solids in tank 2:

$$m_{A2} = V_2 A_2 \tag{19}$$

$$Accumulation = \frac{\mathrm{d}m_{A2}}{\mathrm{d}t} = A_2 \frac{\mathrm{d}V_2}{\mathrm{d}t} + V_2 \frac{\mathrm{d}A_2}{\mathrm{d}t} \tag{20}$$

$$In = K_2 V_1 + A_{in} \nu_{in} \tag{21}$$

$$Out = K_1 A_2 + A_2 \nu_{out} \tag{22}$$

where,

A_{in} Concentration of solids in inflow (assumed to be zero)

Combining in a mass balance yields:

$$\boxed{A_2 \frac{\mathrm{d}V_2}{\mathrm{d}t} + V_2 \frac{\mathrm{d}A_2}{\mathrm{d}t} = K_2 V_1 + A_{in} \nu_{in} - K_1 A_2 - \nu_{out} A_2} \tag{23}$$

Balance on Ionic Species in Tank 2

$$Accumulation = \frac{\mathrm{d}m_{B2}}{\mathrm{d}t} = B_2 \frac{\mathrm{d}V_2}{\mathrm{d}t} + V_2 \frac{\mathrm{d}B_2}{\mathrm{d}t} \tag{24}$$

$$In = B_{in} \nu_{in} + \frac{\psi K_2}{\rho_2} V_1 B_3 \tag{25}$$

$$Out = B_2 \nu_{out} + \frac{\psi K_1}{\rho_2} A_2 B_2 \tag{26}$$

Combining in a mass balance yields:

$$\boxed{\frac{\mathrm{d}B_2}{\mathrm{d}t} = \frac{B_{in} \nu_{in}}{V_2} + \frac{\psi K_2 V_1 B_3}{\rho_2 V_2} - \frac{B_2 \nu_{out}}{V_2} - \frac{\psi K_1 A_2 B_2}{\rho_2 V_2} - \frac{B_2}{V_2} \frac{\mathrm{d}V_2}{\mathrm{d}t}} \tag{27}$$

where,

B_{in} Concentration of ionic species in inflow (assumed to be zero)

B_2 Concentration of ionic species in tank 2

B_3 Concentration of ionic species in tank 3

1.1.3 Washball Simulation: Balance on Tank 3

Overall Balance The mass of tank 3:

$$m_3 = V_3 \rho_{in} \tag{28}$$

where,

V_3 is the volume of the liquid in the slurry

ρ_{in} is the density of the liquid phase

Differentiating with respect to time yields:

$$Accumulation = \frac{\mathrm{d}m_3}{\mathrm{d}t} = \rho_{in}\frac{\mathrm{d}V_3}{\mathrm{d}t} \tag{29}$$

$$In = \psi K_1 A_2 \tag{30}$$

$$Out = \psi K_2 V_1 \tag{31}$$

Substituting all of these terms leads to the following differential equation:

$$\boxed{\frac{\mathrm{d}V_3}{\mathrm{d}t} = \frac{\psi K_1}{\rho_{in}} A_2 - \frac{\psi K_2}{\rho_{in}} V_1} \tag{32}$$

Balance on Ionic Species in Tank 3

$$Accumulation = \frac{\mathrm{d}m_{B3}}{\mathrm{d}t} = B_3\frac{\mathrm{d}V_3}{\mathrm{d}t} + V_3\frac{\mathrm{d}B_3}{\mathrm{d}t} \tag{33}$$

$$In = \frac{\psi K_1}{\rho_{in}} A_2 B_2 \tag{34}$$

$$Out = \frac{\psi K_2}{\rho_{in}} V_1 B_3 \tag{35}$$

Combining in a mass balance yields:

$$\boxed{\frac{\mathrm{d}B_3}{\mathrm{d}t} = -\frac{\psi K_2 V_1 B_3}{\rho_{in} V_3} + \frac{\psi K_1 A_2 B_2}{\rho_{in} V_3} - \frac{B_3}{V_3}\frac{\mathrm{d}V_3}{\mathrm{d}t}} \tag{36}$$

1.1.4 Washball Simulation: Settling and Agitation Constants

The flux of solids settling to the slurry phase can be written as,

$$Settling = A_2 A_t v_s \tag{37}$$

where,

A_t area of the tank bottom

v_s average settling velocity of the agitated solids

Therefore,

$$K_1 = A_t v_s \tag{38}$$

The flux of solids agitated due to washing can be written as,

$$Agitation = \rho_1 v_b A_b \tag{39}$$

where,

v_b average velocity of wash ball jet as it traverses the bottom of the tank

A_b cross sectional area of solids directly effected by wash ball jet

A_b can be estimated as follows,

$$A_b = (2R_b)h_1 \tag{40}$$

where,

R_b radius which jet agitates the solids (radius of influence)

h_1 height of solids in tank 1

Therefore,

$$K_2 = \frac{2\rho_1 v_b R_b}{A_t} \tag{41}$$

1.1.5 Washball Simulation: Numerical Simulation

We now have a system of 6 nonlinear ODEs and 6 unknown variables. The unknown variables are,

1. V_1
2. V_2
3. V_3
4. A_2
5. B_2
6. B_3

The corresponding ODEs include,

1. Equation 6
2. Equation 18
3. Equation 32
4. Equation 23
5. Equation 27
6. Equation 36

If we define the significant constants as:

$$v_s = 0.05 \frac{\text{ft}}{\text{min}} \tag{42}$$

Based on observations from RAL analysts, the heel samples took on the order of a half-hour before the agitated sample clears (in approximately 6 in of solution). A particle with the above velocity would take 10 minutes to settle 6 in. Therefore, this settling velocity assumption appears to be somewhat conservative and will result in more solids staying in the tank during our simulation.

$$v_b = 4(2\pi)30 \ \frac{\text{ft}}{\text{min}} = 734 \ \frac{\text{ft}}{\text{min}} \tag{43}$$

Based on discussions with the wash ball design team, the wash ball should rotate around the tank at a rate about 4rpm. The wash ball will sit approximately 20ft from the bottom if

the tank. Therefore an average distance that the jet has to travel to reach the tank bottom is approximately 30feet. this simulation uses the conservative value of:

$$v_b = 140\ \frac{\text{ft}}{\text{min}} \tag{44}$$

Other discussions with the wash ball design team revealed that at the inflow of 65 $\frac{\text{gal}}{\text{min}}$ (our operating conditions) the total time for the jet to cover the entire tank is approximately 15min. Based on this figure a conservative estimate for the wash ball effective radius can be computed. We begin with the following equation,

$$2R_b(t_w v_b) = A_t \tag{45}$$

The wash ball jet is assumed to effect a nearly rectangular area over the washing period. The width of this area is $2R_b$ while the length of this area is $t_w v_b$. Where t_w is the wash time (14min). By definition this area should equal the area of the bottom of the tank. Consequently R_b can be conservatively estimated as,

$$R_b = \frac{A_t}{2t_w v_b} \tag{46}$$

This equation gives a radius of influence equaling 0.25 ft or 3.00 in.

The specific gravity of the solids was observed to be 1.88. Therefore, the density of the solids is shown below,

$$\rho_1 = 118.6\frac{\text{lbs}}{\text{ft}^3} \tag{47}$$

The liquid fraction in the slurry was observed to be 0.731.

$$\phi = 0.731 \tag{48}$$

1.1.6 Washball Simulation: Closure Sequence Description

We now need to define the initial conditions of this initial value problem. From video footage of WM-182 and WM-183, we see that the slurry level in the heel is approximately 4 in and 8 in respectively. This equates to an initial slurry volume of approximately 4,900 gal for WM-182 and 9,800 gal for WM-183. The tanks also contain an amount of freestanding liquid. The total heel height is then approximately 6 in for WM-182 and 10 in for WM-183. This equates to an total initial heel volume of approximately 7,350 gal for WM-182 and 12,250 gal for WM-183.

After discussions with tank farm operations personnel, our current closure plan tank preparation involves the following steps with the goal of increasing the liquid phase pH to slightly above 2.0 after the first washing (the existing steam jets will need to be modified such that the suction heights can be adjusted in order to prevent the jets drawing material directly from the settled sludge):

1. Remove the standing liquid layer (Drain #1)
   - Remove as much liquid waste as possible
2. Operate washball with outlet jet off (Fill #1)
   - Agitates system and creates a liquid layer for outlet jet to draw off
3. Operate washball with outlet jet on(Wash #1)
   - Removes agitated solids and raises pH to above 2
4. Let the solids settle (Settle #1)
   - Allow the 2 phases to separate
5. Fill the tank with 285,000 gal of basin water (Fill #2)
   - Possibel requirement from tank farm operations
   - May dilute liquid phase
6. Remove the liquid layer to the top of the slurry (Drain #2)
   - Remove as much liquid waste as possible
7. Operate washball with outlet jet off (Fill #3)
   - Agitates system and creates a liquid layer for outlet jet to draw off
8. Operate washball with outlet jet (Wash #2)
   - Cleans walls, removes agitated solids and liquid waste
9. Let the solids settle for (Settle #2)
   - Allow the 2 phases to separate
10. Remove the liquid layer to the top of the slurry (Drain #3)
    - Remove as much liquid waste as possible

Please note that the concentration of species in the water used in each of these steps is assumed to be negligible to the concentration of the species in the tank heel liquid. Also, the operating procedure of the washball is currently not well defined. Therefore, assumptions were made in this EDF to attempt to maximize the removal of the solids.

Lastly, a conservative assumption that no diffusion between the liquid in the sludge and the standing liquid layer is made in these simulations. This assumption is substantiated by INEEL personnel who made the following observation:

> I propose that we use the wash ball to perform these dilution flushes rather than transfer-in and then transfer-out as we have done in the past. This way we will get some mixing. The simple dilution algorithm as described won't represent what is going to happen in the tank. I can explain this in a real life example. In tank WM-182 we had analysis of Cs-137 at 460 mCi/L then the tank was emptied to heel level. Following this some volume adjustments were made over a 3-year period as represented in the attached power-point file. Knowing the composition of the other tanks involved an adjusted composition assuming mixing was calculated to be 50 mCi/L Cs-137. Subsequent analysis results from October and November 1999 are 150 mCi/L Cs-137. So instead of dilution by a factor of 10 we only achieved a dilution by a factor of 3.

Since system discussed above was allowed to equilibrate on the order of months between the volume adjustments, it appears as if the system was non-homogeneous and the diffusion rate was very slow. Therefore, this non-diffusion assumption appears to be validated.

1.2 Washball Simulation: Analysis

The nonlinear system described above was solved numerically with a 5-th order Runge-Kutta method. The solution results for each step of the tank preparation sequence for WM-182 are shown in Figures 2-11. When these steps are combined the results are shown in Figures 12-15. Finally, plots showing the initial and final status of the tank for each sequence step are shown in Figures 16-19.

The solution results for each step of the tank preparation sequence for WM-183 are shown in Figures 20-29. When these steps are combined the results are shown in Figures 30-33. Finally, plots showing the initial and final status of the tank for each sequence step are shown in Figures 34-37.

Since this system is non-reacting in nature, we can use effectiveness factors to compute final compositions from an initial tank inventory. As new analytical laboratory data becomes available, the effectiveness factor can be applied to the data to obtain a new final composition. The effectiveness factor is defined as:

$$\text{Effectiveness Factor} = \frac{\text{Final Amount in Tank}}{\text{Initial Amount in Tank}} \tag{49}$$

The effectiveness factor for material remaining after each sequence step for WM-182 and WM -183 is shown in Table 1.

From Table 1, one can see that about 23,000 gal are needed to wash the sludge to an approximate pH of 2.0 for WM-182 and approximately 63,000 gal are needed for WM-183. This equates to a wash time of about 5 hr 45 min for WM-182 and 16 hr for WM-183. Minimizing the amount of new waste added to the tank farm and amount of time needed for washing should be of great importance to this project.

In an attempt to optimize the washing process, a control system could be added to control the flowrate of the steamjet or the washball. This control system would try to keep the initial

volume of 2 inches of water above the sludge layer constant throughout the washing. As solids are removed and the sludge volume drops the amount of tank heel will also drop. Making the volume of heel smaller in the tank gives a more concentrated outflow and minimizes the amount of time needed to reach a pH of 2.

The control law we shall use in the following simulations is shown below:

$$\nu_{in} = \nu_{out}\left(\frac{A_{2c} - A_2}{A_{2c}}\right) \tag{50}$$

From the above control law, it is apparent that one must monitor the concentration of agitated solids in the tank. Since the concentration of solids in the tank is the same as the concentration of solids in the outflow, one can add a sonic solids concentration sensor to the outlet pipe for the necessary measurements. The control law also has the behavior of when $A_2 \rightarrow 0$ then $\nu_{out} \rightarrow \nu_{in}$ and when $A_2 \rightarrow A_{2c}$ then $\nu_{out} \rightarrow \infty$. The variable A_{2c} is defined as the solids concentration in the slurry phase and is shown below:

$$A_{2c} = (1-\phi)\rho_1 = (0.27)(118.6)\,\frac{\text{lbs}}{\text{ft}^3} = 32.0\,\frac{\text{lbs}}{\text{ft}^3} \tag{51}$$

With this control law in place, the solution results for each step of the tank preparation sequence for WM-182 are shown in Figures 38-47. When these steps are combined the results are shown in Figures 48-51. Finally, plots showing the initial and final status of the tank for each sequence step are shown in Figures 52-55.

With the control law in place, the solution results for each step of the tank preparation sequence for WM-183 are shown in Figures 56-65. When these steps are combined the results are shown in Figures 66-69. Finally, plots showing the initial and final status of the tank for each sequence step are shown in Figures 70-73.

The effectiveness factor for material remaining after each sequence step for WM-182 and WM -183 with the improved control law is shown in Table 2.

From Table 2, one can see that about 17,000 gal are needed to wash the sludge to an approximate pH of 2.0 for WM-182 and approximately 29,000 gal are needed for WM-183. This equates to a wash time of about 4 hr 15 min for WM-182 and 7 hr 15 min for WM-183.

1.3 Washball Simulation: Conclusions

Table 3 compares the amount of wash water needed for the first washing. One can see that a 46.6% for WM-182 and 32.4% for WM-183 decrease in wash-water volume and wash-time is realized through the addition of this control system.

For the improved washing technique, the washball flowrate varies based on the suspended solids in the outflow. Based on our simulations, the washball flowrate in WM-183 would vary as shown in Figure 74. To achieve this type of flow rate a control system similar to the one shown in Figure 75 may be employed.

Ideally, minimization of the washwater volume would result in a control law that kept the agitated phase solids concentration just below the level needed to plug the transfer lines.

Currently, we do not know this concentration. However, a washball/tank mockup is planned for the summer of 2000. During these mockup, we hope to find this maximum concentration as well as washing results that could be used to fit the key parameters in this model.

Using activities that are based on a combination of recent analytical laboratory data and conservative estimates based on the known activity of the waste that historically entered the tanks [2], one can examine the effects of each step in the tank preparation closure project on tank activity and volume levels. Since WM-183 has the highest quantity of solids and the improved control system has been demonstrated to be a more effective, the percent of waste remaining in the tank is shown in Table 4. Note that these figures assume that WM-183 is initially filled to the 285, 00 gal capacity with liquid waste while 8 in of sludge is present in the tank heel.

The volumetric effect of each tank preparation step is shown for each waste component in Table 5. Note that the y-axis on this figure is truncated at 12, 000 gal to show the details in all the phases.

The percent composition by volume of each tank preparation step is shown for each waste component in Table 6.

The amount of activity remaining after each tank preparation step is shown for each waste component in Table 7.

The percent composition by activity of each tank preparation step is shown for each waste component in Table 8.

The above figures indicate that the washball washing significantly removes volume and activity of the waste remaining in the tank prior to grouting. These figures also show that the vast majority of activity in the tanks is attributed to the solids rather than the liquids, even with a full tank of liquid waste and assuming 73.1% (vol) liquid in the heel. Because of this difference in solids and liquids activity level, only washing with the washball under "feed and bleed" conditions reduces the activity levels in the tank significantly.

2 Grout Layer Mass Balance

In the previous section, we have determined that the washball operation should result in a solid height of approximately one-half inch just prior to grouting. In this section, we make the assumption that the grout placements remove no additional solids and start with a conservative solids height of one inch. This assumption results in 1, 224 gal. of solids that will be permanently disposed in the tank. With this volume of solids (and an additional 400 gal. of liquid waste around the grout outlet pump), we will determine the amount of grout needed to reach a NRC class C definition.

Based on analytical lab data from WM-183 (see Table 9), we see that the amount of interstitial liquid in the tank heel is approximately 73.1% by volume.

With this fraction of interstitial liquid in the sludge, we can now calculate the amount of solids and liquids assumed to be in the tank after grout placement (based on a 1 in. sludge "disk" and 400 gal of liquid around the outlet pump). This calculation is shown in Table 10.

Now that the quantities of solids and liquid are established, we need to calculate the activity of the solids and liquid for selected isotopes (see Table 11). These activities are based on a combination of recent analytical laboratory data and conservative estimates based on the known activity of the waste that historically entered the tanks [2].

Now that we have a source-term, we can find the amount of grout needed to reach class C. Assuming a grout specific gravity of 2.1, a grout volume is found such that using a lesser quantity of grout results in a greater than class C designation. The applicable grout properties are shown in Table 12. This table shows that approximately 5.63 ft of grout needs to be poured to reach class C.

The calculations required to designate the grout layer as class C are shown in Tables 13 and 14. Table 13shows that with this quantity of grout the waste is not a TRU waste as defined by DOE[3]. Table 14 shows that this quantity of grout meets the class C definition discussed in the Code of Federal Regulations[1].

From these tables, ^{238}Pu is the major contributor to the large amount of grout required to reach class C. Examining Dan Staiger's spreadsheet reveals that the ^{238}Pu activity used in this calculation is not an estimate but the largest reported value from analytical lab data for WM-182, $19,324\ \frac{\text{nCi}}{\text{g}}$. WM-188 has a highest reported ^{238}Pu activity of $9,108\ \frac{\text{nCi}}{\text{g}}$. The variation between these activities is approximately a factor of one-half and using the higher value has a significant impact on the amount of grout needed to reach class C (using the WM-188 activity for ^{238}Pu results in 3.6 ft of grout). With these wide variations from tank to tank, ^{238}Pu activities should be carefully characterized for each tank to determine the amount of grout to reach class C.

3 Solids Treatment

From LDUA sampling efforts, specifically in WM-182 and WM-183, it has become apparent that the amount of solids in the tank farm exceeds expectations. This is significant since design teams are currently designing treatment processes to treat liquid waste with very little undissolved solids (UDS). When UDS is present in the liquid waste, performance of the treatment processes drop significantly. Therefore, understanding the nature of the tank farm solids, separating them from the liquid phase, and treating them with a separate process could be of great import. This section will attempt to quantify the total amount of solids in the tank farm and predict the quantity of waste that would be produced if the solids were treated various designations.

Since we currently do not have verification on the quantities of solids present in each of the tanks in the tank farm, we will predict the quantities based on the tank farm history and the amounts of solids in WM-188, WM-182, and WM-183 (see Table 15). With this in mind, the following assumptions are made:

- This calculation assumes 73.1% (vol.) interstitial liquid for all tanks.
- Tanks WM-180, WM-181, WM-184, WM-185, and WM-186 are expected to have solids

levels near the value of WM-182 (4"). For a conservative estimate, a sludge height of 2" is assumed in these tanks. After washing, the solids on the walls are assumed to be removed and produce an additional 1/2" layer.

- Tanks WM-187, and WM-189 are expected to have solids levels near the value of WM-188 (1/4"). Since this already a conservative value, a sludge height of 1/4" is assumed in these tanks. After washing, the solids on the walls are assumed to be removed and produce an additional 1/4" layer.

- From video footage tank WM-183 had a sludge height of 8". After washing, the solids on the walls are assumed to be removed and produce an additional 1/2" layer.

- The solids composition is estimated from Dan Staiger's bounding tank estimate[2]. Although some these concentrations are estimates, the main isotope responsible for the high dilution required to meet the various designations (i.e. TRU, greater than class C, class C, class, B, Class A) is Pu-238. The activity level for Pu-238 is taken from actual analytical laboratory data for WM-182 and is not an estimate.

If this quantity of sludge is transferred to one tank, the sludge layer would have the properties shown in Table 16

The isotopic activity of this quantity of solids is shown in Table 17.

If a HLW glass is produced with a specific gravity of 2.6, approximately 340 canisters similar to those used in the defense waste processing facility in Savannah River would need to be disposed (see Table 18). Potentially, these canisters could be disposed at the National Repository (i.e. Yucca Mountain). This quantity of glass is highly dependent on the assumed waste loading of the glass. Based on the phosphorous content of the solids, Applied Technology quoted a waste loading of approximately 35%.

If the solids are dried and to remove free liquids, the solids could possibly be disposed at WIPP. If the packing of the dried solid particles remains at 27% by volume. An estimated quantity of 600 55-gallon drums of dried TRU solids would need to be disposed see Table 19.

Lastly, if a grout is produced with a specific gravity of 2.1 that just reaches class C, approximately $42,000$ $55-$ gal drums of class C grout would need to be disposed (see Table 20). Potentially, these drums could be disposed at NTS, Envirocare, Hanford, or at a future INEEL LLW disposal site. Note that since this grout barely achieves class C (i.e. a lesser quantity of grout used yields a greater than class C waste) and additional site specific WAC need to be met, this quantity of grout represents a lower bound.

The quantities of waste to be disposed are significant. Treatment processes for the solids should be pursued in addition or conjunction with the high activity liquid waste processes. The major isotope behind the these large waste values is the Pu-238 activity. This activity is based on data from WM-182, variations in activity of Pu-238 for the other tanks would have a major impact on the amount of grout or frit needed. Therefore, more analytical laboratory data (e.g. Pu-238 activities) need to be collected on the solids in the other tanks.

4 Cost Justification

Based on the quantity of tank farm sludge predicted in the previous section, an average tank would conservatively contain approximately 3 inches of sludge. With this quantity of solids, Dan Staiger's compositional bounding estimates, and the budgeted cost to close the tank farm, one can perform an analysis detailing the cost to remove each curie of activity.

The budget to close the 11 tanks in the tank farm amounts to 116 M. This equates to approximately 10.6 M per tank. Starting with a tank full of process liquid and 3 in of heel, the current closure plan consists of the following:

- Drain the standing liquid to the sludge heel. The liquid removed would then be sent to the HLW evaporator and disposed. A cost of $\frac{\$1.00}{\text{gal. evap feed}}$ is imposed on using the existing equipment to remove the liquid and dispose of it with the existing INTEC evaporators. This equates to approximately 0.28 M of the per tank budget.

- Use the washball to wash the interstitial liquid to a pH of 2 and sludge height of $\frac{1}{2}$ in.. The cost of using the washball system to decontaminate a tank amounts to approximately 3 M of the per tank budget.

- The cost of performing the remaining tank closure (i.e. sampling and grouting the remaining heel) accounts for the remainder of the per tank budget, 7.3 M.

Decontaminating the tanks further would involve the use of a robotic arm to reduce the sludge height to approximately $\frac{1}{4}$ in. However the cost of applying this technology would amount to an additional 106 M or $\frac{9.6\ \text{M}}{tank}$. Performing the above decontamination steps results in the decrease of activity shown in Figure 76.

The cost to decontaminate one tank and the activity remaining the tank are shown in Figure 77. From this figure, it is obvious that the decontamination cost increases greatly for using the robotic arm while the total amount of activity removed is small. This is confirmed when one calculates the cost per Curie removed (see Figure 78).

When one evaluates the total cost to close the tank (see Figure 79), one can see that the additional step of using the robotic arm doubles the budget while removing very little activity.

Calculating the percent of activity removed for each decontamination step as a function of cost results in Figures 80 and 81 . A power law line of best fit can be calculated for these data. The equation describing this line is shown below ($R^2 = 0.9976$):

$$Percent\ Removed = 100 - 4.07\,(Decontamination\ Cost\ (M))^{-0.6924} \tag{52}$$

As one can see, the cost to achieve 98% removal is approximately 2.8 M. The washball decontamination step already exceeds this mark. To remove less than a percent more activity using the robotic arm the decontamination costs increase by a factor of 4. Consequently, the additional decontamination step appears to have a significant cost while yielding very little performance gain.

References

[1] Licensing requirements for land disposal of radioactive waste. Code of Fedral Regulations. 10CFR61.55.

[2] Daniel M Staiger. Estimate for Bounding Tank. Interoffice Memorandum, March 2000. MDS-05-00, Memo to Keith Quigley.

[3] U.S. Department of Energy. Radioactive waste management. DOE Order 435.1, July 1999.

5 Tables and Figures

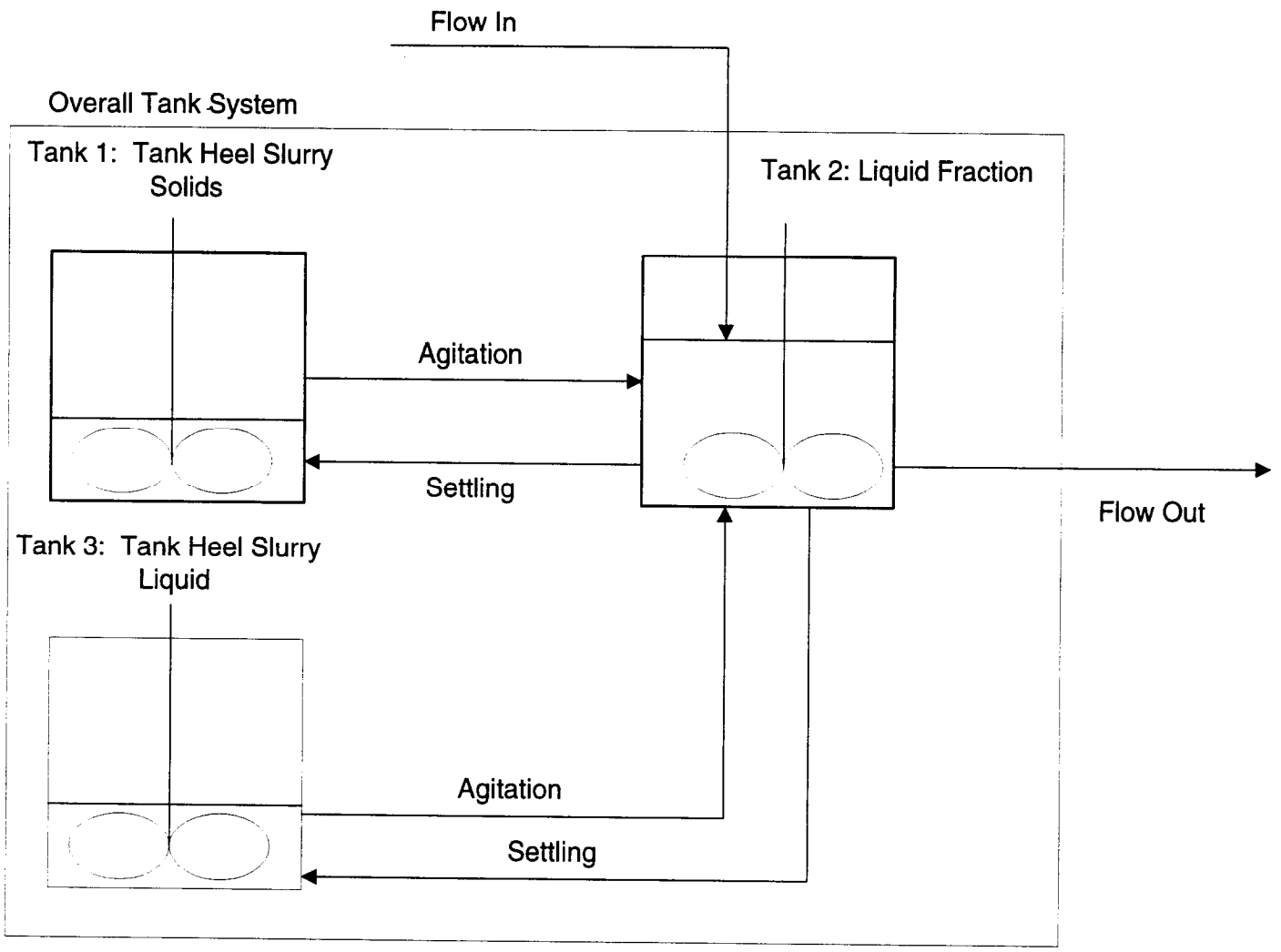


Figure 1: Tank System Model

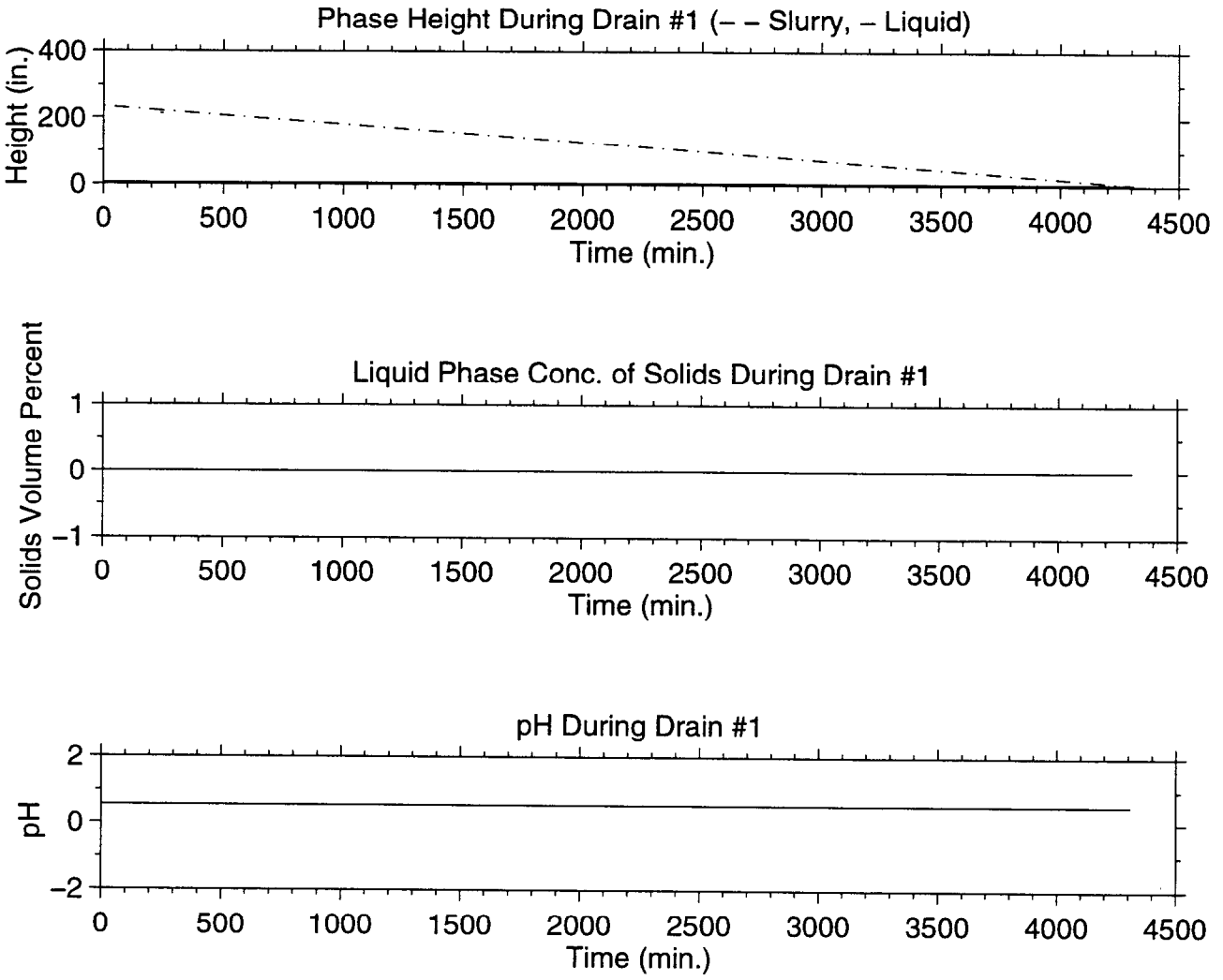


Figure 2: Tank WM-182 Status During Step #1

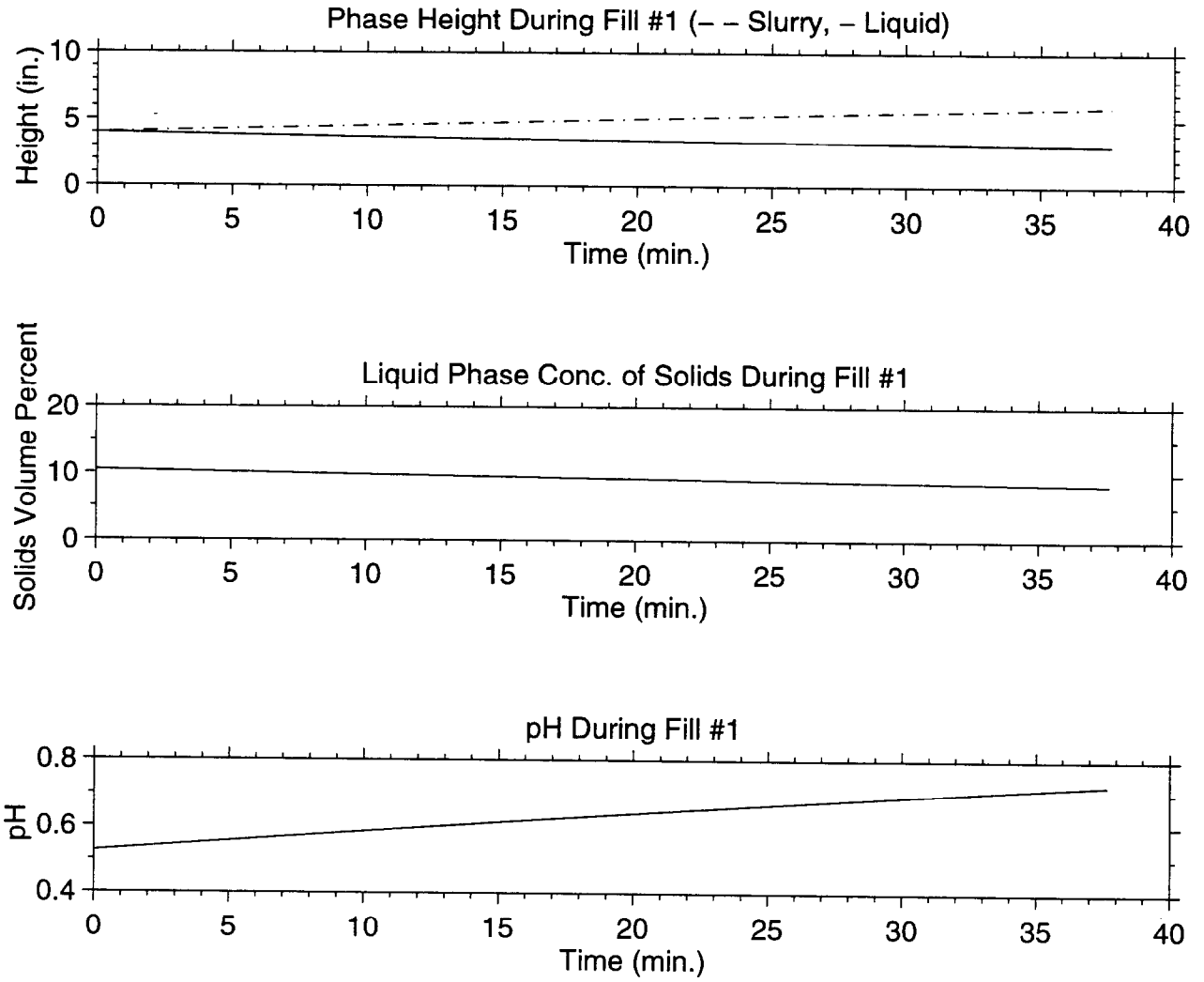


Figure 3: Tank WM-182 Status During Step #2

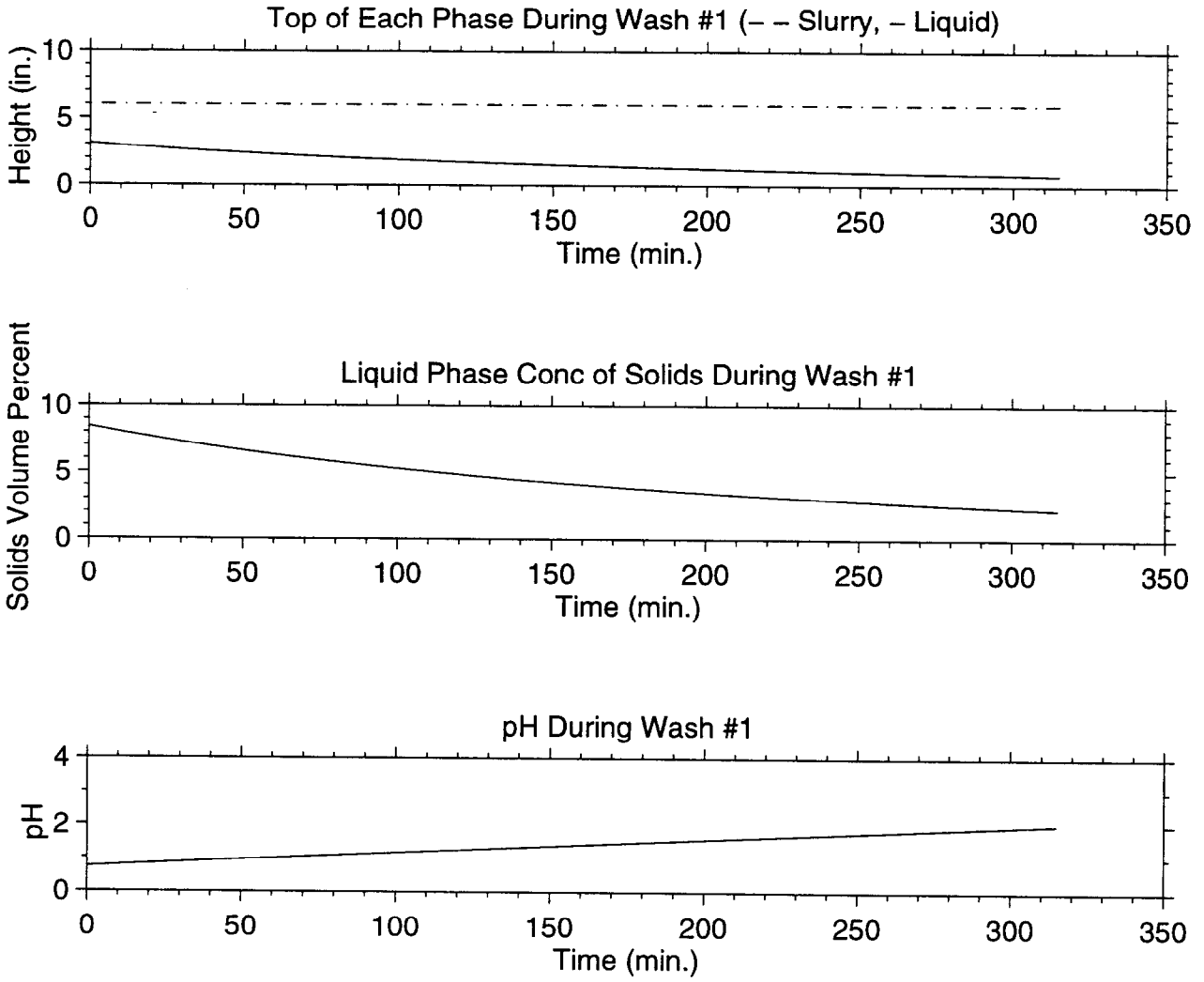


Figure 4: Tank WM-182 Status During Step #3

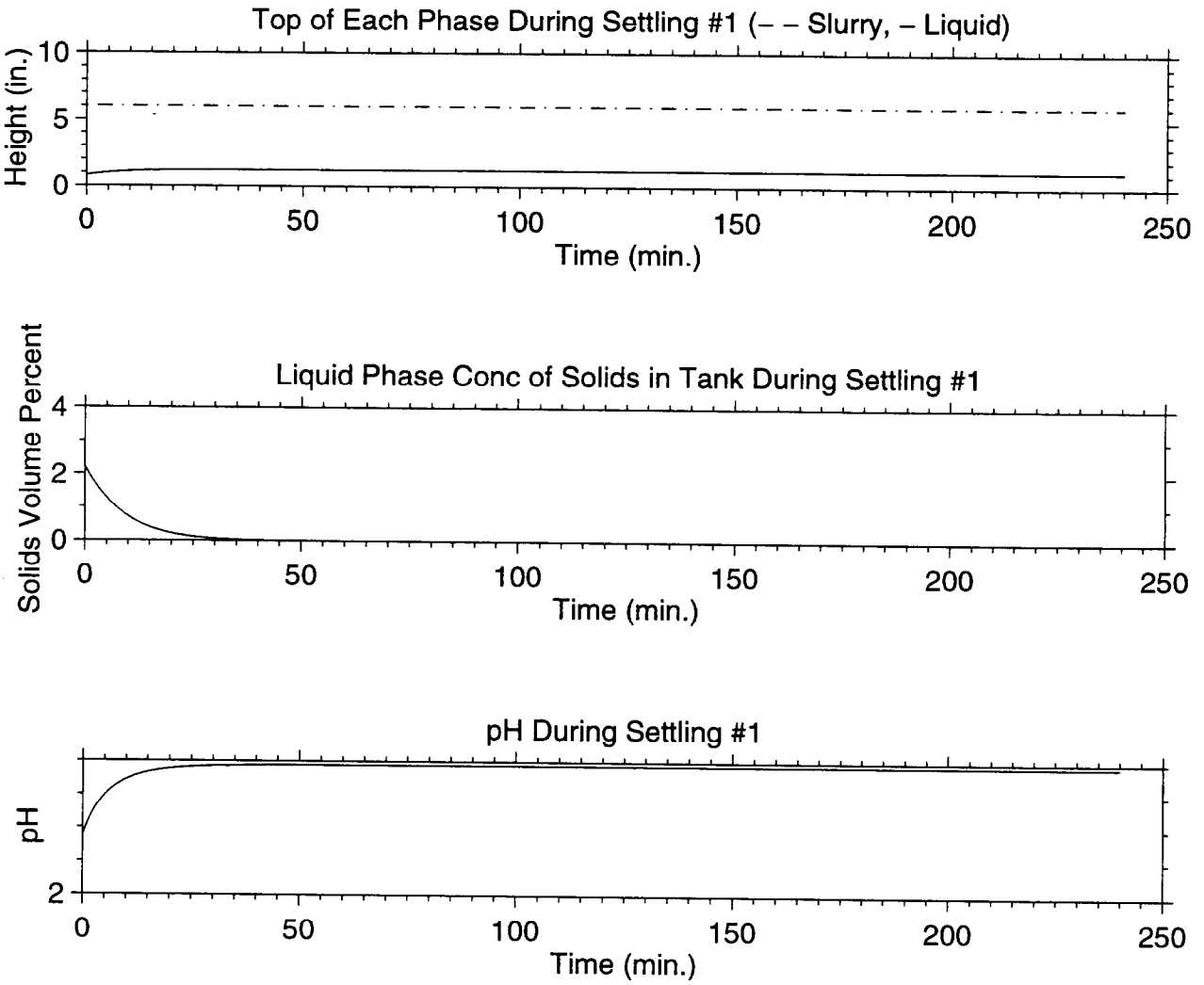


Figure 5: Tank WM-182 Status During Step #4

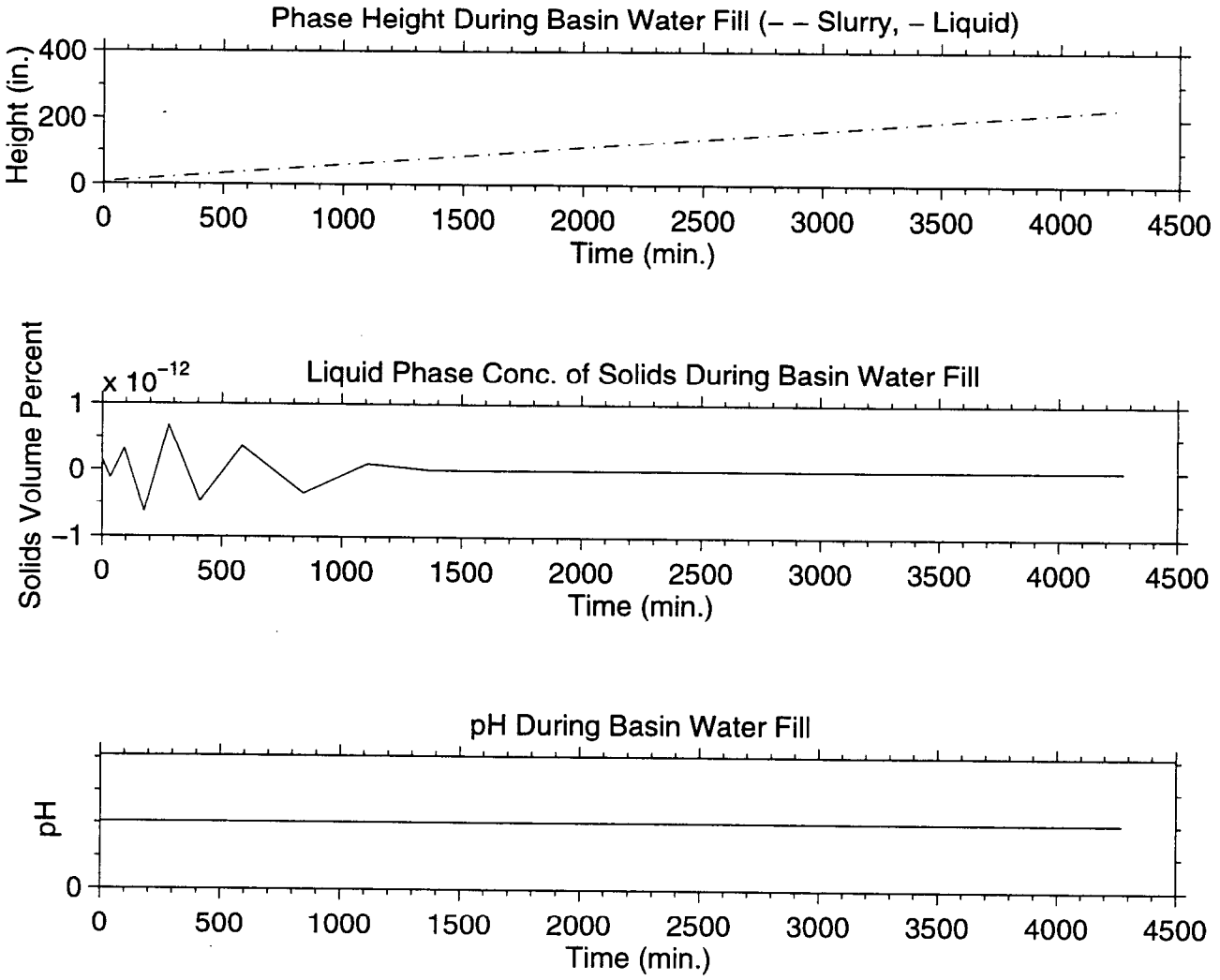


Figure 6: Tank WM-182 Status During Step #5

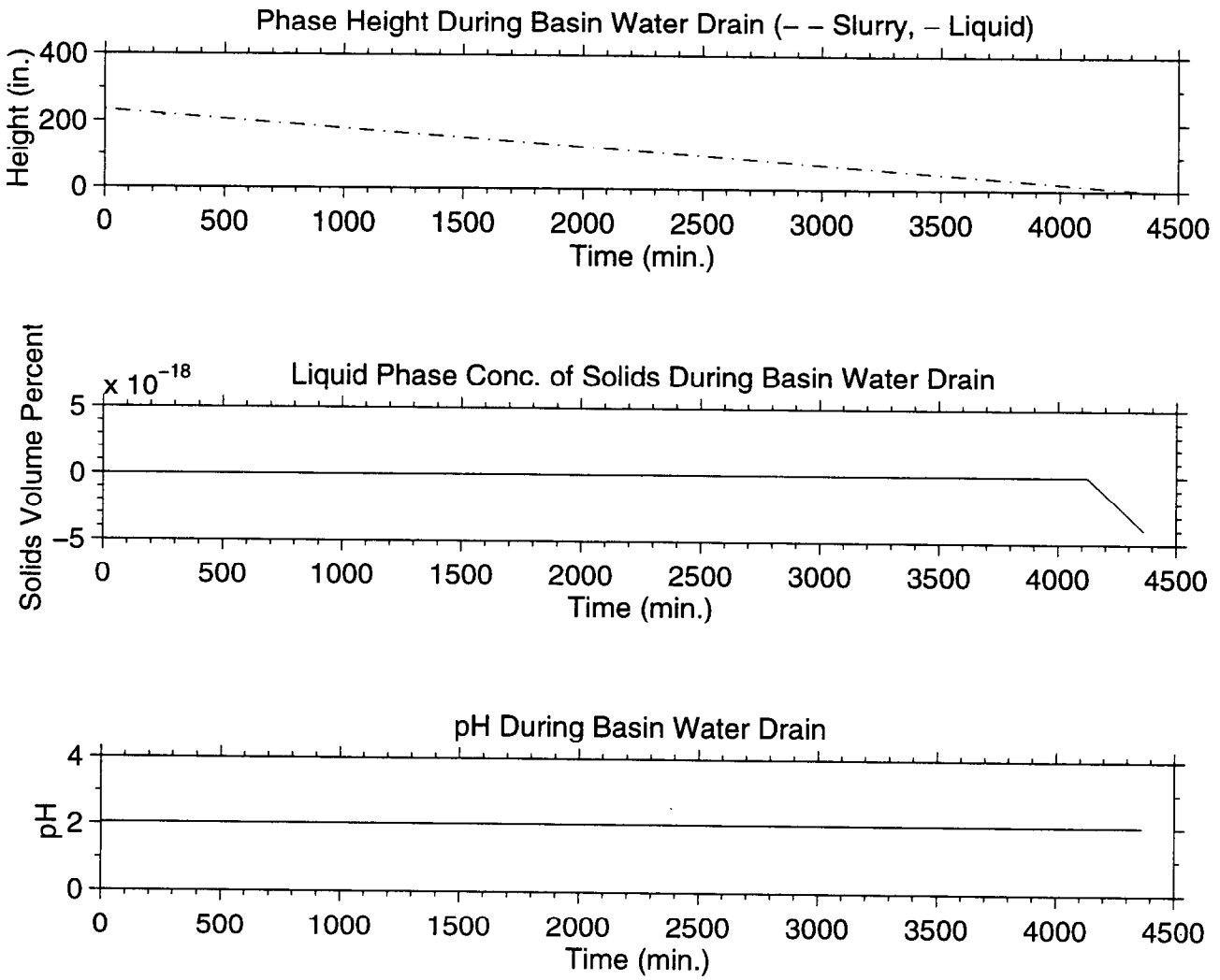


Figure 7: Tank WM-182 Status During Step #6

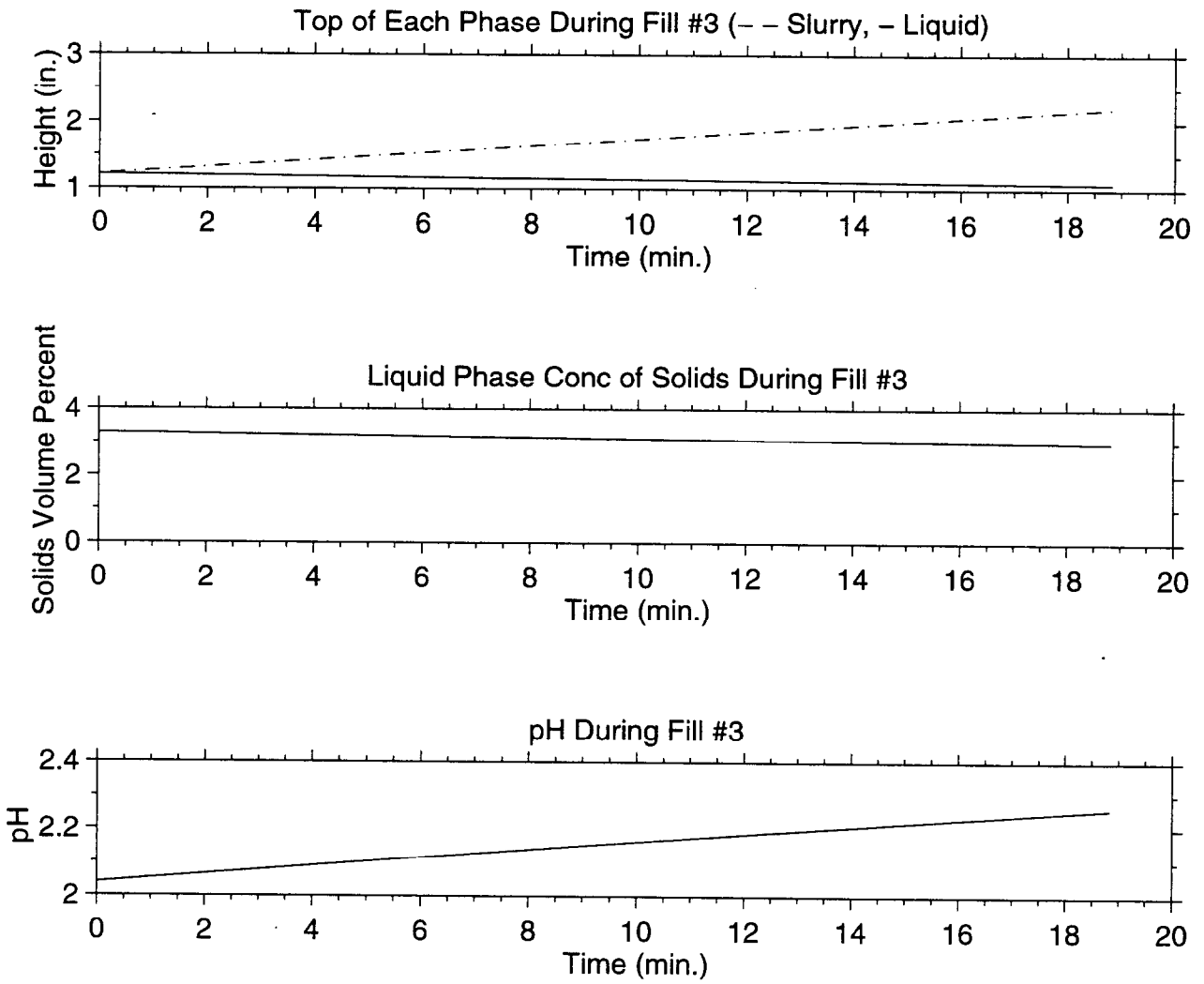


Figure 8: Tank WM-182 Status During Step #7

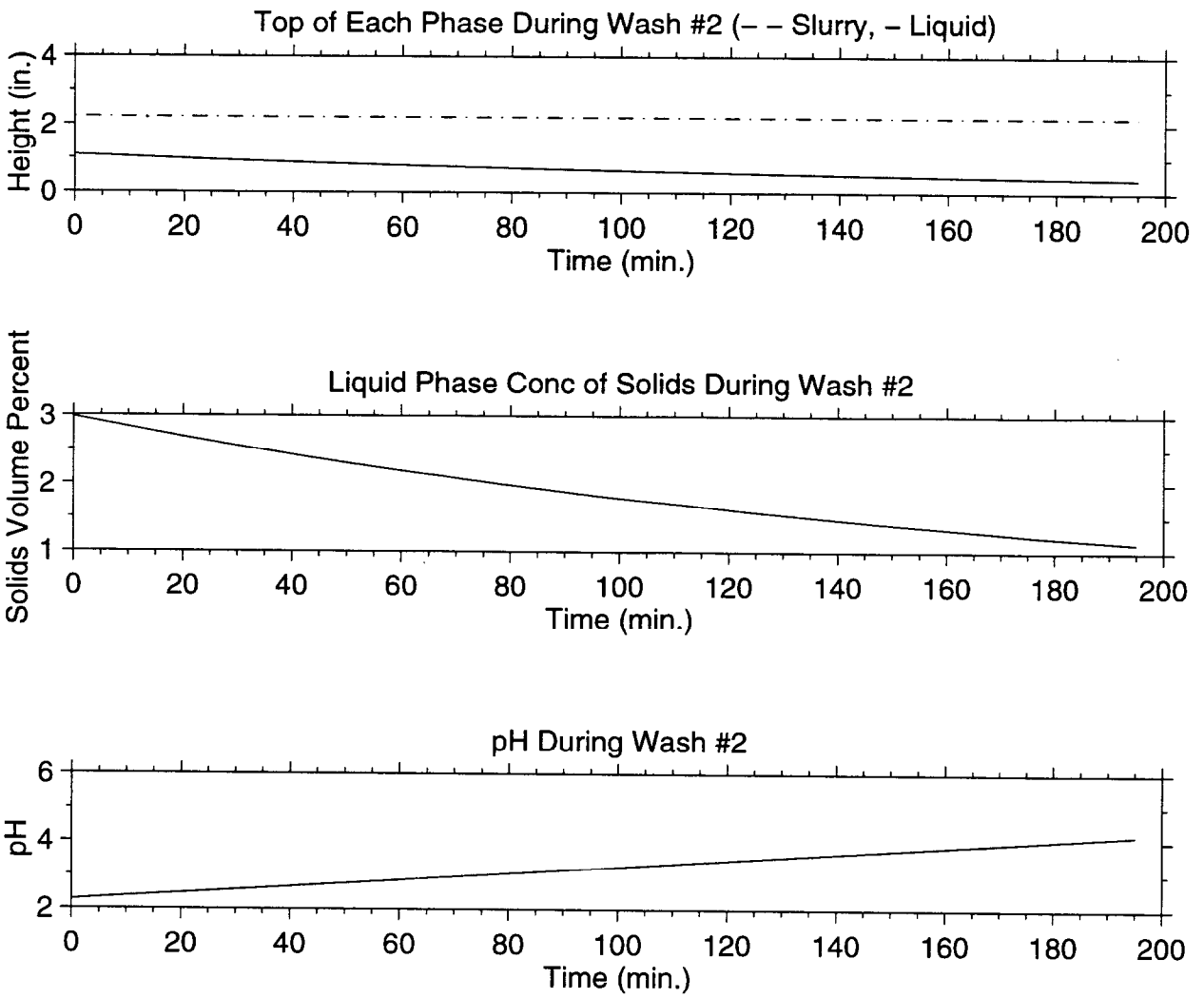


Figure 9: Tank WM-182 Status During Step #8

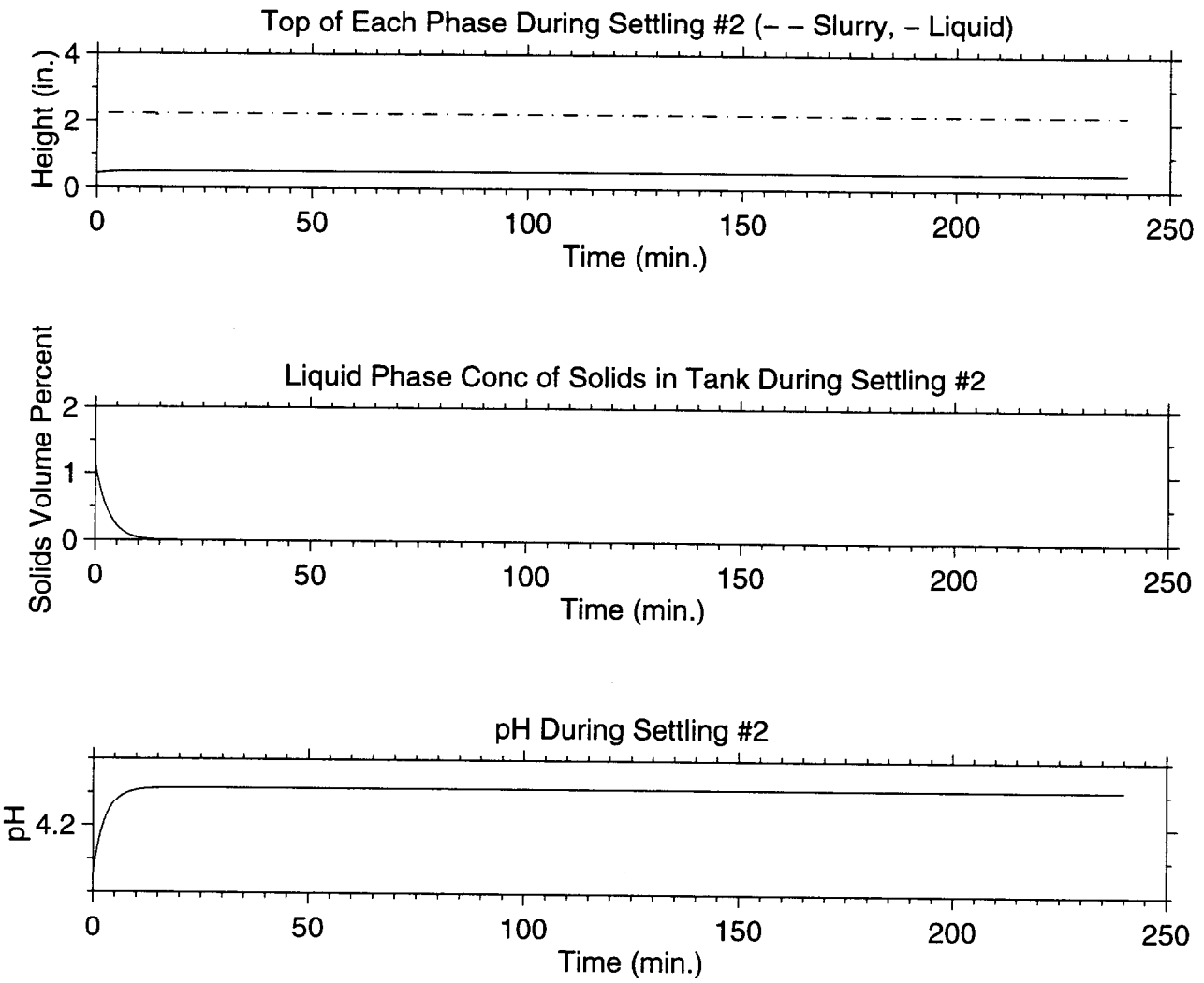


Figure 10: Tank WM-182 Status During Step #9

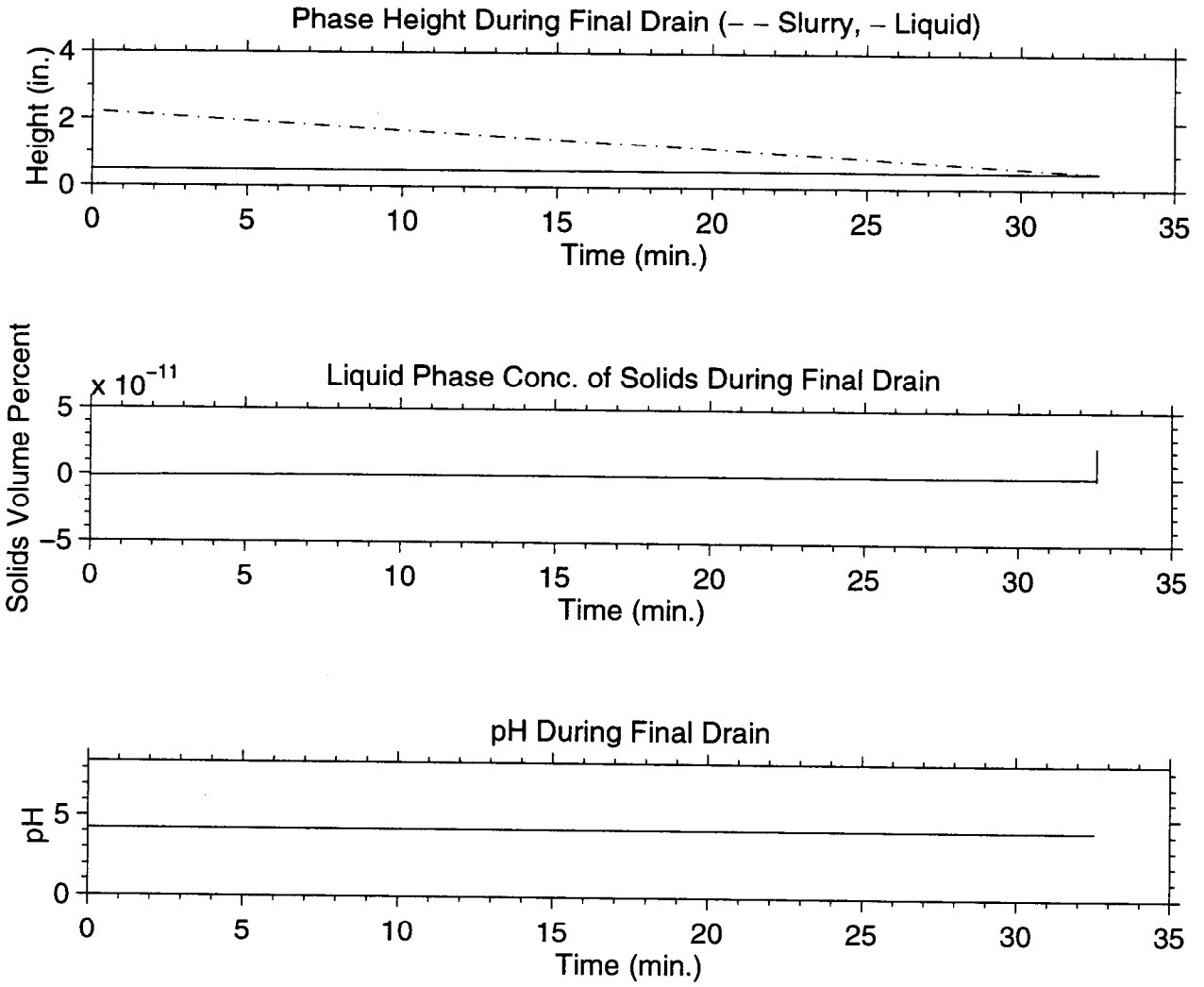


Figure 11: Tank WM-182 Status During Step #10

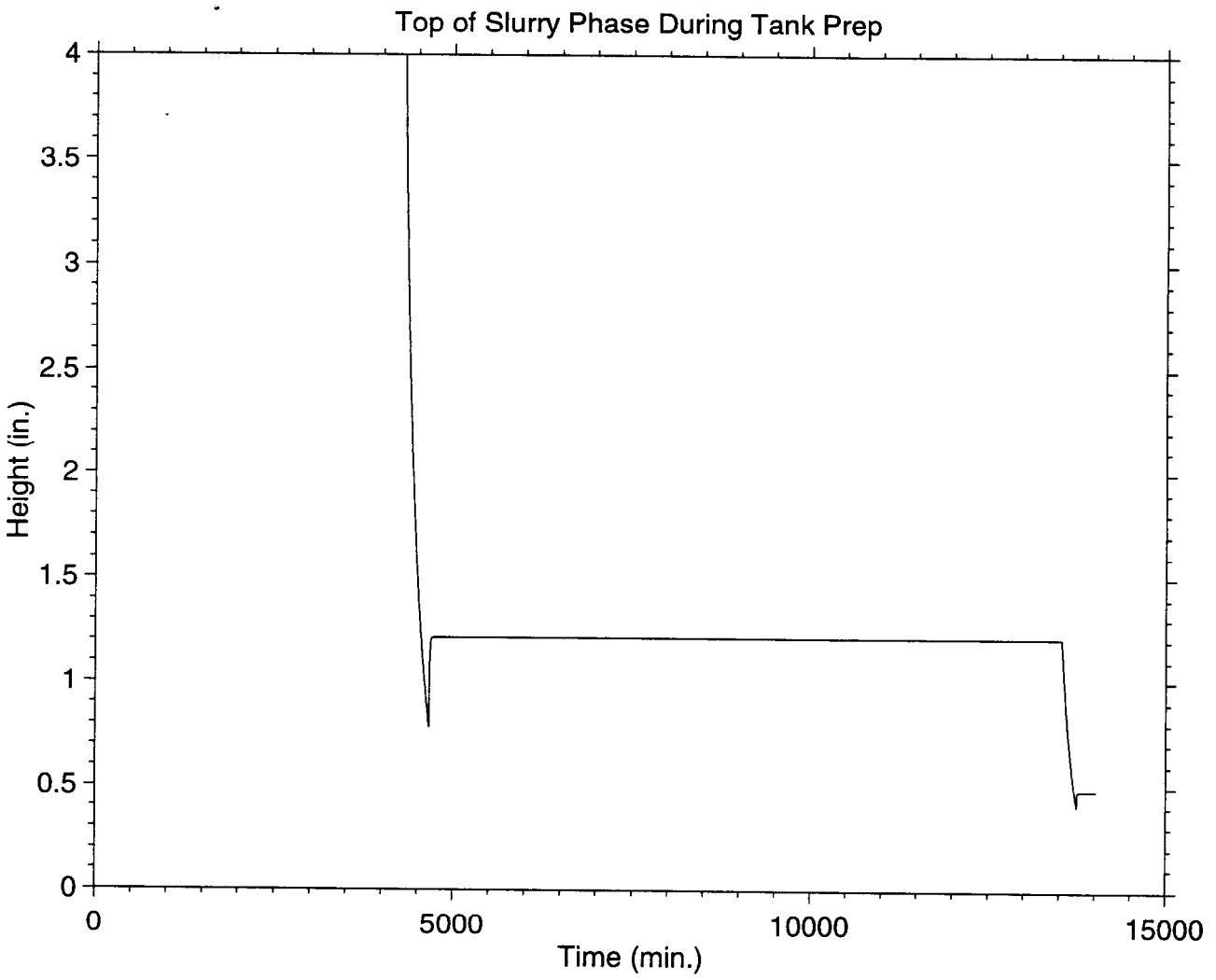


Figure 12: Tank WM-182 Slurry Phase Height During Tank Prep

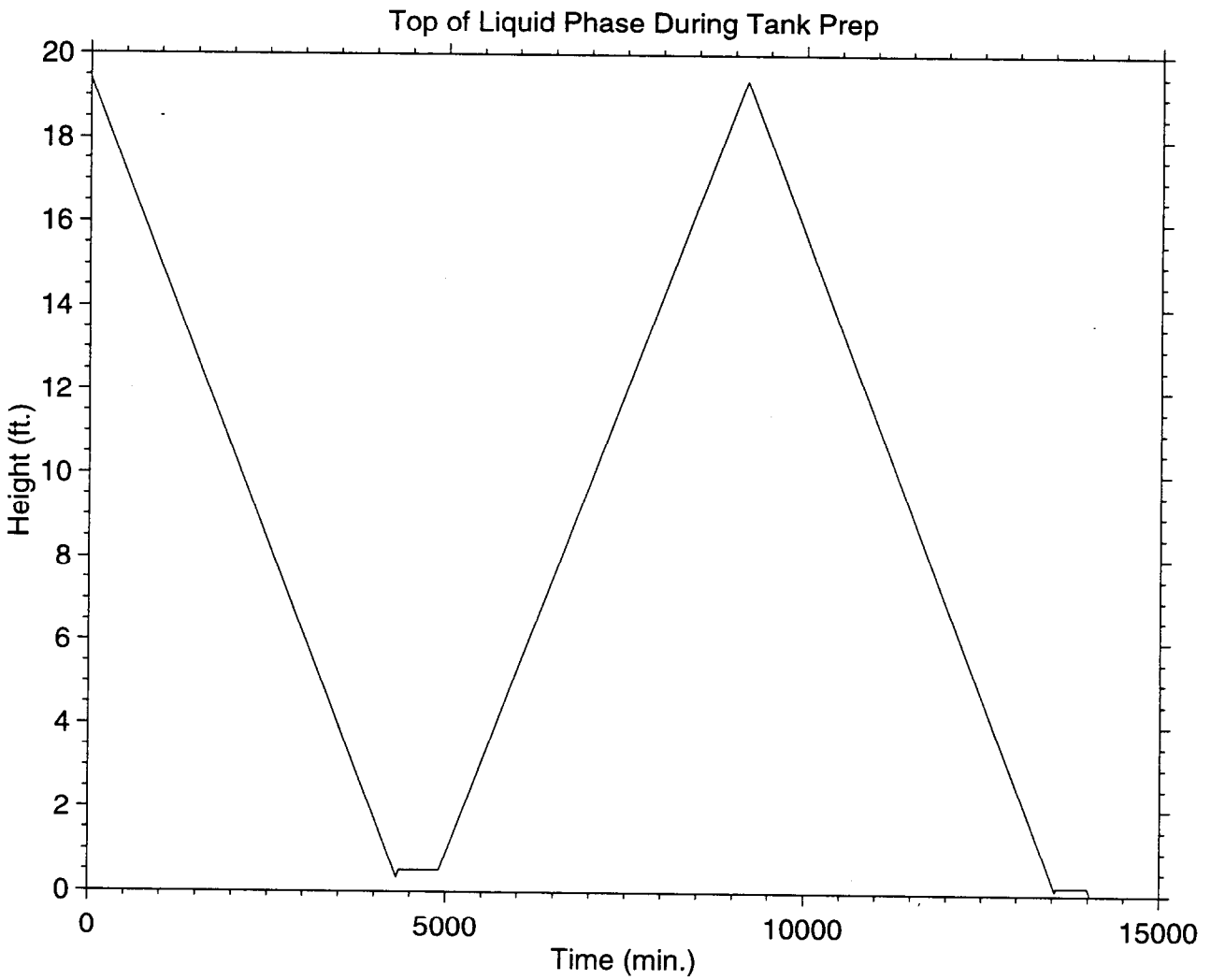


Figure 13: Tank WM-182 Liquid Phase Height during Tank Prep

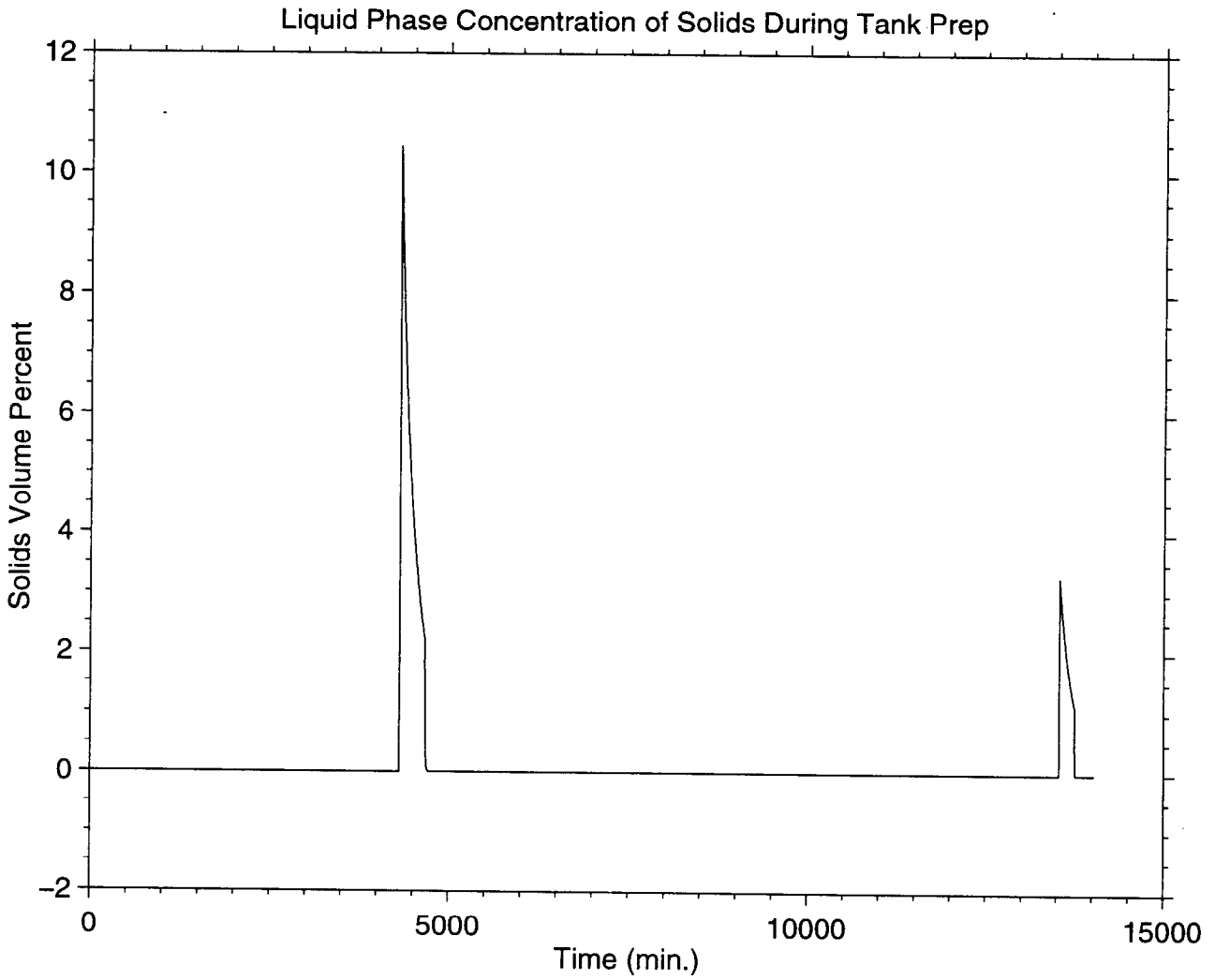


Figure 14: Tank WM-182 Liquid Phase Height during Tank Prep

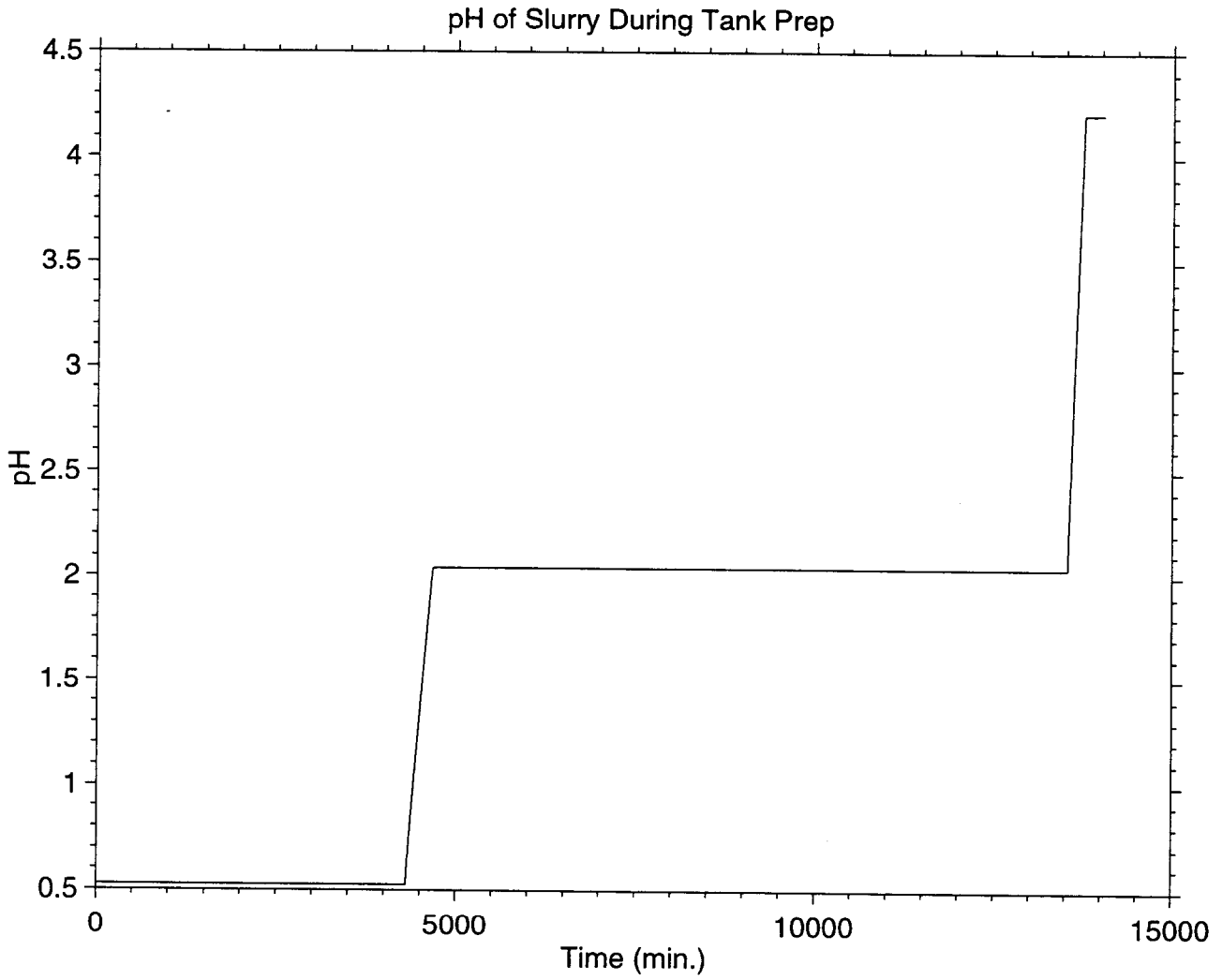


Figure 15: Tank WM-182 Slurry pH During Tank Prep

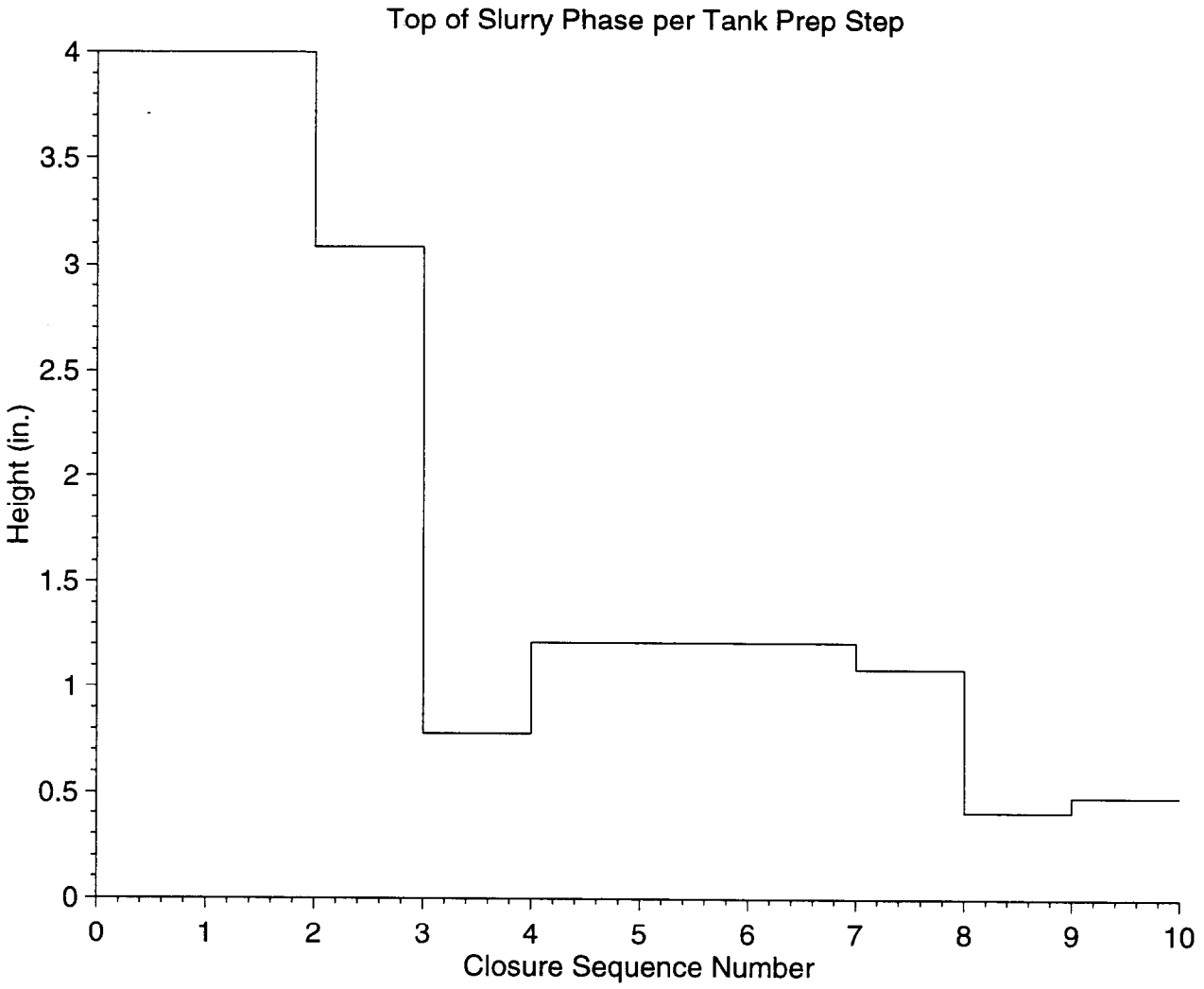


Figure 16: Tank WM-182 Slurry Phase Height per Sequence Step

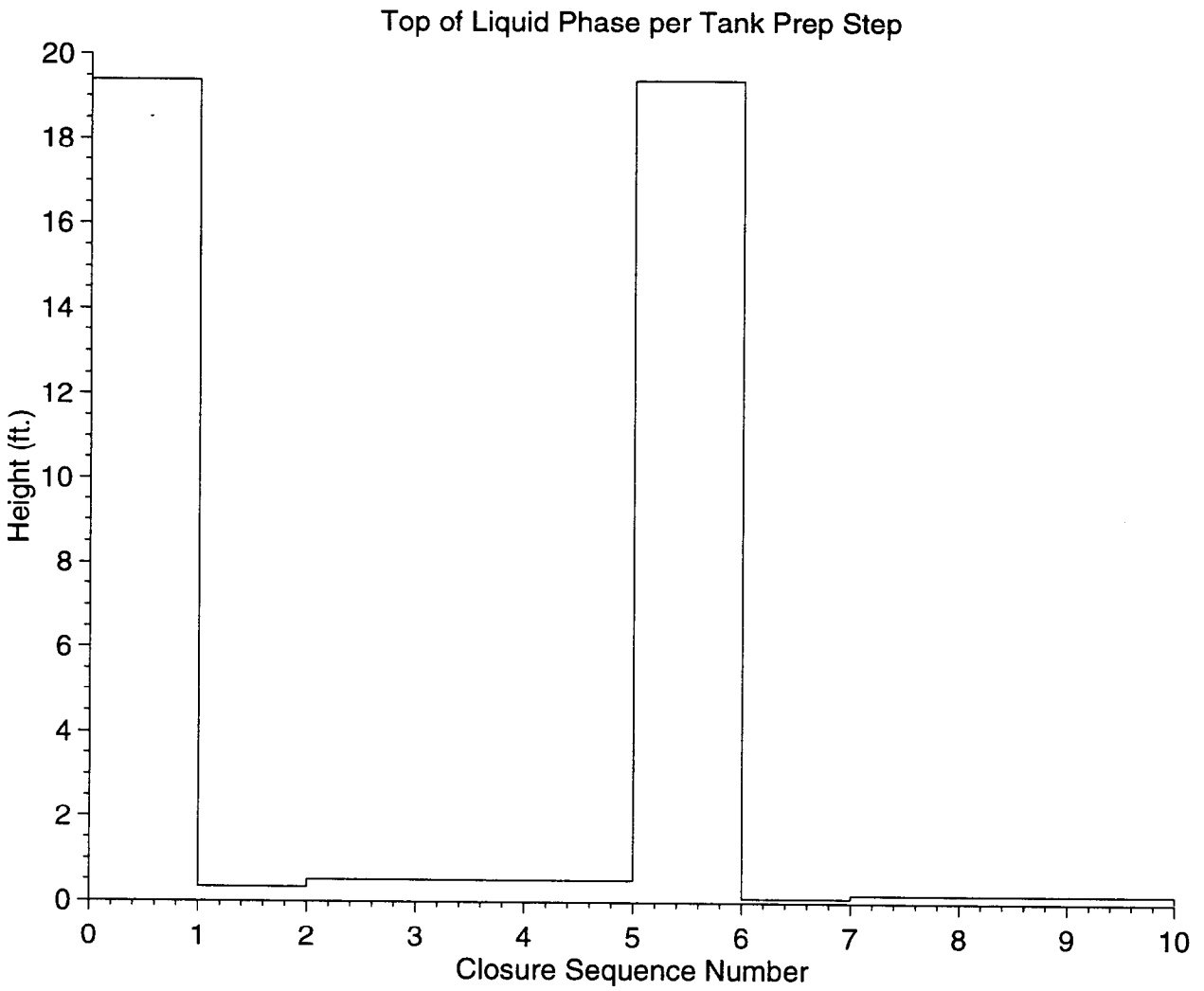


Figure 17: Tank WM-182 Liquid Phase Height per Sequence Step

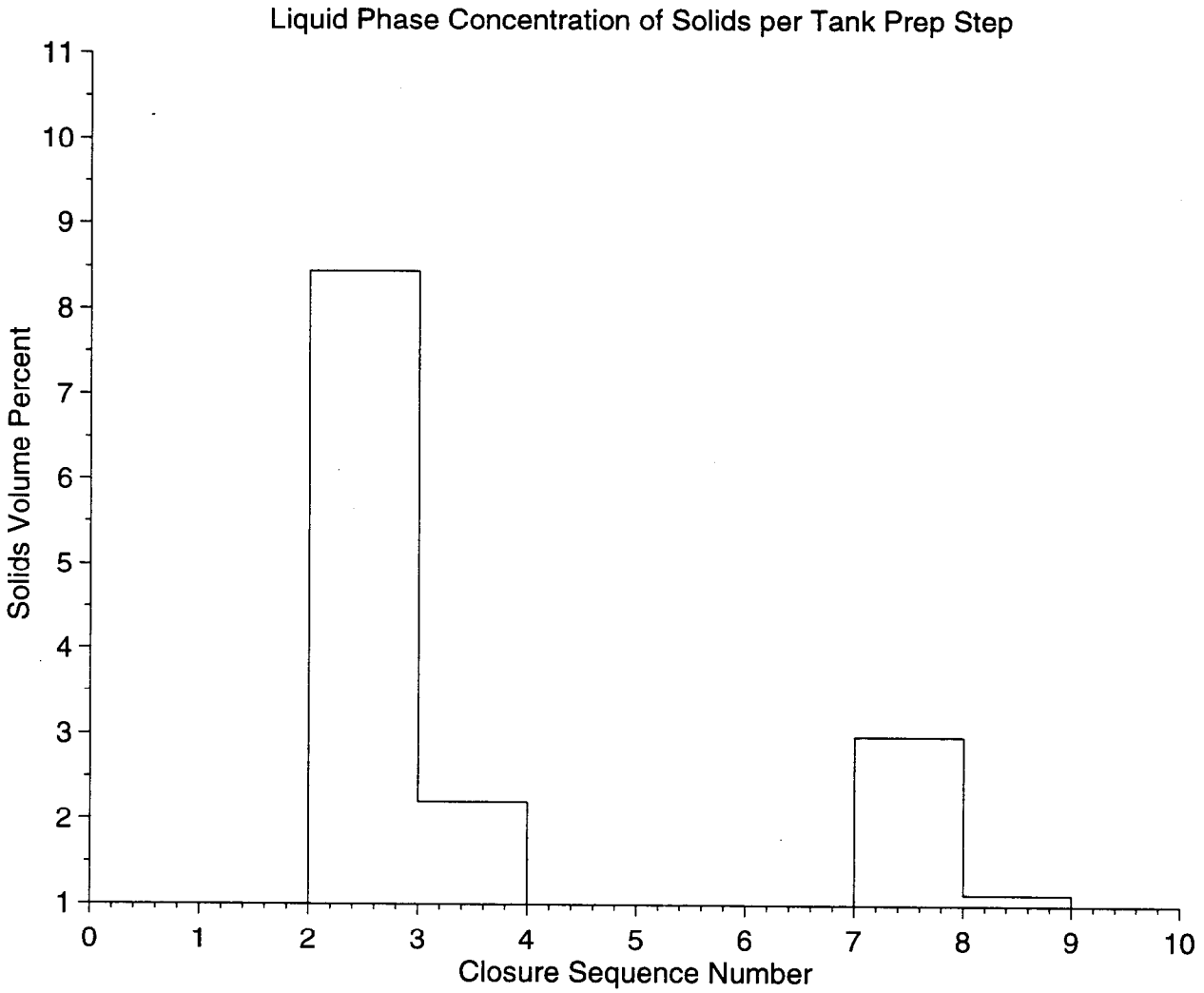


Figure 18: Tank WM-182 Liquid Phase Height per Sequence Step

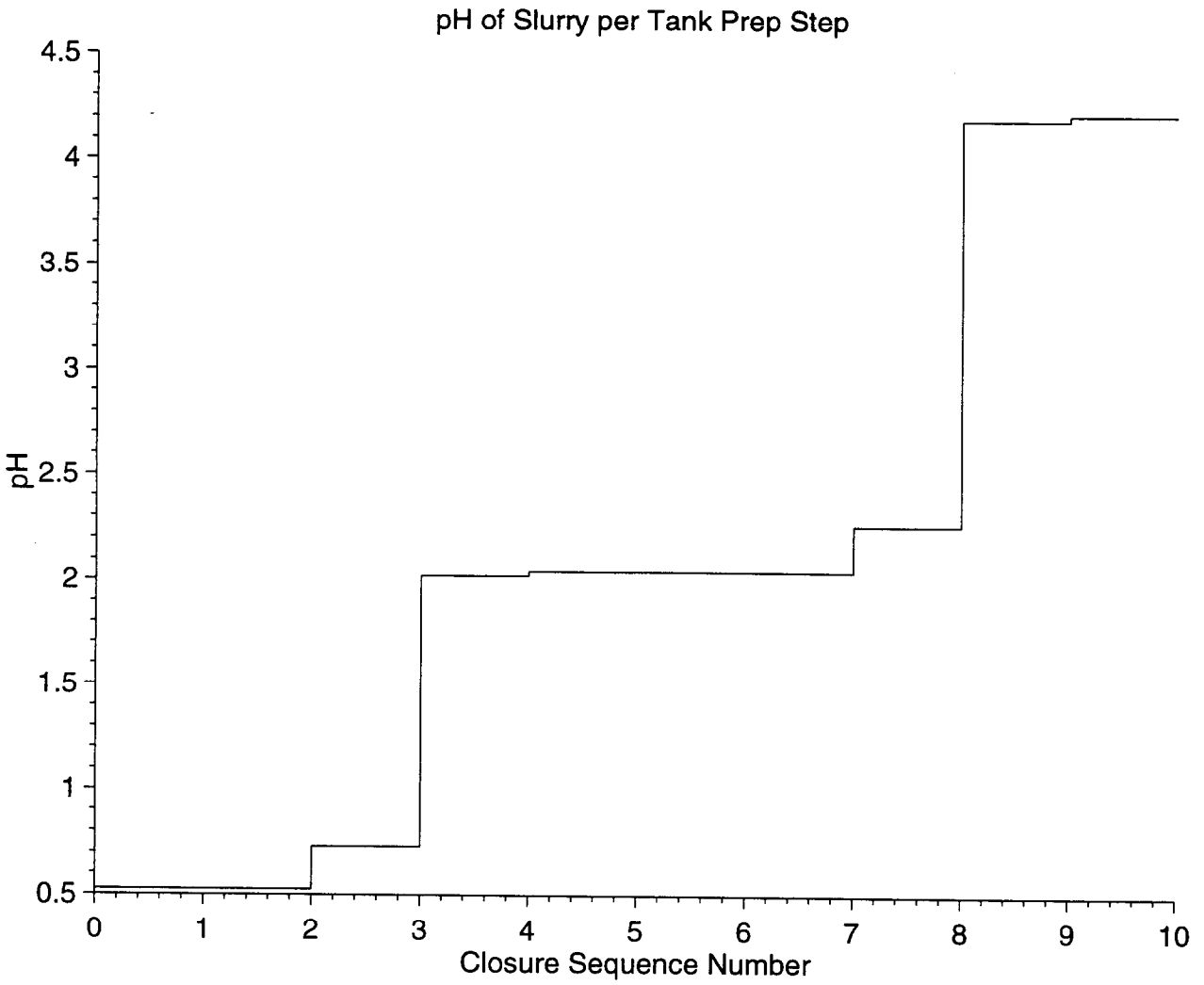


Figure 19: Tank WM-182 Slurry pH per Sequence Step

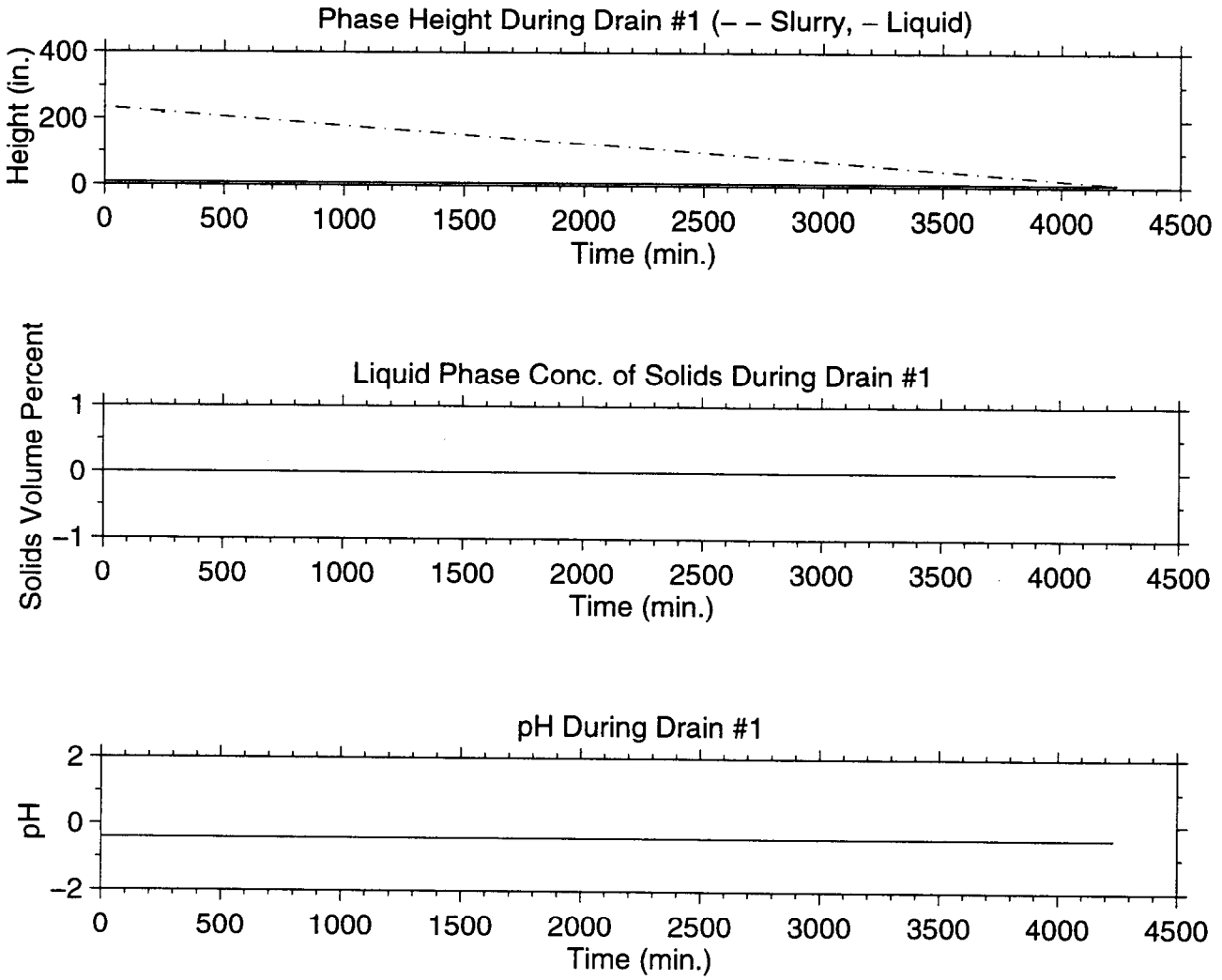


Figure 20: Tank WM-183 Status During Step #1

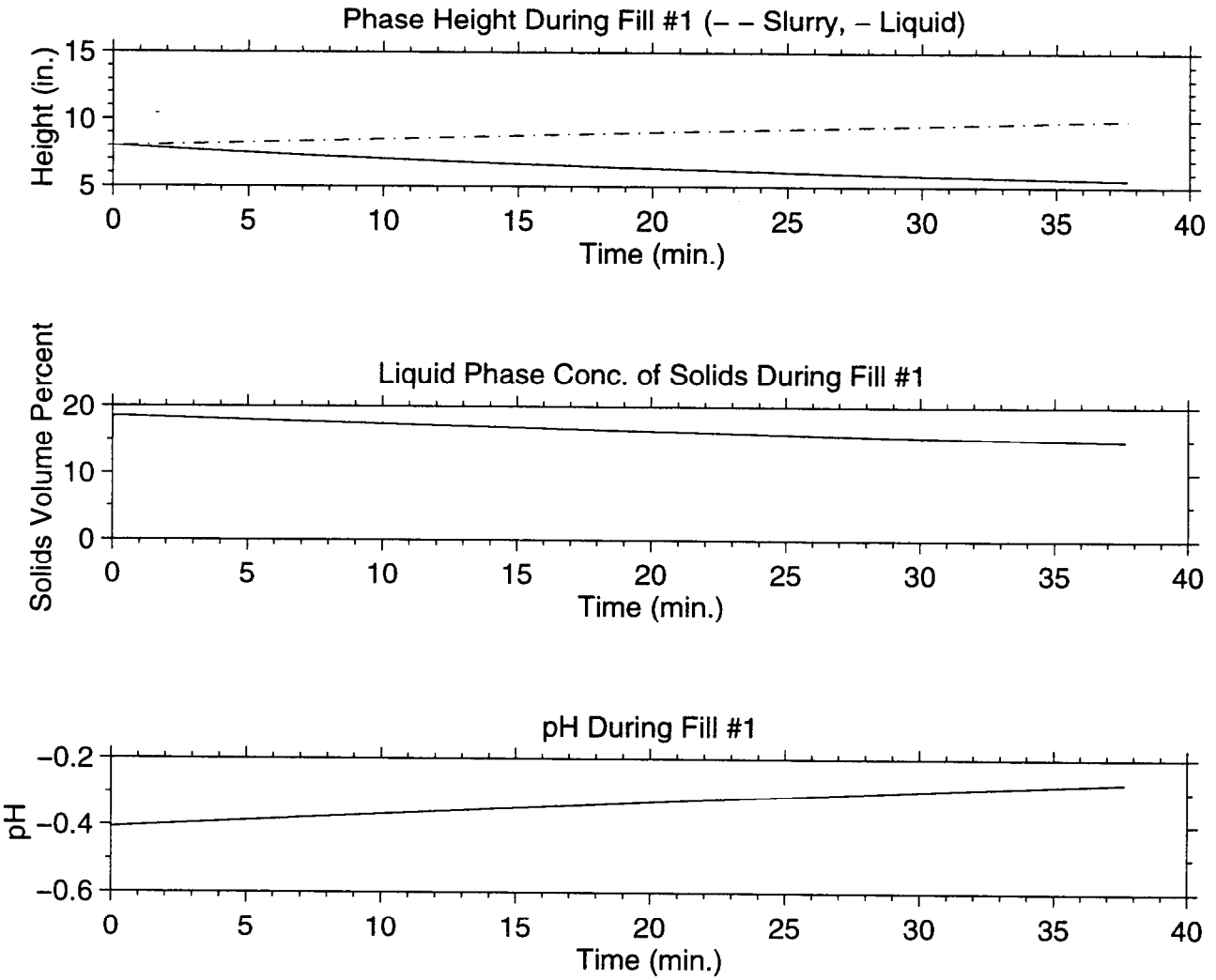


Figure 21: Tank WM-183 Status During Step #2

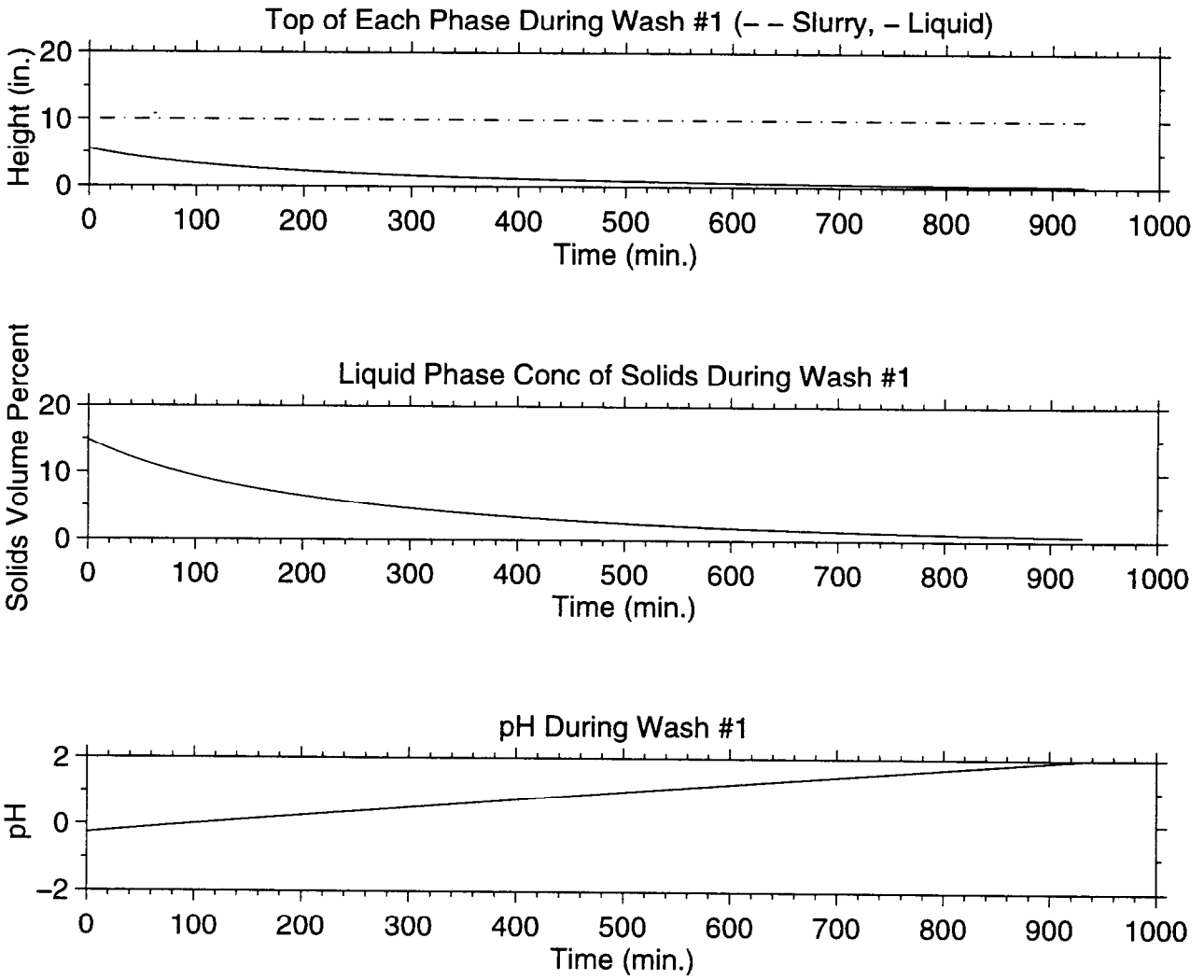


Figure 22: Tank WM-183 Status During Step #3

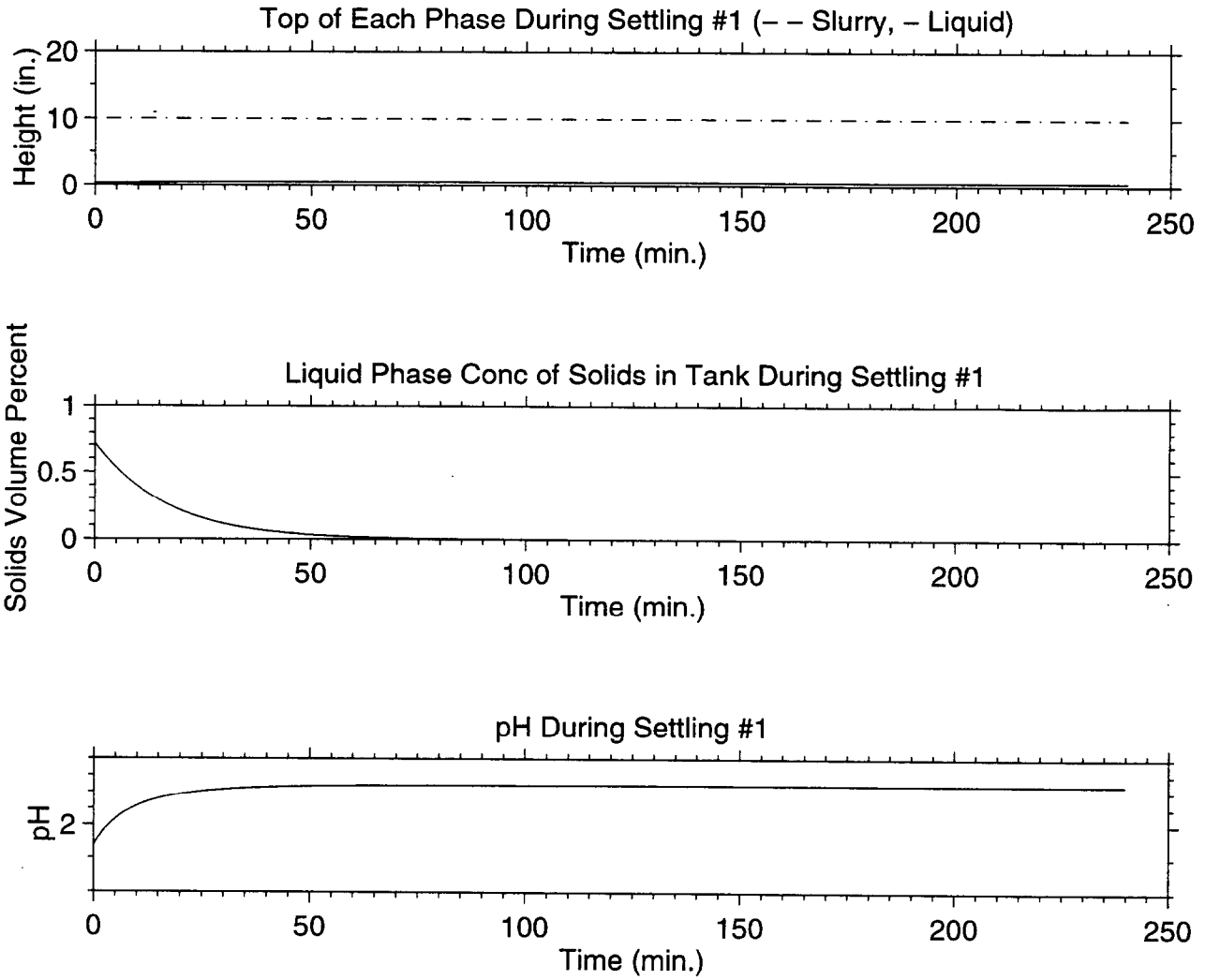


Figure 23: Tank WM-183 Status During Step #4

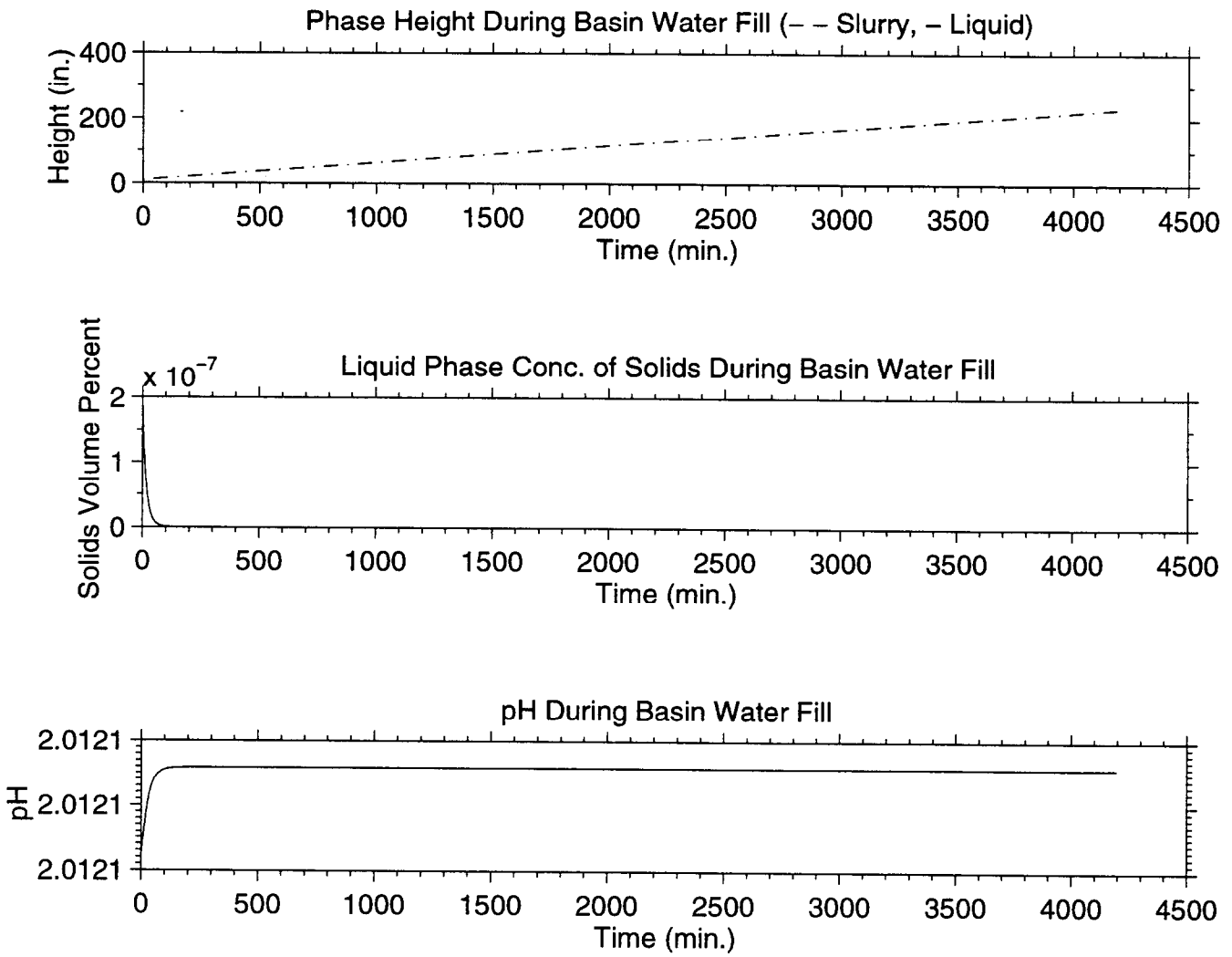


Figure 24: Tank WM-183 Status During Step #5

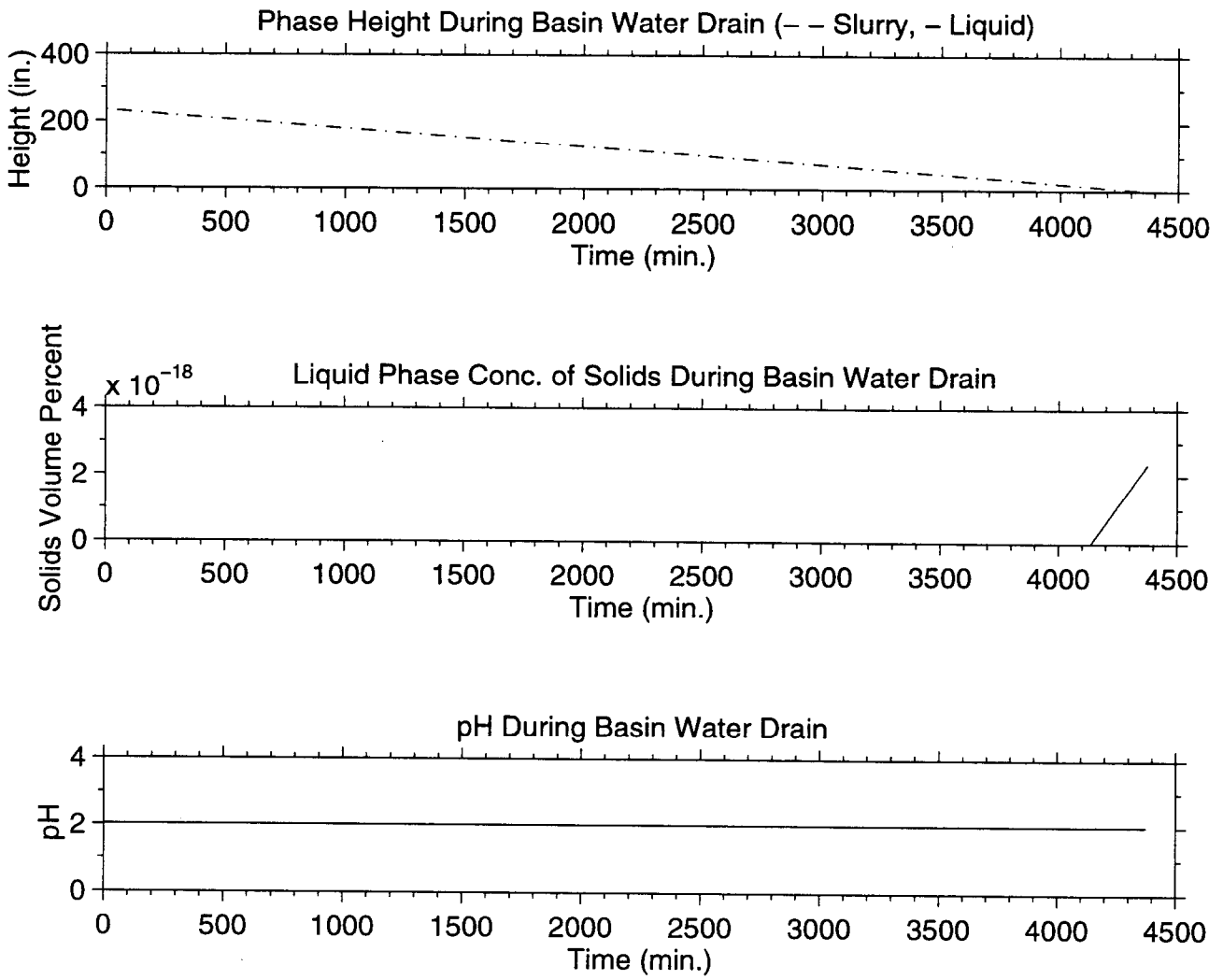


Figure 25: Tank WM-183 Status During Step #6

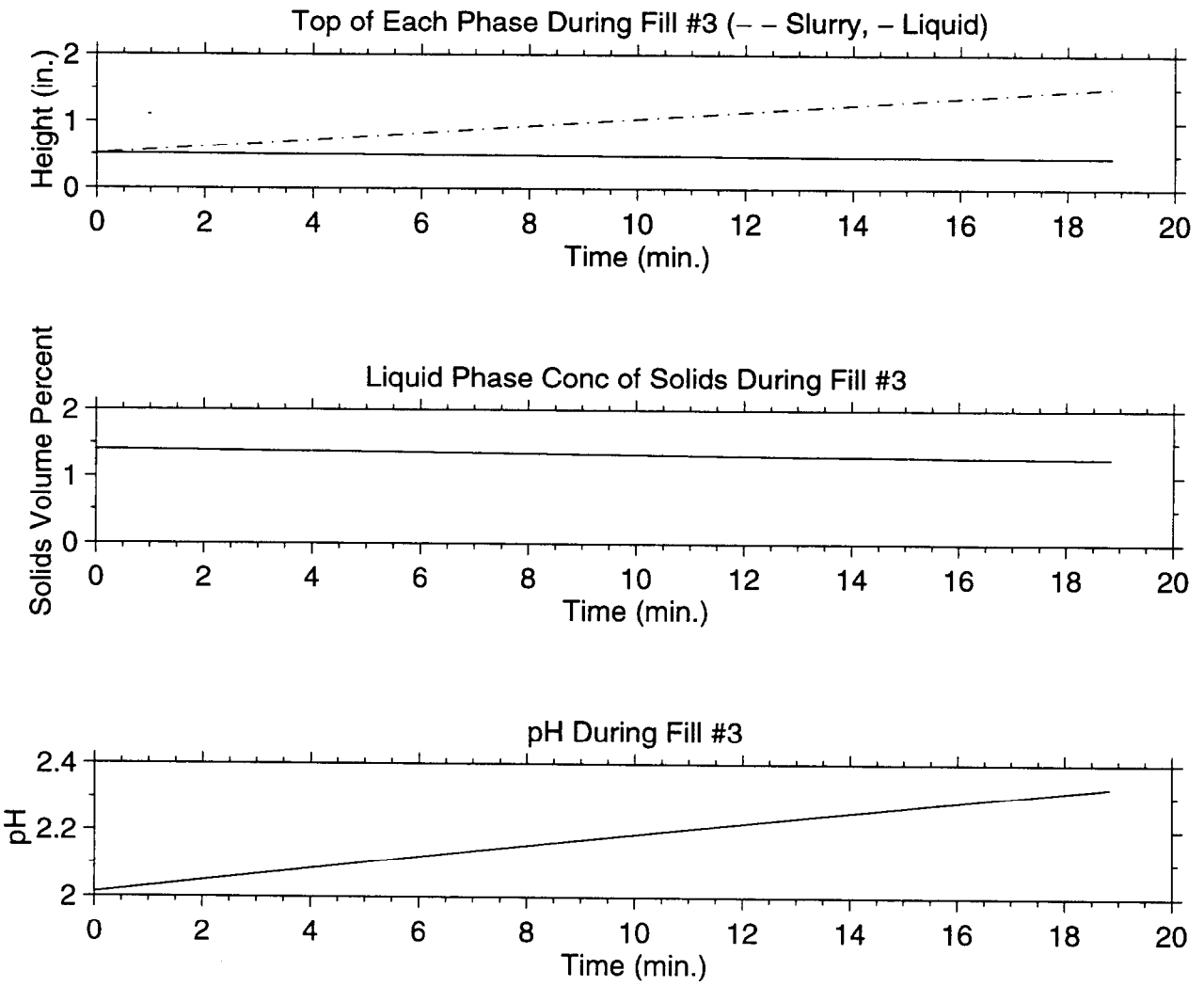


Figure 26: Tank WM-183 Status During Step #7

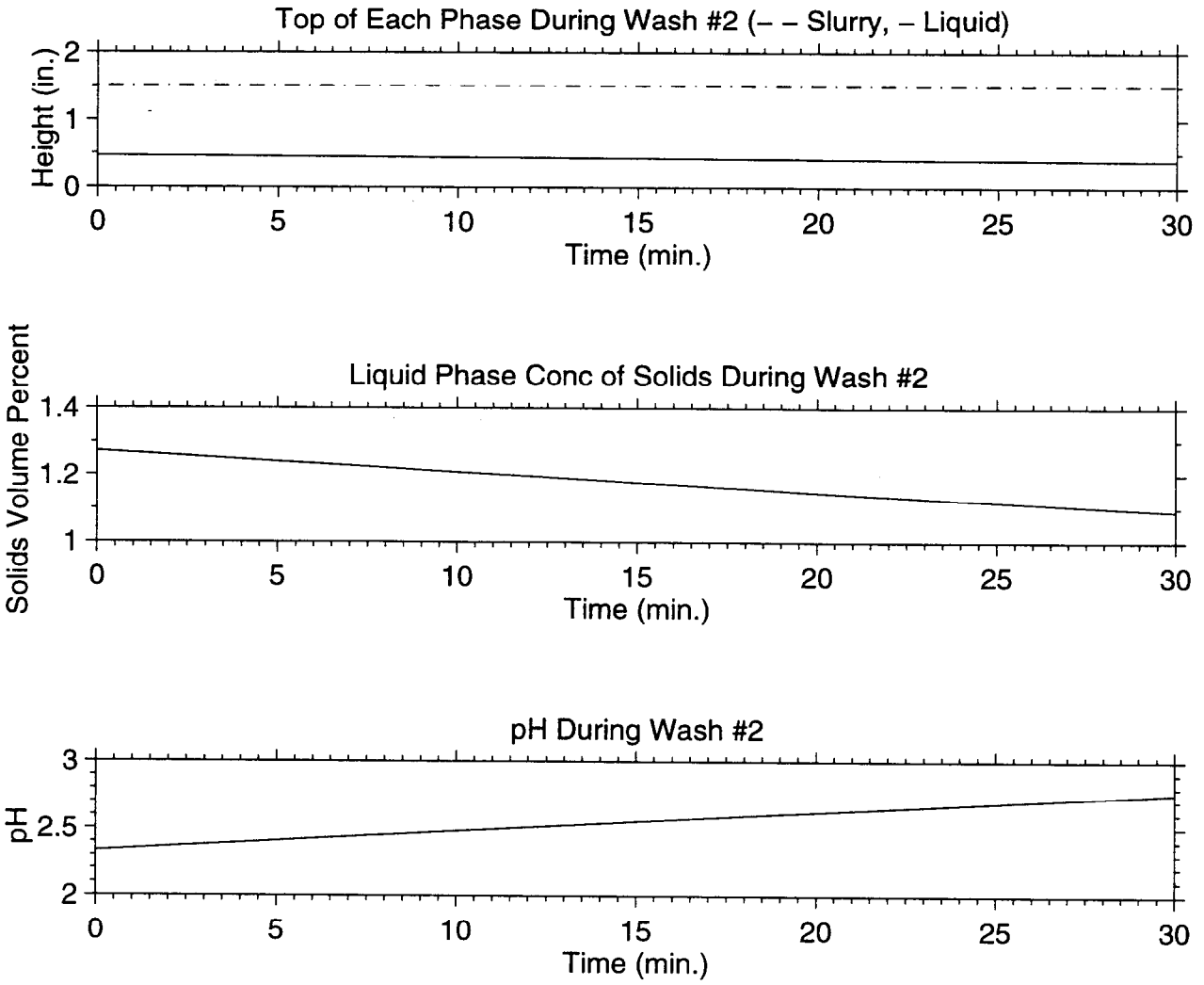


Figure 27: Tank WM-183 Status During Step #8

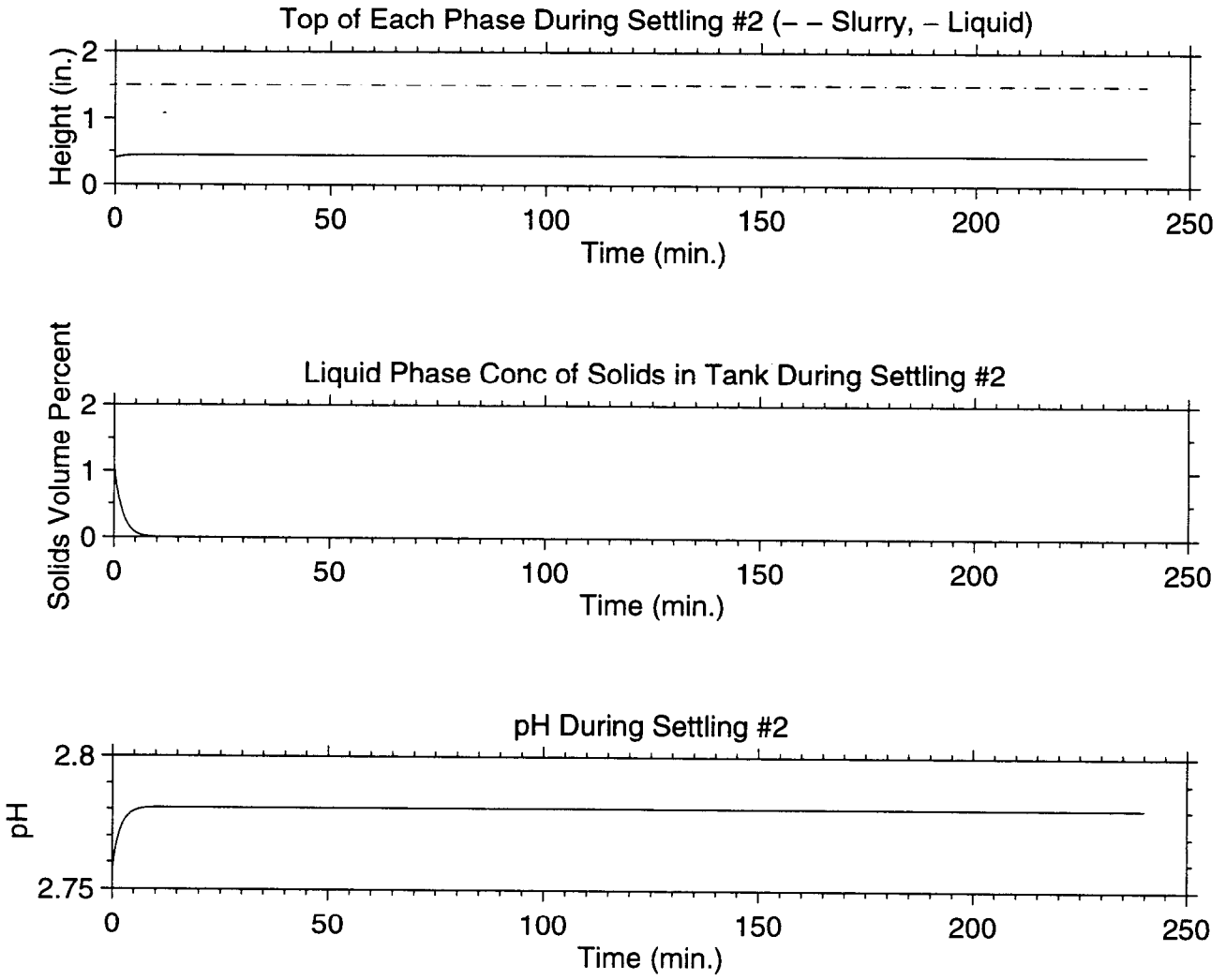


Figure 28: Tank WM-183 Status During Step #9

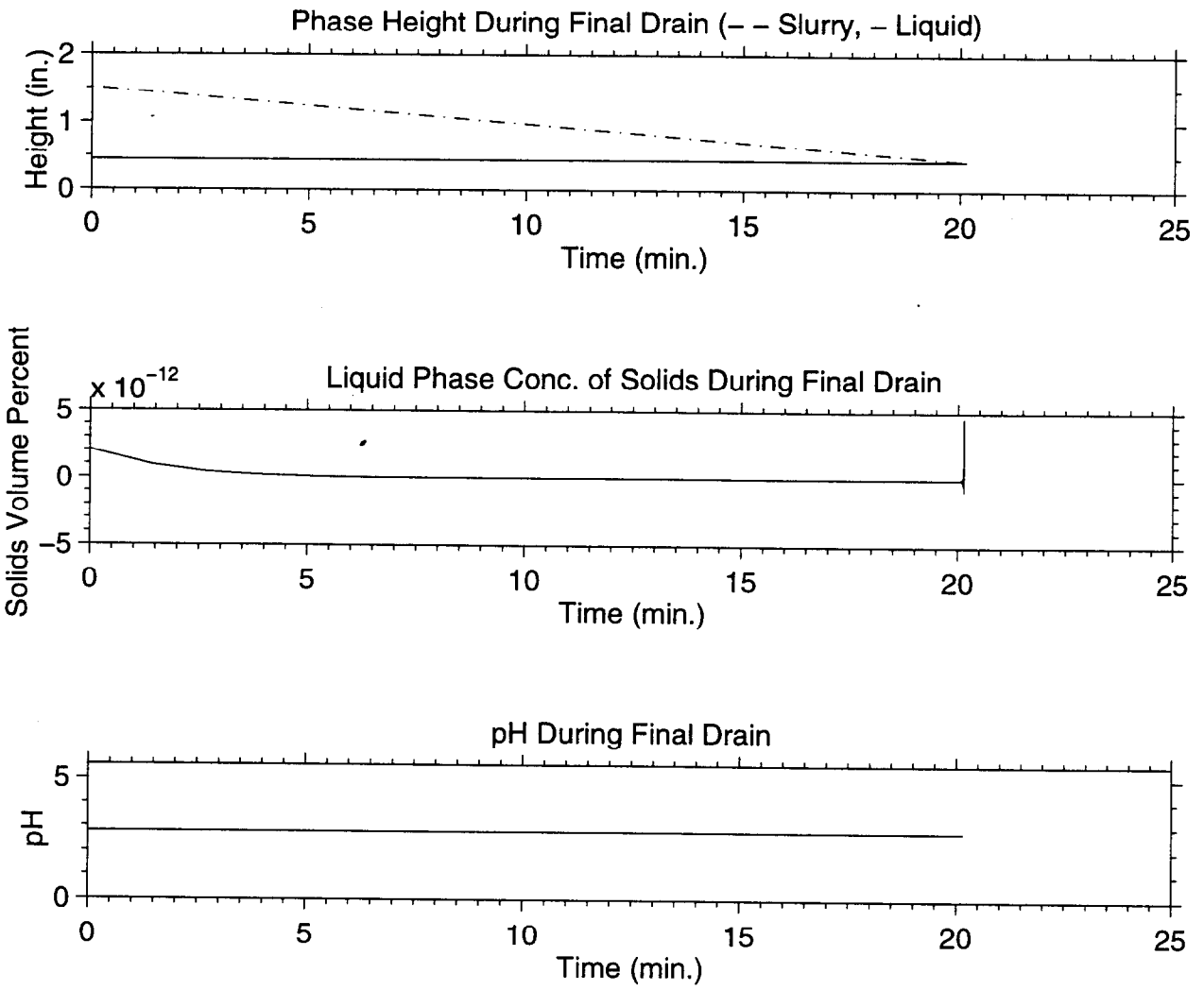


Figure 29: Tank WM-183 Status During Step #10

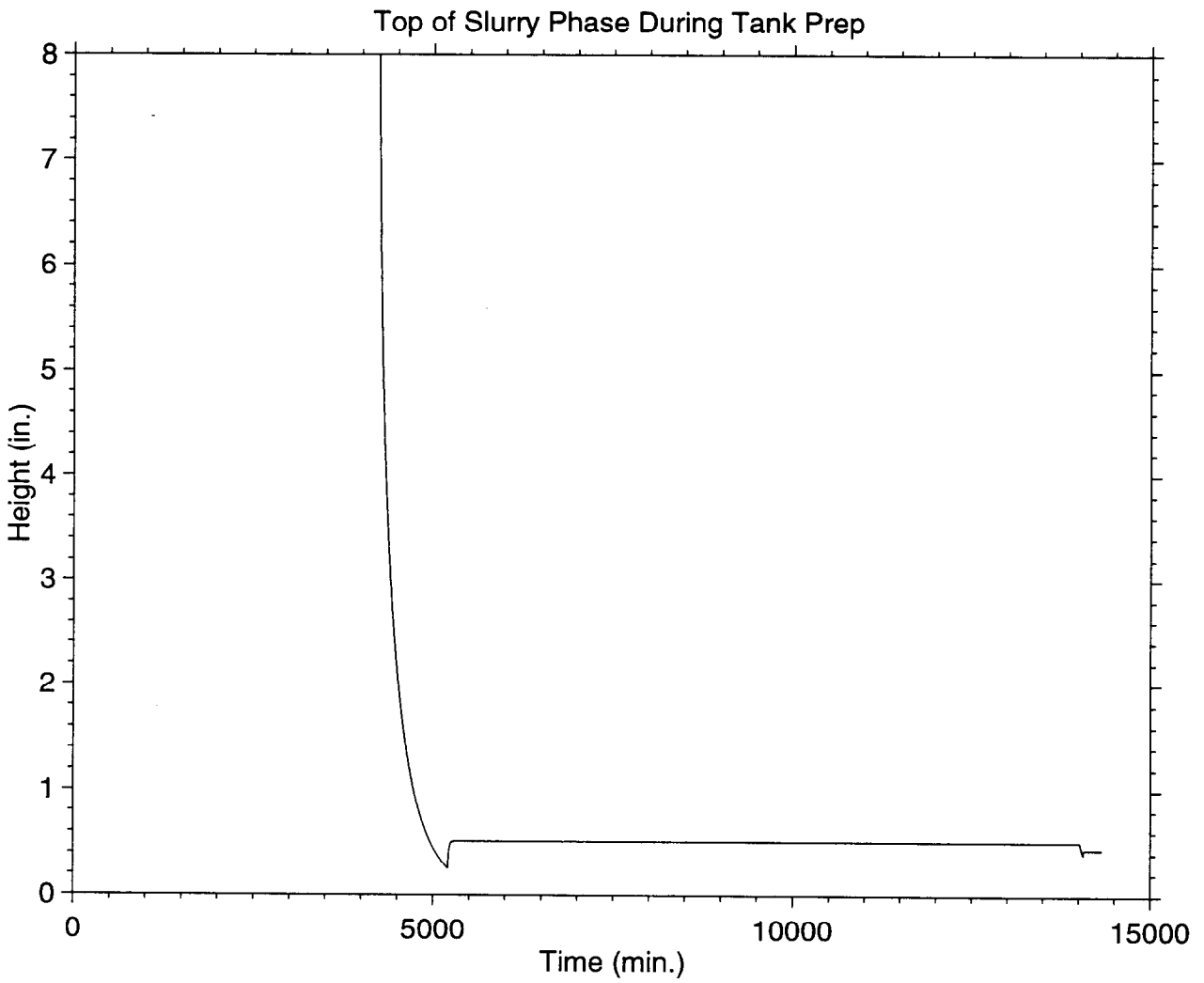


Figure 30: Tank WM-183 Slurry Phase Height During Tank Prep

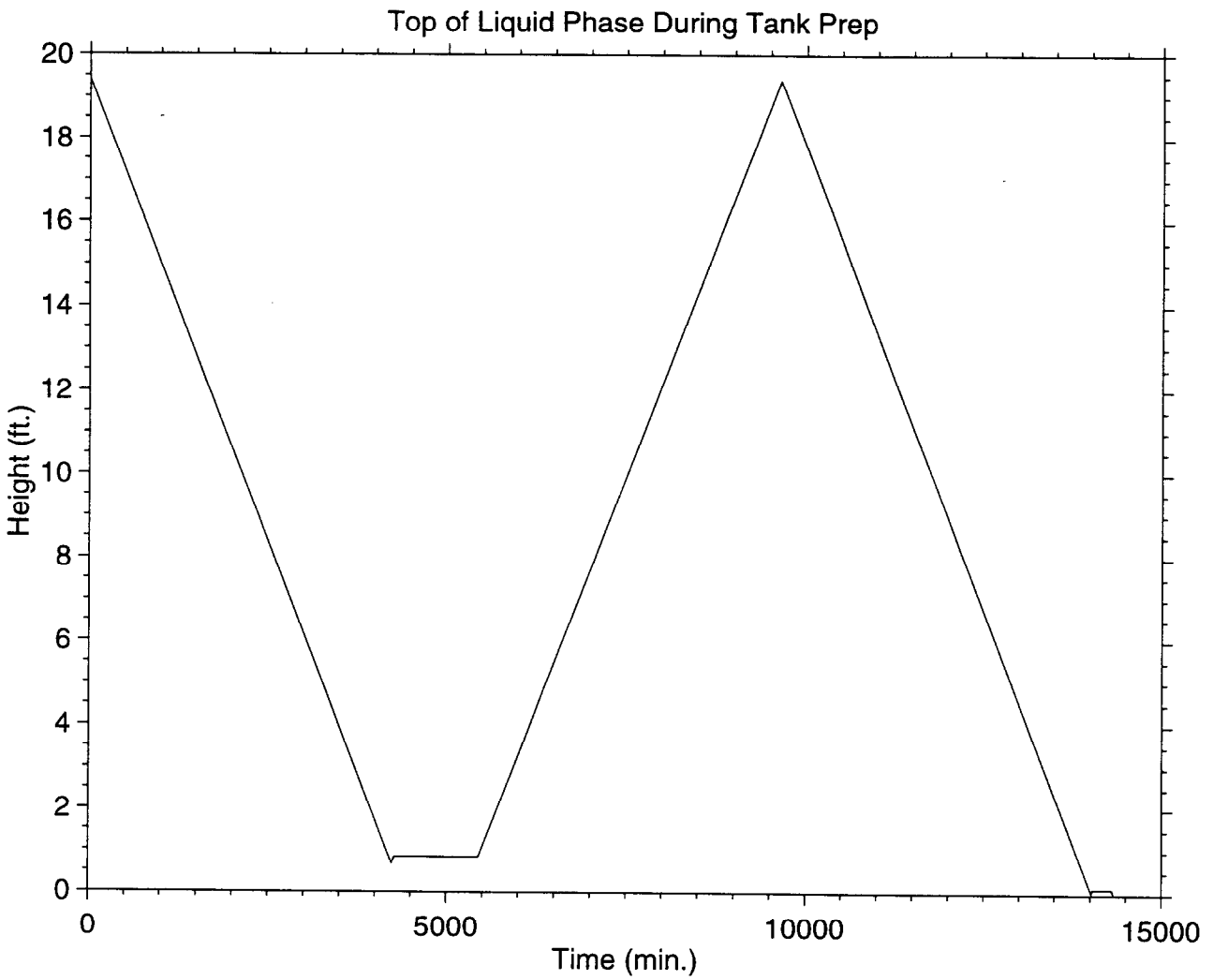


Figure 31: Tank WM-183 Liquid Phase Height during Tank Prep

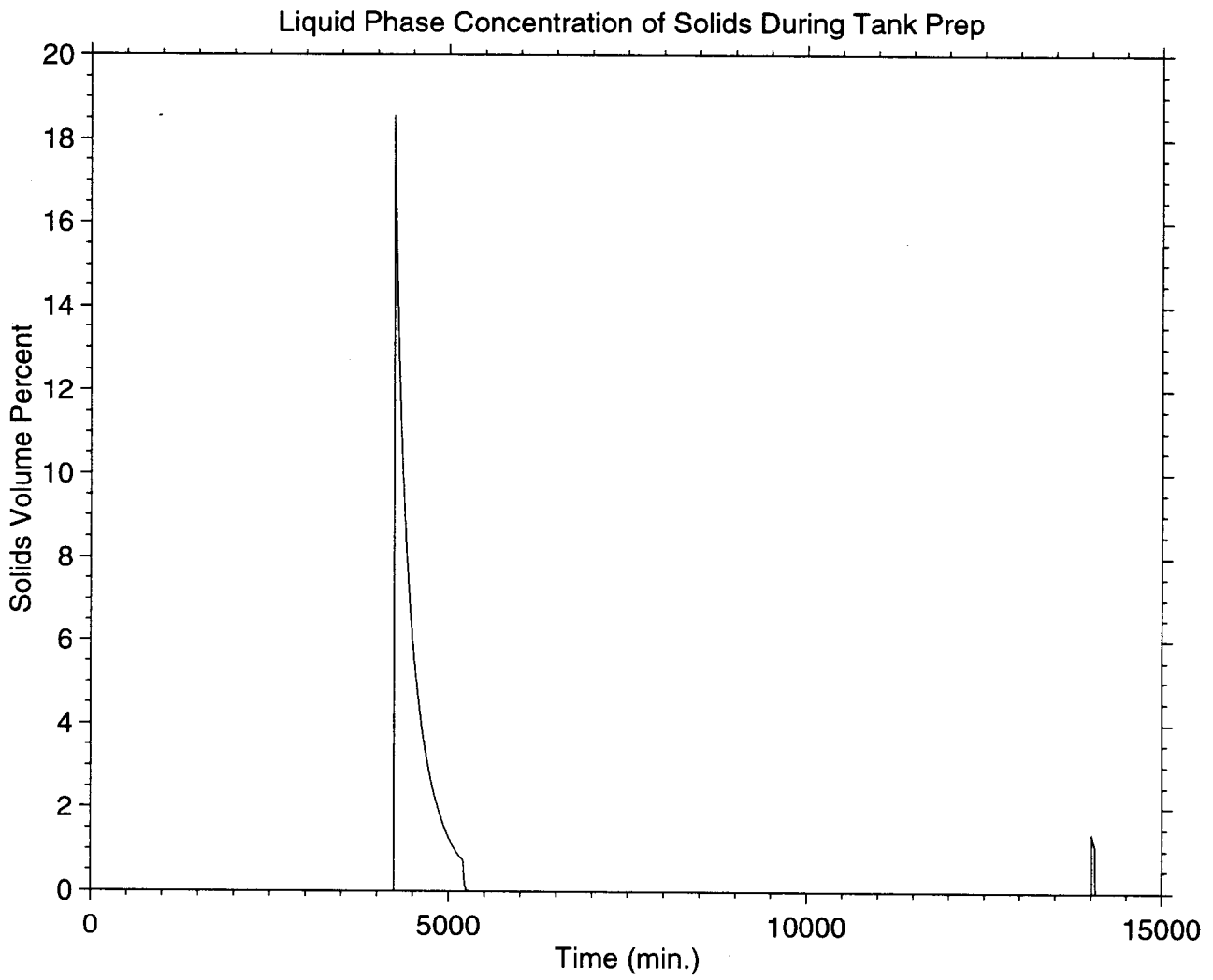


Figure 32: Tank WM-183 Liquid Phase Height during Tank Prep

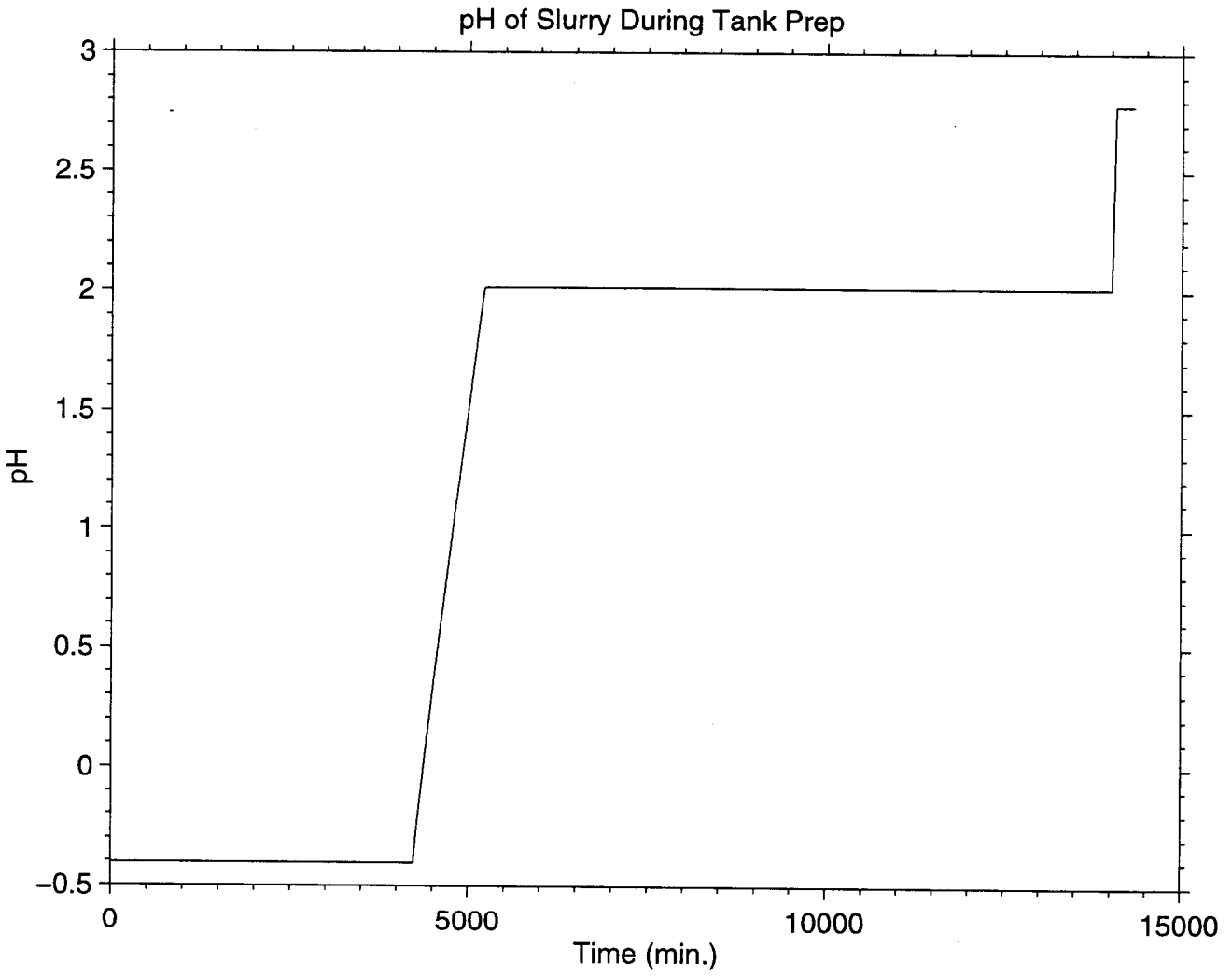


Figure 33: Tank WM-183 Slurry pH During Tank Prep

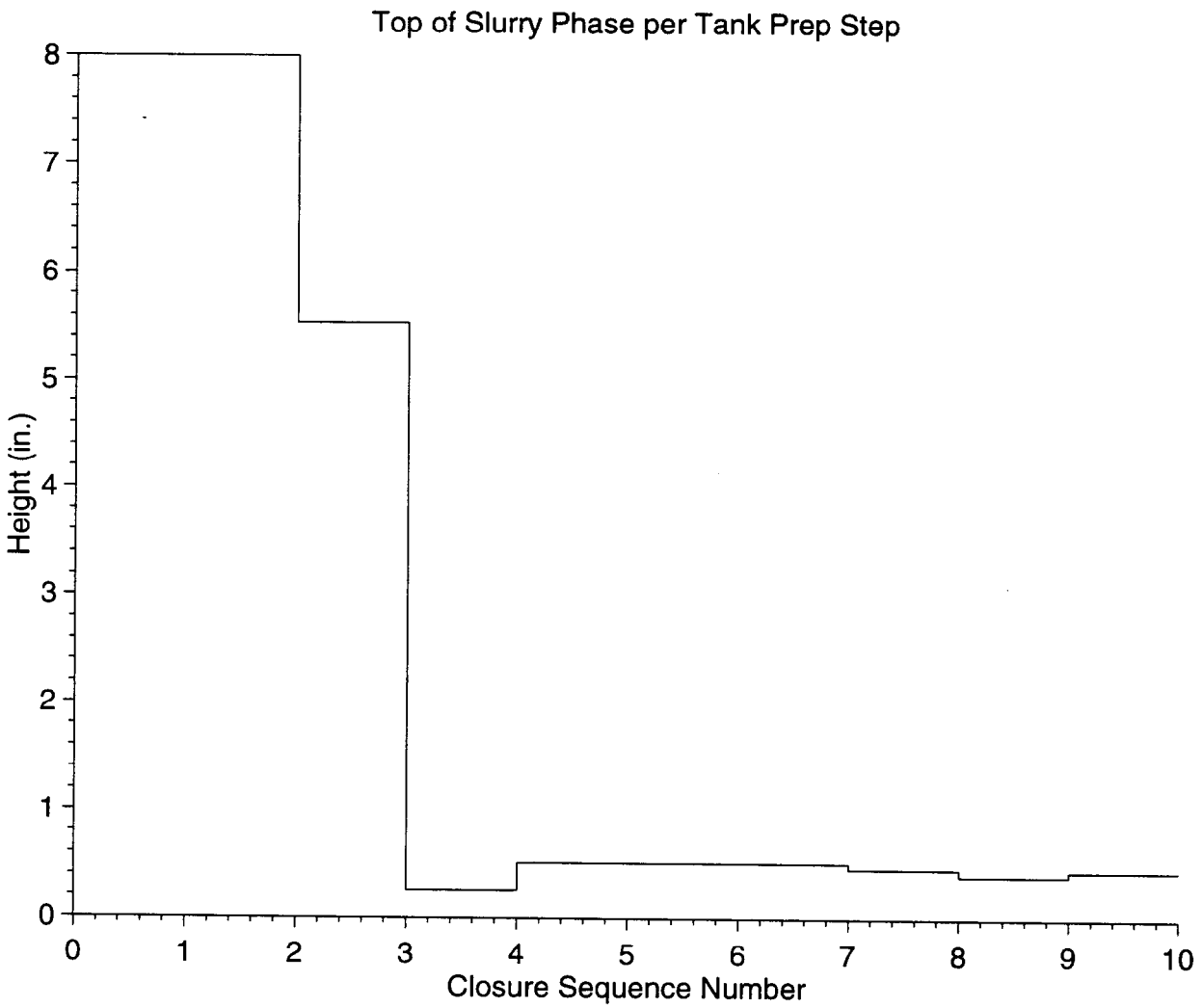


Figure 34: Tank WM-183 Slurry Phase Height per Sequence Step

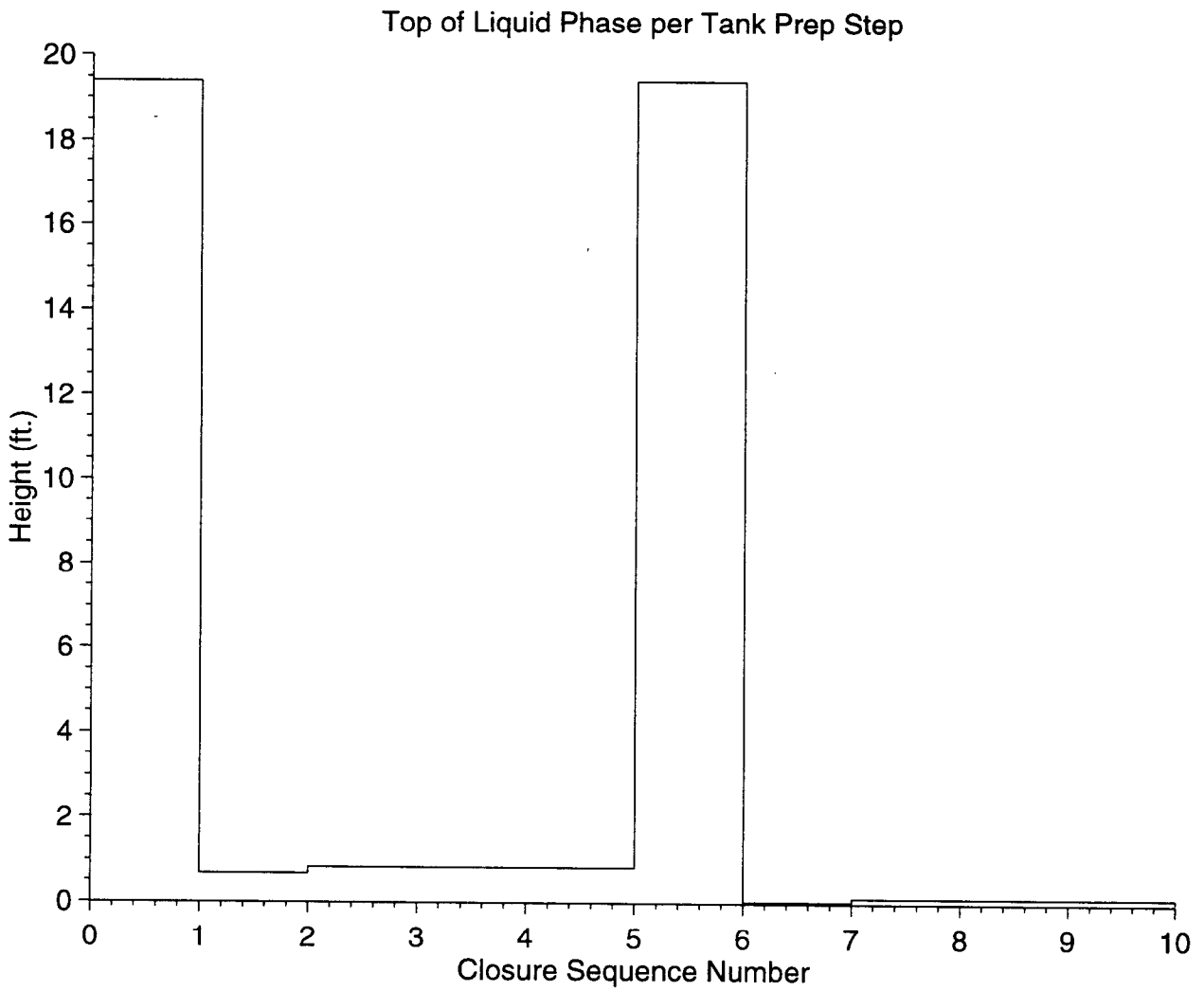


Figure 35: Tank WM-183 Liquid Phase Height per Sequence Step

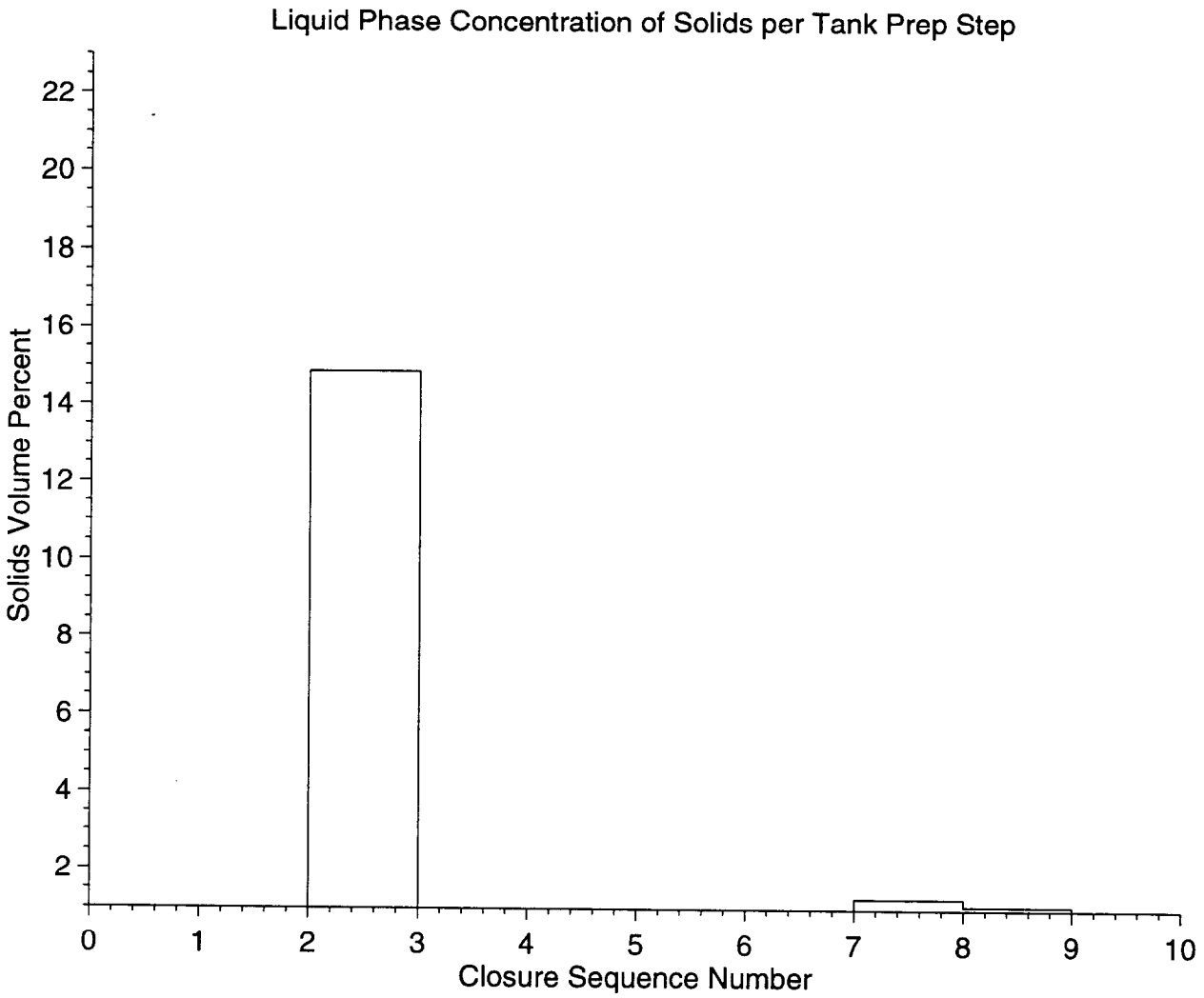


Figure 36: Tank WM-183 Liquid Phase Height per Sequence Step

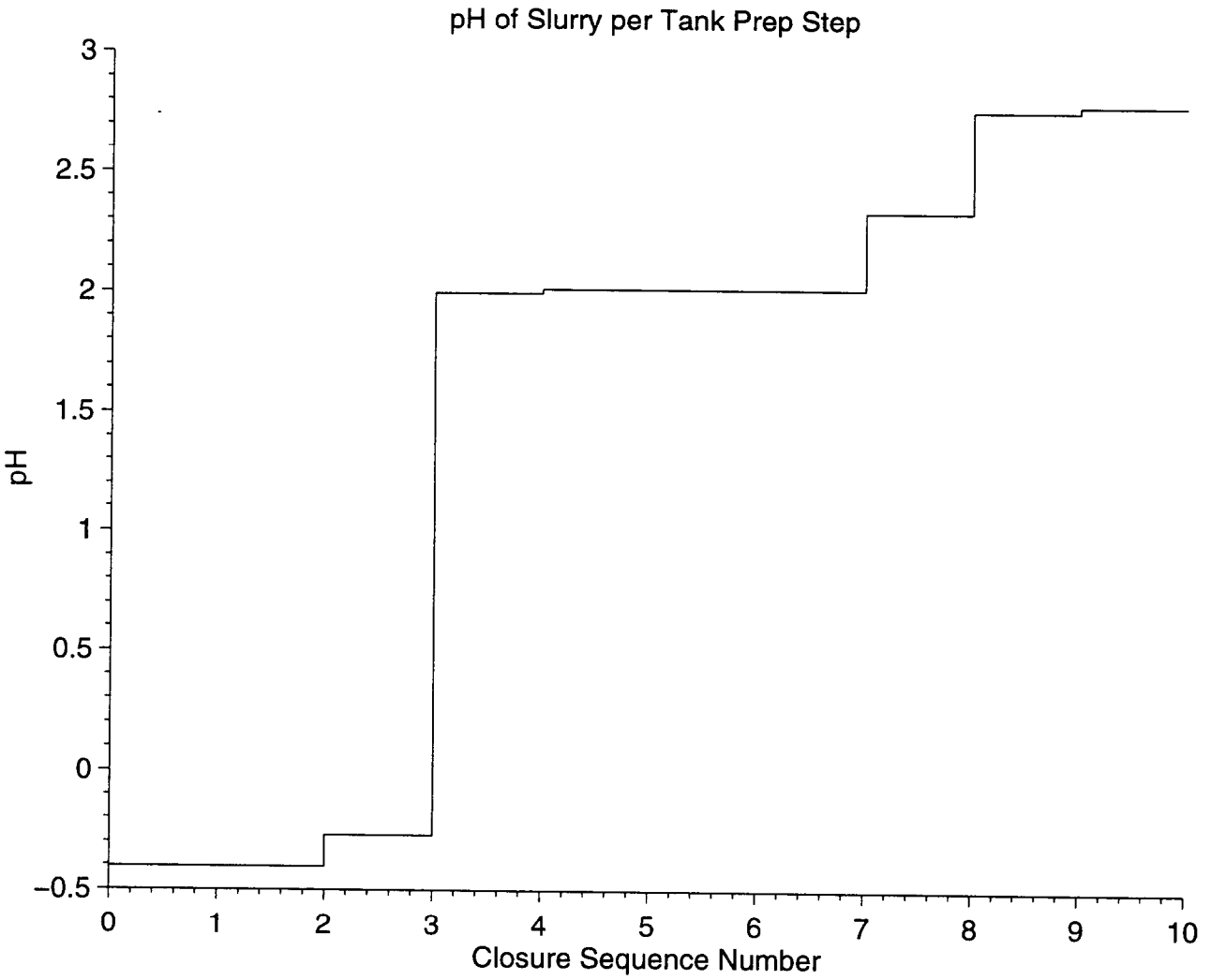


Figure 37: Tank WM-183 Slurry pH per Sequence Step

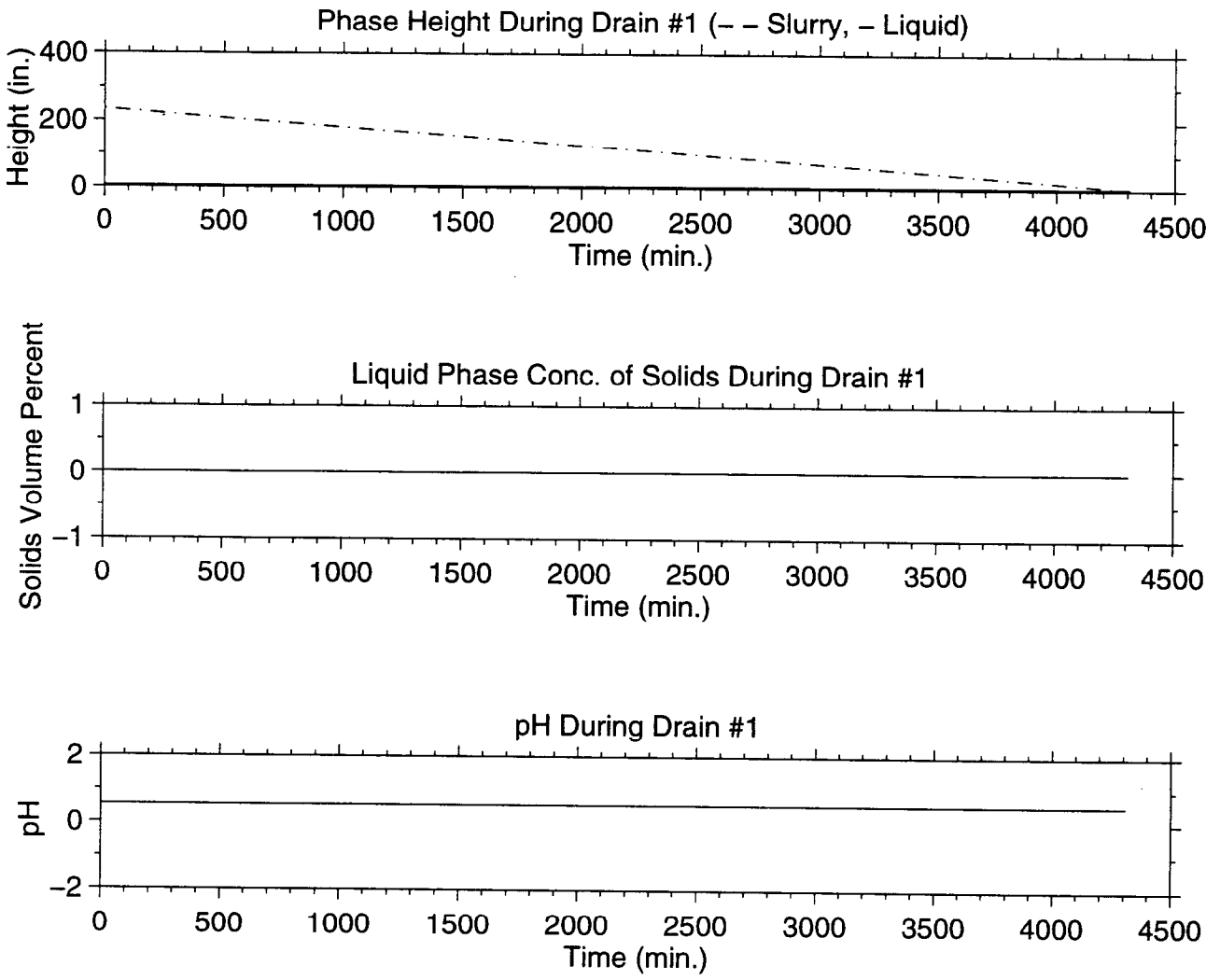


Figure 38: Tank WM-182 (Improved Control Law) Status During Step #1

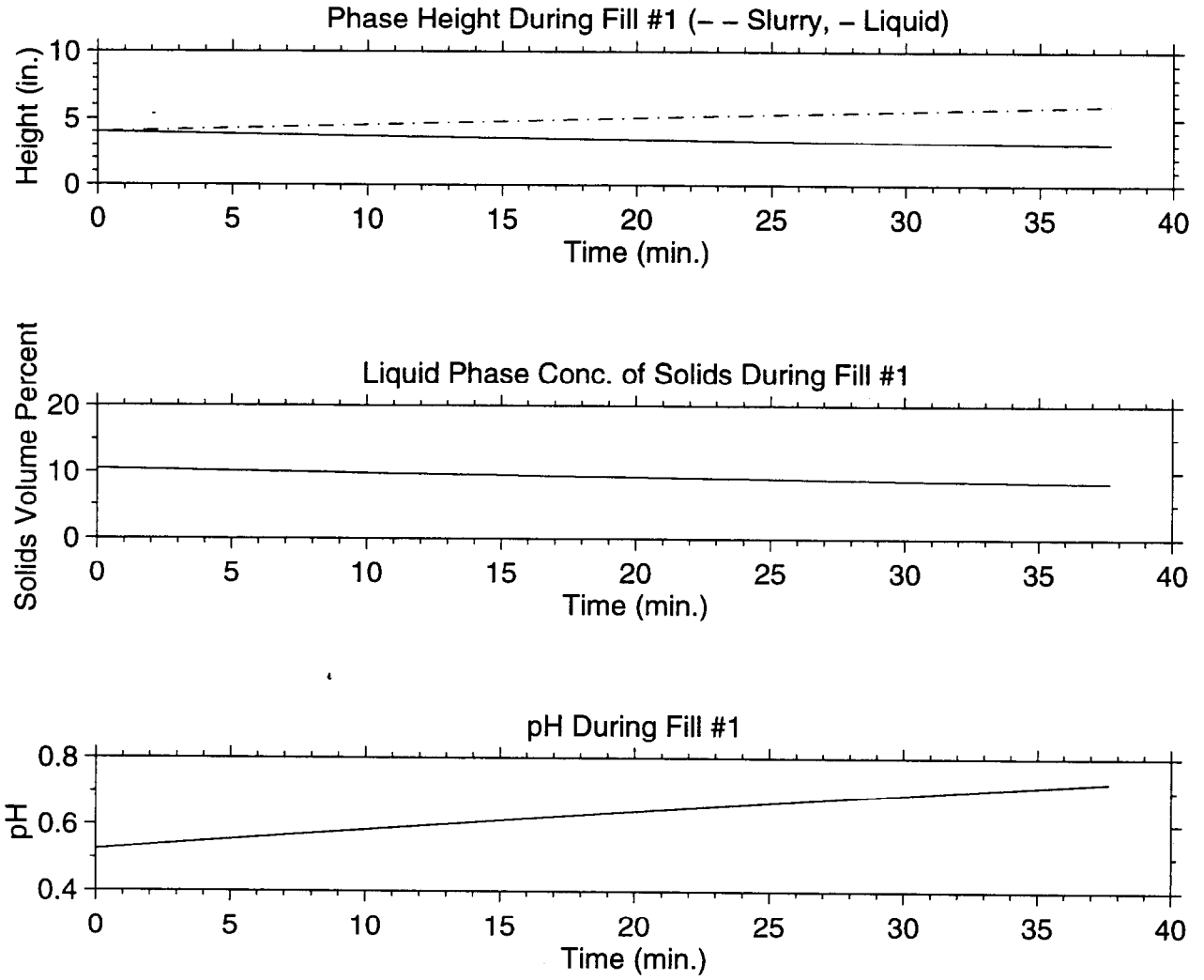


Figure 39: Tank WM-182 (Improved Control Law) Status During Step #2

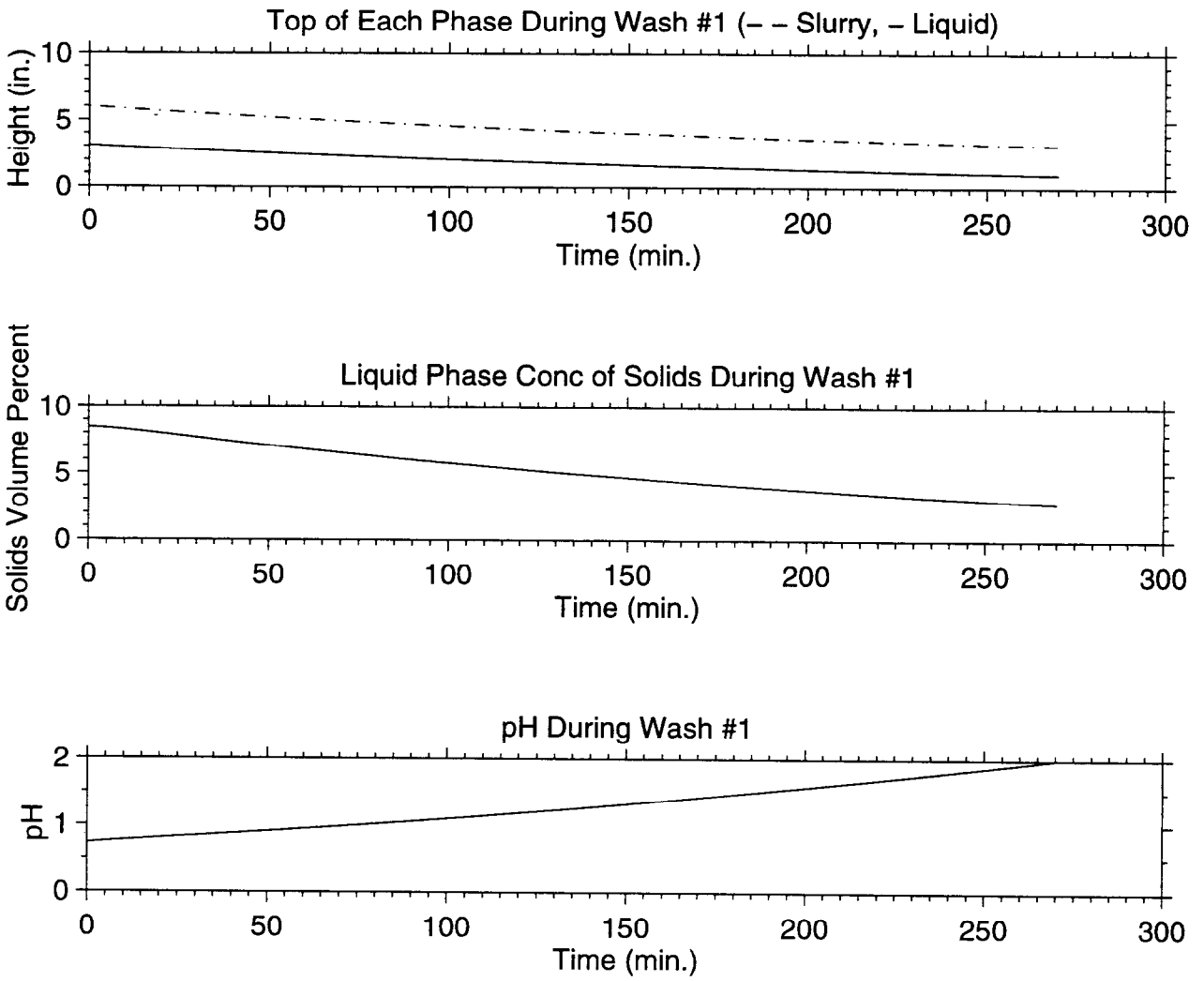


Figure 40: Tank WM-182 (Improved Control Law) Status During Step #3

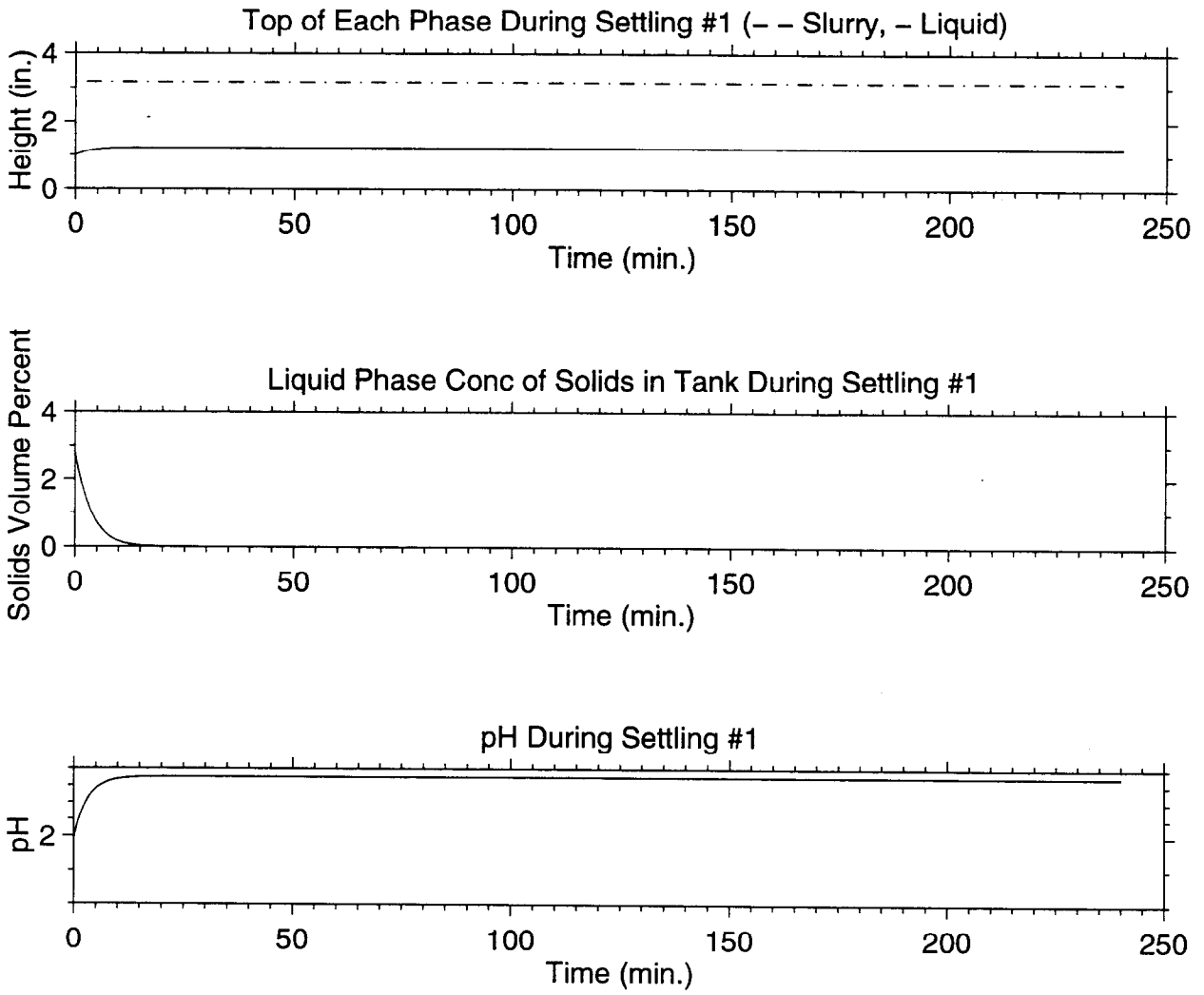


Figure 41: Tank WM-182 (Improved Control Law) Status During Step #4

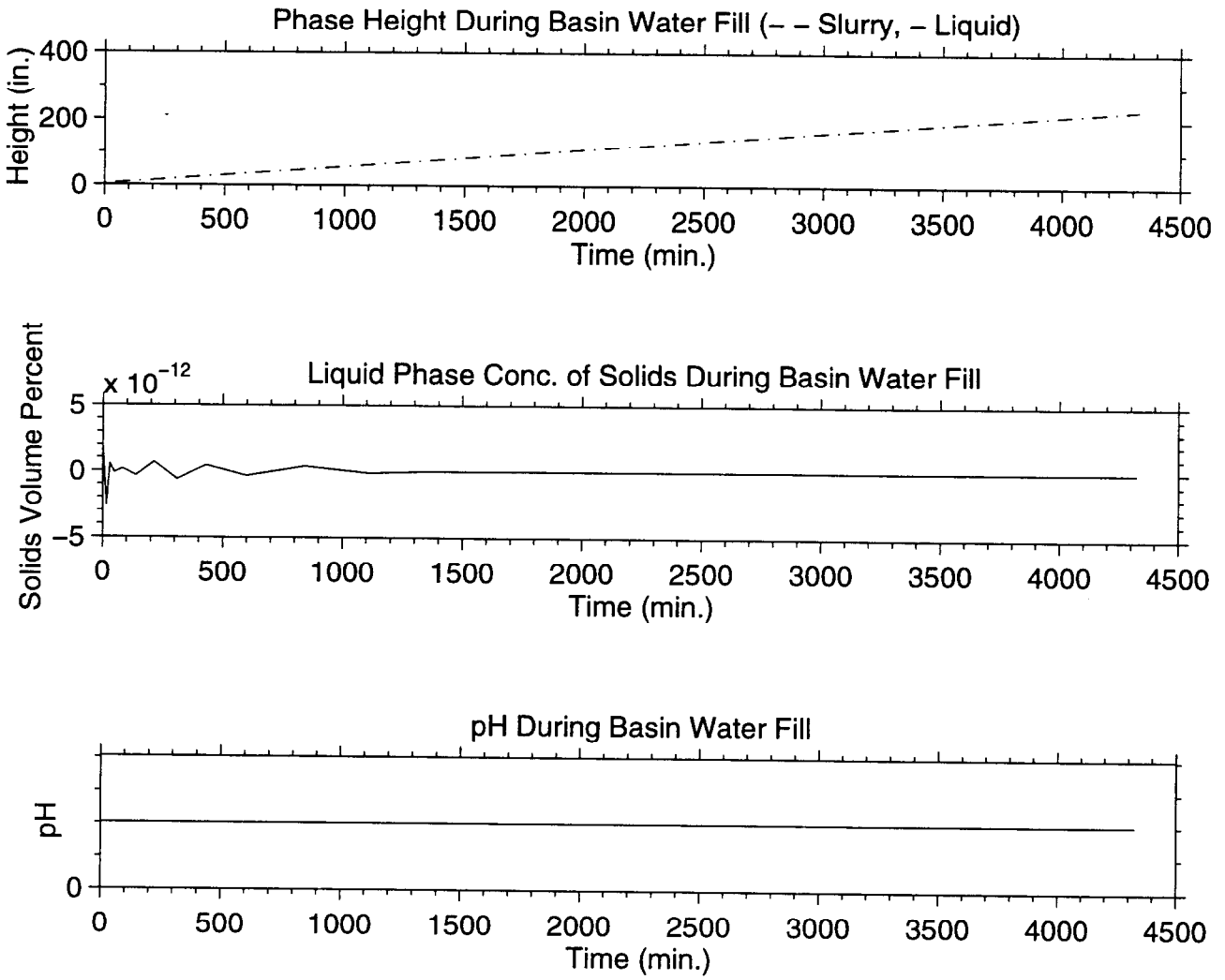


Figure 42: Tank WM-182 (Improved Control Law) Status During Step #5

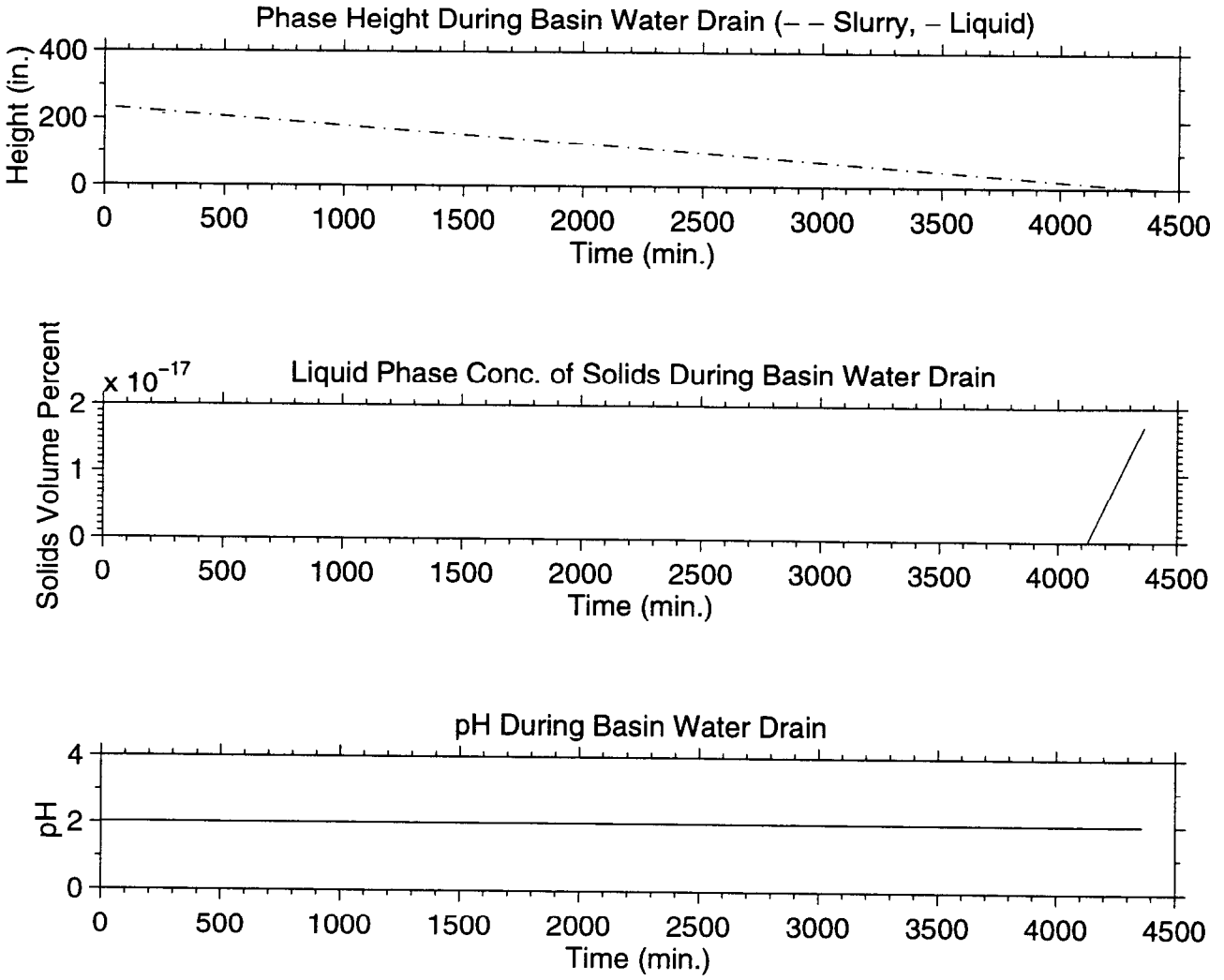


Figure 43: Tank WM-182 (Improved Control Law) Status During Step #6

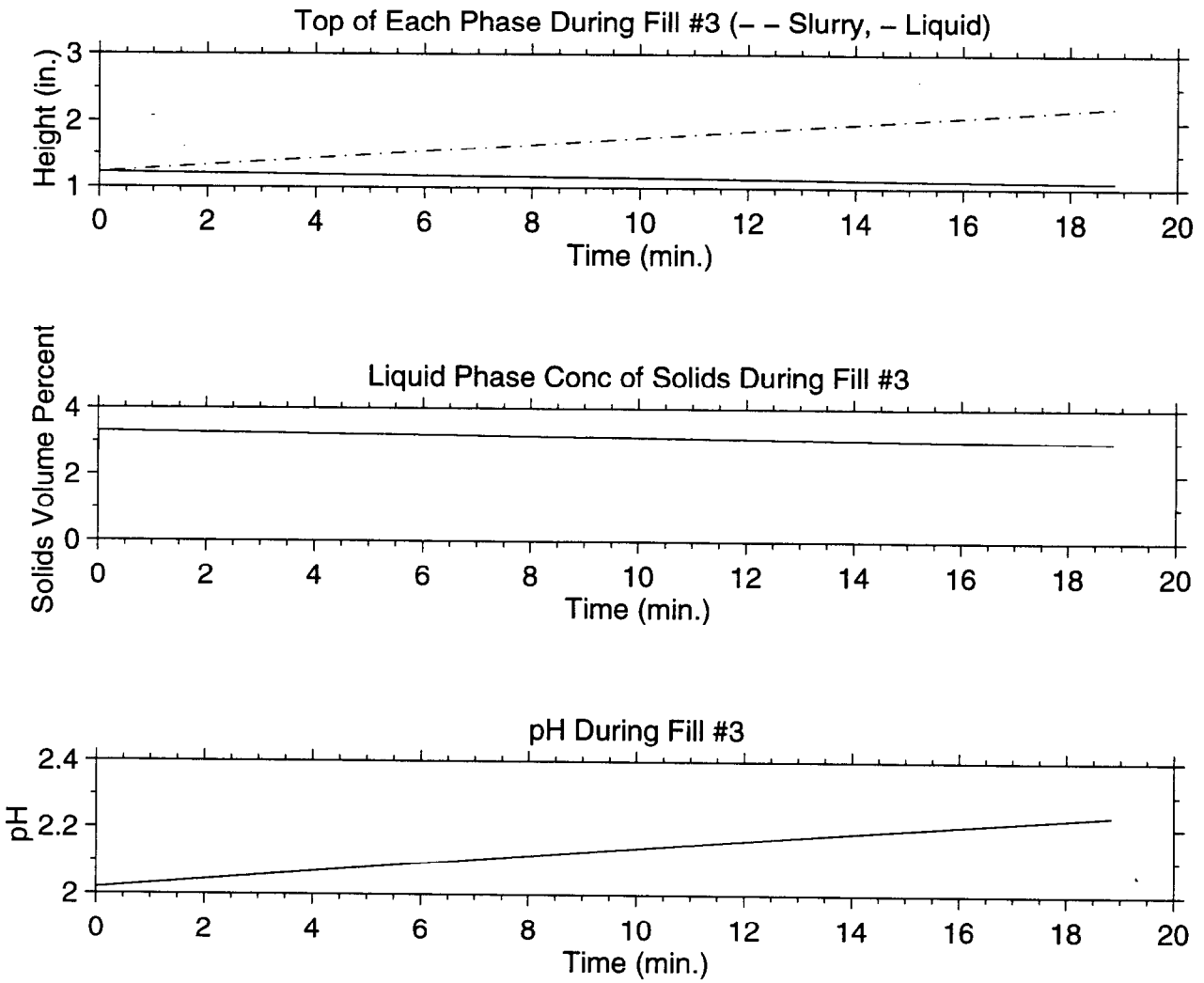


Figure 44: Tank WM-182 (Improved Control Law) Status During Step #7

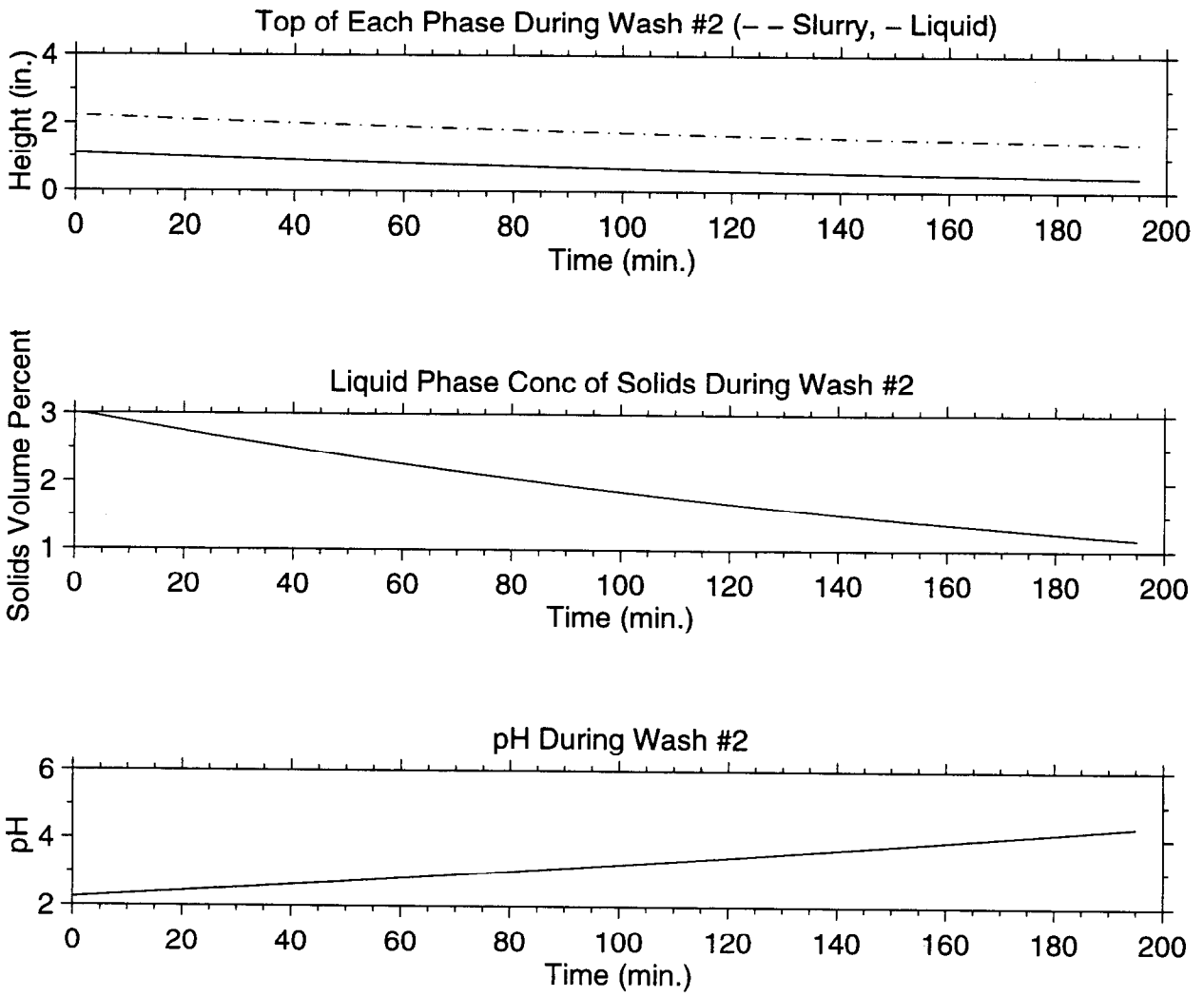


Figure 45: Tank WM-182 (Improved Control Law) Status During Step #8

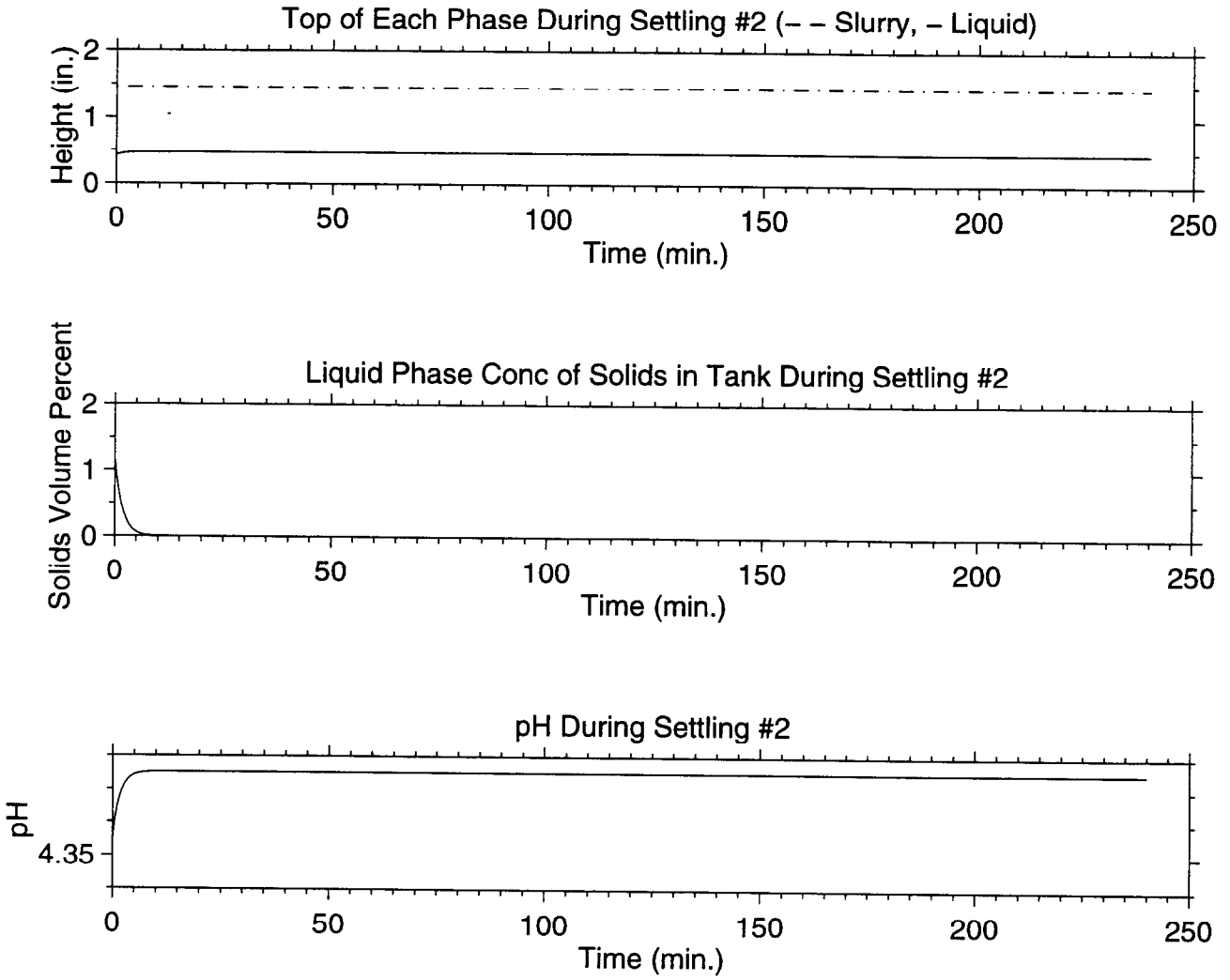


Figure 46: Tank WM-182 (Improved Control Law) Status During Step #9

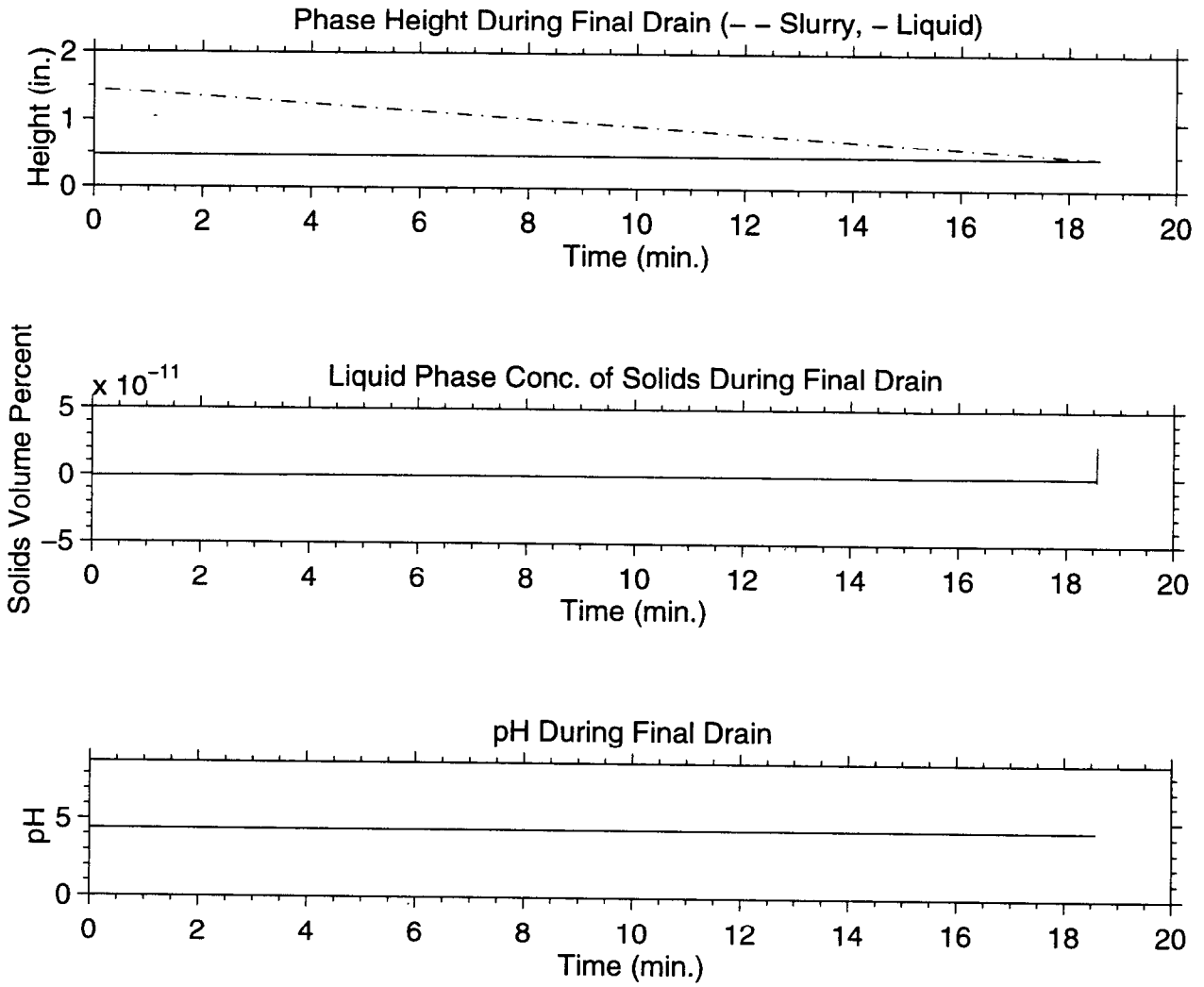


Figure 47: Tank WM-182 (Improved Control Law) Status During Step #10

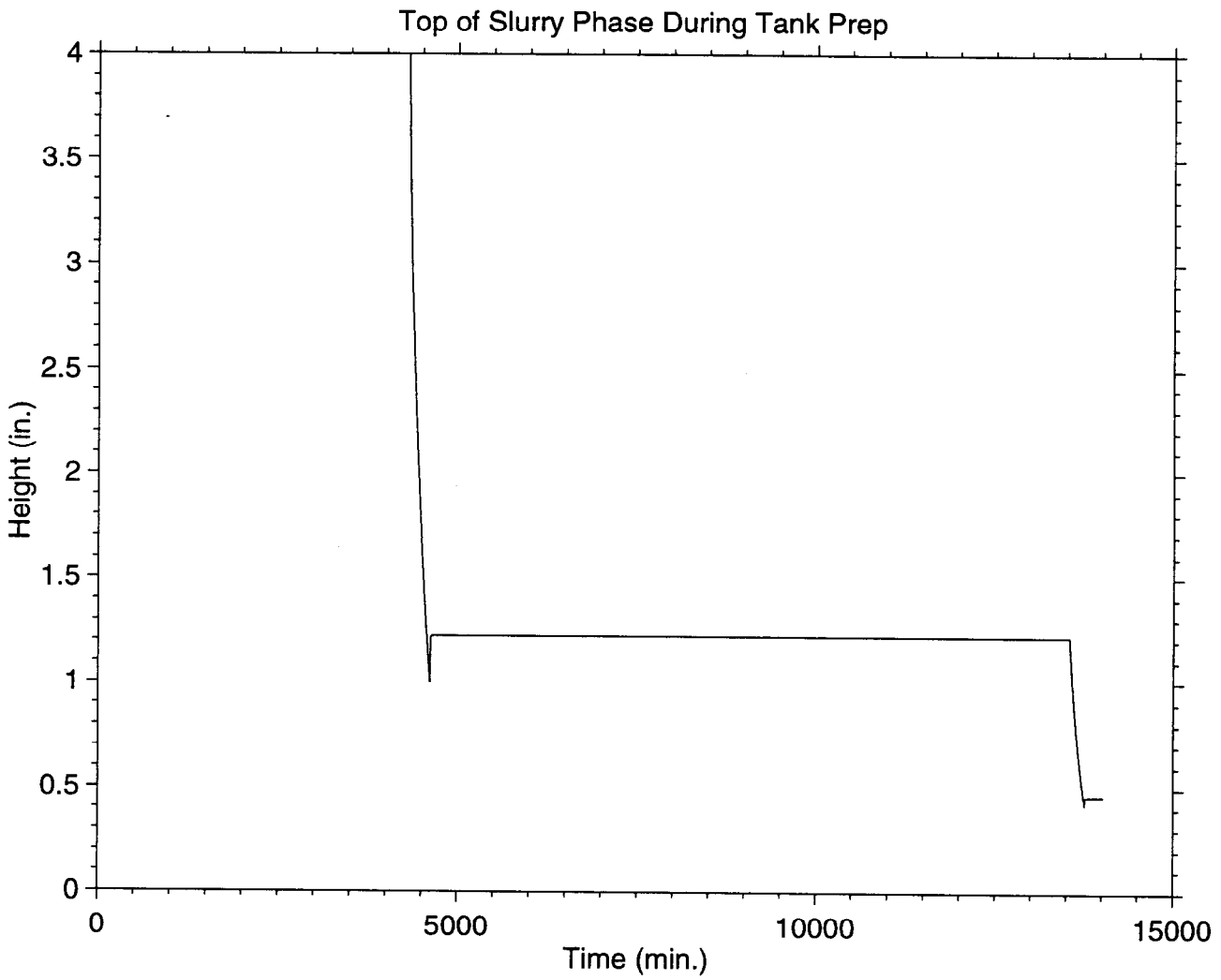


Figure 48: Tank WM-182 (Improved Control Law) Slurry Phase Height During Tank Prep

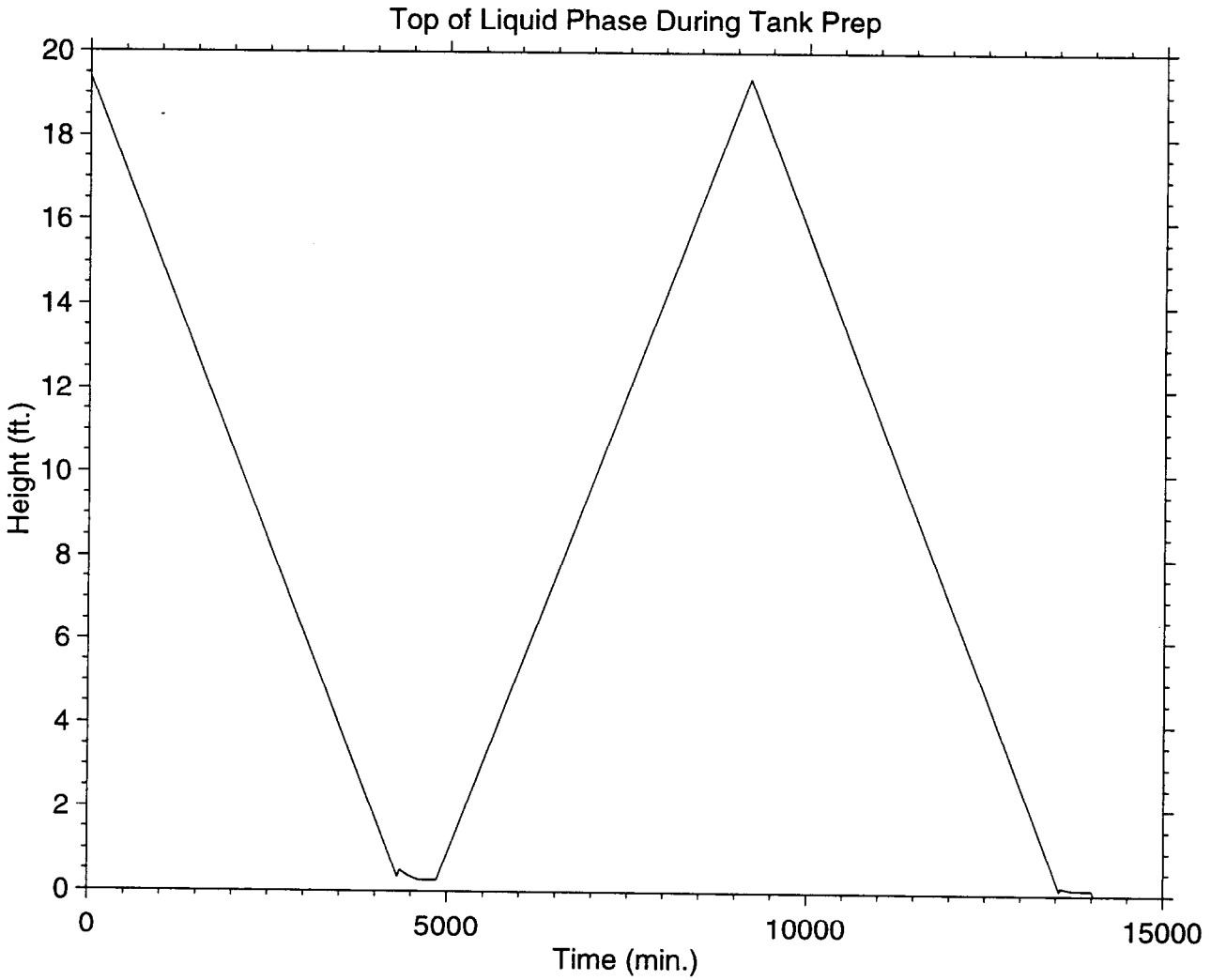


Figure 49: Tank WM-182 (Improved Control Law) Liquid Phase Height during Tank Prep

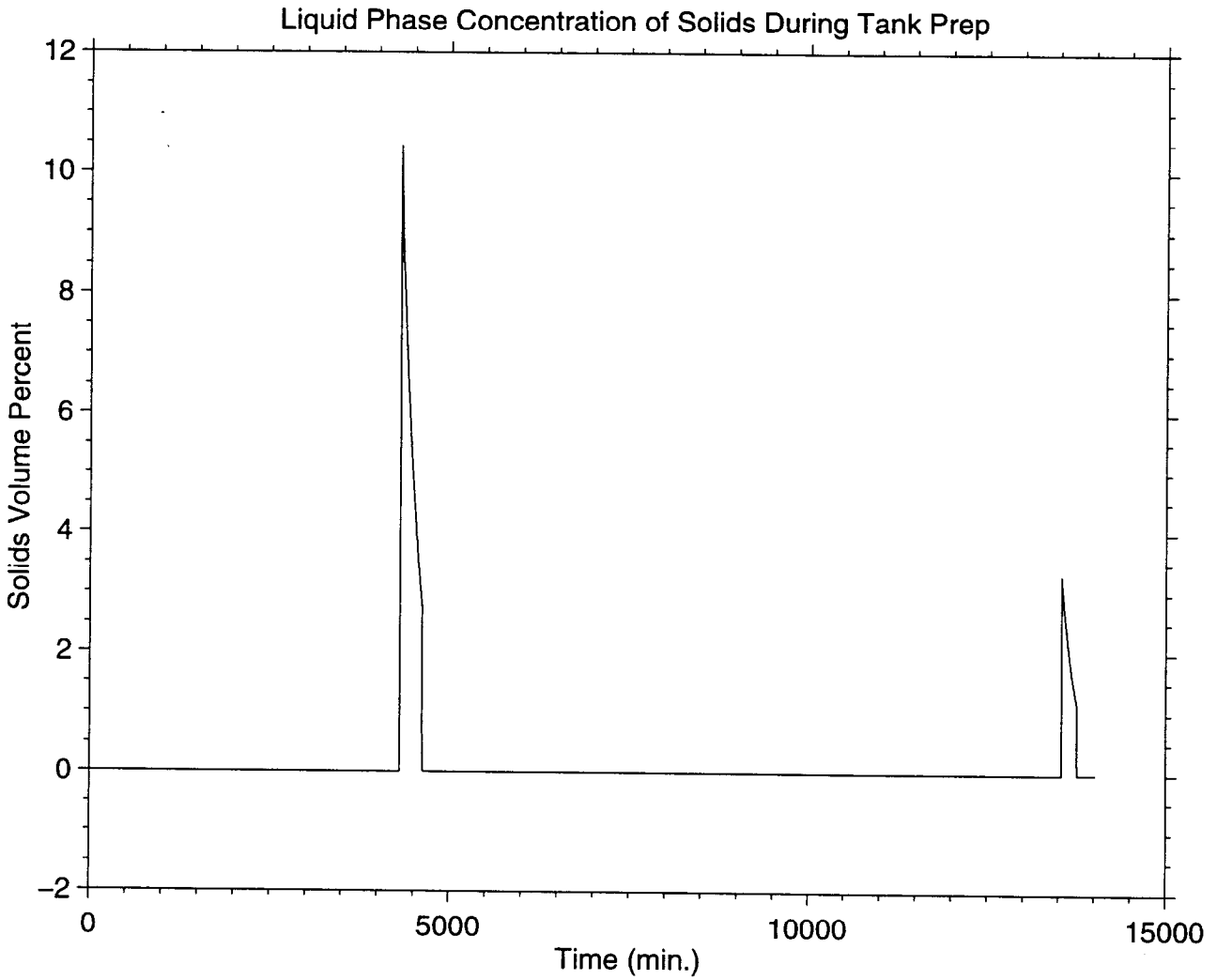


Figure 50: Tank WM-182 (Improved Control Law) Liquid Phase Height during Tank Prep

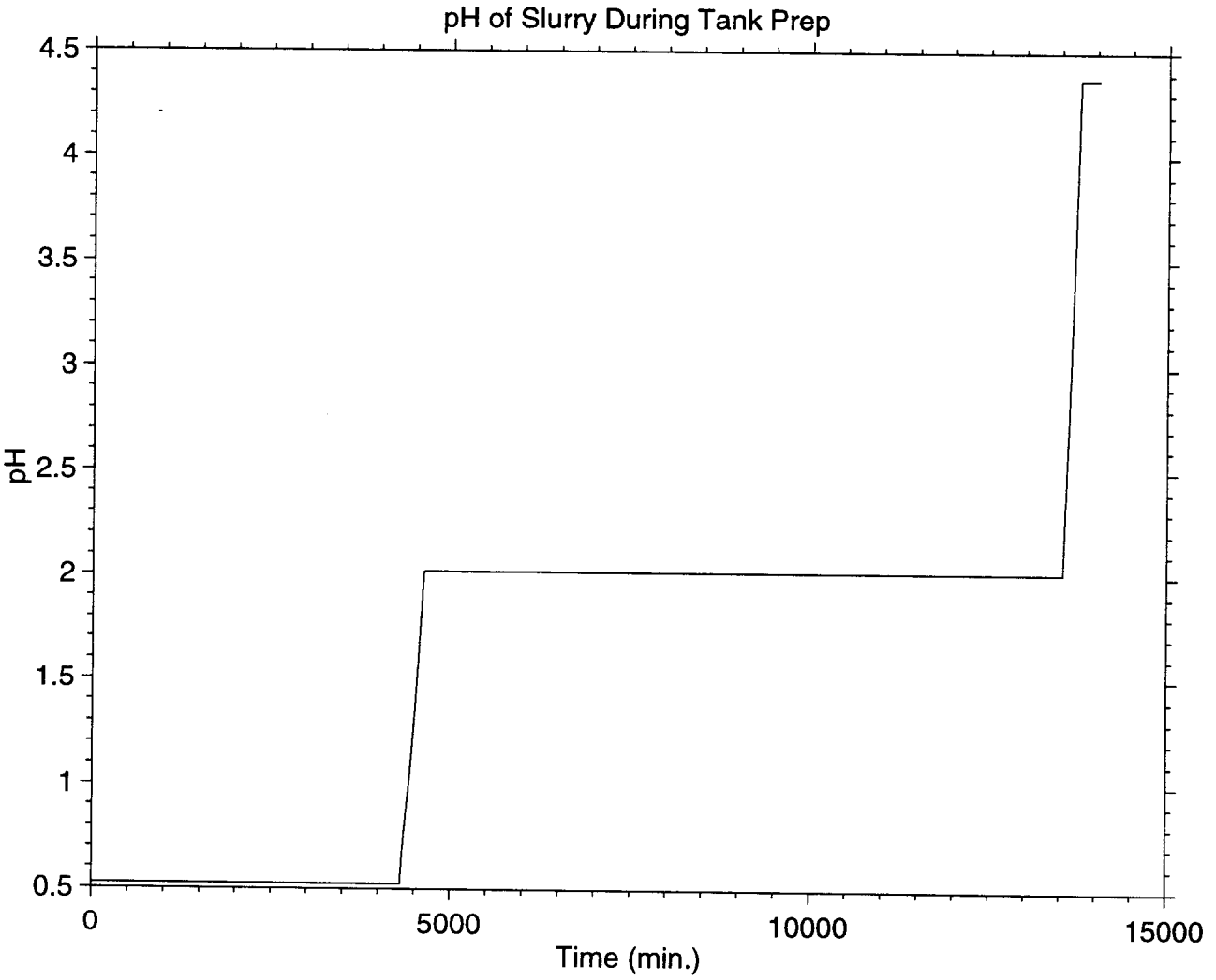


Figure 51: Tank WM-182 (Improved Control Law) Slurry pH During Tank Prep

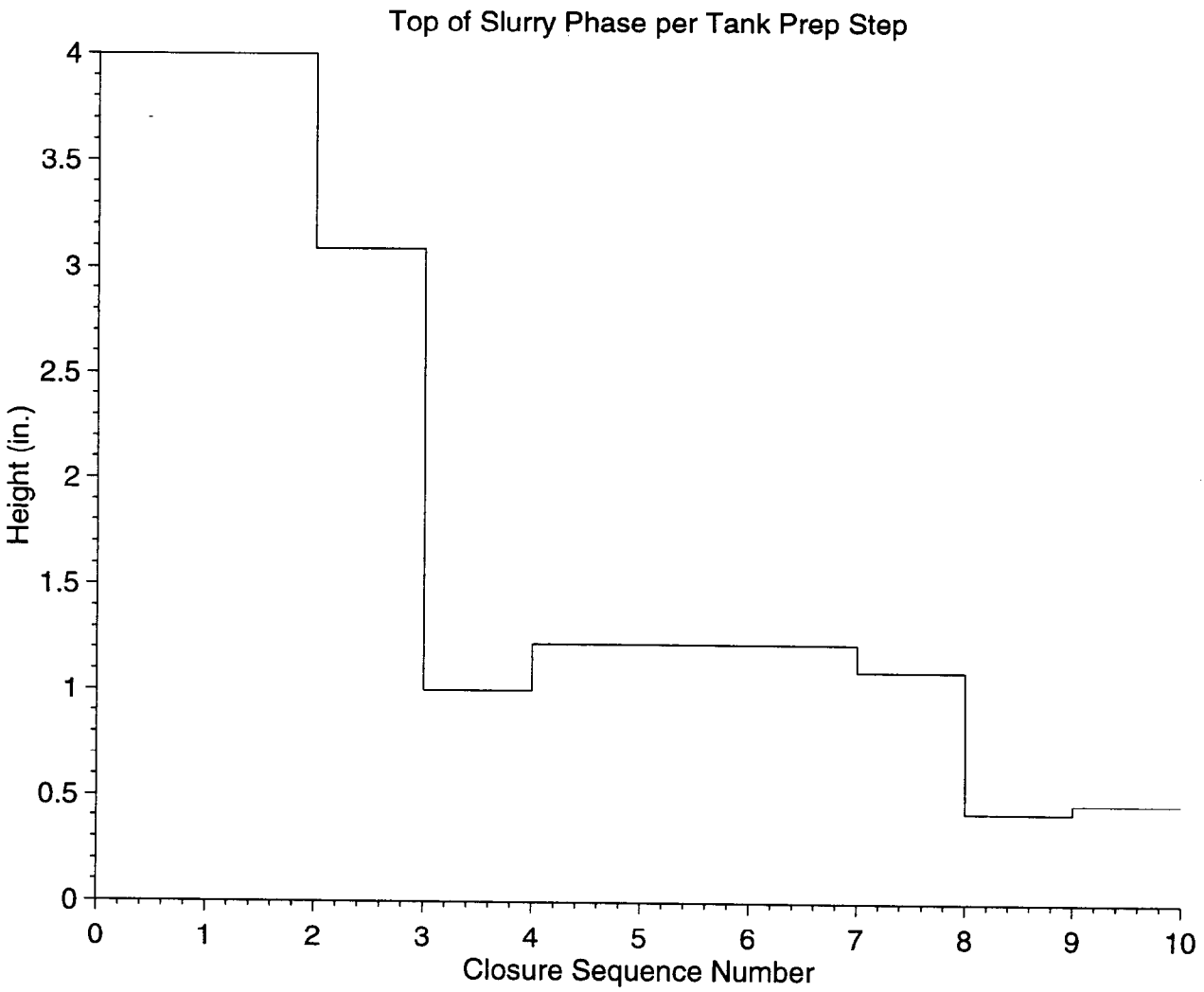


Figure 52: Tank WM-182 (Improved Control Law) Slurry Phase Height per Sequence Step

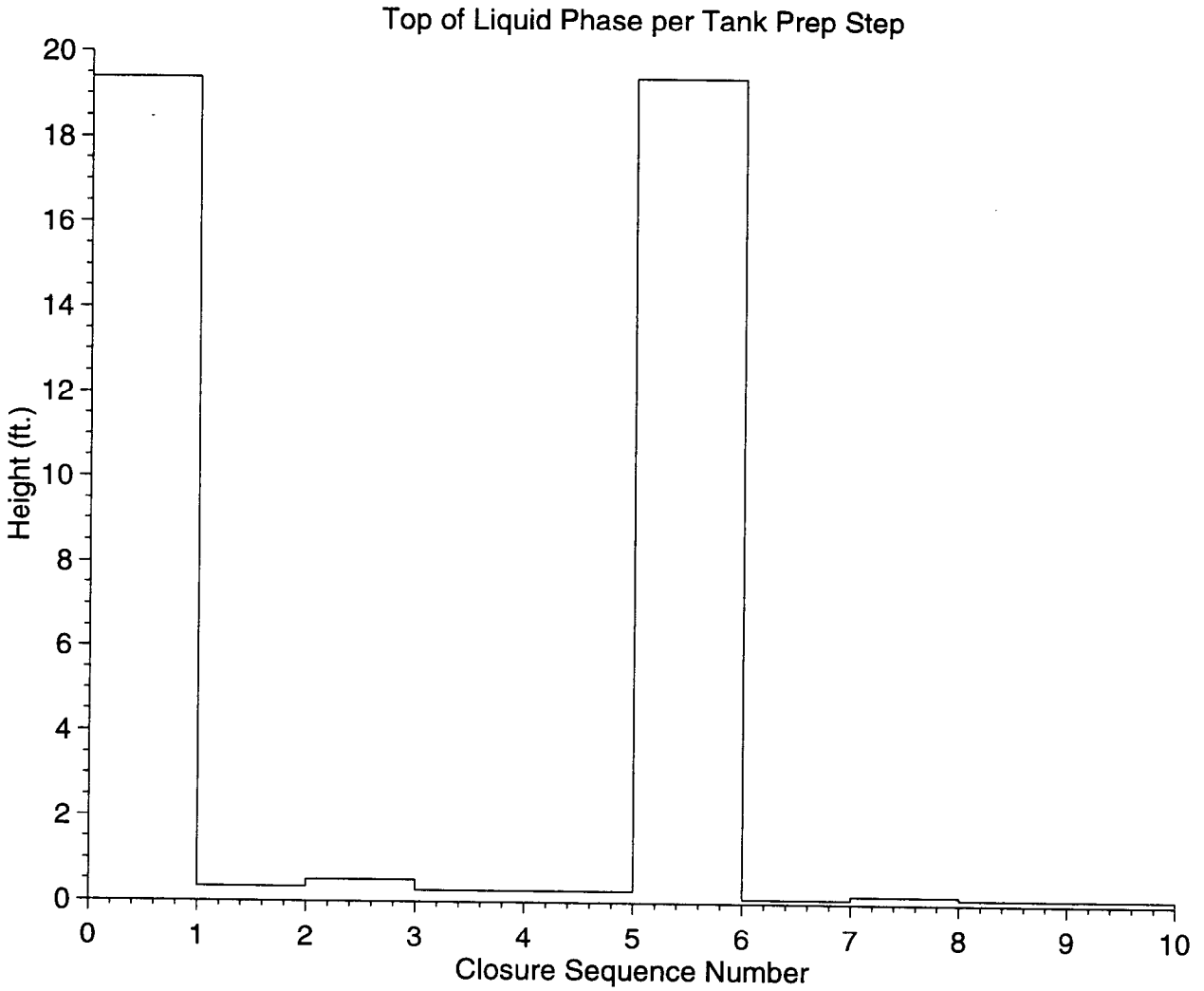


Figure 53: Tank WM-182 (Improved Control Law) Liquid Phase Height per Sequence Step

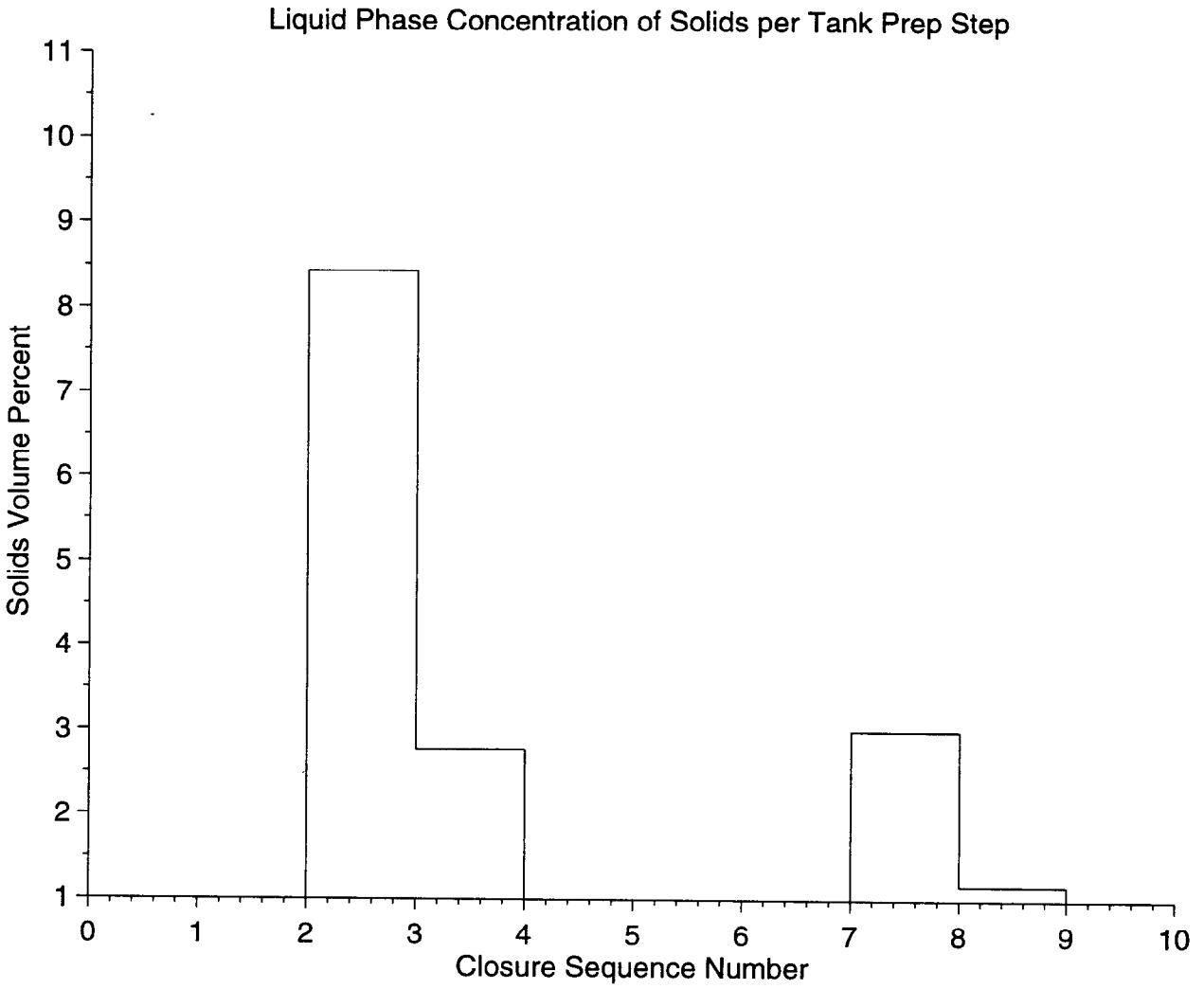


Figure 54: Tank WM-182 (Improved Control Law) Liquid Phase Height per Sequence Step

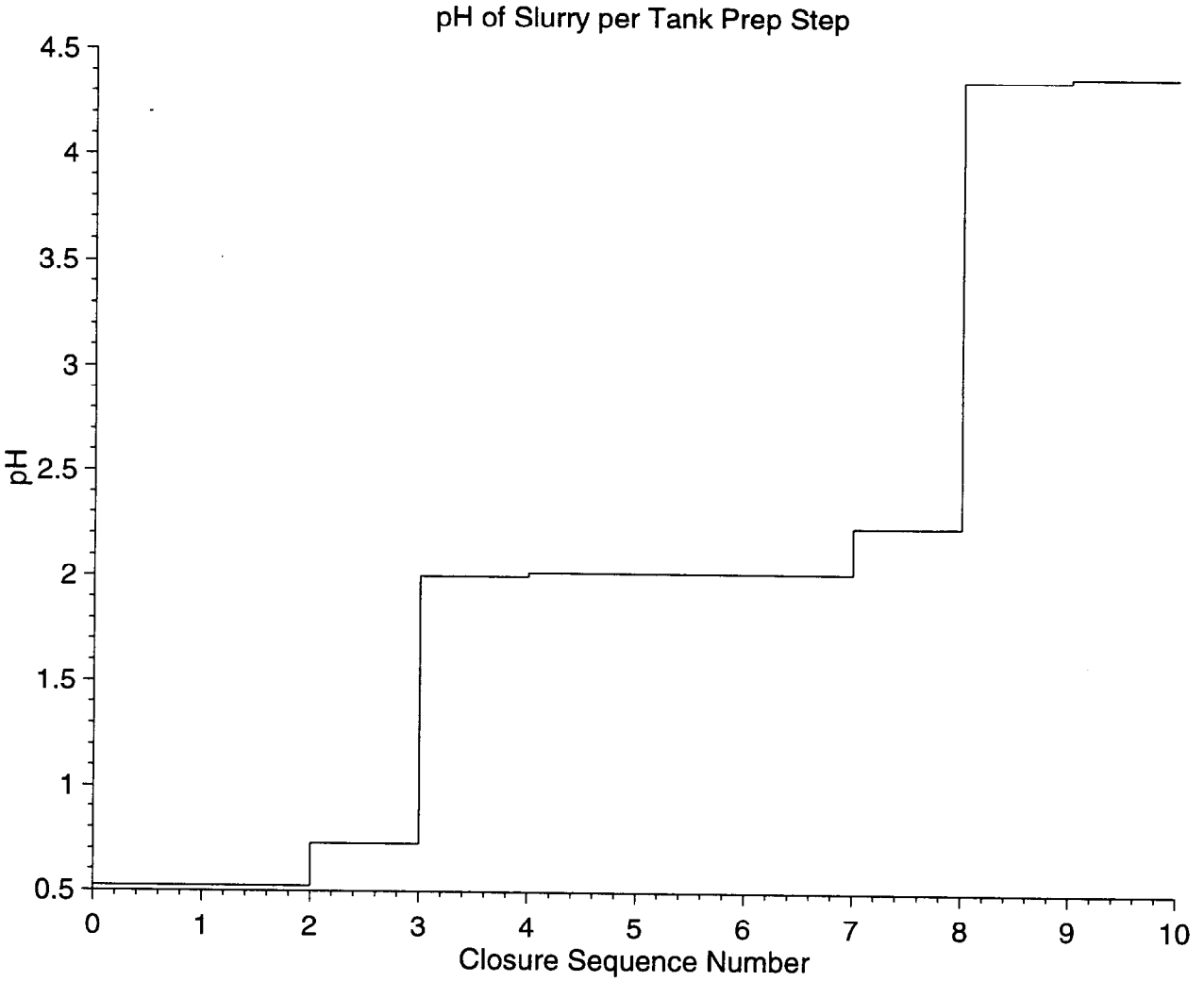


Figure 55: Tank WM-182 (Improved Control Law) Slurry pH per Sequence Step

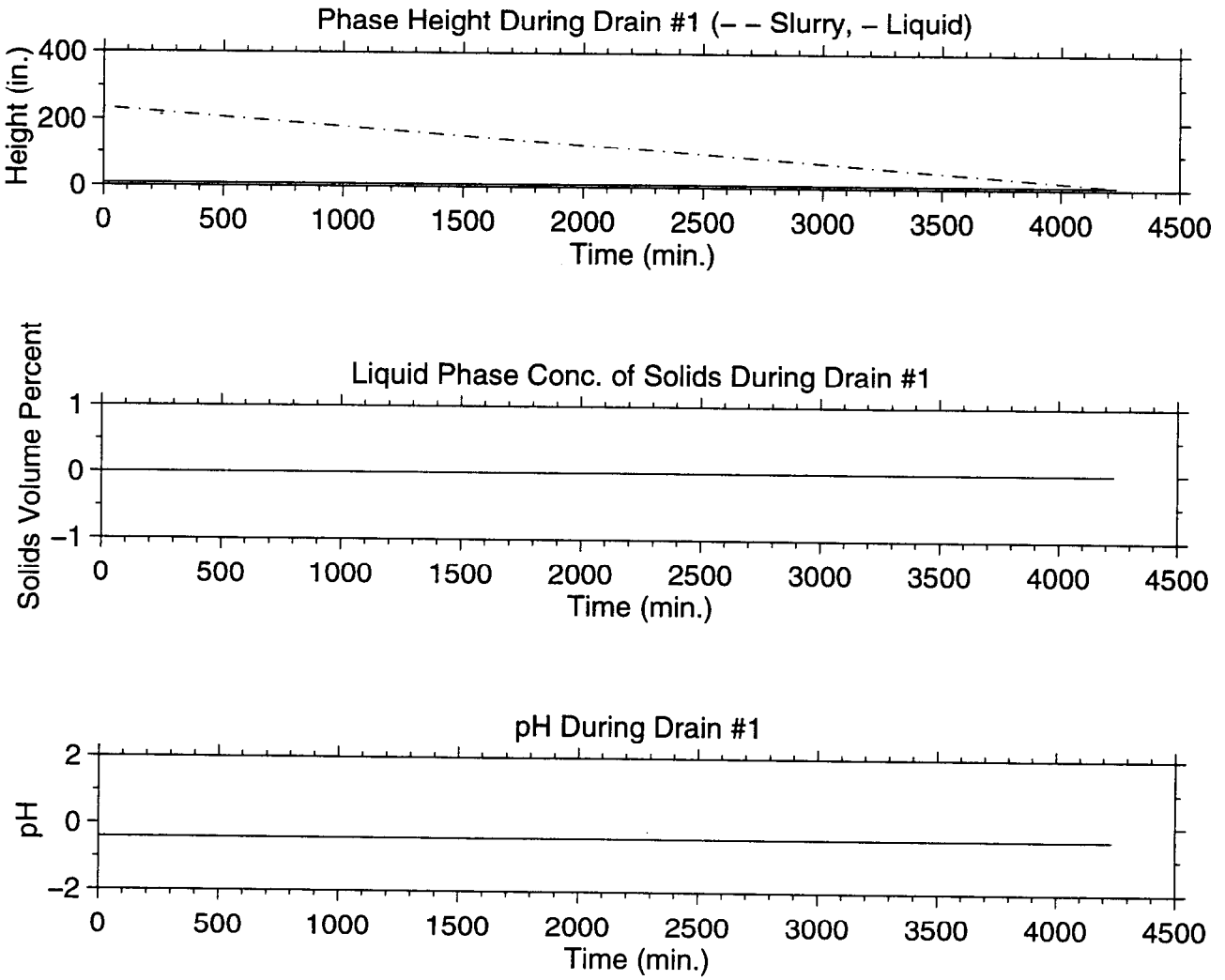


Figure 56: Tank WM-183 (Improved Control Law) Status During Step #1

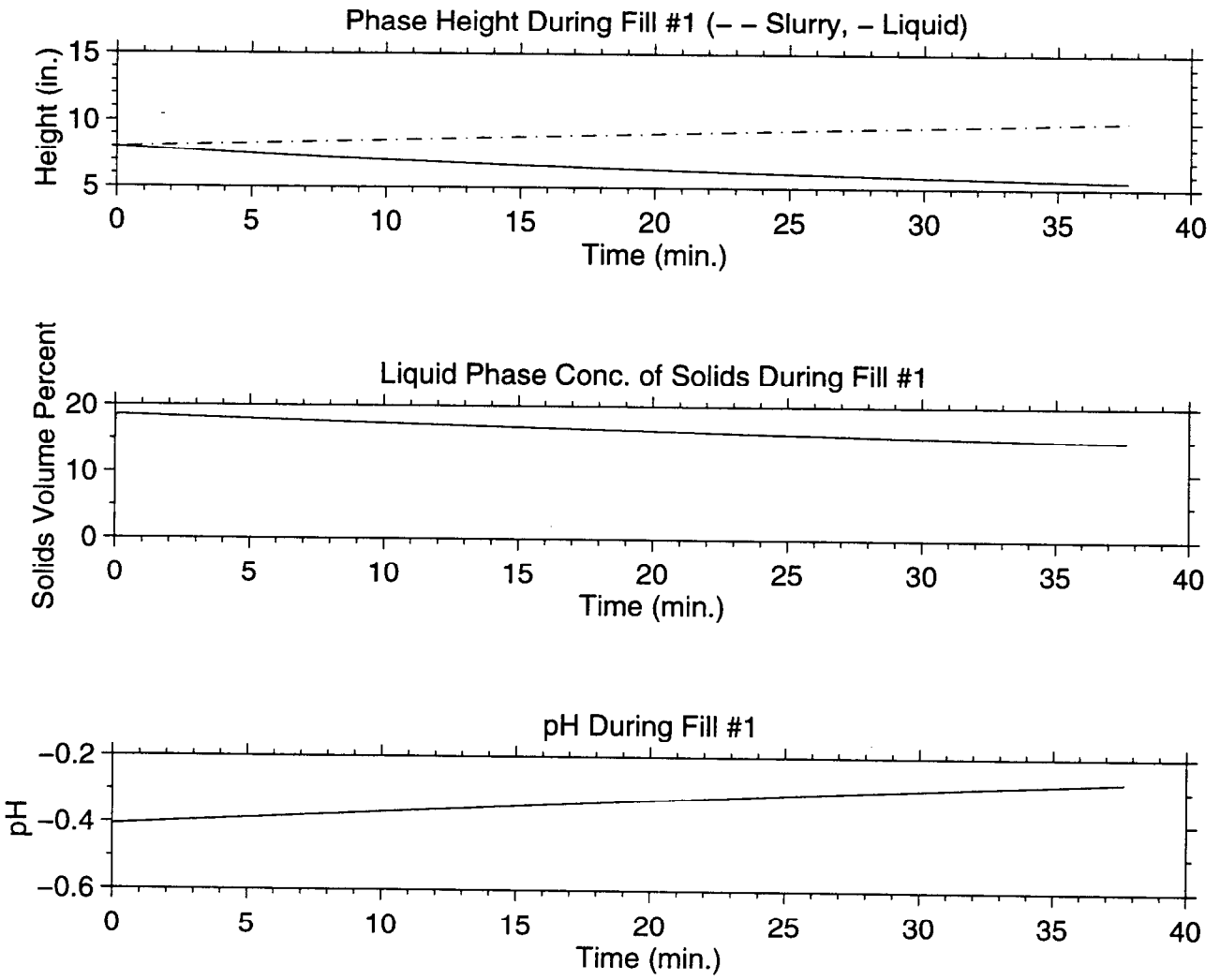


Figure 57: Tank WM-183 (Improved Control Law) Status During Step #2

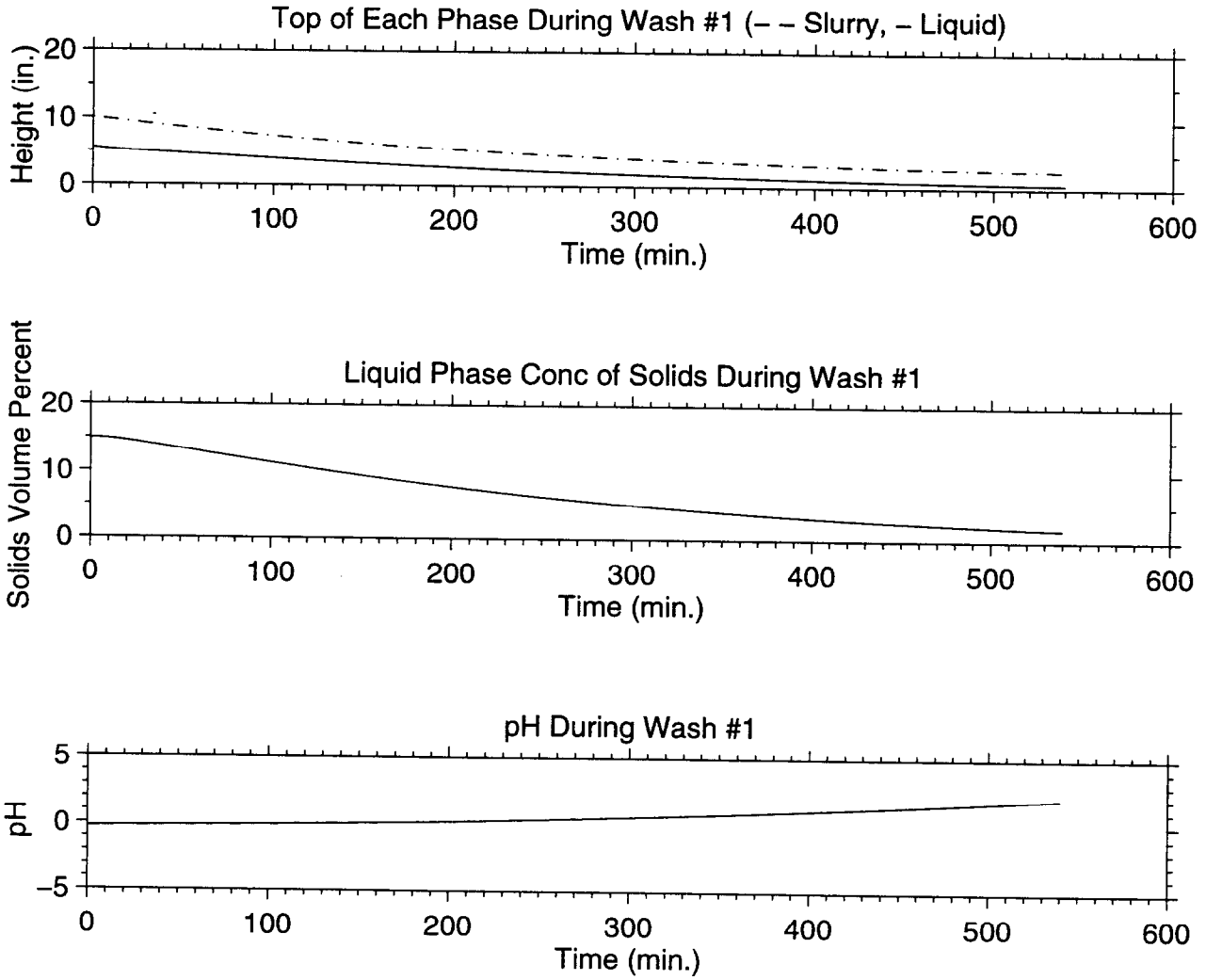


Figure 58: Tank WM-183 (Improved Control Law) Status During Step #3

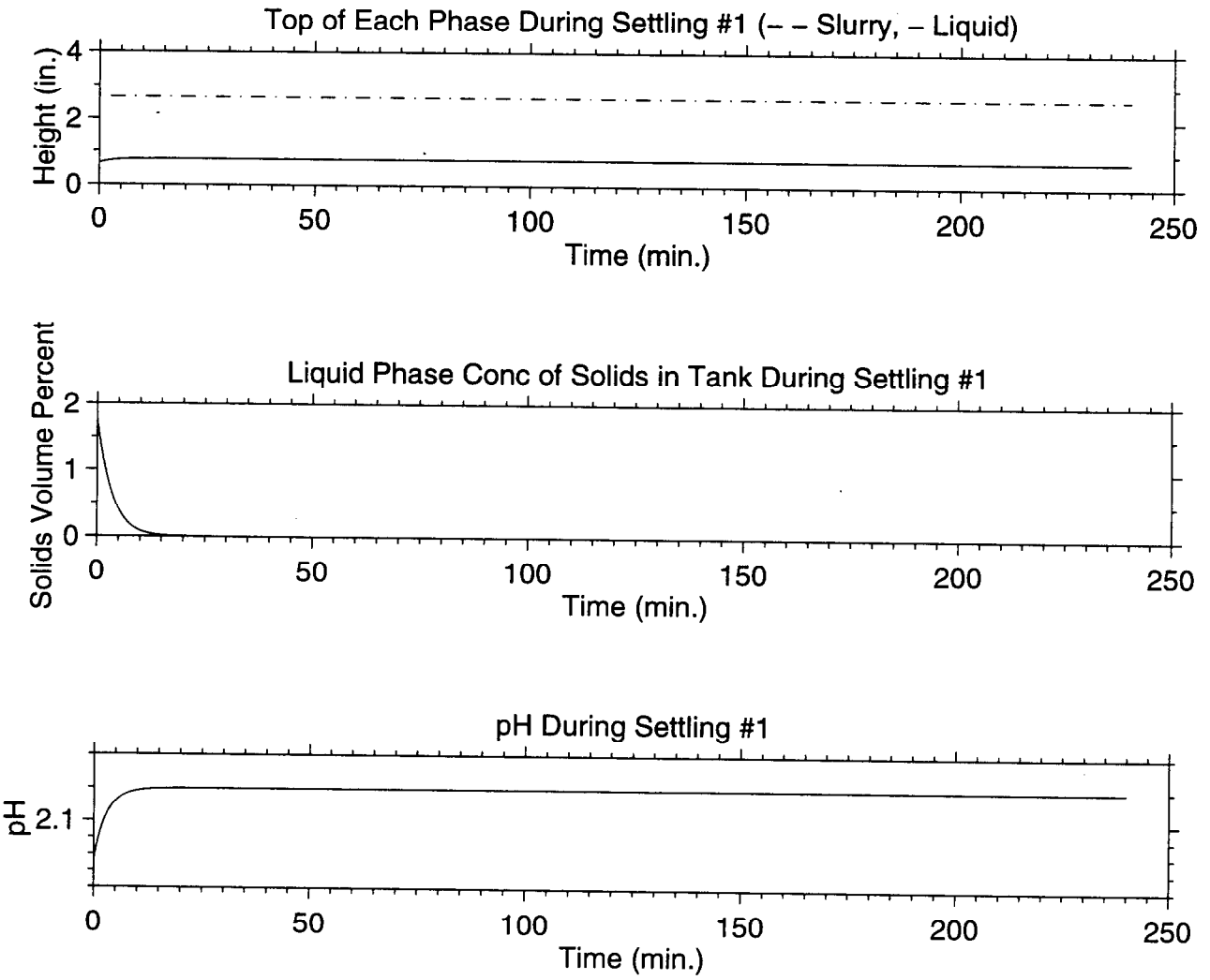


Figure 59: Tank WM-183 (Improved Control Law) Status During Step #4

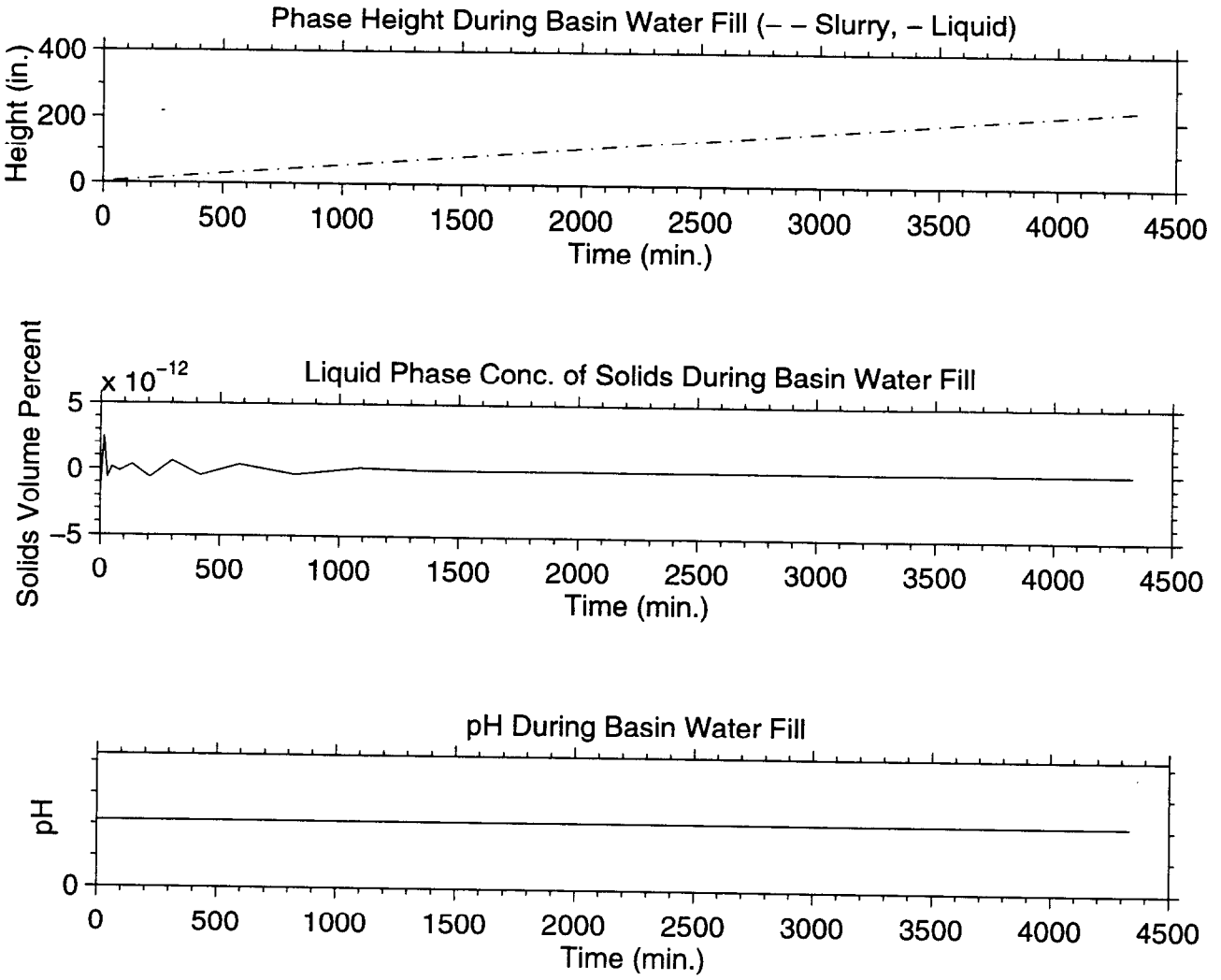


Figure 60: Tank WM-183 (Improved Control Law) Status During Step #5

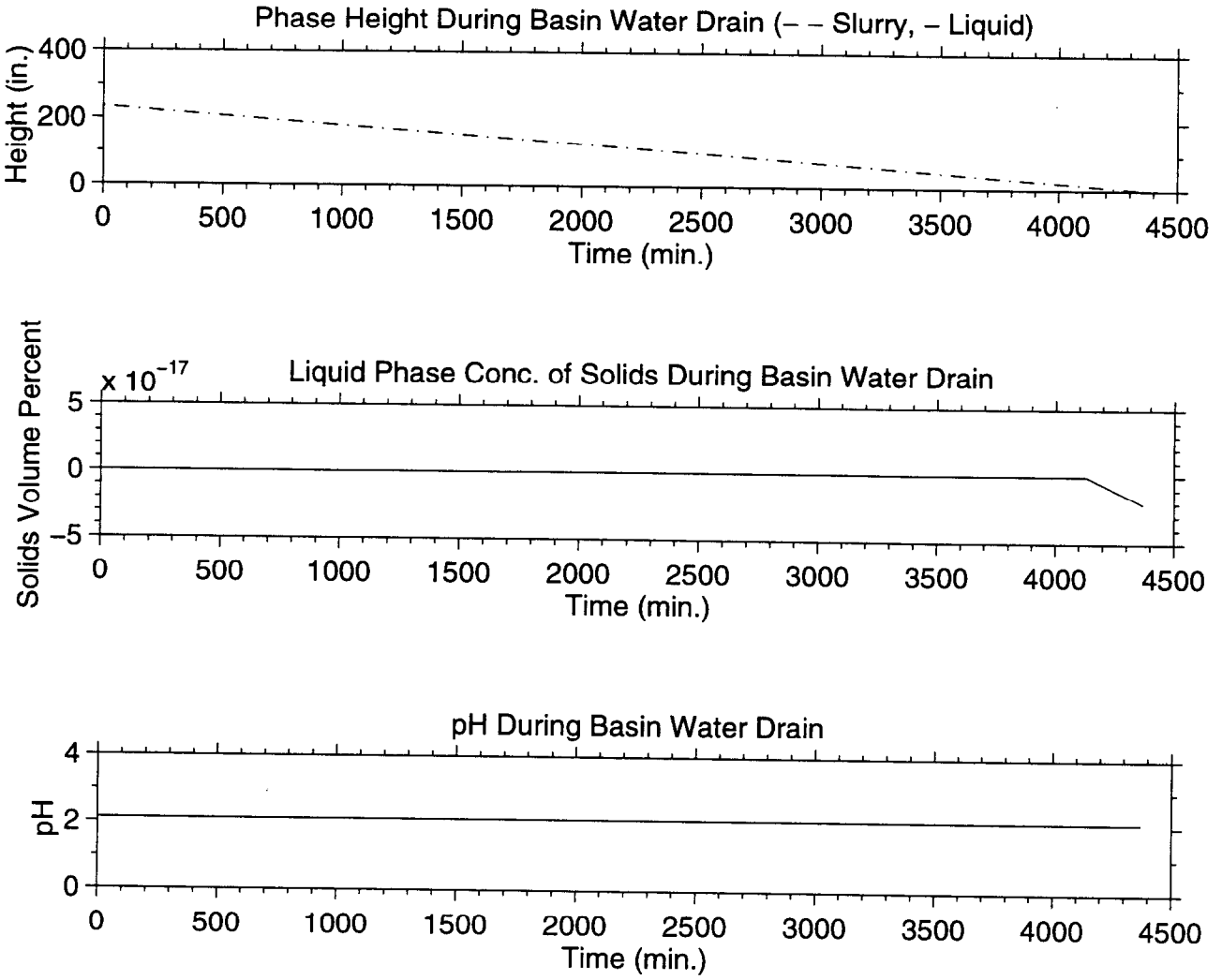


Figure 61: Tank WM-183 (Improved Control Law) Status During Step #6

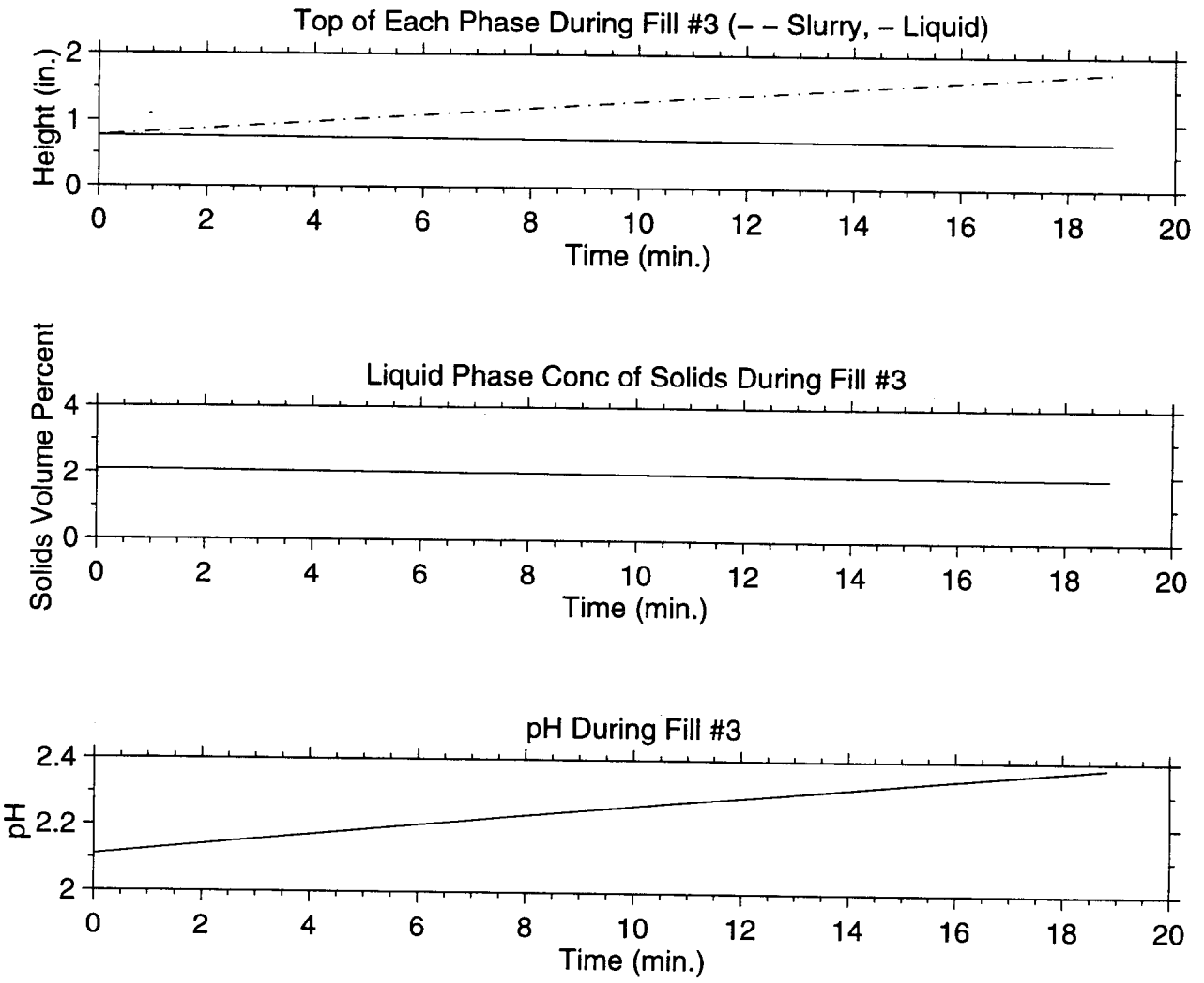


Figure 62: Tank WM-183 (Improved Control Law) Status During Step #7

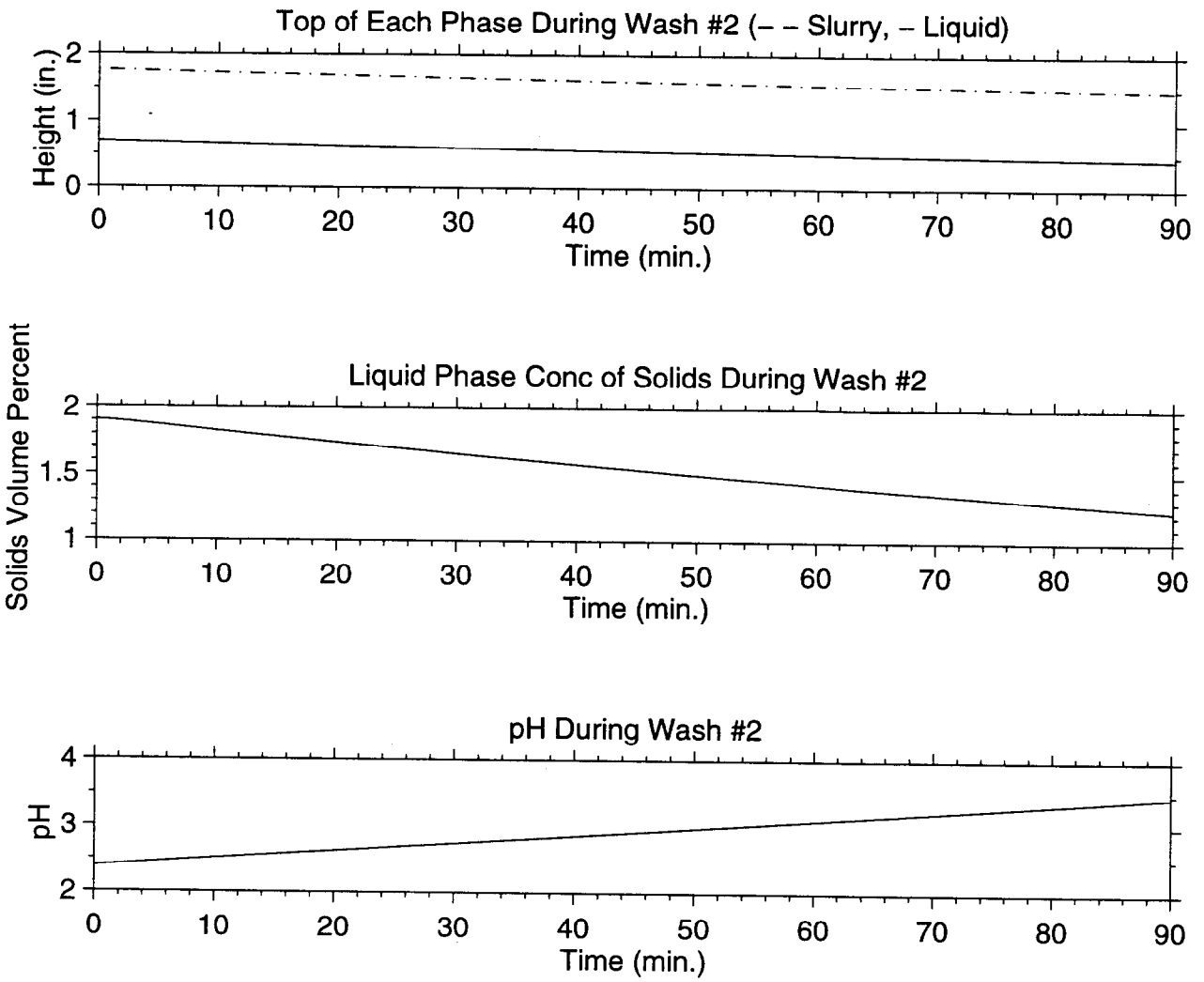


Figure 63: Tank WM-183 (Improved Control Law) Status During Step #8

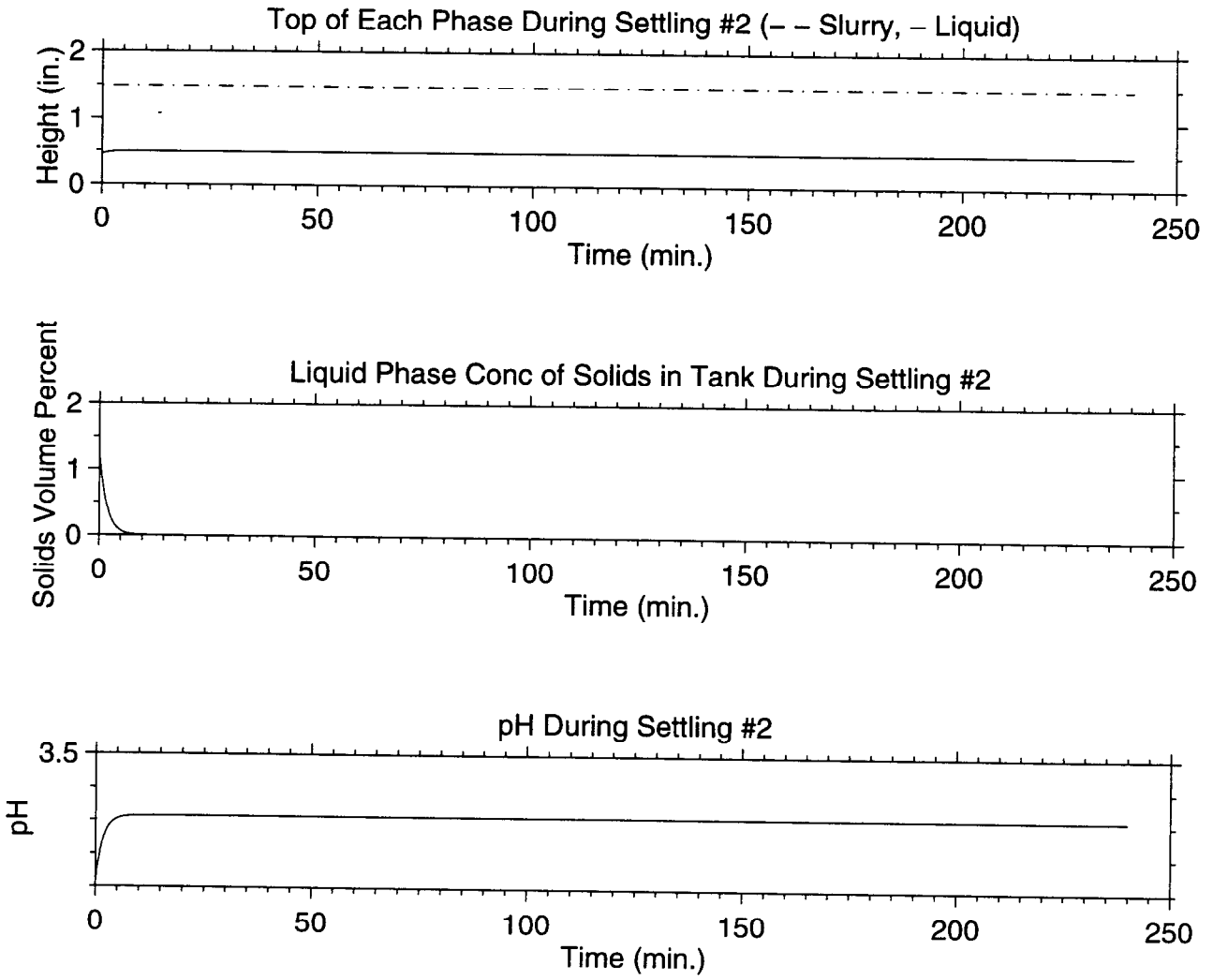


Figure 64: Tank WM-183 (Improved Control Law) Status During Step #9

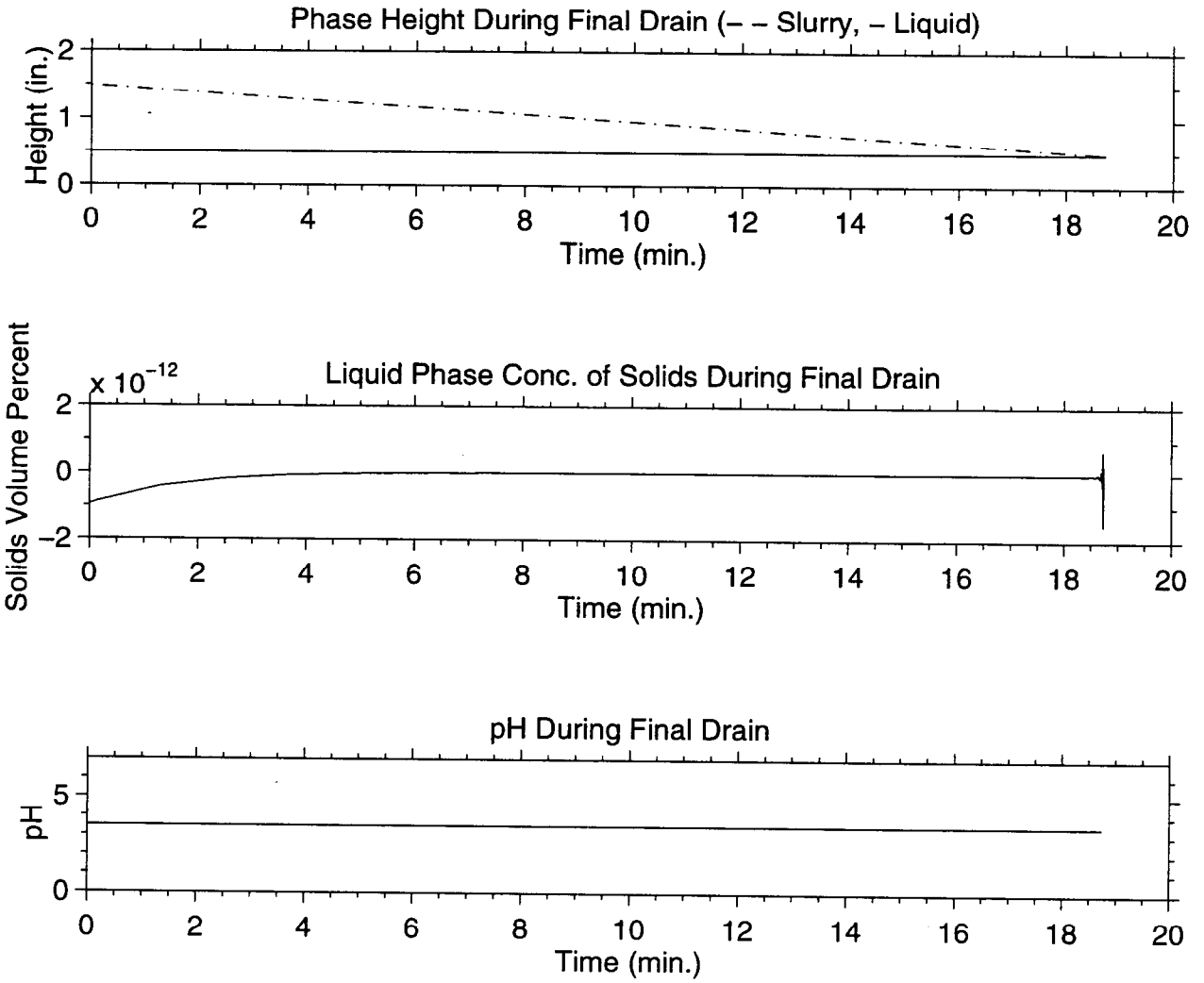


Figure 65: Tank WM-183 (Improved Control Law) Status During Step #10

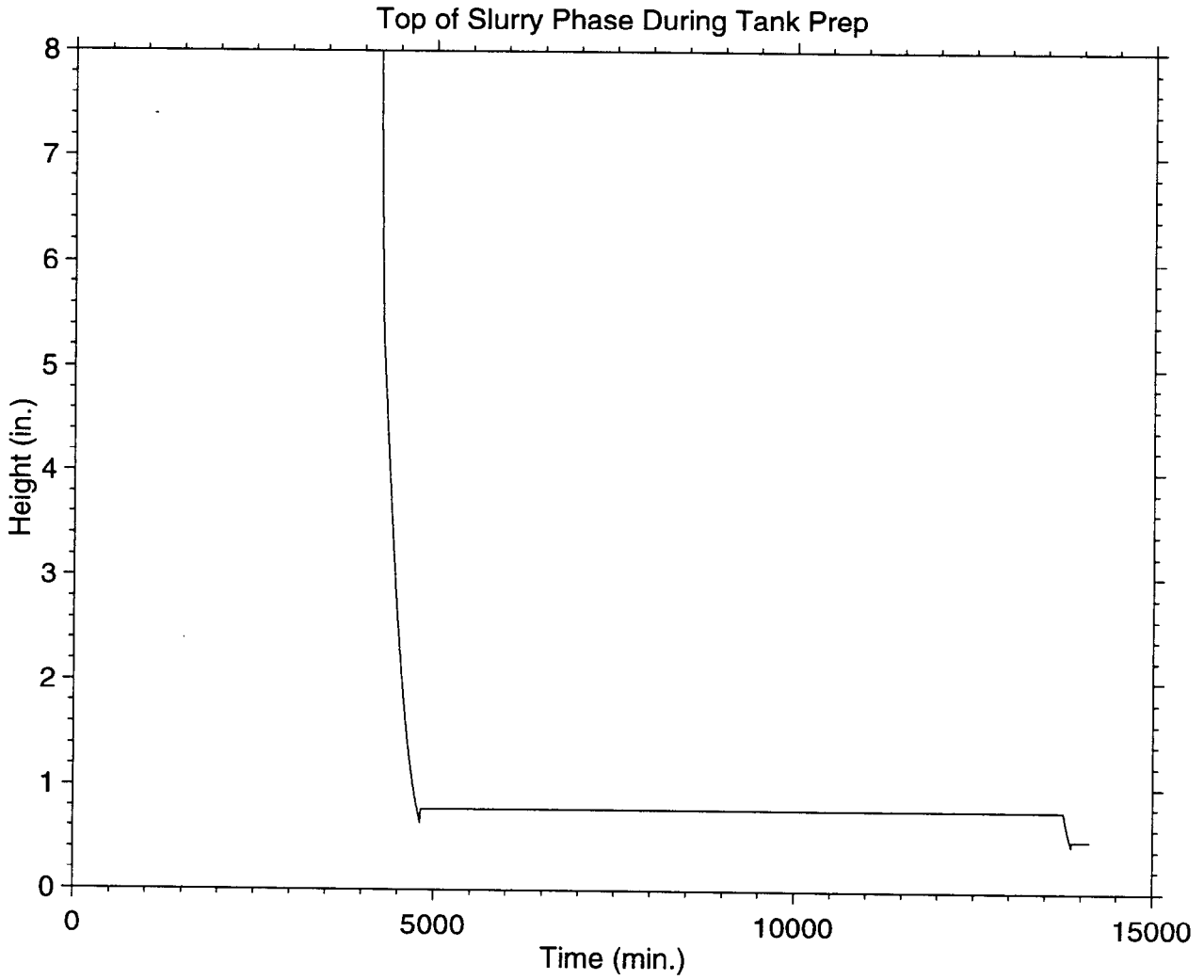


Figure 66: Tank WM-183 (Improved Control Law) Slurry Phase Height During Tank Prep

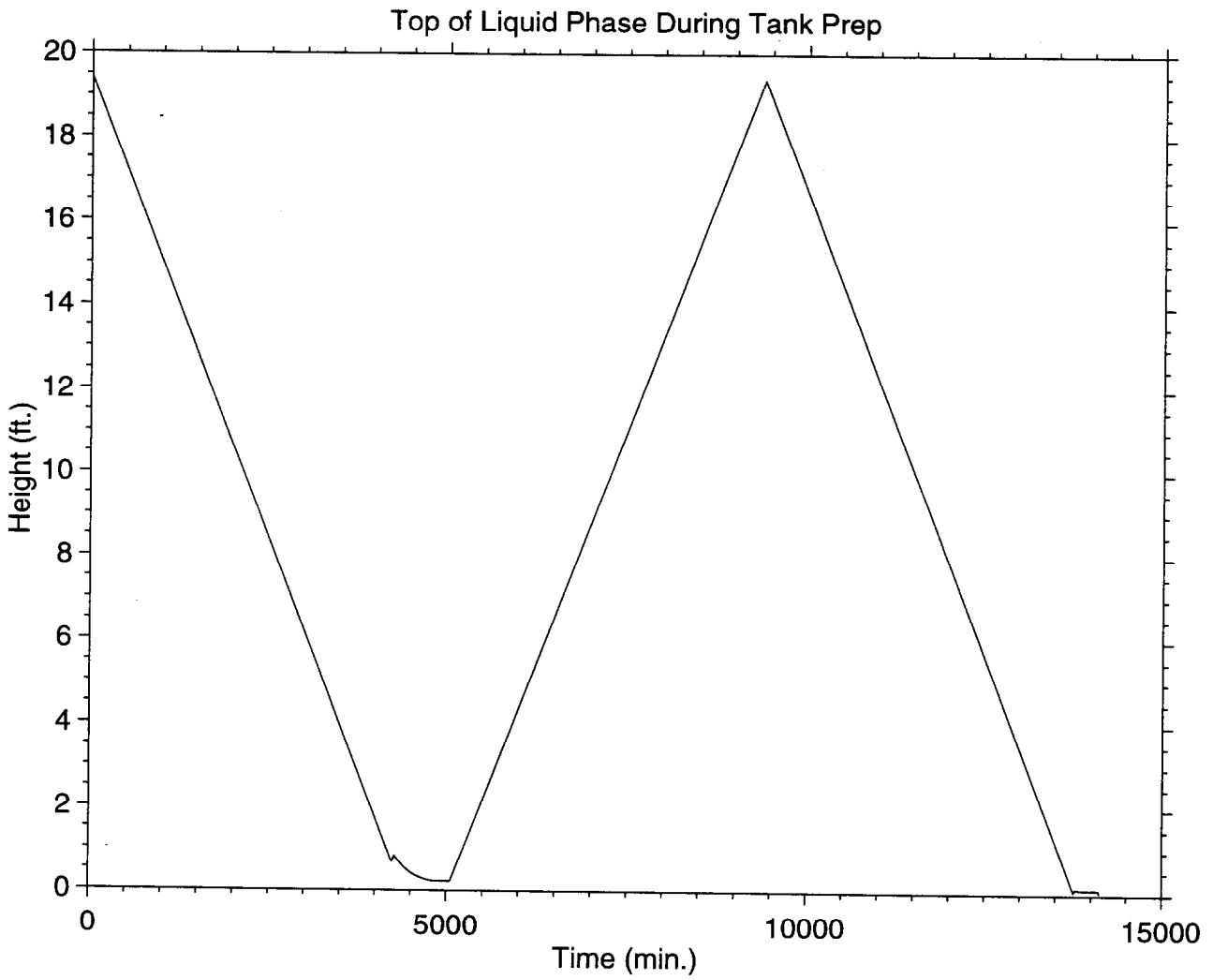


Figure 67: Tank WM-183 (Improved Control Law) Liquid Phase Height during Tank Prep

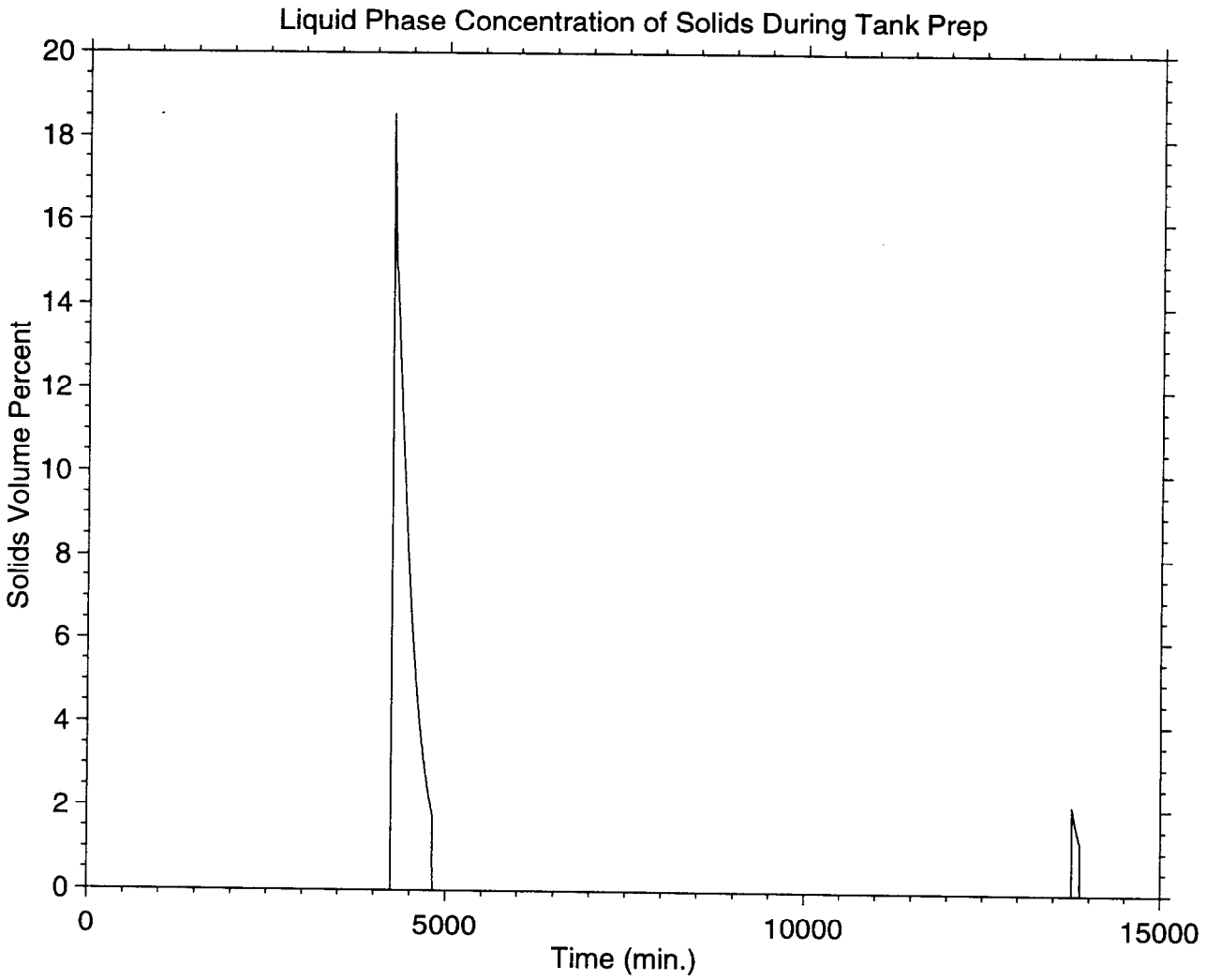


Figure 68: Tank WM-183 (Improved Control Law) Liquid Phase Height during Tank Prep

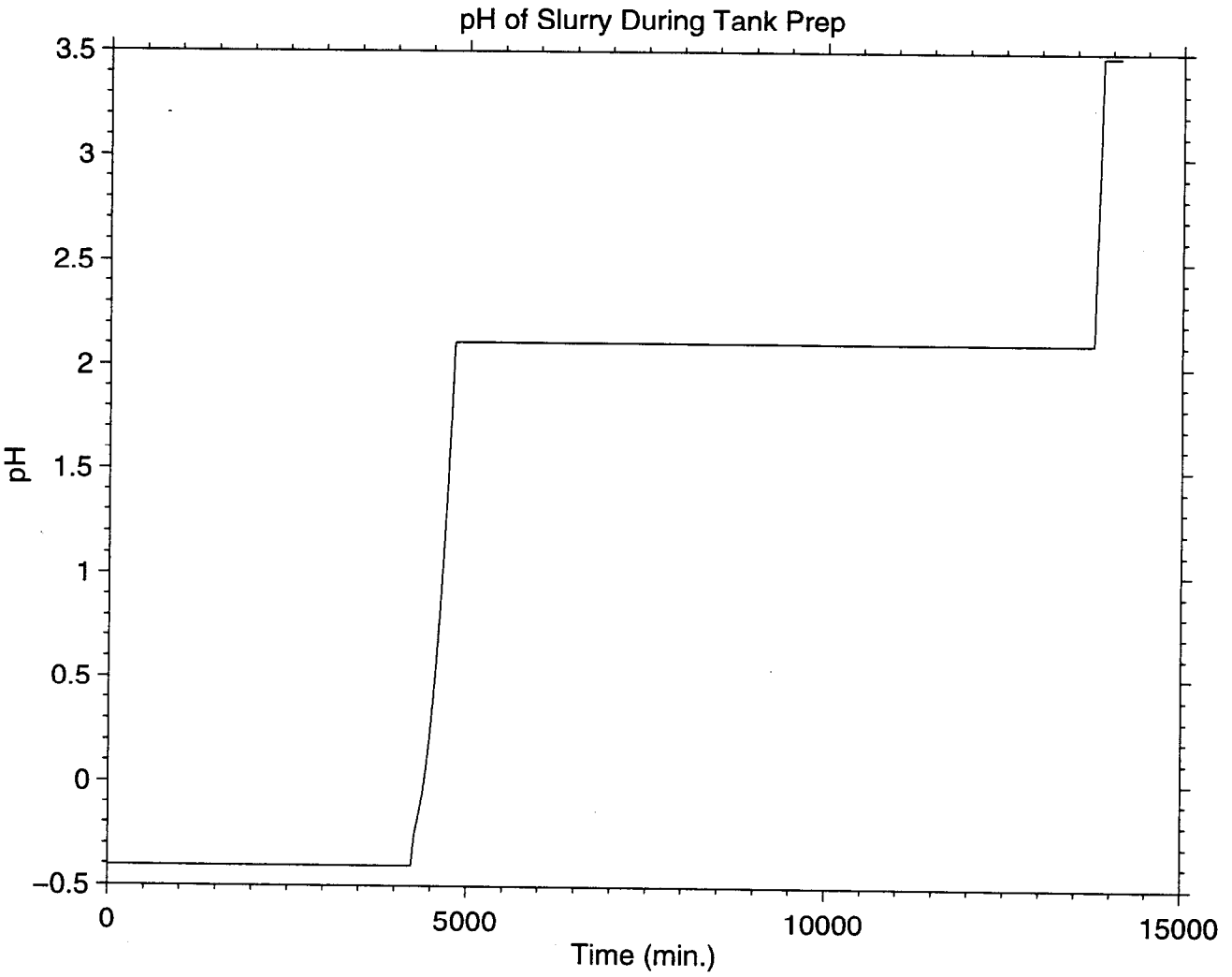


Figure 69: Tank WM-183 (Improved Control Law) Slurry pH During Tank Prep

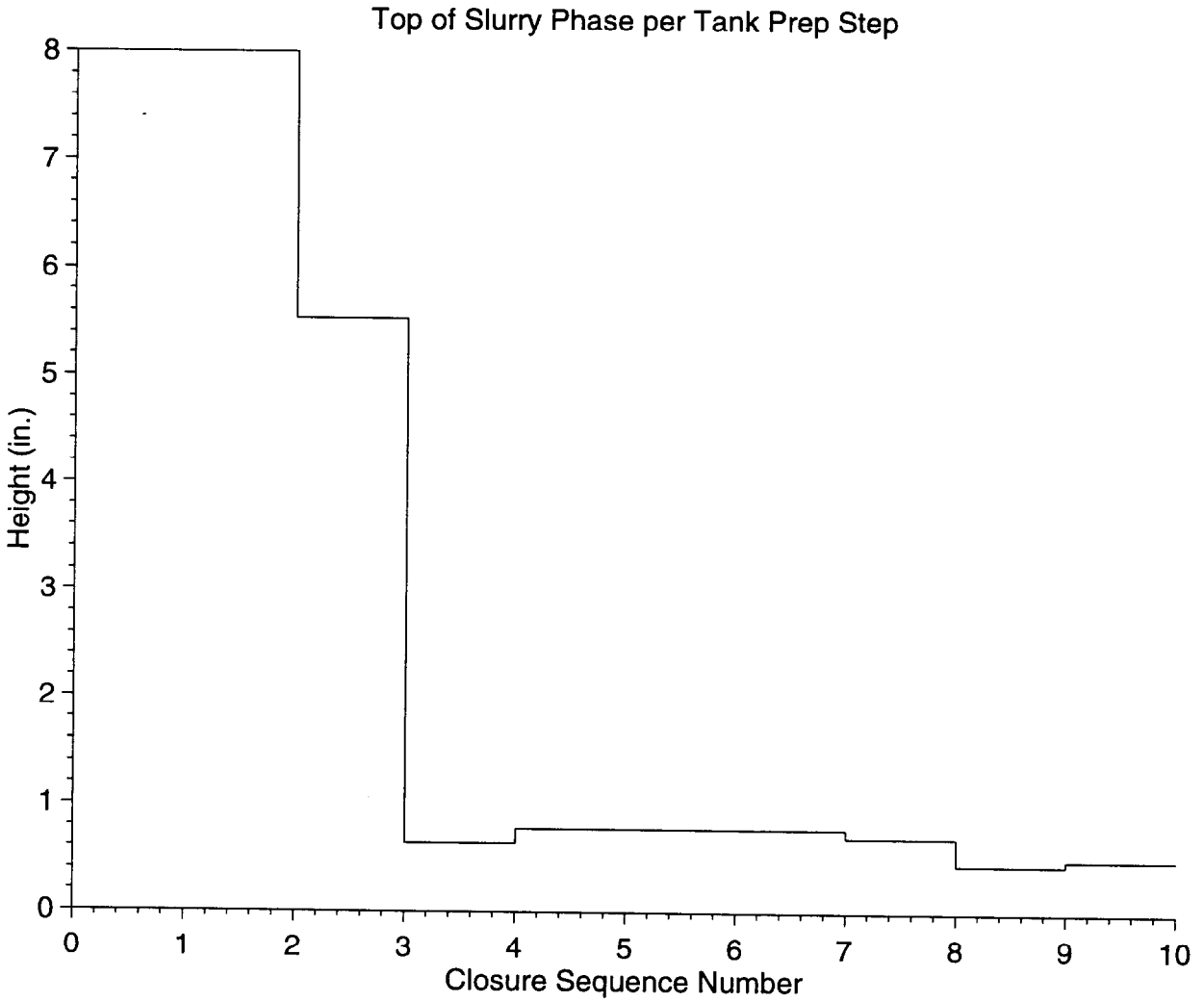


Figure 70: Tank WM-183 (Improved Control Law) Slurry Phase Height per Sequence Step

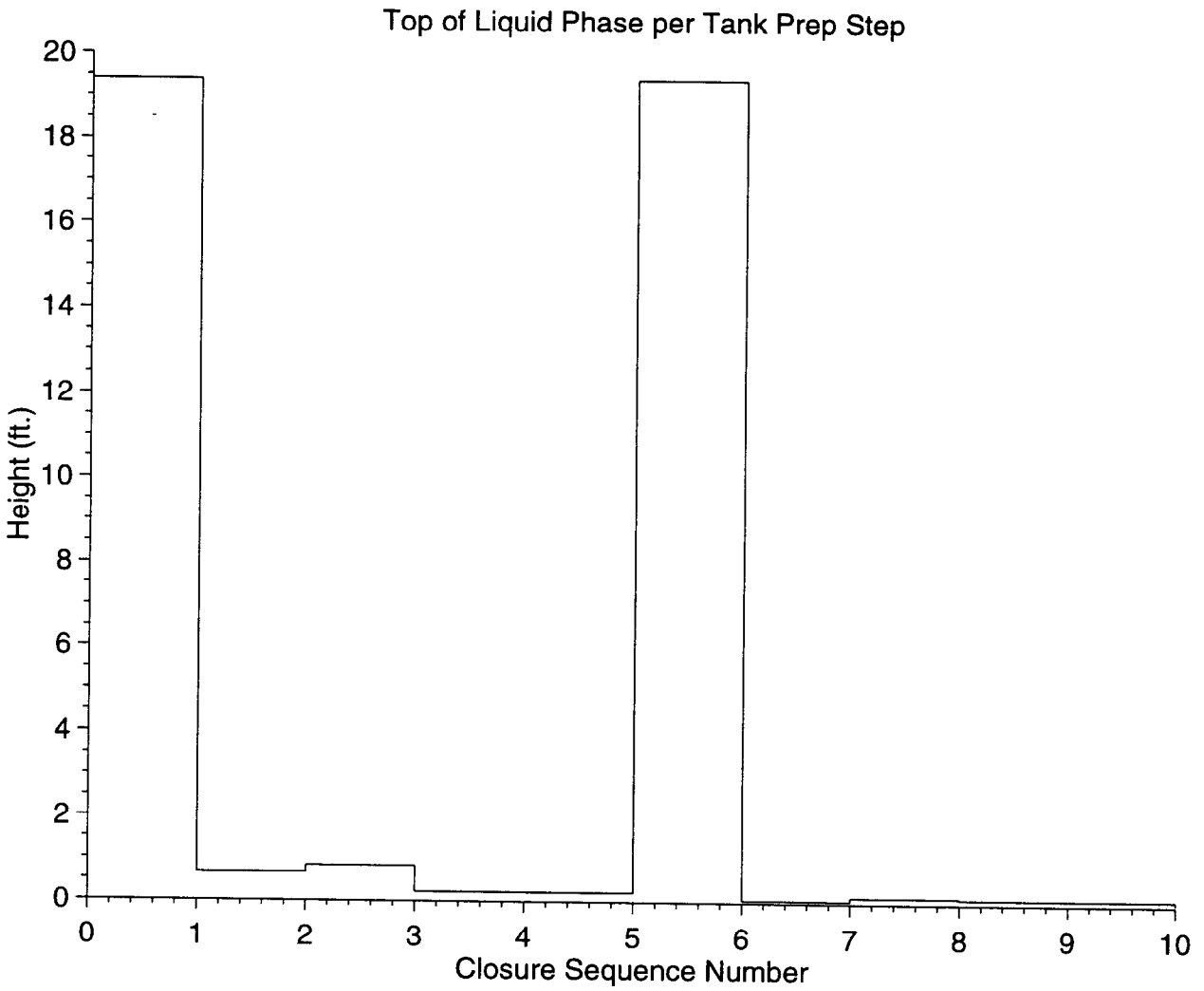


Figure 71: Tank WM-183 (Improved Control Law) Liquid Phase Height per Sequence Step

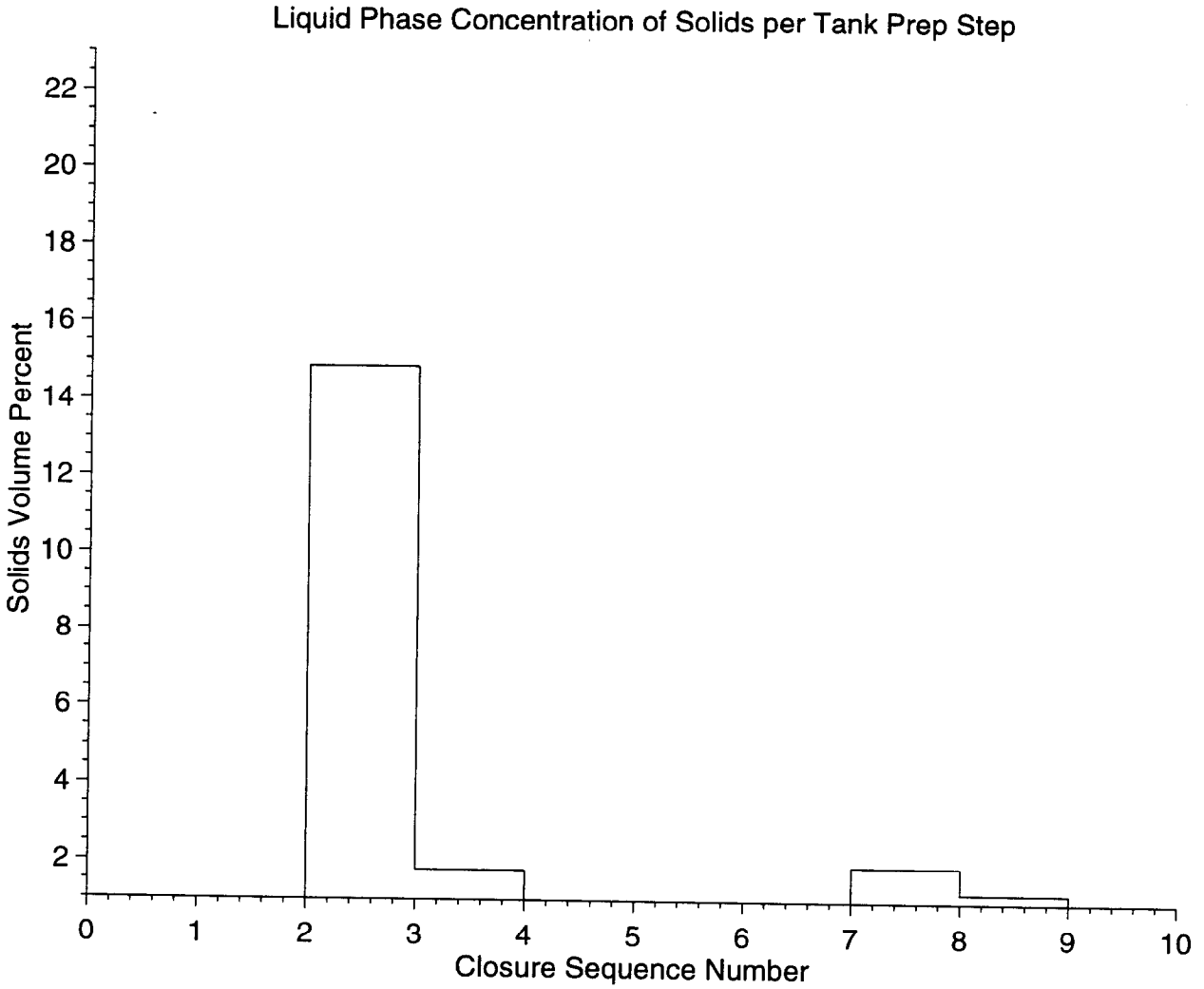


Figure 72: Tank WM-183 (Improved Control Law) Liquid Phase Height per Sequence Step

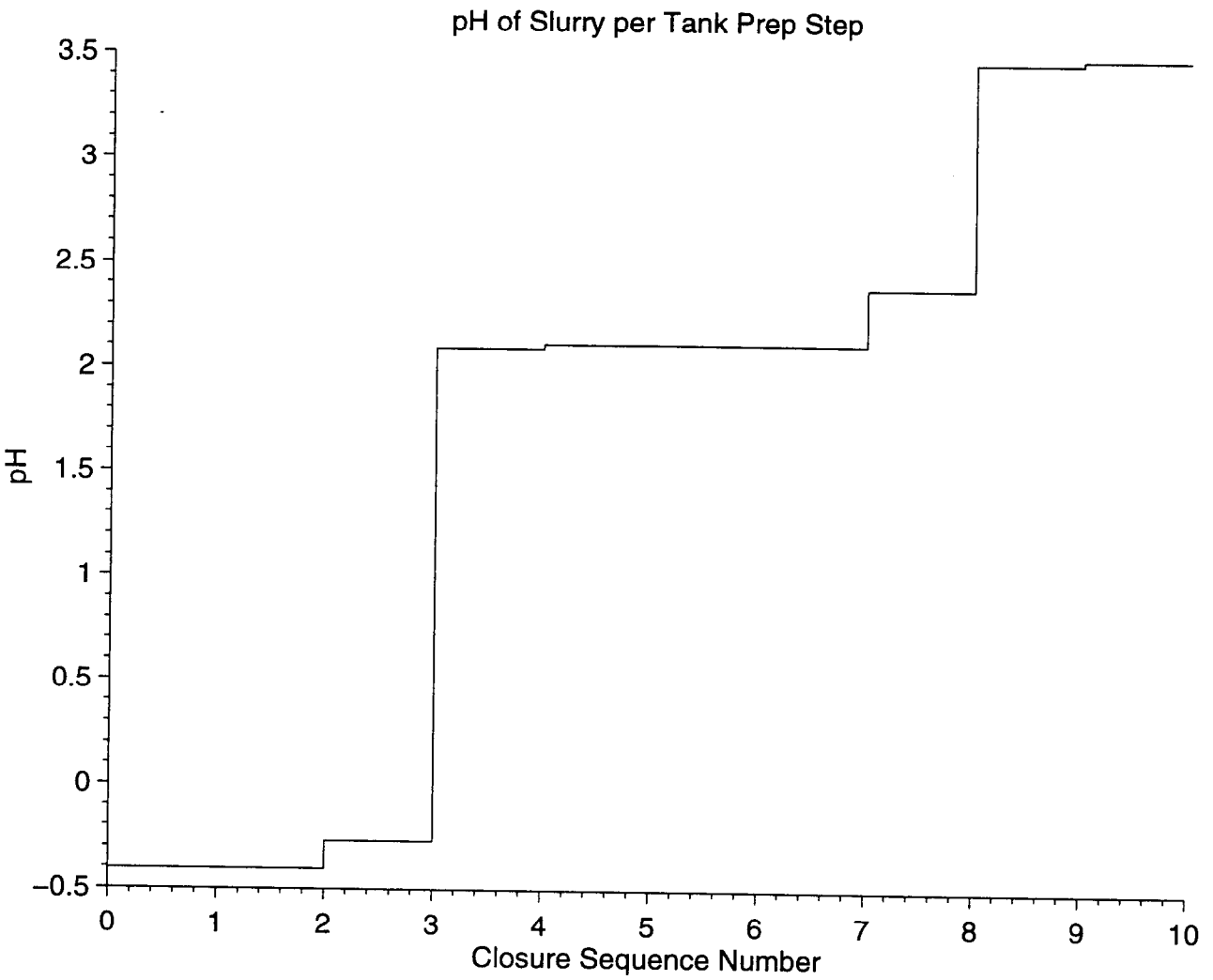


Figure 73: Tank WM-183 (Improved Control Law) Slurry pH per Sequence Step

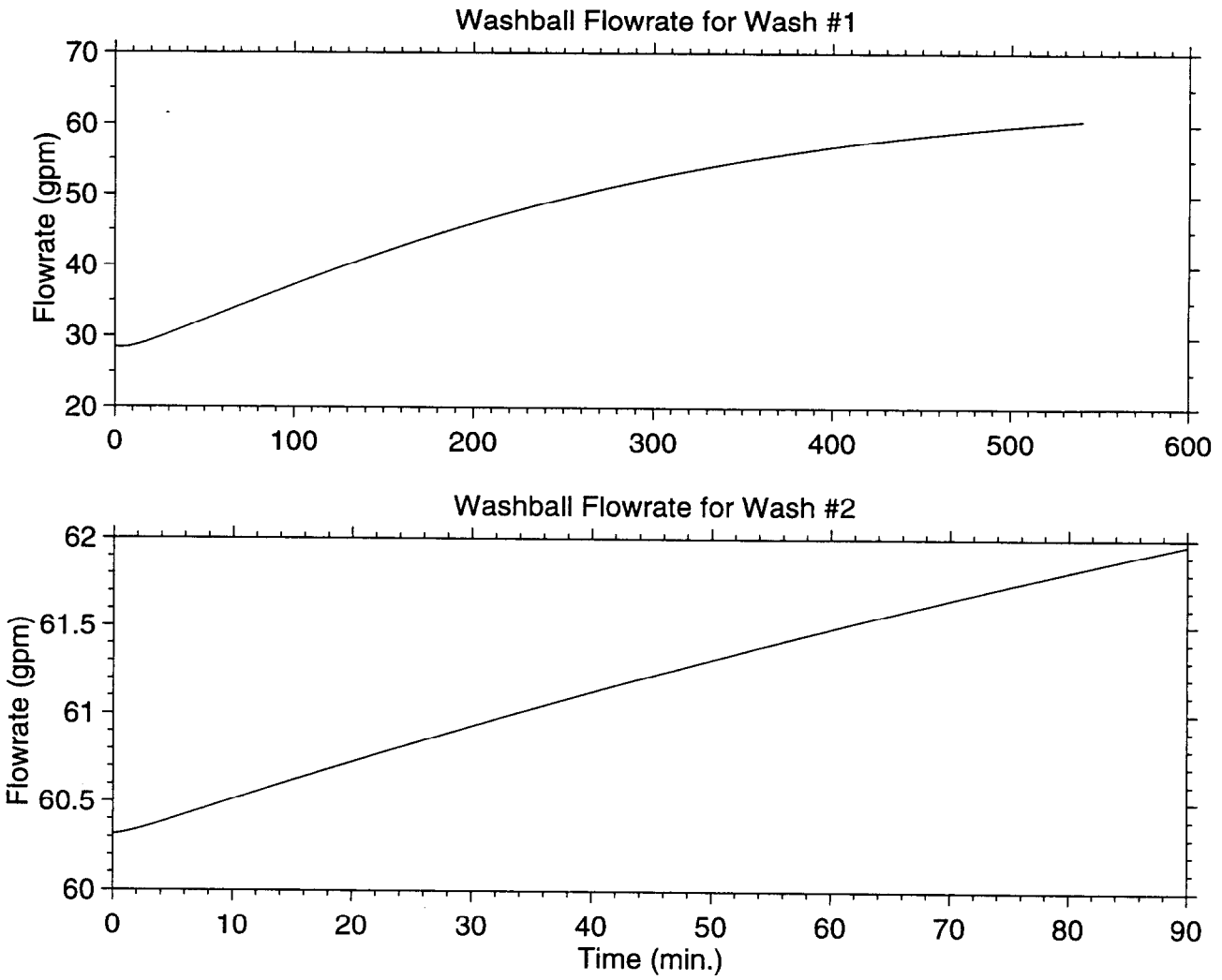


Figure 74: WM-183 Washball Flowrate

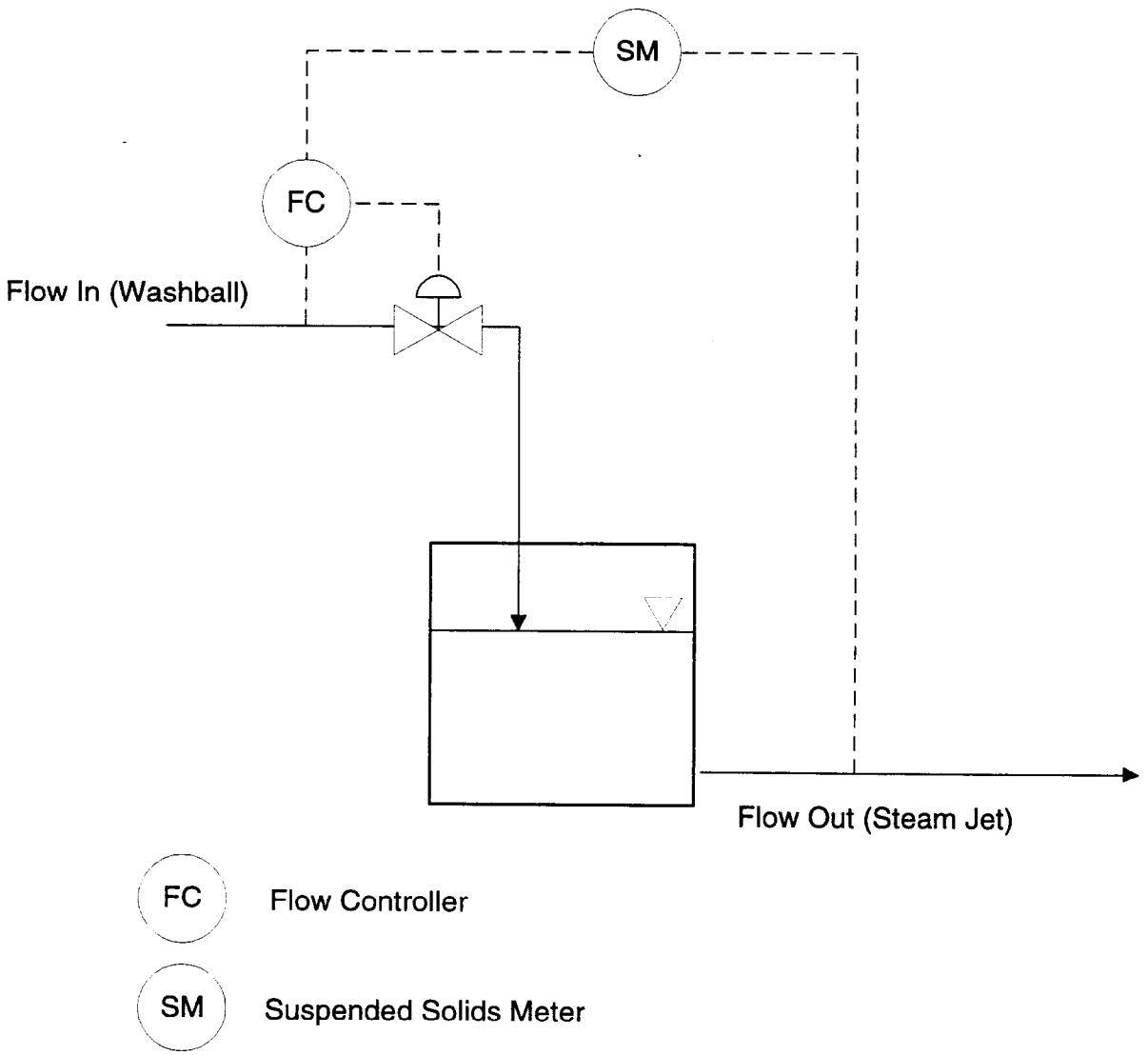


Figure 75: Proposed Control System Diagram

Figure 76: Effectiveness of Decontamination Steps for One Tank

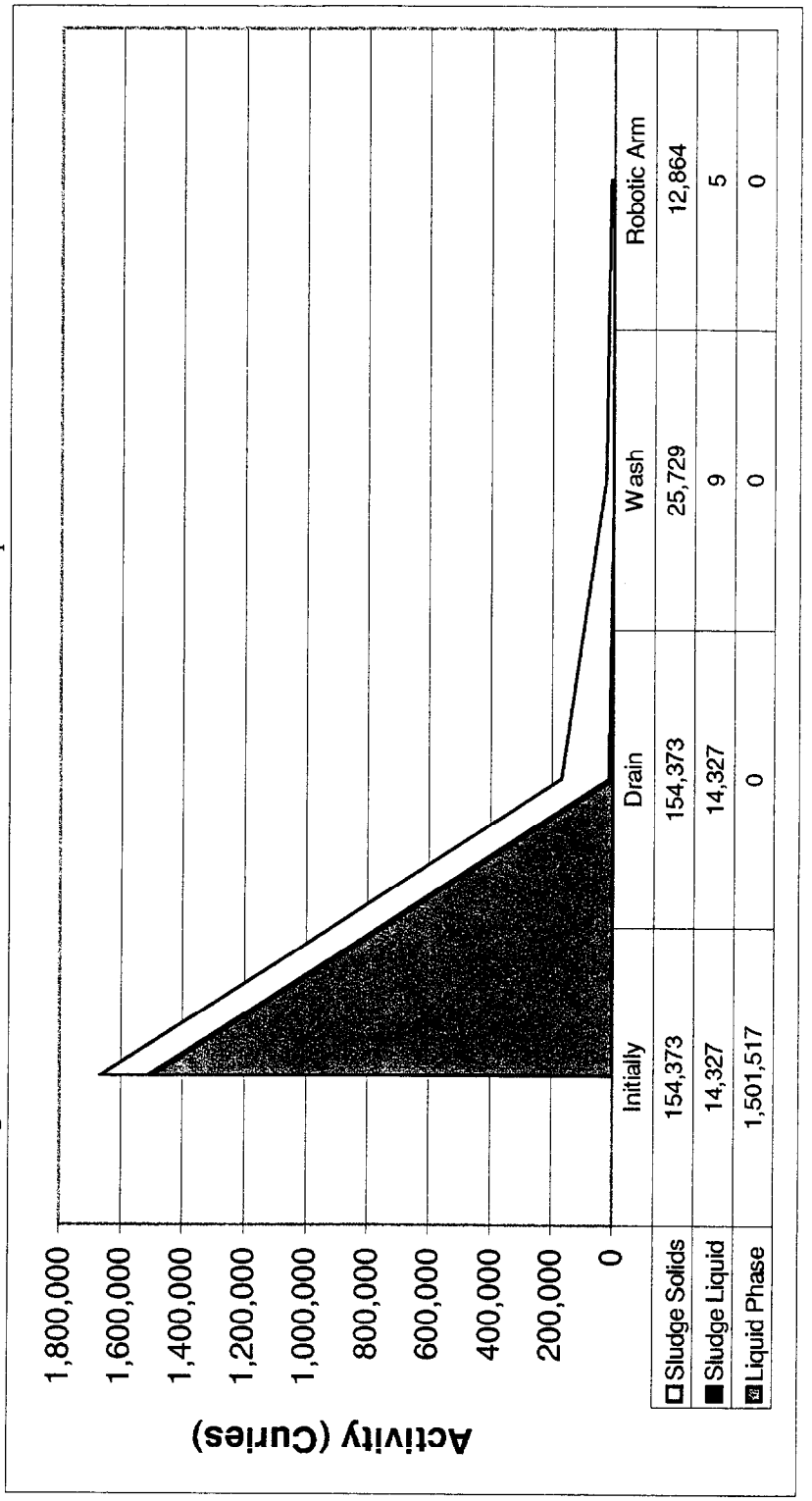


Figure 77: Decontamination Cost Effectiveness

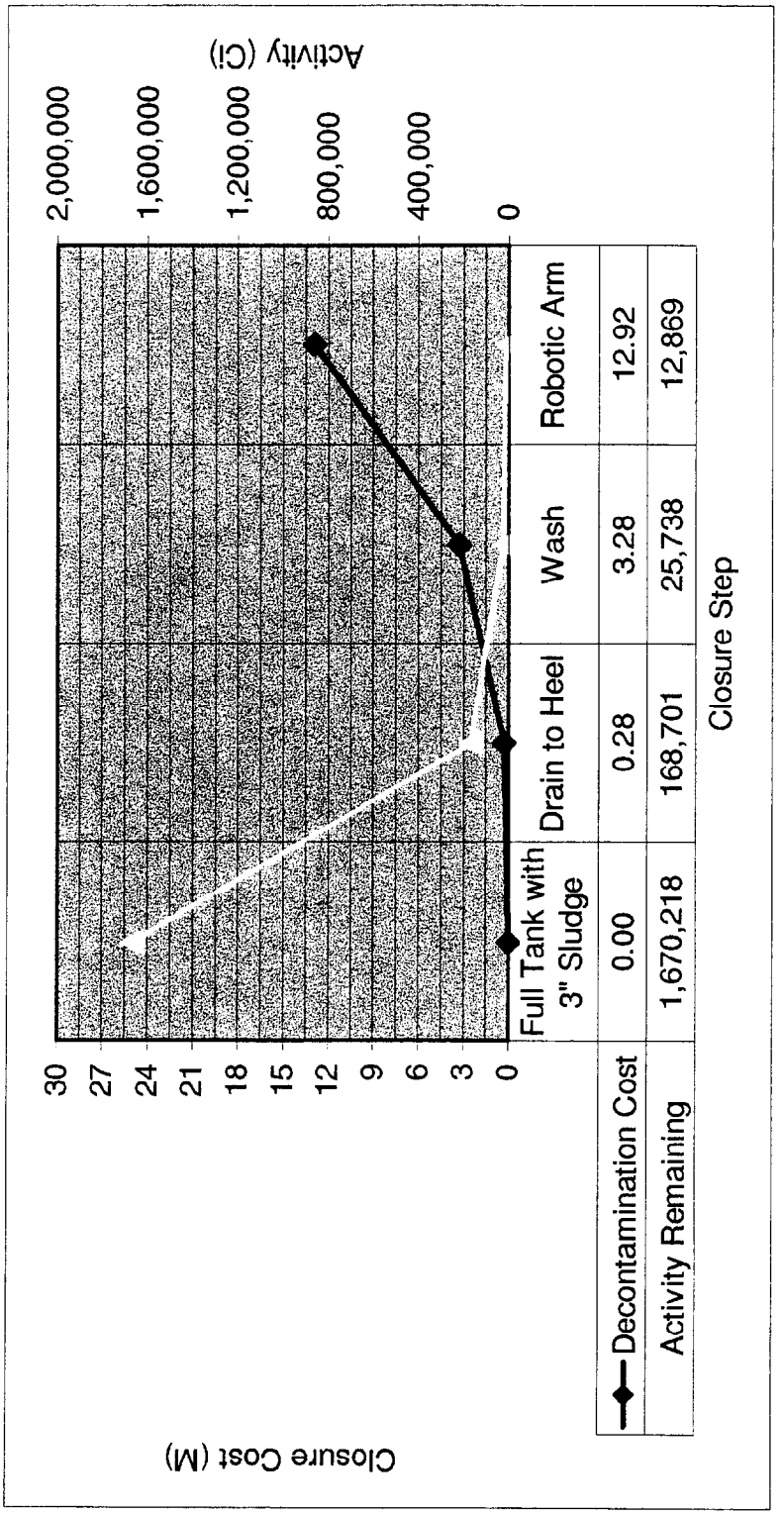


Figure 78: Cost for Each Curie Removed

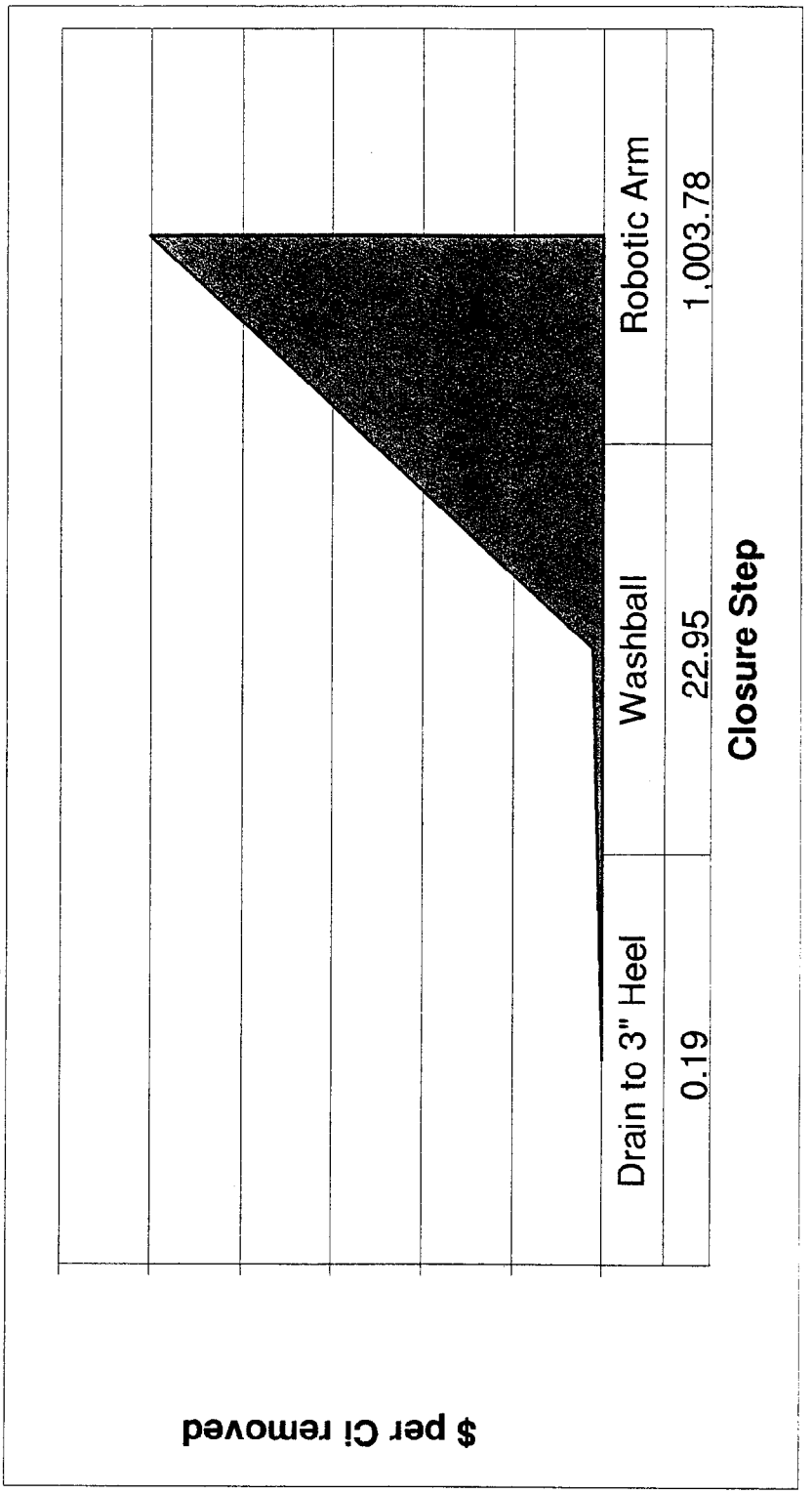


Figure 79: Tank Closure Cost Effectiveness

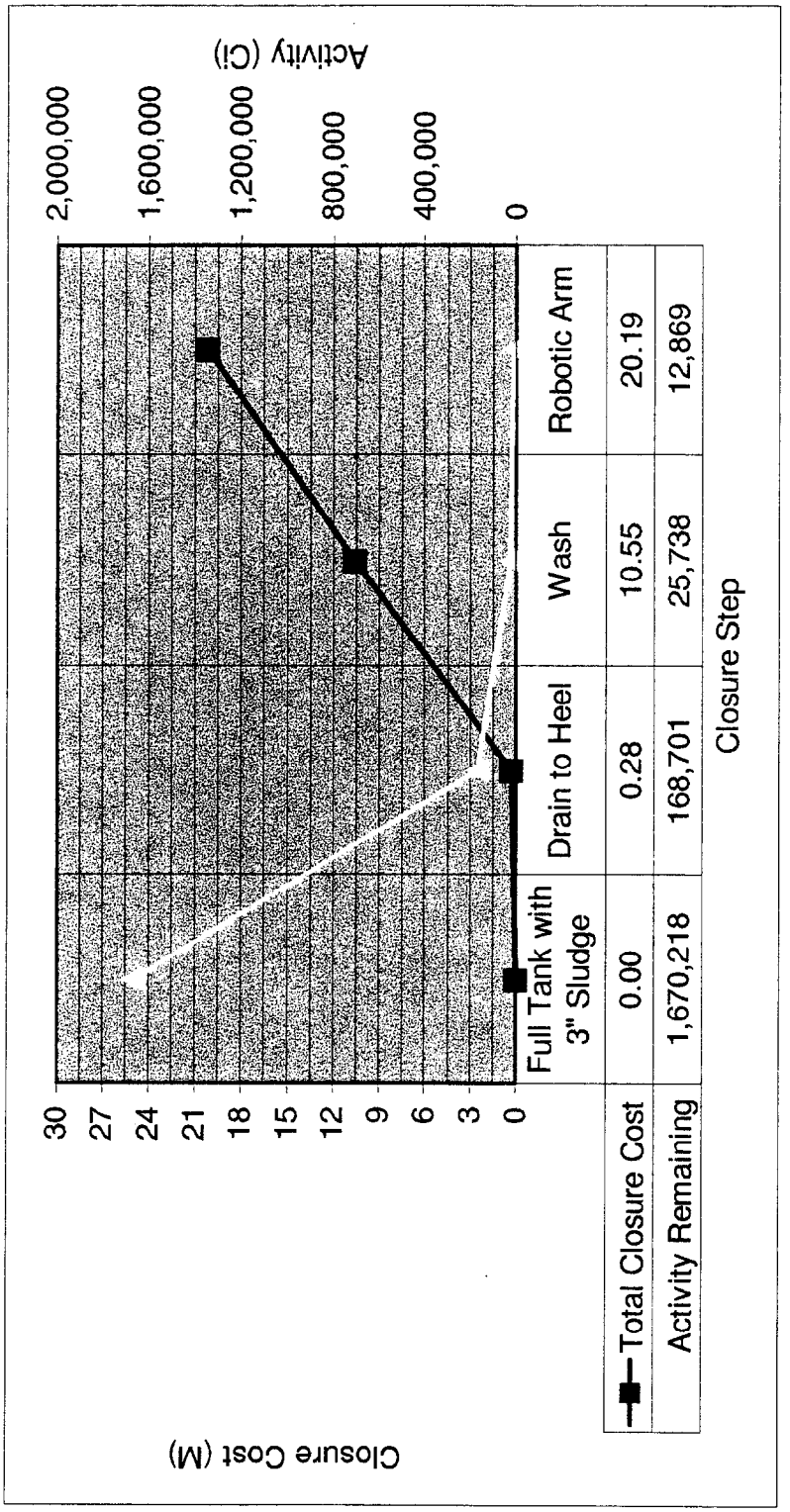


Figure 80: Percent of Activity Removed as a Function of Decontamination Costs

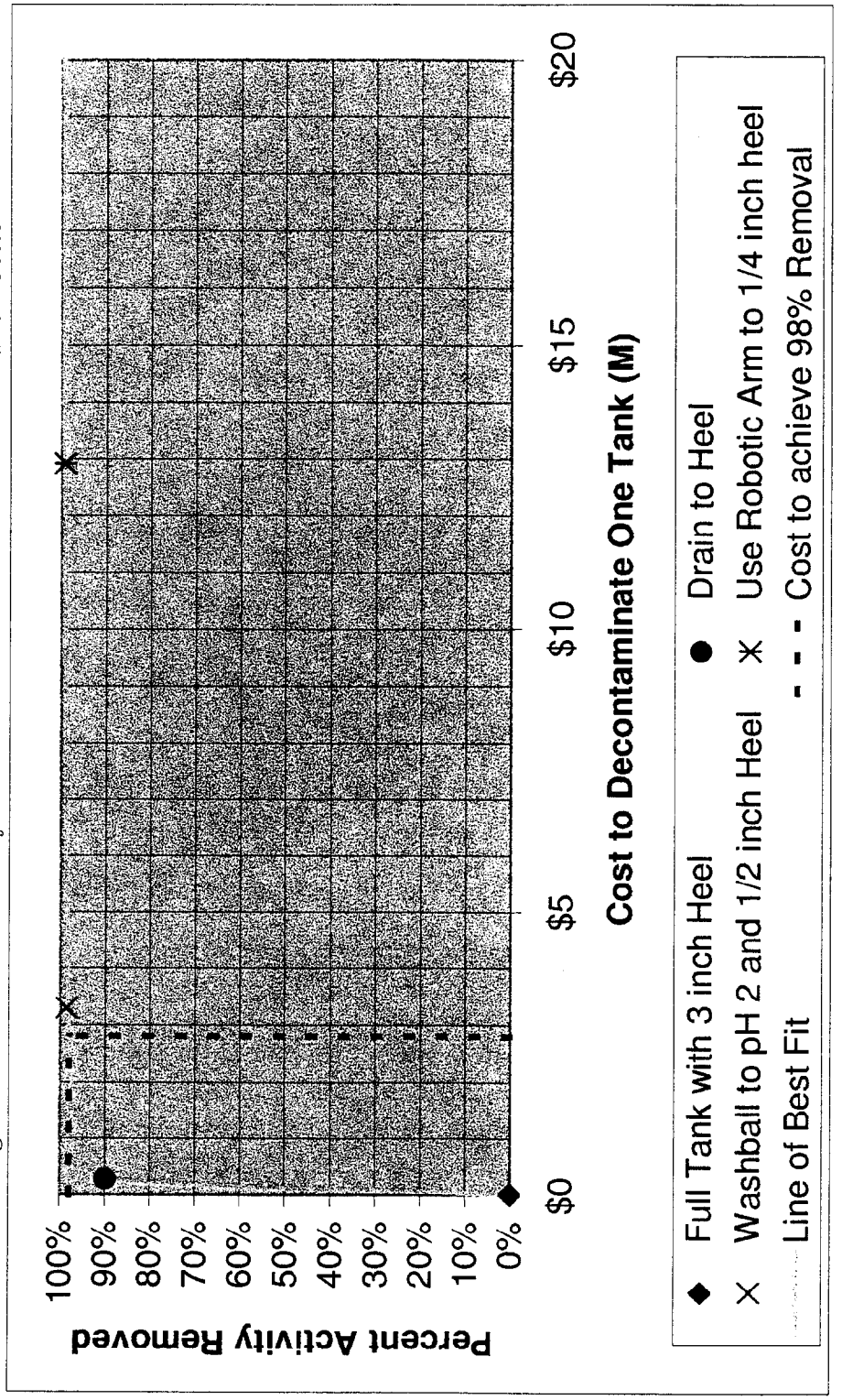


Figure 81: Percent of Activity Removed as a Function of Decontamination Costs (Zoomed)

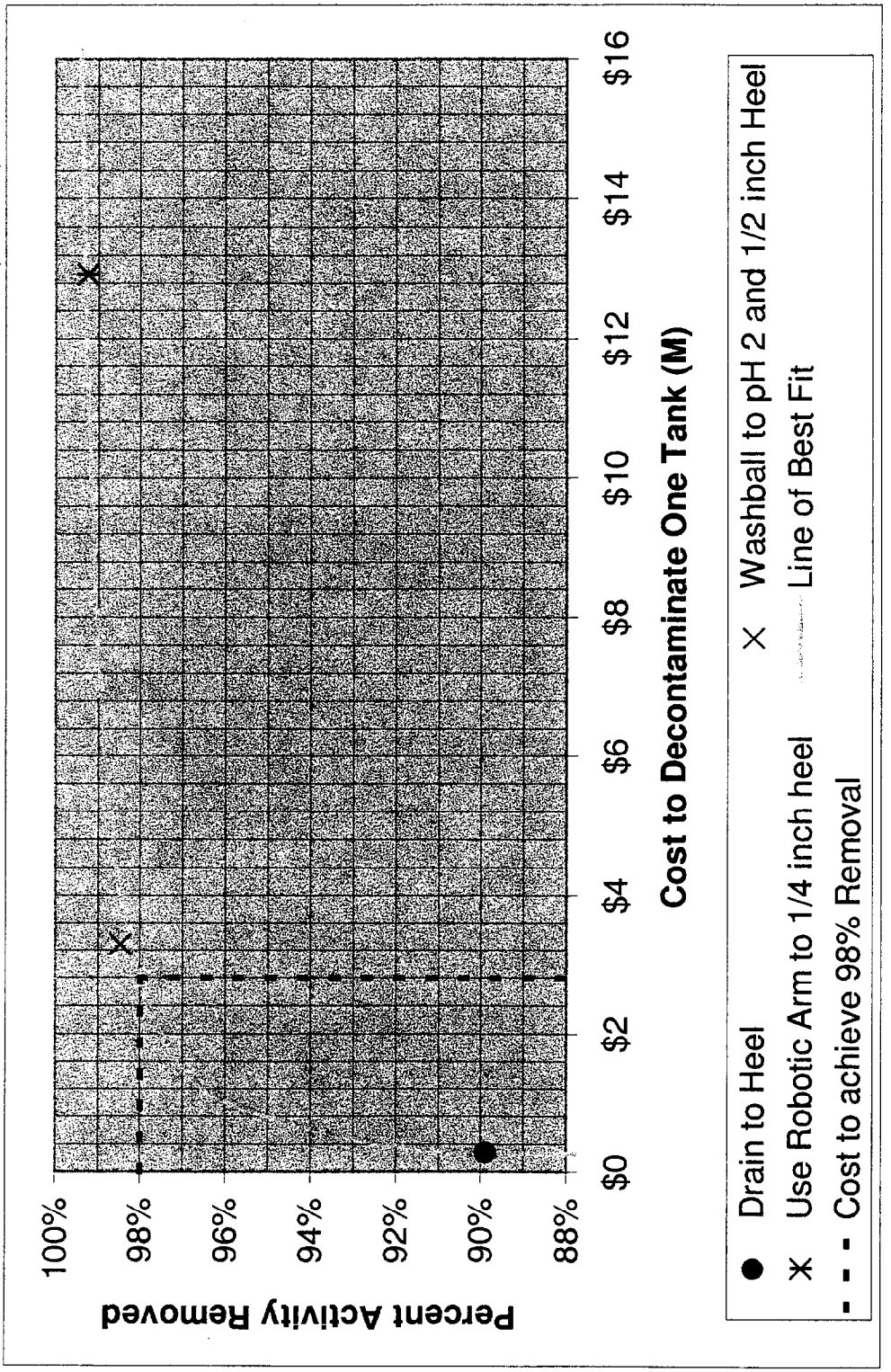


Table 1: Effectiveness Factors for WM-182 and WM-183

Model	Step	Description	Effectiveness Factor for Standing Liquid	Effectiveness Factor for Sludge Liquids	Overall Liquid Phase Effectiveness Factor	Solids Effectiveness Factor	Water In (gal.)	Step Time (min.)
WM-182	1	Drain #1	2.67E-06	1.00E+00	1.26E-02	1.00E+00	0	4,309
	2	Fill #1	2.47E+03	4.84E-01	1.00E+00	1.00E+00	2,448	38
	3	Wash #1	9.51E-02	1.30E-02	5.54E-02	3.03E-01	20,480	315
	4	Settle #1	9.39E-01	1.47E+00	1.00E+00	1.00E+00	0	240
	5	Fill #2	1.00E+00	1.00E+00	1.00E+00	1.00E+00	277,700	4,272
	6	Drain #2	2.64E-06	1.00E+00	1.67E-01	1.00E+00	0	4,362
	7	Fill #3	3.50E+04	5.41E-01	1.00E+00	1.00E+00	1,224	19
	8	Wash #2	1.98E-02	4.44E-03	1.15E-02	3.99E-01	12,680	195
	9	Settle #2	9.69E-01	1.12E+00	1.00E+00	1.00E+00	0	240
	10	Drain #3	3.53E-04	1.00E+00	2.33E-01	1.00E+00	0	33
	Overall		3.70E-10	2.48E-05	3.14E-07	1.21E-01	36,820	567
WM-183	1	Drain #1	2.67E-06	1.00E+00	1.26E-02	1.00E+00	0	4,309
	2	Fill #1	2.47E+03	4.84E-01	1.00E+00	1.00E+00	2,448	38
	3	Wash #1	3.69E-02	1.72E-02	2.74E-02	3.05E-01	14,080	270
	4	Settle #1	9.23E-01	1.17E+00	1.00E+00	1.00E+00	0	240
	5	Fill #2	1.00E+00	1.00E+00	1.00E+00	1.00E+00	281,100	4,325
	6	Drain #2	2.64E-06	1.00E+00	3.58E-01	1.00E+00	0	4,362
	7	Fill #3	9.69E+04	5.41E-01	1.00E+00	1.00E+00	1,224	19
	8	Wash #2	6.02E-03	2.94E-03	4.36E-03	3.83E-01	11,740	195
	9	Settle #2	9.68E-01	1.06E+00	1.00E+00	1.00E+00	0	240
	10	Drain #3	6.19E-04	1.00E+00	3.86E-01	1.00E+00	0	19
	Overall		2.07E-10	1.65E-05	2.08E-07	1.17E-01	29,490	522

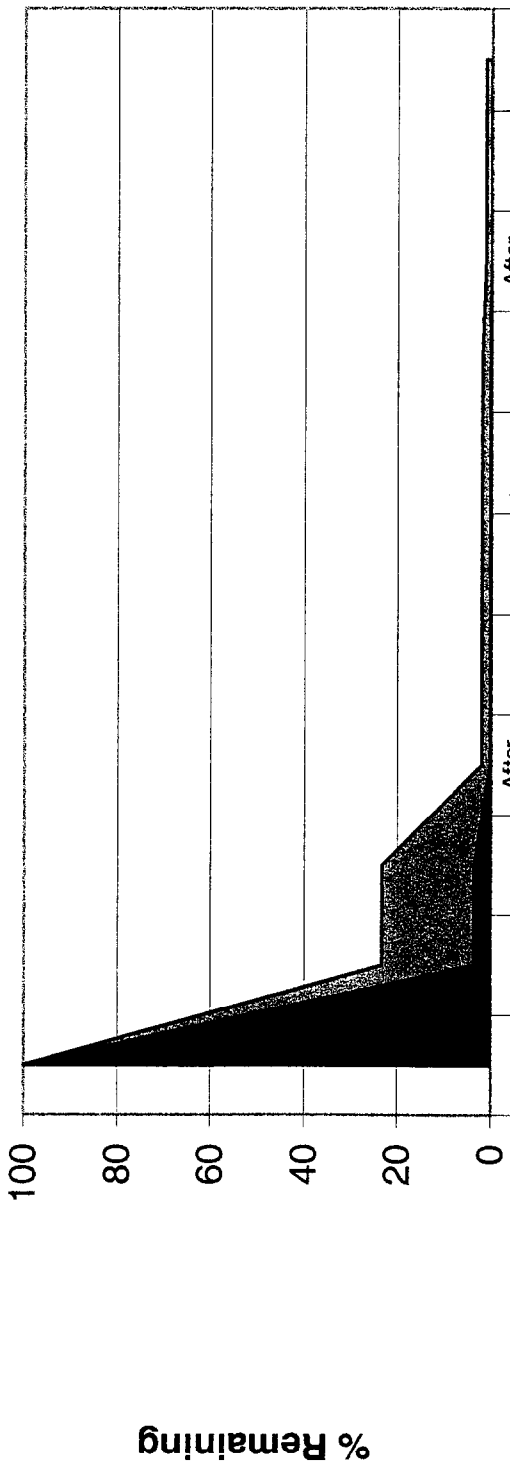
Table 2: Effectiveness Factors for WM-182 and WM-183 (Improved Control Law)

Model	Step	Description	Effectiveness Factor for Standing Liquid	Effectiveness Factor for Sludge Liquids	Overall Liquid Phase Effectiveness Factor	Solids Effectiveness Factor	Water in (gal.)	Step Time (min.)
WM-182	1	Drain #1	2.72E-06	1.00E+00	2.54E-02	1.00E+00	0	4,234
(Improved)	2	Fill #1	4.72E+03	5.07E-01	1.00E+00	1.00E+00	2,448	38
	3	Wash #1	1.23E-02	2.46E-04	6.20E-03	6.38E-02	60,450	930
	4	Settle #1	9.80E-01	1.95E+00	1.00E+00	1.00E+00	0	240
	5	Fill #2	1.00E+00	1.00E+00	1.00E+00	1.00E+00	272,800	4,196
	6	Drain #2	2.63E-06	1.00E+00	3.92E-02	1.00E+00	0	4,375
	7	Fill #3	8.79E+03	4.34E-01	1.00E+00	1.00E+00	1,224	19
	8	Wash #2	4.66E-01	3.21E-01	4.03E-01	8.64E-01	1,950	30
	9	Settle #2	9.70E-01	1.06E+00	1.00E+00	1.00E+00	0	240
	10	Drain #3	5.71E-04	1.00E+00	3.65E-01	1.00E+00	0	20
	Overall		9.25E-10	3.58E-05	9.08E-07	5.51E-02	66,070	1,016
WM-183	1	Drain #1	2.72E-06	1.00E+00	2.54E-02	1.00E+00	0	4,234
(Improved)	2	Fill #1	4.72E+03	5.07E-01	1.00E+00	1.00E+00	2,448	38
	3	Wash #1	1.58E-03	5.03E-04	1.03E-03	9.61E-02	26,090	540
	4	Settle #1	9.51E-01	1.15E+00	1.00E+00	1.00E+00	0	240
	5	Fill #2	1.00E+00	1.00E+00	1.00E+00	1.00E+00	281,800	4,335
	6	Drain #2	2.63E-06	1.00E+00	2.83E-01	1.00E+00	0	4,370
	7	Fill #3	7.79E+04	4.61E-01	1.00E+00	1.00E+00	1,224	19
	8	Wash #2	8.44E-02	5.36E-02	6.96E-02	6.42E-01	5,507	90
	9	Settle #2	9.66E-01	1.06E+00	1.00E+00	1.00E+00	0	240
	10	Drain #3	6.14E-04	1.00E+00	3.92E-01	1.00E+00	0	19
	Overall		1.98E-10	7.98E-06	2.02E-07	6.17E-02	35,270	687

Table 3: Percent Decrease in Washwater with Additional Control System

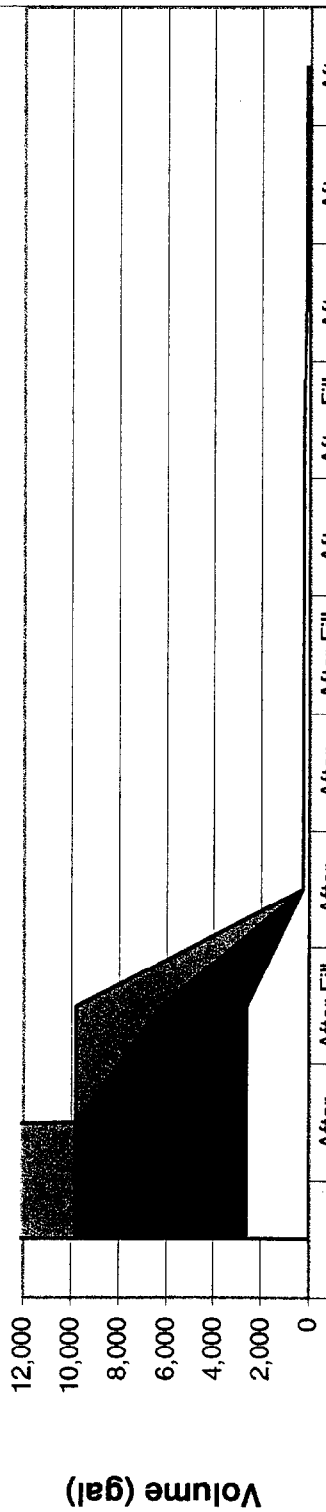
Tank	Control Scheme	Wash Water (gal)	Wash Time (min)
WM-182	Constant Volume	36,820	567
WM-182	Constant 2 in. Liquid Layer	29,490	522
WM-182	**% Improvement**	19.9	7.9
WM-183	Constant Volume	66,070	1,016
WM-183	Constant 2 in. Liquid Layer	35,270	687
WM-183	**% Improvement**	46.6	32.4

Table 4: Percent of Waste Remaining in WM-183 with Improved Control Law



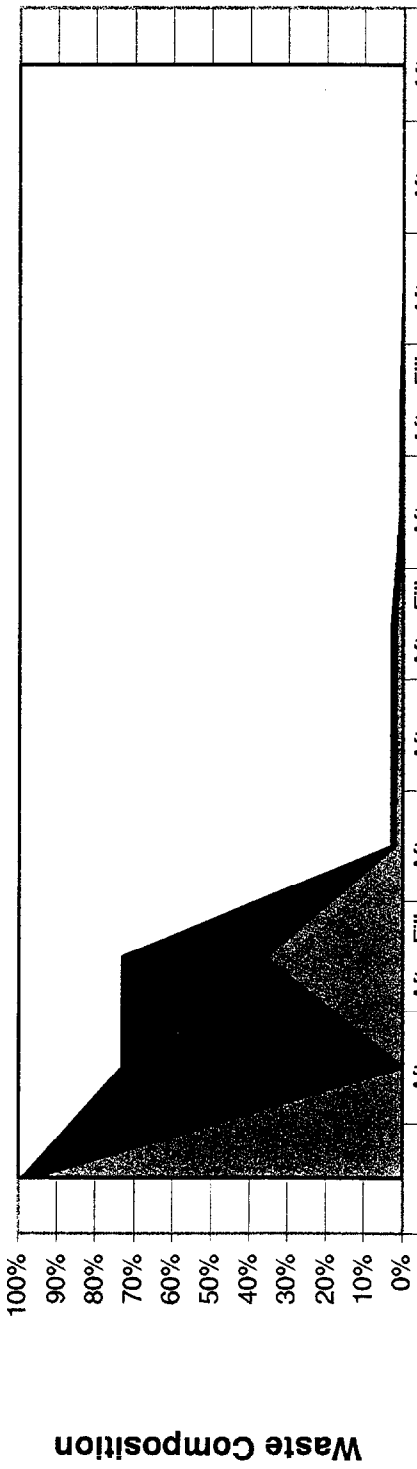
	Initially	After Drain #1	After Fill #1	After Wash #1	After Settle #1	After Fill #2	After Drain #2	After Fill #3	After Wash #2	After Settle #2	After Drain #3
% Remaining by Activity	100	23.4	23.4	2.06	2.06	2.06	2.06	2.06	1.32	1.32	1.32
% Remaining by Volume	100	3.44	3.44	0.0914	0.0914	0.0914	0.0895	0.0895	0.0570	0.0570	0.0570

Table 5: WM-183 Tank Prep. Effectiveness by Volume with Improved Control Law



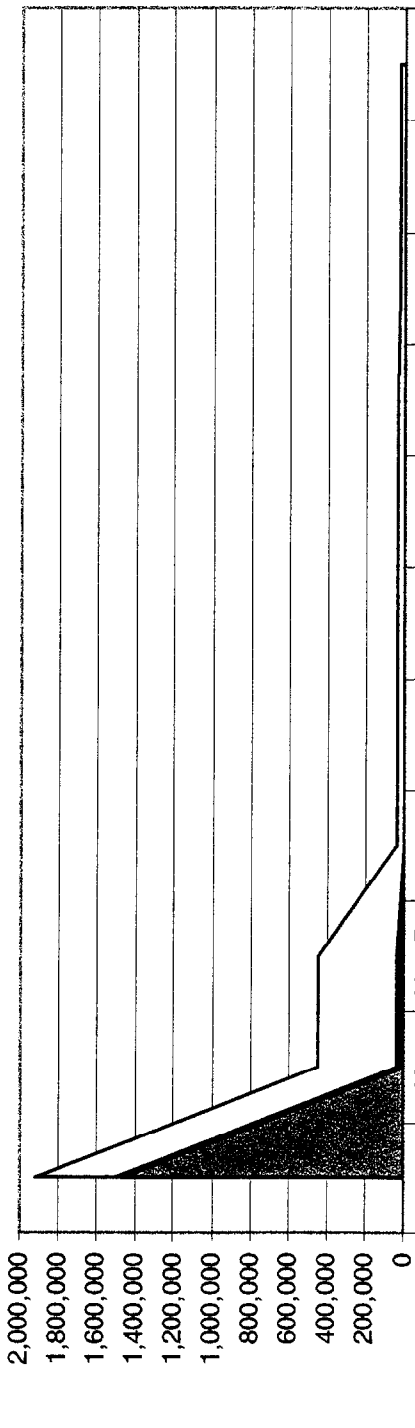
	Initially	After Drain #1	After Fill #1	After Wash #1	After Settle #1	After Fill #2	After Drain #2	After Fill #3	After Wash #2	After Settle #2	After Drain #3
Liquid Phase	275,207	0.748	3,532	5.56	5.29	5.29	0.0000139	1.09	0.09	0.09	0.000054
Sludge Liquid	7,158	7,158	3,628	1.82	2.09	2.09	2.09	1.008	0.054	0.057	0.057
Sludge Solids	2,634	2,634	2,634	253	253	253	253	253	162	162	162

Table 6: WM-183 Tank Prep. Waste Composition by Volume (gal) with Improved Control Law



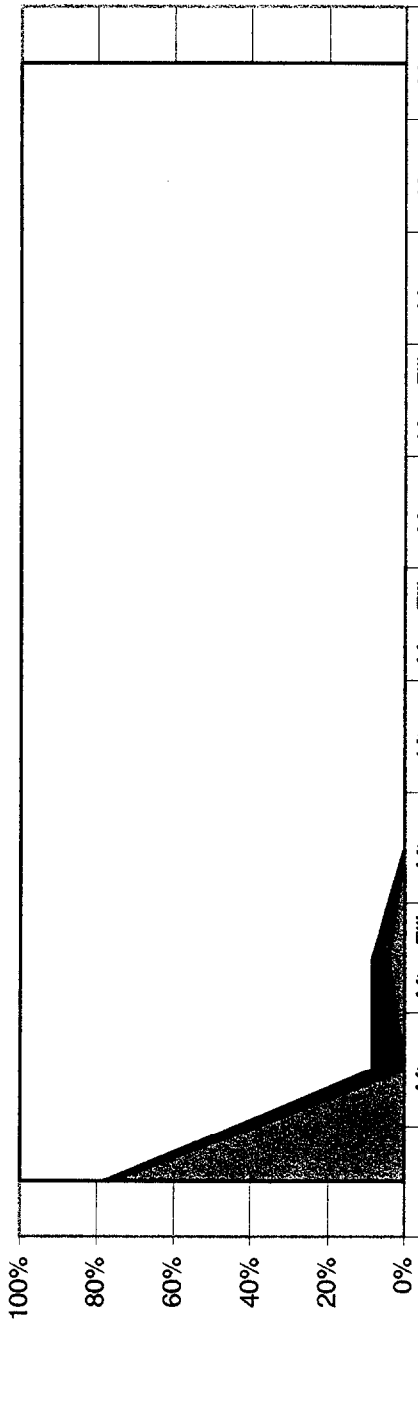
	Initially	After Drain #1	After Fill #1	After Wash #1	After Settle #1	After Fill #2	After Drain #2	After Fill #3	After Wash #2	After Settle #2	After Drain #3
Sludge Solids	2,634	2,634	2,634	253	253	253	253	253	162	162	162
Sludge Liquid	7,158	7,158	3,628	1.82	2.09	2.09	2.09	1.008	0.054	0.057	0.057
Liquid Phase	275,207	0.748	3,532	5.56	5.29	5.29	0.000013	1.09	0.09	0.09	0.000054

Table 7: WM-183 Tank Prep. Effectiveness by Activity with Improved Control Law



	Initially	After Drain #1	After Fill #1	After Wash #1	After Settle #1	After Fill #2	After Drain #2	After Fill #3	After Wash #2	After Settle #2	After Drain #3
Sludge Solids	411,663	411,663	411,663	39,545	39,545	39,545	39,545	39,545	25,382	25,382	25,382
Sludge Liquid	38,206	38,206	19,364.5	9.7309	11.1747	11.1747	11.1747	5.3802	0.28833	0.3048	0.3048
Liquid Phase	1,468,851	3.9925	18,850.5	29.690	28.250	28.250	0.000074	5.7944	0.4890	0.4724	0.000290

Table 8: WM-183 Tank Prep. Waste Composition by Activity (Ci) with Improved Control Law



	Initially	After Drain #1	After Fill #1	After Wash #1	After Settle #1	After Fill #2	After Drain #2	After Fill #3	After Wash #2	After Settle #2	After Drain #3
Sludge Solids	411,663	411,663	411,663	39,545	39,545	39,545	39,545	39,545	25,382	25,382	25,382
Sludge Liquid	38,206	38,206	19,364.5	9.7309	11.1747	11.1747	11.1747	5.3802	0.28833	0.3048	0.3048
Liquid Phase	1,468,851	3.9925	18,850.5	29.690	28.250	28.250	0.000074	5.7944	0.4890	0.4724	0.000290

Table 9: Various WM-183 Density Data

59.43	wt. % of Liquid in Sludge (from RAL)
2.906	Sludge Weight (g)
2.33	Sludge Volume (cc)
1.247	Sludge Density (g/cc)
1.179	Air Dried Sample Weight (g)
1.880	Air Dried Particle Density (g/cc)
0.627	Vol of Air Dried Solids in Sample (cc)
0.269	Vol Fraction of Solids in Sludge
0.731	Vol Fraction of Liquid in Sludge
0.406	Mass Fraction of Solids in Sludge
0.594	Mass Fraction of Liquids in Sludge (Checks with RAL number)
1.014	Computed Density of Liquid in Sludge (g/cc) (RAL= 0.99540 g/cc)
1.20	App WM-183 Liquid Density (g/cc)
1.38	Est. WM-183 Sludge Density (g/cc)
0.366	Est. Mass Fraction Solids in Sludge
0.634	Est. Mass Fraction Liquid in Sludge

Table 10: Assumed Quantity of Tank Heel Remaining in Tank

SG of Liquid	1.00
Particle SG	1.88
Area of Bottom of tank	1963 ft^2
Depth of Disk	1.00 in
Volume of Disk	164 ft^3
Volume of Disk	1224 gal
Volume of Disk	4634 l
Volume of pump liquid	400 gal
Volume of pump liquid	1514 l
Liquid Fraction	0.731 l
Volume of Solids	1247 l
Volume of Liquid	4902 l
Mass of Solids	2343 kg
Mass of Liquid	4902 kg

Table 11: Assumed Activities of Selected Nuclides in the Tank Heel

Actinides: (Curies)	
^{241}Am	1.99E+00
^{243}Am	4.18E-02
^{242}Cm	4.39E-03
^{244}Cm	4.00E-01
^{237}Np	6.79E-03
^{233}Pa	5.75E-01
^{238}Pu	4.55E+01
^{239}Pu	3.44E+00
^{240}Pu	2.08E+00
^{241}Pu	1.12E+02
^{242}Pu	3.77E-03
^{230}Th	1.14E-03
^{231}Th	4.16E-03
^{232}U	1.53E-03
^{233}U	6.39E-06
^{234}U	1.60E-01
^{235}U	6.19E-04
^{236}U	7.16E-04
^{237}U	2.85E-03
^{238}U	2.88E-04
Fission & Activation Products: (Curies)	
^{137m}Ba	1.05E+04
^{144}Ce	2.87E+00
^{60}Co	1.41E+00
^{134}Cs	1.64E+01
^{135}Cs	3.05E-01
^{137}Cs	1.09E+04
^{152}Eu	8.26E-01
^{154}Eu	3.86E+00
^{155}Eu	5.27E+01
^{147}Pm	3.45E+02
^{144}Pr	3.36E-02
^{63}Ni	6.67E+01
^{106}Ru	2.07E+00
^{125}Sb	1.84E+02
^{151}Sm	4.29E+02
^{90}Sr	1.27E+04
^{99}Tc	1.05E+01
^{90}Y	1.43E+04
^{3}H	2.98E-02
^{129}I	1.05E-02
Others: (Curies)	
^{14}C	1.68E-03
^{59}Ni	5.71E-01
^{94}Nb	8.63E+00
Total Activity: (Curies)	4.96E+04

Table 12: Grout Layer Properties

Heel Mass (kg)	7,245
Heel Volume (l)	6,148
Grout SG	2.10
Grout Mass (kg)	657,432
Grout Volume (l)	313,063
Total Mass (kg)	664,677
Total Volume (l)	319,211
Height of Grout Layer (ft)	5.63
CFR Classification	Class C

Table 13: TRU Waste Analysis

TRU Nuclide	TRU Limit (nCi/g)	Grout Layer (nCi/g)	Fraction of TRU Limit	Meets TRU Limit?
Am-241	100	2.99	0.0299	TRUE
Am-243	100	0.0629	0.000629	TRUE
Np-237	100	0.0102	0.000102	TRUE
Pu-238	100	68.5	0.685	TRUE
Pu-239	100	5.18	0.0518	TRUE
Pu-240	100	3.12	0.0312	TRUE
Pu-242	100	0.00567	0.0000567	TRUE
Total:	100	79.9	0.799	TRUE

Table 14: LLW Analysis

Class Determination:	Class C	Class A limit (Ci/m^3)	Class B limit (Ci/m^3)	Class C limit (Ci/m^3)	Grout Layer (Ci/m^3)	Fraction of Class A Limit	Fraction of Class B Limit	Fraction of Class C Limit	Meets Class A Limit?	Meets Class B Limit?	Meets Class C Limit?
short lived:											
	Alpha Emitting (half life < than 5 years)	700	n/a	n/a	0	0	0	0	TRUE	TRUE	TRUE
	H-3	40	n/a	n/a	0.0000935	0.00000234	0	0	TRUE	TRUE	TRUE
	Co-60	700	n/a	n/a	0.00441	0.00000630	0	0	TRUE	TRUE	TRUE
	Ni-63	3.5	70	700	0.209	0.0597	0.00298	0.000298	TRUE	TRUE	TRUE
	Ni-63 in activated metal	35	700	7000	0	0	0	0	TRUE	TRUE	TRUE
	Sr-90	0.04	150	7000	39.7	993	0.265	0.00568	FALSE	TRUE	TRUE
	Cs137	1	44	4600	34.0	34	0.774	0.00740	FALSE	TRUE	TRUE
	Sum of Fractions Number (should be <1)					1,027	1.04	0.0134	FALSE	FALSE	TRUE
long lived:											
	C-14	0.8	0.8	8	0.00000525	0.00000656	0.00000656	0.000000656	TRUE	TRUE	TRUE
	C-14 in activated metal	8	8	80	0	0	0	0	TRUE	TRUE	TRUE
	Ni-59	22	22	220	0.00179	0.0000814	0.0000814	0.00000814	TRUE	TRUE	TRUE
	Nb-94	0.02	0.02	0.2	0.0270	1.35	1.35	0.135	FALSE	FALSE	TRUE
	Tc-99	0.3	0.3	3	0.0330	0.110	0.110	0.0110	TRUE	TRUE	TRUE
	I-129	0.008	0.008	0.08	0.0000330	0.00413	0.00413	0.000413	TRUE	TRUE	TRUE
	Alpha Emitting TRU (half life > 5 years)**	10	10	100	80.5	8.05	8.05	0.805	FALSE	FALSE	TRUE
	Pu-241*	350	350	3500	169.2	0.483	0.483	0.0483	TRUE	TRUE	TRUE
	Cm-242*	2000	2000	20000	0.00660	0.00000330	0.00000330	0.000000330	TRUE	TRUE	TRUE
	Sum of Fractions Number (should be <1)					10.00	10.00	1.00	FALSE	FALSE	TRUE

* units of nCi/g

** units of nCi/g; includes Am-241, Am-243, Cm-244, Np-237, Pu-238, Pu-239, Pu-240, Pu-242

Table 15: Estimated Solids Quantities (inches of sludge)

Tank	Sludge Height	Sludge on Walls	Total Sludge
WM-180	2.00	0.50	2.50
WM-181	2.00	0.50	2.50
WM-182	4.00	0.50	4.50
WM-183	8.00	0.50	8.50
WM-184	2.00	0.50	2.50
WM-185	2.00	0.50	2.50
WM-186	2.00	0.50	2.50
WM-187	0.25	0.25	0.50
WM-188	0.25	0.25	0.50
WM-189	0.25	0.25	0.50
WM-190	0.00	0.00	0.00
Total	22.75	4.25	27.00

Table 16: Estimated Total Sludge Layer Properties

SG of Liquid	1.00
Particle SG	1.88
Area of Bottom of tank	1963 ft^2
Depth of Disk	27.00 in
Volume of Disk	4418 ft^3
Volume of Disk	33050 gal
Volume of Disk	125114 l
Volume of pump liquid	0 gal
Volume of pump liquid	0 l
Liquid Fraction	0.731 l
Volume of Solids	33656 l
Volume of Liquid	91458 l
Mass of Solids	63273 kg
Mass of Liquid	91458 kg

Table 17: Tank Farm Sludge Estimated Source Term

Actinides: (Curies)	
^{241}Am	5.36E+01
^{243}Am	1.13E+00
^{242}Cm	1.18E-01
^{244}Cm	1.08E+01
^{237}Np	1.82E-01
^{233}Pa	1.55E+01
^{238}Pu	1.23E+03
^{239}Pu	9.29E+01
^{240}Pu	5.60E+01
^{241}Pu	3.04E+03
^{242}Pu	1.02E-01
^{230}Th	3.09E-02
^{231}Th	1.12E-01
^{232}U	4.12E-02
^{233}U	1.73E-04
^{234}U	4.31E+00
^{235}U	1.66E-02
^{236}U	1.93E-02
^{237}U	7.70E-02
^{238}U	7.68E-03
Fission & Activation Products: (Curies)	
^{137m}Ba	2.84E+05
^{144}Ce	7.76E+01
^{60}Co	3.80E+01
^{134}Cs	4.44E+02
^{135}Cs	8.24E+00
^{137}Cs	2.93E+05
^{152}Eu	2.23E+01
^{154}Eu	1.04E+02
^{155}Eu	1.42E+03
^{147}Pm	9.32E+03
^{144}Pr	9.06E-01
^{63}Ni	1.80E+03
^{106}Ru	5.60E+01
^{125}Sb	4.96E+03
^{151}Sm	1.16E+04
^{90}Sr	3.42E+05
^{99}Tc	2.84E+02
^{90}Y	3.85E+05
^{3}H	7.98E-01
^{129}I	2.84E-01
Others: (Curies)	
^{14}C	3.15E-02
^{59}Ni	1.54E+01
^{94}Nb	2.33E+02
Total Activity: (Curies)	1.34E+06

Table 18: HLW Glass Properties

Physical Data:	
Heel Mass (kg)	154,731
Heel Volume (l)	125,114
Glass SG	2.60
Glass Mass (kg)	287,357
Glass Volume (l)	110,522
Total Mass (kg)	442,088
Total Volume (l)	235,636
Number of 0.7 m^3 Canisters Needed	337
Waste Loading (mass %)	35.0
CFR Classification	HLW
Potential Disposal Sites	National Repository

Table 19: TRU Solids Properties

Physical Data:	
Heel Mass (kg)	154,731
Heel Volume (l)	125,114
Number of 55-gal Drums Needed	601
CFR Classification	TRU
Potential Disposal Sites	WIPP

Table 20: Class C Grout Properties

Physical Data:	
Heel Mass (kg)	154,731
Heel Volume (l)	125,114
Grout SG	2.10
Grout Mass (kg)	17,850,000
Grout Volume (l)	8,500,000
Total Mass (kg)	18,004,731
Total Volume (l)	8,625,114
Number of 55-gal Drums Needed	41,426
Waste Loading (mass %)	0.86
CFR Classification	Class C
Potential Disposal Sites	NTS, Evirocare, Hanford, etc.

EDF-1464

ENGINEERING DESIGN FILE

PROJECT FILE NO.

EDF SERIAL NO. EDF-1464

FUNCTIONAL FILE NO.

PROJECT/TASK INTEC TANK FARM CLOSURE

SUBTASK FILL GROUT

TITLE INTEC TANK FARM CLOSURE GROUT MIX DESIGN

SUMMARY

The EDF summarizes the mix design for two types of fill grout. They are a cement and fly ash grout, called the pipe grout, and a cement, fly ash and sand grout, called either the tank grout or the vault grout.

The EDF includes the following sections:

INTRODUCTION
MIXTURE REQUIREMENTS
PIPE GROUT
TANK AND VAULT GROUT
CONCLUSIONS
RECOMMENDATIONS
SUMMARY OF DATA

QUALITY LEVEL ☐ 1 ☐ 2 ☒ 3

LEVEL OF RISK ☒ Low ☐ High

KEYWORDS (e.g. area, structure no., general subject matter, etc.): Grout, mix design

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E. L. Baker	3/31/00	E. C. Anderson	3/31/05
BBWI Review	DATE	BBWI Review	DATE

INTRODUCTION

Two types of grout mixtures are proposed for the closure of the INTEC Tank Farm. One type is a mixture of cement, fly ash, water and water reducing admixtures. For the purposes of this project it is called the pipe grout. It will be used to fill piping, small vessels or other items that require a very fluid grout.

The other type of grout is a mixture of cement, fly ash, sand, water and water reducing admixtures. For this project this type of grout mixture is called either tank grout or vault grout. The main differences between the tank grout and the vault grout are the required strength and the slump or flowability. The vault grout is required to flow around at least half the circumference of the existing 50 ft diameter tanks.

The following sections discuss the mix design for pipe, tank and vault grouts. The discussion is based on design mix tests and placements of grout for both the WCF RCRA Closure and the conceptual design for closure of the INTEC Tank Farm.

MIXTURE REQUIREMENTS

The grout mixtures must flow easily since placement locations and methods are limited. This requirement has been measured in the past using standard concrete slump tests (ASTM C 143). At least 9 in. of slump was required for all the mixtures and the pipe grout required slumps in excess of 11 in.

The grout mixtures may also be required to harden to a minimum compressive strength. This minimum has yet to be determined but is expected to be at least 500 psi. The vault grout must have a minimum compressive strength of 3,000 if it is used to cover the tanks without completely filling the tanks.

The flowability or fluidity of the mixtures is the main requirement for the grouts. The tank grout must also be able to move the tank waste liquids and to some extent solids to locations where the wastes can more easily be removed from the tanks. For this reason, the tank grout needs to be less fluid than the other grout mixtures. Adjusting the amount of water present in the mixtures appears to be easiest way to obtain the desired fluidity.

Other qualities that are desirable for the grout mixtures include:

- no bleed water or as low amount of bleed water as is achievable
- low shrinkage and limited shrinkage cracking
- low heat generation, since high temperatures will cause cracking and other undesirable affects

Cracks increase the chance for materials to move into or out of the hardened grout. The quantity and their size of cracks should therefore be as small as possible.

The cost of the mixture is also a consideration but was not a primary factor in the design of the mixtures as presented herein.

The proposed mixtures meet the requirements by:

- using water reducers to increase slump and flowability
- using relatively low quantities of cement
- using fly ash as a replacement for cement
- limiting the amount of water in the mix to the extent possible

PIPE GROUT

The basic mix design for a cubic yard of the pipe grout is as follows:

Cement	680 lbs	Type I & II cement
Pozzolan Class F	1,600 lbs	Fly ash
Water	Up to 800 lbs	(96 gallons)
Medium-range water reducer	32 oz	
High-range water reducer	64 oz	

The latest tests for the pipe grout used 91 gallons of water per cubic yard. This reduced the shrinkage and bleed water associated with the pipe grout mix and increased the compressive strength. The 28 day and 56 day compressive strengths for the pipe grout mixture with 91 gallons of water were 3,360 psi and 4,680 psi respectively. The lowest 28 day test compressive strength for the pipe grout mixture tests was 2,400 psi. These strengths are much higher than any known strength requirements for this grout.

The pipe grout will readily flow through pipes as small as 1/2 inch in nominal diameter. It has been pumped through holes as small as 1/8 inch in diameter. However, if the pipe grout is pumped for an extended period or pumping stops and is then restarted the small diameter holes or pipe tend to plug. The slump of this grout as tested by ASTM C 143 is in excess of 11.5 inches. This test procedure is not very accurate for grouts that are this fluid. Future flowability tests should use a different test procedure.

For larger pipes it may be possible to reduce the water content of this mixture and thus reduce the shrinkage and bleed water associated with the high water content. If the water is decreased the dry materials will need to be increased maintain the yield volume at a cubic yard.

Bleed water amounts from past tests of this mixture were low. The maximum amounts were observed when 55 gallon barrels were filled with the grout mixture and then covered. The largest quantity of water observed on the top of the grout was a depth of approximately 1/4 in. in a 55 gallon barrel.

TANK AND VAULT GROUT

The tank and vault grouts have different purposes but the same basic mixture is currently proposed for both uses. The difference is mainly in the flowability of the grout mixture. The flowability has been measured in the past using a standard concrete slump test (ASTM C 143). The minimum slump for the

vault grout using ASM C 143 is 11 inches. The tank grout slump using ASTM C 143 will vary from about 10 inches to 11 inches depending on the requirements of a placement.

The vault grout is required to have a compressive strength of at least 3,000 psi. It also must flow readily around the circumference of the liquid waste storage tank.

The tank grout will be used to minimize the waste left within the tanks. A minimum compressive strength for the tank grout has not been set. It also provides the weight necessary to resist buoyant forces from the first vault grout placement.

The basic mix design tank and vault grout is as follows:

Cement	320 lbs	Type I & II cement
Pozzolan Class F	640 lbs	Fly ash
Fine aggregate	2,200 lbs	Sand
Water	Up to 433 lbs	(52 gallons)
Medium-range water reducer	64 oz	
High-range water reducer	96 oz	

The grout placement tests associated with the first stage of the conceptual design for closure of the INTEC Tank Farm showed that that grout with a slump of more than 11 inches will flow halfway around the circumference of a 50 ft diameter tank. The difference in elevation between the grout at the placement location and the opposite side of the tank for one of the tests was about 8 inches.

The test grout used less water than the 52 gallons per cubic yard shown above. The amount of water ranged from a low of 45 gallons to a high of 50 gallons. The water to cementious materials ratio ranged from 0.40 to 0.43. The water to cementious material ratio for the mix with 52 gallons of water is 0.45.

High and medium range water reducing admixtures are included in the mixes to enhance the workability of the grout mixtures without increasing the water content. Additional water reduces strength and density, increases shrinkage and shrinkage cracking, increases bleed water and increases permeability of the cured grout. Therefore the water content of the grout mixtures needs to be minimized.

The materials used in the grout mixtures were used because they are readily available in the intermountain west. Most ready-mix suppliers in the region near the INEEL are also set up to supply concrete or grout mixtures similar to the proposed grout mixtures. Other materials, such as finely ground blast furnace slag, were considered for the grout mixtures. However, they were not used since they are not readily available in the region near the INEEL.

The testing to date indicates that all mixtures are flowable and will achieve 28 day compressive strengths of at least 2,000 psi. Because of the high fly ash content of the mixtures, they continue to gain significant strength for a longer time period than is normal for typical construction grouts.

56 day compressive strengths are approximately 1,000 psi stronger than the 28 day compressive strengths.

Additional data on flowability, bleed water, shrinkage and temperature as well as strength are available for the proposed grout mixtures in at least two unpublished reports. The compressive strength data is filed at the INEEL Material Test Lab located at the Central Facilities Area (CFA).

CONCLUSIONS

All of the test batches appeared to perform in a satisfactory manner regarding bleed water amounts and shrinkage.

Flowability was acceptable when concrete slumps were within the ranges previously mentioned.

Compressive strengths exceeded requirements, in some cases by substantial amounts. See the attached graph.

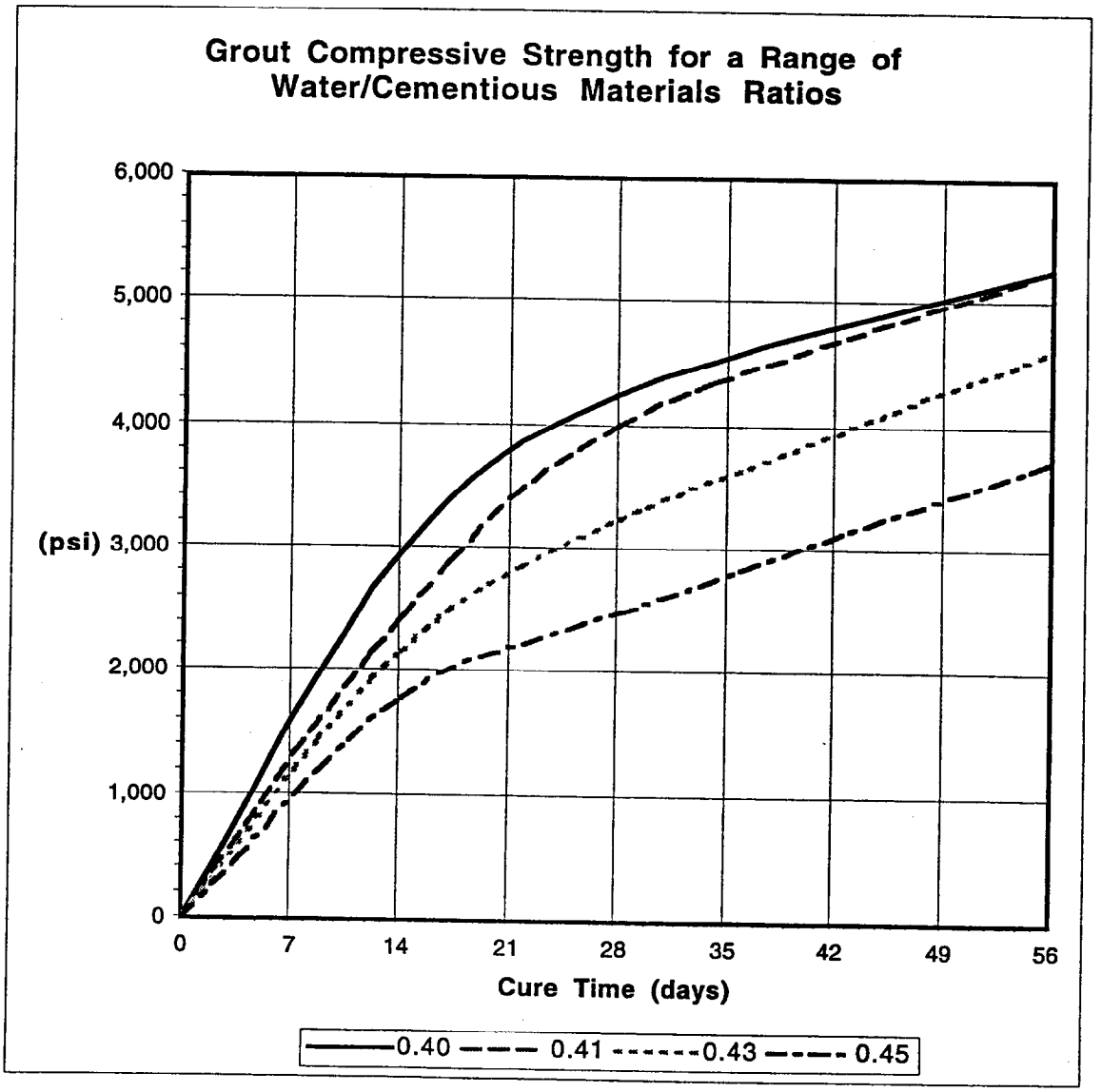
RECOMMENDATIONS

Future studies are recommended for the grout mixtures, particularly the tank grout. These studies may include additional strength tests, flow tests, sensitivity of the grout mixture to different environmental conditions, tests to determine the pumping characteristics for the grout, tests that indicate the long term durability of the cured grout, and other tests related to the proposed grout placement equipment or systems. The strength tests may include grout cylinders cured under conditions more closely matching actual conditions inside the tanks.

A more sensitive test for flowability of the grout mixture is necessary. ASTM C 143 does not provide enough sensitivity since the required slumps for the grout are at least 9 inches and for most proposed placements are in excess of 11 inches. The standard could be a cone flow test, a measurement of the diameter of the grout puddle obtain from a slump cone test, a measurement of difference in elevation of grout in a trough or variations of these.

SUMMARY OF DATA

The following graph summarizes the strength data obtained for the tank and vault grouts mixtures from the most recent tests.



Concrete Mix Design Spreadsheet

Tank/Vault Grout (52 gallons per cubic yard)

Material	Specific Gravity	Unit Weight (lbs/cu ft)	Quantities: Weight (lbs)	Weight %	Volume (cu ft)	Water Volume (gallons)	w/c ratios
Water	1.00	62.4	433	12.0%	6.9	52	
Cement (Type I-II)	3.15	196.6	320	8.9%	1.6	w/c =	1.35
Fly Ash	2.23	139.2	640	17.8%	4.6	w/(c+ash) =	0.45
Sand	2.48	154.8	2,200	61.1%	14.2	c/(c+ash) =	0.33
Gravel	2.63	164.1	0	0.0%	0.0		
Mid-range	1.00	62.4	4.0	0.1%	0.1	oz/cwt(c+ash) =	6.7
High-range	1.00	62.4	6.0	0.2%	0.1	oz/cwt(c+ash) =	10.0
Retarder	1.00	62.4	0.0	0.0%	0.0	oz/cwt(c) =	0.0
Totals		**130.8**	**3,603**	**100%**	**27.5**		

Tank/Vault Grout (50 gallons per cubic yard)

Material	Specific Gravity	Unit Weight (lbs/cu ft)	Quantities: Weight (lbs)	Weight %	Volume (cu ft)	Water Volume (gallons)	w/c ratios
Water	1.00	62.4	417	11.6%	6.7	50	
Cement (Type I-II)	3.15	196.6	320	8.9%	1.6	w/c =	1.30
Fly Ash	2.23	139.2	640	17.8%	4.6	w/(c+ash) =	0.43
Sand	2.48	154.8	2,200	61.3%	14.2	c/(c+ash) =	0.33
Gravel	2.63	164.1	0	0.0%	0.0		
Mid-range	1.00	62.4	4.0	0.1%	0.1	oz/cwt(c+ash) =	6.7
High-range	1.00	62.4	6.0	0.2%	0.1	oz/cwt(c+ash) =	10.0
Retarder	1.00	62.4	0.0	0.0%	0.0	oz/cwt(c) =	0.0
Totals		**131.5**	**3,587**	**100%**	**27.3**		

Tank/Vault Grout (48 gallons per cubic yard)

Material	Specific Gravity	Unit Weight (lbs/cu ft)	Quantities: Weight (lbs)	Weight %	Volume (cu ft)	Water Volume (gallons)	w/c ratios
Water	1.00	62.4	400	11.2%	6.4	48	
Cement (Type I-II)	3.15	196.6	320	9.0%	1.6	w/c =	1.25
Fly Ash	2.23	139.2	640	17.9%	4.6	w/(c+ash) =	0.42
Sand	2.48	154.8	2,200	61.6%	14.2	c/(c+ash) =	0.33
Gravel	2.63	164.1	0	0.0%	0.0		
Mid-range	1.00	62.4	4.0	0.1%	0.1	oz/cwt(c+ash) =	6.7
High-range	1.00	62.4	6.0	0.2%	0.1	oz/cwt(c+ash) =	10.0
Retarder	1.00	62.4	0.0	0.0%	0.0	oz/cwt(c) =	0.0
Totals		**132.2**	**3,570**	**100%**	**27.0**		

Tank/Vault Grout (45 gallons per cubic yard)

Material	Specific Gravity	Unit Weight (lbs/cu ft)	Quantities: Weight (lbs)	Weight %	Volume (cu ft)	Water Volume (gallons)	w/c ratios
Water	1.00	62.4	375	10.3%	6.0	45	
Cement (Type I-II)	3.15	196.6	320	8.8%	1.6	w/c =	1.17
Fly Ash	2.23	139.2	640	17.6%	4.6	w/(c+ash) =	0.39
Sand	2.48	154.8	2,300	63.1%	14.9	c/(c+ash) =	0.33
Gravel	2.63	164.1	0	0.0%	0.0		
Mid-range	1.00	62.4	4.0	0.1%	0.1	oz/cwt(c+ash) =	6.7
High-range	1.00	62.4	6.0	0.2%	0.1	oz/cwt(c+ash) =	10.0
Retarder	1.00	62.4	0.0	0.0%	0.0	oz/cwt(c) =	0.0
Totals		**133.7**	**3,645**	**100%**	**27.3**		

EDF-1473

ENGINEERING DESIGN FILE

1. Project File No. 015722 2. Project/Task INTEC Tank Farm Facility Closure FY 2000 Conceptual Design

3. Subtask Waste Transfer Sequence

4. Title: Tank Farm Closure Waste Management Plan

5. Summary: Under the guidelines of the Scope of Work for the INTEC Tank Farm Facility Closure, an analysis was performed to develop and document a plan for transferring the wastes contained in the tank farm tanks in such a way that the following project objectives are met.

- Ensure that various tanks will be offline and ready for closure to meet project milestones.
- The tank farm can maintain adequate storage capacity to support expected operations during closure activities.
- The tank farm maintains sufficient waste inventory to support expected operations (i.e., NWCF, CSIX, etc.)

The results of the analysis provide sufficient confidence that these objectives can be met. The basis of this conclusion is the data contained in a model developed and maintained by Clark Millet. Clark's model defines a waste management plan for acceptance and the subsequent processing of the waste by the various tank farm facilities. The model is based on a number of assumptions. As long as these assumptions prove to be realistic, the objectives of this study can be met. Major assumptions used in the model include;

- Processing most of the waste from WM-189 through the calciner by May 2000
- The calciner being shutdown and place in standby by September 2000.
- New storage tanks available for use by 2010.
- SBW Treatment (represented by CsIX) begins operation in FY-2009.

This EDF serves to document and convey a tank farm operational scenario which will support the tank farm closure activities. Key assumptions and other aspects of the scenario relevant to meeting the objectives of tank closure activities are documented in this EDF. It is important that the model and the assumptions it is based on continue to be monitored and updated appropriately in order to provide early indications of problems, which would impact tank closure activities. As the model is updated, it is necessary this information be made available to the Tank Farm Closure team.

6. Distribution (complete package):

Distribution (summary package only):

7. Review (R) and Approval (A) Signatures: (Minimum reviews and approvals are listed. Additional reviews/approvals may be added as necessary.)

	R/A	Printed Name	Signature	Date
Author	R	Dennis Heyen		5-22-00
Independent Verification	R	Adam Poloski		6-14-00
Requestor	A	Edward Anderson		6-15-00
Data Validation	R	Clark Millet		
Project Coordination	A	Keith Quigley		

1. Baseline Documentation

The analysis of this task was based on the following documentation.

- Scope of Work for INTEC Tank Farm Facility Closure, FY 2000 Conceptual Design, dated October 11, 1999. This document provided the scope for the analysis performed.

- Idaho Nuclear Technology and Engineering Center Tank Farm Facility Conceptual DOE and HWMA/RCRA Closure Approach (DRAFT), dated September 1999. This document provided proposed tank closure sequence and dates.

- PLN-439, INEEL Liquid Waste Management Plan, Revision 0, dated September 30, 1998. INEEL/EXT-98-00730, Supporting Information to PLN-439. These two documents provide the basis of estimated waste generation from site operations. Waste categories and expected volumes of each category were defined. The Excel model is based on processing these waste categories and volumes.

- Clark Millet (EM HLW Program Support, X3105) has developed an Excel based model to support INTEC waste management analysis. Several operational scenarios have been analyzed in order to develop a viable plan to meet both operational and closure constraints. The file "FY2000 IPABS Basis.xls" contains the recommended scenario for tank farm waste transfer, and provides the basis for this analysis.

2.0 Assumptions

The analysis is based on the following assumptions.

2..1 Tank Closure Sequence

The operational scenario defined in the model assumes the following tank closure sequence. With the exception of Tank WM-182, a tank closure sequence is scheduled to be a two year block of time.

Tank	Fiscal Year Start	Fiscal Year Complete	Cease Use Mandate
WM-182	1999	2003	June 2003
WM-183	2003	2004	June 2003
WM-184	2004	2005	June 2003
WM-186	2005	2006	June 2003
WM-181	2006	2007	December 2012
WM-103,-104,-105,-106	2007	2009	December 2012
WM-185	2010	2011	June 2003
WM-180	2011	2012	December 2012
WM-187	2012	2013	December 2012
WM-188	2013	2014	December 2012
WM-189	2014	2015	December 2012
WM-190	2015	2016	December 2012

2.2. Operational assumptions:

- "Cease Use" means the tank has to be drained of liquid waste down to heel level, and no longer used to accept waste from normal operations. The flushing of the tank and/or heel adjustment is part of closure activities and not required for meeting Cease Use criteria.

- Calciner operations for run 4 part 2 started January 23, 1999 and finished June 27, 1999 processing solution from WM-189 and WM-185. The actual tank inventory was recorded through January 2000 obtained from the "Tank Farm and PEW Evaporator Monthly Report Tables" published by Frank Ward (CCN 00-004790, February23, 2000).

- The Calciner will operate again from March 2000 through May 2000 using a high temperature flowsheet (Option C). This scenario removes as much waste as possible from WM-189 via calcination.

- The Calciner will be placed in standby mode until an EIS decision determines closure or permitting.

- The transfer of WM-183 contents to WM-185 for LDUA inspection was performed in December 1999. This transfer will effect the ability to calcine WM-185. It was preferred to transfer WM-183 to WM-187 but was hampered by a valve failure.

- In these scenarios the term concentrated waste refers to HLLWE bottoms or other concentrated wastes which can not be further evaporated in the HLLWE, such as the high activity solutions returned from NWCF from bed dissolution. Dilute wastes include PEWE bottoms which can be further evaporated in the HLLWE.

- In this scenario the PEWE bottoms are collected in WM-187. The miscellaneous concentrated wastes will be collected in WM-188.

- The HLLWE will blend WM-186 & WM-181 then WM-184 & WM-181, then WM-187 will be concentrated, afterward HLLWE will be used as required to keep new waste additions concentrated. Concentrated HLLWE bottoms will be collected in WM-188 then WM-189.

- The SBW Treatment (represented by CsIX) will commence operation in FY 2009. Operation schedule is planned for three years.

- WM-100-102 will be used to store Newly Generated Liquid Wastes from 2005 through 2009.

- Tank sequencing to SBW Treatment will then follow WM-180, WM-188, WM-189, WM-100,101,102 and New Tanks.

- New Tankage is provided by 2010.

- Segregation of Type 2 from Type 1 wastes is not done.

- WM-190 is used only to manage 603 basin water by filling and emptying it once otherwise it is maintained as the emergency spare.

- Tank Closure is modeled by preclosure flushing with new water and assumes 40k gallons which is boiled down by a ratio of 8:1 in HLLWE, back to the 5k heel. If 603-basin water is used for the rinsing, we may be double counting 40k per tank plus the 603 basin water. The basin water shows a boil down of 1000:1 which contains 50 ppm chloride and needs to be processed with the HLLWE overheads in the PEWE. Tanks available to accept 603 Basin water in FY-2001 are WM-182, 183, 185, 189, and 190.

- PEWE processing of 300,000 gal per month based on a feed rate of 12,000 gallons per day. It is assumed the 12,000 rate will apply for 4 out of 5 days (80%) resulting in 80% on stream time which yields 288,000/month (300,000 times 80%).

2.3 Production Source and Rate Assumptions

The model also utilizes the following production related assumptions.

Source	Value		Comment
Waste Generation:			Volumes to Tank Farm are after PEWE reduction
NWCF Turnaround Conc.	9,100	gallons	Volume per turnaround (40% concentrated)
NWCF Turnaround Dilute	13,650	gallons	Volume per turnaround (60% dilute)
NWCF Bed Dissolution	17,500	gallons	Volume per bed dissolution
NWCF Ops-Deep Recycle	3,000	gallons	Volume per month of calciner operation
NWCF Ops-Adsorber Washes	8,000	gallons	Volume per calciner campaign
Tank heel rinse	40,000	gallons	Volume per tank with subsequent 8:1 HLLWE reduction
Other sources	varies		See also PLN-439
Calciner Operation:			
Gross feed rate	180.0	gal/hr	accounted for in Net waste feed rate
Scrub recycle	20	%	accounted for in Net waste feed rate
Net waste feed rate:	56.8	gal/hr	for 600° C scenario
On-stream factor	75	%	
Startup month Hot feed	75	%	
Volume reduction factor	3.15:1	ratio	
Campaign length	9	months	
Campaign turnaround	4	months	
HLLW Evaporator:			
Feed rate	100.0	gal/hr	
On-stream factor	75	%	
Reduction factor	1.8:1	ratio	
Tank Inventory:			
Actual volumes	varies	gallons	From FSW monthly reports to current date
Tank capacity	285,000	gallons	Usable capacity of 300,000 gallon tanks
Heel level	5,000	gallons	All tanks except WM-187 and WM-188
Heel level	15,000	gallons	Tanks WM-187, and WM-188
Calcine Storage (CSSF):			
Bin Set #1 inventory	217	m^3	status full
Bin Set #2 inventory	856	m^3	status full
Bin Set #3 inventory	1,092	m^3	status full
Bin Set #4 inventory	488	m^3	status full
Bin Set #5 inventory	992	m^3	status full
Bin Set #6 capacity	1,507	m^3	status 43% full (642 cubic meters on 5/31/99)
Bin Set #7 capacity	1,784	m^3	empty, unused
Production rate	1.2	liters	per gallon of tank waste calcined

3. Waste Processing

Details of the operational scenario are maintained in the Excel model. The objective of this analysis is not to document the details of the model, but to verify the capability of the tank farm to meet the objectives stated in the EDF summary. Tables 1 through 13 provide a summary of waste transfers into and out of each tank. Detailed closure activities are not provided in the tables. However, the model does provide for general 40,000 gal of waste to be generated per tank during closure, and the acceptance of this waste into remaining operational tanks. Figure 3 is produced directly from the model and provides a high level summary of all tank farm waste processing over the period of concern. The point to be gained from Figure 3 is that indeed the tank farm will provide sufficient storage capability and be able to remove tanks from operational use to meet the cease use deadlines and support tank closure activities.

Table 1. WM-180 Waste Transfer Summary

Date	Tank Volume	Volume Change	Source	Amount	Destination	Amount
Jan-00	278600					
Oct-08	253788	-24812			CsIX	-24812
Nov-08	228976	-24812			CsIX	-24812
Dec-08	204164	-24812			CsIX	-24812
Jan-09	179352	-24812			CsIX	-24812
Feb-09	154540	-24812			CsIX	-24812
Mar-09	129728	-24812			CsIX	-24812
Apr-09	104916	-24812			CsIX	-24812
May-09	80104	-24812			CsIX	-24812
Jun-09	55292	-24812			CsIX	-24812
Jul-09	30480	-24812			CsIX	-24812
Aug-09	5668	-24812			CsIX	-24812

Table 2. WM-181 Waste Transfer Summary

Date	Tank Volume	Volume Change	Source	Amount	Destination	Amount
Jan-00	274800					
Sep-00	238800	-36000			HLLWE	-36000
Oct-00	201600	-37200			HLLWE	-37200
Nov-00	165600	-36000			HLLWE	-36000
Dec-00	128400	-37200			HLLWE	-37200
Jan-01	91200	-37200			HLLWE	-37200
Feb-01	57600	-33600			HLLWE	-33600
Mar-01	20400	-37200			HLLWE	-37200
Apr-01	5000	-15400			HLLWE	-15400

Table 3. WM-182 Waste Transfer Summary

Tank Number	WM-182					
Date	Tank Volume	Volume Change	Source	Amount	Destination	Amount
Jan-00	6400					
Nov-00	285000	278600	603 Basin	278600		
Dec-00	285000	0				
Jan-01	6400	-278600			PEWE	-278600

Table 4. WM-183 Waste Transfer Summary

Date	Tank Volume	Volume Change	Source	Amount	Destination	Amount
Jan-00	12800					
Nov-00	285000	272200	603 Basin	272200		
Dec-00	285000	0				
Jan-01	285000	0				
Feb-01	12800	-272200			PEWE	-272200

Table 5. WM-184 Waste Transfer Summary

Date	Tank Volume	Volume Change	Source	Amount	Destination	Amount
Jan-00	262600					
Dec-00	246300	-16300			HLLWE	-16300
Jan-01	171900	-74400			HLLWE	-74400
Feb-01	104700	-67200			HLLWE	-67200
Mar-01	30300	-74400			HLLWE	-74400
Apr-01	4660	-25640			HLLWE	-25640

Table 6. WM-185 Waste Transfer Summary

Date	Tank Volume	Volume Change	Source	Amount	Destination	Amount
Jan-00	43000					
Apr-00	5000	-38000			WM-187	-38000
Nov-00	285000	280000	603 Basin	280000		
Dec-00	285000	0				
Jan-01	285000	0				
Feb-01	285000	0				
Mar-01	5000	-280000			PEWE	-280000

Table 7. WM-186 Waste Transfer Summary

Date	Tank Volume	Volume Change	Source	Amount	Destination	Amount
Jan-00	281500					
Sep-00	209500	-72000			HLLWE	-72000
Oct-00	135100	-74400			HLLWE	-74400
Nov-00	63100	-72000			HLLWE	-72000
Dec-00	5000	-58100			HLLWE	-58100

Table 8. WM-187 Waste Transfer Summary

Tank Number			WM-187			
Date	Tank Volume	Volume Change	Source	Amount	Destination	Amount
Jan-00	61400					
Feb-00	64834	3434	Type 2 Segregate	3434		
Mar-00	68268	3434	Type 2 Segregate	3434		
Apr-00	109702	41434	Type 2 Segregate	3434		
			WM-185	38000		
May-00	113136	3434	Type 2 Segregate	3434		
Jun-00	118963	5827	Type 2 Segregate	5827		
Jul-00	130918	11956	Type 2 Segregate	11955		
Aug-00	174353	43434	Type 2 Segregate	3434		
			WM-182 Heel Flush	40000		
Sep-00	217787	43434	Type 2 Segregate	3434		
			WM-183 Heel Flush	40000		
Oct-00	219736	1950	Type 2 Segregate	1949		
Nov-00	221686	1950	Type 2 Segregate	1950		
Dec-00	223636	1950	Type 2 Segregate	1950		
Jan-01	225586	1950	Type 2 Segregate	1950		
Feb-01	227536	1950	Type 2 Segregate	1950		
Mar-01	229486	1950	Type 2 Segregate	1950		
Apr-01	231436	1950	Type 2 Segregate	1950		
May-01	149686	-81750	Type 2 Segregate	1950	HLLWE	-83700
Jun-01	70636	-79050	Type 2 Segregate	1950	HLLWE	-81000
Jul-01	14833	-55803	Type 2 Segregate	1950	HLLWE	-57753
Aug-01	16783	1950	Type 2 Segregate	1950		
Sep-01	18732	1950	Type 2 Segregate	1949		
Oct-01	20563	1831	Type 2 Segregate	1831		
Nov-01	22394	1831	Type 2 Segregate	1831		
Dec-01	24224	1831	Type 2 Segregate	1830		
Jan-02	26055	1831	Type 2 Segregate	1831		
Feb-02	27886	1831	Type 2 Segregate	1831		
Mar-02	29717	1831	Type 2 Segregate	1831		
Apr-02	31547	1831	Type 2 Segregate	1830		
May-02	33378	1831	Type 2 Segregate	1830		
Jun-02	35209	1831	Type 2 Segregate	1831		
Jul-02	37039	1831	Type 2 Segregate	1830		
Aug-02	38870	1831	Type 2 Segregate	1831		
Sep-02	40701	1831	Type 2 Segregate	1831		
Oct-02	46153	5452	Type 2 Segregate	2119		
			WM-184 Heel Flush	3333		
Nov-02	51605	5452	Type 2 Segregate	2119		
			WM-184 Heel Flush	3333		
Dec-02	57057	5452	Type 2 Segregate	2119		
			WM-184 Heel Flush	3333		
Jan-03	62509	5452	Type 2 Segregate	2119		
			WM-184 Heel Flush	3333		
Feb-03	67961	5452	Type 2 Segregate	2119		
			WM-184 Heel Flush	3333		

Tank Number	WM-187		(continued)			
Date	Tank Volume	Volume Change	Source	Amount	Destination	Amount
Mar-03	73413	5452	Type 2 Segregate	2119		
			WM-184 Heel Flush	3333		
Apr-03	78865	5452	Type 2 Segregate	2119		
			WM-184 Heel Flush	3333		
May-03	84317	5452	Type 2 Segregate	2119		
			WM-184 Heel Flush	3333		
Jun-03	89769	5452	Type 2 Segregate	2119		
			WM-184 Heel Flush	3333		
Jul-03	95221	5452	Type 2 Segregate	2119		
			WM-184 Heel Flush	3333		
Aug-03	100673	5452	Type 2 Segregate	2119		
			WM-184 Heel Flush	3333		
Sep-03	106125	5452	Type 2 Segregate	2119		
			WM-184 Heel Flush	3333		
Oct-03	111153	5028	Type 2 Segregate	1695		
			WM-186 Heel Flush	3333		
Nov-03	116182	5028	Type 2 Segregate	1696		
			WM-186 Heel Flush	3333		
Dec-03	121211	5028	Type 2 Segregate	1696		
			WM-186 Heel Flush	3333		
Jan-04	126239	5028	Type 2 Segregate	1695		
			WM-186 Heel Flush	3333		
Feb-04	131268	5028	Type 2 Segregate	1696		
			WM-186 Heel Flush	3333		
Mar-04	136297	5028	Type 2 Segregate	1696		
			WM-186 Heel Flush	3333		
Apr-04	141326	5028	Type 2 Segregate	1696		
			WM-186 Heel Flush	3333		
May-04	146354	5028	Type 2 Segregate	1695		
			WM-186 Heel Flush	3333		
Jun-04	151383	5028	Type 2 Segregate	1696		
			WM-186 Heel Flush	3333		
Jul-04	156412	5028	Type 2 Segregate	1696		
			WM-186 Heel Flush	3333		
Aug-04	161441	5028	Type 2 Segregate	1696		
			WM-186 Heel Flush	3333		
Sep-04	166469	5028	Type 2 Segregate	1695		
			WM-186 Heel Flush	3333		
Oct-04	174982	8513	Type 2 Segregate	1846		
			WM-181 Heel Flush	6667		
Nov-04	183494	8513	Type 2 Segregate	1845		
			WM-181 Heel Flush	6667		
Dec-04	192007	8513	Type 2 Segregate	1846		
			WM-181 Heel Flush	6667		
Jan-05	200519	8513	Type 2 Segregate	1845		
			WM-181 Heel Flush	6667		
Feb-05	209032	8513	Type 2 Segregate	1846		
			WM-181 Heel Flush	6667		
Mar-05	217544	8513	Type 2 Segregate	1845		
			WM-181 Heel Flush	6667		
Apr-05	141044	-76500			HLLWE	-76500

Tank Number WM-187 (continued)

Date	Tank Volume	Volume Change	Source	Amount	Destination	Amount
May-05	61994	-79050			HLLWE	-79050
Jun-05	17624	-44370			HLLWE	-44370
Jul-05	54624	37000	WM-100,101,102	37000		
Oct-08	57958	3334	WM-185 Heel Flush	3334		
Nov-08	61291	3333	WM-185 Heel Flush	3333		
Dec-08	64624	3333	WM-185 Heel Flush	3333		
Jan-09	67958	3334	WM-185 Heel Flush	3334		
Feb-09	71291	3333	WM-185 Heel Flush	3333		
Mar-09	74624	3333	WM-185 Heel Flush	3333		
Apr-09	77958	3334	WM-185 Heel Flush	3334		
May-09	81291	3333	WM-185 Heel Flush	3333		
Jun-09	84624	3333	WM-185 Heel Flush	3333		
Jul-09	87958	3334	WM-185 Heel Flush	3334		
Aug-09	91291	3333	WM-185 Heel Flush	3333		
Sep-09	94624	3333	WM-185 Heel Flush	3333		
Oct-10	15581	-79044			HLLWE	-79044

Table 9. WM-188 Waste Transfer Summary

Date	Tank Volume	Volume Change	Source	Amount	Destination	Amount
Jan-00	13600					
Feb-00	14788	1188	Type 1 SBW Concentrate	1188		
Mar-00	15975	1187	Type 1 SBW Concentrate	1187		
Apr-00	17163	1188	Type 1 SBW Concentrate	1188		
May-00	18350	1187	Type 1 SBW Concentrate	1187		
Sep-00	72350	54000	HLLWE Bottoms	54000		
Oct-00	128192	55842	HLLWE Bottoms	55842		
Nov-00	182233	54041	HLLWE Bottoms	54041		
Dec-00	238075	55842	HLLWE Bottoms	55842		
Jan-01	278287	40212	HLLWE Bottoms	40212		
Sep-09	253475	-24812			CsIX	-24812
Oct-09	228663	-24812			CsIX	-24812
Nov-09	203851	-24812			CsIX	-24812
Dec-09	179039	-24812			CsIX	-24812
Jan-10	154227	-24812			CsIX	-24812
Feb-10	129415	-24812			CsIX	-24812
Mar-10	104603	-24812			CsIX	-24812
Apr-10	79791	-24812			CsIX	-24812
May-10	54979	-24812			CsIX	-24812
Jun-10	30167	-24812			CsIX	-24812
Jul-10	15355	-14812			CsIX	-14812

Table 10. WM-189 Waste Transfer Summary

Date	Tank Volume	Voume Change	Source	Amount	Destination	Amount
Jan-00	100900					
Mar-00	85042	-15858			NWCF	-15858
Apr-00	54348	-30694			NWCF	-30694
May-00	38490	-15858			NWCF	-15858
Nov-00	323490	285000	603 Basin	285000		
Dec-00	38490	-28000			PEWE	-285000
Jan-01	54120	15630	HLLWE Bottoms	15630		
Feb-01	104561	50441	HLLWE Bottoms	50441		
Mar-01	160403	55842	HLLWE Bottoms	55842		
Apr-01	180965	20562	HLLWE Bottoms	20562		
May-01	208906	27941	HLLWE Bottoms	27941		
Jun-01	235948	27042	HLLWE Bottoms	27042		
Jul-01	255241	19293	HLLWE Bottoms	19293		
Aug-01	255282	41	Type 1 SBW Concentrate	41		
Sep-01	255324	42	Type 1 SBW Concentrate	42		
Oct-01	255366	42	Type 1 SBW Concentrate	42		
Nov-01	255407	41	Type 1 SBW Concentrate	41		
Dec-01	255449	42	Type 1 SBW Concentrate	42		
Jan-02	255491	42	Type 1 SBW Concentrate	42		
Feb-02	255532	41	Type 1 SBW Concentrate	41		
Mar-02	255574	42	Type 1 SBW Concentrate	42		
Apr-02	255616	42	Type 1 SBW Concentrate	42		
May-02	255657	41	Type 1 SBW Concentrate	41		
Jun-02	255699	42	Type 1 SBW Concentrate	42		
Jul-02	255741	42	Type 1 SBW Concentrate	42		
Aug-02	255782	41	Type 1 SBW Concentrate	41		
Sep-02	255824	42	Type 1 SBW Concentrate	42		
Oct-02	255866	42	Type 1 SBW Concentrate	42		
Nov-02	255907	41	Type 1 SBW Concentrate	41		
Dec-02	255949	42	Type 1 SBW Concentrate	42		
Jan-03	255991	42	Type 1 SBW Concentrate	42		
Feb-03	256032	41	Type 1 SBW Concentrate	41		
Mar-03	256074	42	Type 1 SBW Concentrate	42		
Apr-03	256116	42	Type 1 SBW Concentrate	42		
May-03	256157	41	Type 1 SBW Concentrate	41		
Jun-03	256199	42	Type 1 SBW Concentrate	42		
Jul-03	256241	42	Type 1 SBW Concentrate	42		
Aug-03	256282	41	Type 1 SBW Concentrate	41		
Sep-03	256324	42	Type 1 SBW Concentrate	42		
Oct-03	256366	42	Type 1 SBW Concentrate	42		
Nov-03	256407	41	Type 1 SBW Concentrate	41		
Dec-03	256449	42	Type 1 SBW Concentrate	42		
Jan-04	256491	42	Type 1 SBW Concentrate	422		
Feb-04	256532	41	Type 1 SBW Concentrate	41		
Mar-04	256574	42	Type 1 SBW Concentrate	42		
Apr-04	256616	42	Type 1 SBW Concentrate	42		
May-04	256657	41	Type 1 SBW Concentrate	41		
Jun-04	256699	42	Type 1 SBW Concentrate	42		

Tank Number	WM-189		(continued)			
Date	Tank Volume	Voume Change	Source	Amount	Destination	Amount
Jul-04	256741	42	Type 1 SBW Concentrate	42		
Aug-04	256782	41	Type 1 SBW Concentrate	41		
Sep-04	256824	42	Type 1 SBW Concentrate	42		
Oct-04	256866	42	Type 1 SBW Concentrate	42		
Nov-04	256907	41	Type 1 SBW Concentrate	41		
Dec-04	256949	42	Type 1 SBW Concentrate	42		
Jan-05	256991	42	Type 1 SBW Concentrate	42		
Feb-05	257032	41	Type 1 SBW Concentrate	41		
Mar-05	257074	42	Type 1 SBW Concentrate	42		
Apr-05	279616	22542	Type 1 SBW Concentrate	42		
			HLLWE Bottoms	22500		
May-05	279657	41	Type 1 SBW Concentrate	41		
Jun-05	279699	42	Type 1 SBW Concentrate	42		
Jul-05	279741	42	Type 1 SBW Concentrate	42		
Aug-05	279782	41	Type 1 SBW Concentrate	41		
Sep-05	279824	42	Type 1 SBW Concentrate	42		
Jul-10	269824	-10000			CsIX	-1000
Aug-10	245012	-24812			CsIX	-24812
Sep-10	220200	-24812			CsIX	-24812
Oct-10	195388	-24812			CsIX	-24812
Nov-10	170576	-24812			CsIX	-24812
Dec-10	145764	-24812			CsIX	-24812
Jan-11	120952	-24812			CsIX	-24812
Feb-11	96140	-24812			CsIX	-24812
Mar-11	71328	-24812			CsIX	-24812
Apr-11	46516	-24812			CsIX	-24812
May-11	21704	-24812			CsIX	-24812
Jun-11	5000	-16704			CsIX	-16704

Table 11. WM-190 Waste Transfer Summary

Date	Tank Volume	Volume Change	Source	Amount	Destination	Amount
Jan-00	500					
Nov-00	285000	284500	603 Basin	284500		
Dec-00	285000	0				
Jan-01	285000	0				
Feb-01	285000	0				
Mar-01	285000	0				
Apr-01	5000	-280000			PEWE	-280000

Table 12. WM-100, -101, -102 Waste Transfer Summary

Tank Number	WM-100,101,102					
Date	Tank Volume	Volume Change	Source	Amount	Destination	Amount
Jan-00	9100					
May-05	32350	23250	HLLWE Bottoms	23250		
Jun-05	45400	13050	HLLWE Bottoms	13050		
Jul-05	8400	-37000			WM-187	37000
Oct-05	8903	503	HLLWE Bottoms	503		
Nov-05	9406	503	HLLWE Bottoms	503		
Dec-05	9909	503	HLLWE Bottoms	503		
Jan-06	10412	503	HLLWE Bottoms	503		
Feb-06	10916	503	HLLWE Bottoms	503		
Mar-06	11419	503	HLLWE Bottoms	503		
Apr-06	11922	503	HLLWE Bottoms	503		
May-06	12425	503	HLLWE Bottoms	503		
Jun-06	12928	503	HLLWE Bottoms	503		
Jul-06	13431	503	HLLWE Bottoms	503		
Aug-06	13934	503	HLLWE Bottoms	503		
Sep-06	14437	503	HLLWE Bottoms	503		
Oct-06	14941	503	HLLWE Bottoms	503		
Nov-06	15444	503	HLLWE Bottoms	503		
Dec-06	15947	503	HLLWE Bottoms	503		
Jan-07	16450	503	HLLWE Bottoms	503		
Feb-07	16953	503	HLLWE Bottoms	503		
Mar-07	17456	503	HLLWE Bottoms	503		
Apr-07	17959	503	HLLWE Bottoms	503		
May-07	18462	503	HLLWE Bottoms	503		
Jun-07	18965	503	HLLWE Bottoms	503		
Jul-07	19469	503	HLLWE Bottoms	503		
Aug-07	19972	503	HLLWE Bottoms	503		
Sep-07	20475	503	HLLWE Bottoms	503		
Oct-07	20978	503	HLLWE Bottoms	503		
Nov-07	21481	503	HLLWE Bottoms	503		
Dec-07	21984	503	HLLWE Bottoms	503		
Jan-08	22487	503	HLLWE Bottoms	503		
Feb-08	22990	503	HLLWE Bottoms	503		
Mar-08	23494	503	HLLWE Bottoms	503		
Apr-08	23997	503	HLLWE Bottoms	503		
May-08	24500	503	HLLWE Bottoms	503		
Jun-08	25003	503	HLLWE Bottoms	503		
Jul-08	25506	503	HLLWE Bottoms	503		
Aug-08	26009	503	HLLWE Bottoms	503		
Sep-08	26512	503	HLLWE Bottoms	503		
Oct-08	27015	503	HLLWE Bottoms	503		
Nov-08	27518	503	HLLWE Bottoms	503		
Dec-08	28022	503	HLLWE Bottoms	503		

Tank Number WM-100,101,102 (Combined)

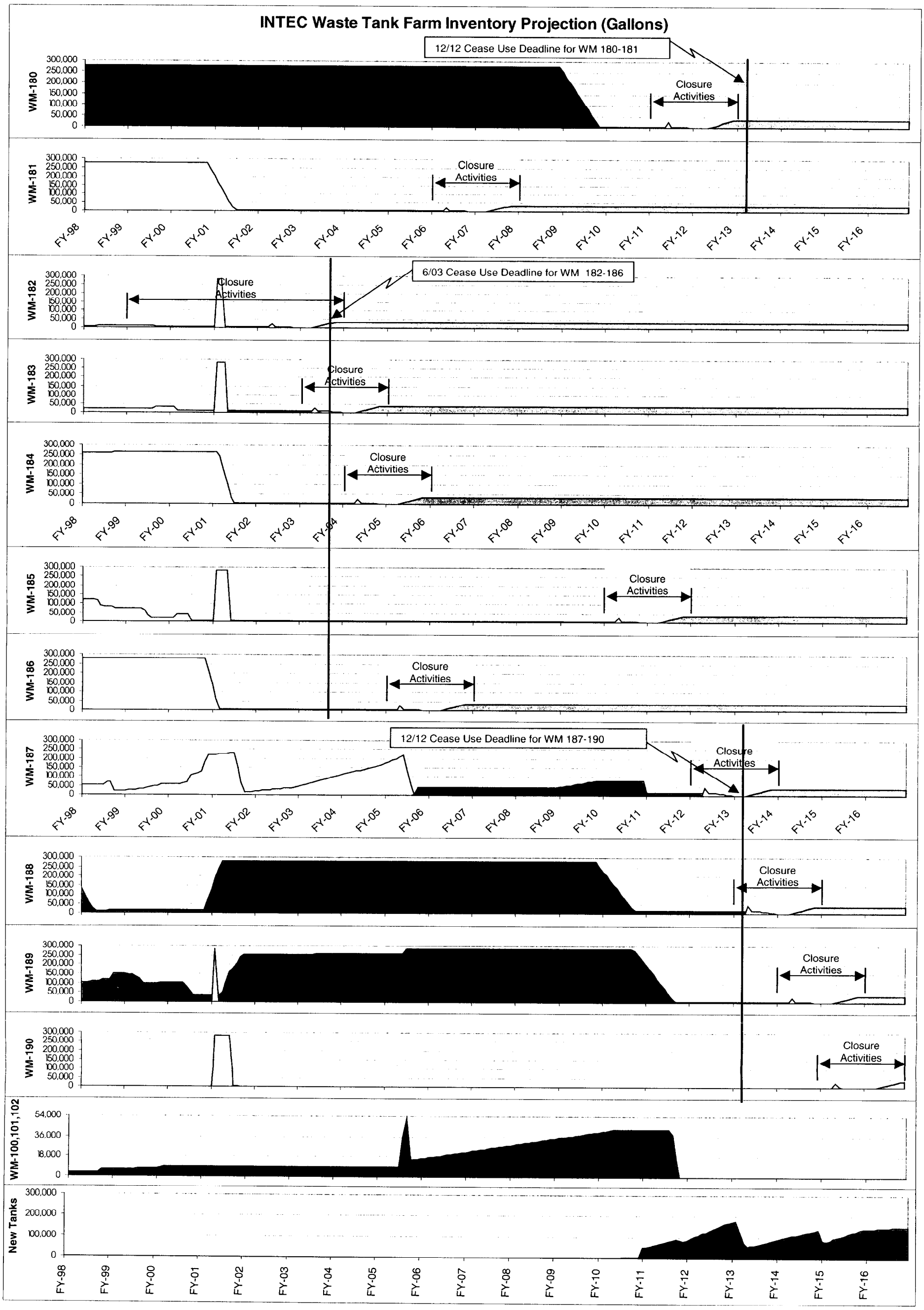
Date	Tank Volume	Volume Change	Source	Amount	Destination	Amount
Jan-09	28525	503	HLLWE Bottoms	503		
Feb-09	29028	503	HLLWE Bottoms	503		
Mar-09	29531	503	HLLWE Bottoms	503		
Apr-09	30034	503	HLLWE Bottoms	503		
May-09	30537	503	HLLWE Bottoms	503		
Jun-09	31040	503	HLLWE Bottoms	503		
Jul-09	31543	503	HLLWE Bottoms	503		
Aug-09	32047	503	HLLWE Bottoms	503		
Sep-09	32550	503	HLLWE Bottoms	503		
Oct-09	33053	503	HLLWE Bottoms	503		
Nov-09	33556	503	HLLWE Bottoms	503		
Dec-09	34059	503	HLLWE Bottoms	503		
Jan-10	34562	503	HLLWE Bottoms	503		
Feb-10	35065	503	HLLWE Bottoms	503		
Jun-11	26957	-8108			CsIX	-8108
Jul-11	2145	-24812			CsIX	-24812
Aug-11	0	-2145			CsIX	-2145

Table 13. New Tanks Waste Transfer Summary

Date	Tank Volume	Volume Change	Source	Amount	Source	Amount	Source	Amount	Destination	Amount
Feb-10	0									
Mar-10	965	965	Type 1 Concentrate	42	Type 1 Dilute	923				
Apr-10	1929	964	Type 1 Concentrate	41	Type 1 Dilute	923				
May-10	2894	965	Type 1 Concentrate	42	Type 1 Dilute	923				
Jun-10	3858	964	Type 1 Concentrate	41	Type 1 Dilute	923				
Jul-10	4823	965	Type 1 Concentrate	42	Type 1 Dilute	923				
Aug-10	5787	964	Type 1 Concentrate	41	Type 1 Dilute	923				
Sep-10	6752	965	Type 1 Concentrate	42	Type 1 Dilute	923				
Oct-10	61161	54408	Type 1 Concentrate	50069	Type 1 Dilute	1006	WM-180 Heel Flush	3333		
Nov-10	65542	4381	Type 1 Concentrate	42	Type 1 Dilute	1006	WM-180 Heel Flush	3333		
Dec-10	69923	4381	Type 1 Concentrate	42	Type 1 Dilute	1006	WM-180 Heel Flush	3333		
Jan-11	74305	4381	Type 1 Concentrate	42	Type 1 Dilute	1006	WM-180 Heel Flush	3333		
Feb-11	78686	4381	Type 1 Concentrate	42	Type 1 Dilute	1006	WM-180 Heel Flush	3333		
Mar-11	83067	4381	Type 1 Concentrate	42	Type 1 Dilute	1006	WM-180 Heel Flush	3333		
Apr-11	87448	4381	Type 1 Concentrate	42	Type 1 Dilute	1006	WM-180 Heel Flush	3333		
May-11	91829	4381	Type 1 Concentrate	42	Type 1 Dilute	1006	WM-180 Heel Flush	3333		
Jun-11	96211	4381	Type 1 Concentrate	42	Type 1 Dilute	1006	WM-180 Heel Flush	3333		
Jul-11	100592	4381	Type 1 Concentrate	42	Type 1 Dilute	1006	WM-180 Heel Flush	3333		
Aug-11	82306	-18286	Type 1 Concentrate	42	Type 1 Dilute	1006	WM-180 Heel Flush	3333	CsIX	-22667
Sep-11	61875	-20431	Type 1 Concentrate	42	Type 1 Dilute	1006	WM-180 Heel Flush	3333	CsIX	-24812
Oct-11	66173	4298	Type 1 Concentrate	42	Type 1 Dilute	923	WM-187,188 Heel Flush	6666	CsIX	-3333
Nov-11	73804	7631	Type 1 Concentrate	42	Type 1 Dilute	923	WM-187,188 Heel Flush	6666		
Dec-11	81435	7631	Type 1 Concentrate	42	Type 1 Dilute	923	WM-187,188 Heel Flush	6666		
Jan-12	89066	7631	Type 1 Concentrate	42	Type 1 Dilute	923	WM-187,188 Heel Flush	6667		
Feb-12	96698	7632	Type 1 Concentrate	42	Type 1 Dilute	923	WM-187,188 Heel Flush	6666		
Mar-12	104329	7631	Type 1 Concentrate	42	Type 1 Dilute	923	WM-187,188 Heel Flush	6666		
Apr-12	111960	7631	Type 1 Concentrate	42	Type 1 Dilute	923	WM-187,188 Heel Flush	6666		
May-12	119591	7631	Type 1 Concentrate	42	Type 1 Dilute	923	WM-187,188 Heel Flush	6667		
Jun-12	127223	7632	Type 1 Concentrate	42	Type 1 Dilute	923	WM-187,188 Heel Flush	6666		
Jul-12	134858	7635	Type 1 Concentrate	42	Type 1 Dilute	923	WM-187,188 Heel Flush	6666		
Aug-12	142485	7627	Type 1 Concentrate	42	Type 1 Dilute	923	WM-187,188 Heel Flush	6666		
Sep-12	150116	7631	Type 1 Concentrate	42	Type 1 Dilute	923	WM-187,188 Heel Flush	6667		
Oct-12	154414	4298	Type 1 Concentrate	42	Type 1 Dilute	923	WM-189 Heel Flush	3333		
Nov-12	158712	4298	Type 1 Concentrate	41	Type 1 Dilute	923	WM-189 Heel Flush	3333		

Date	Tank Volume	Volume Change	Source	Amount	Source	Amount	Source	Amount	Destination	Amount
Dec-12	107210	-51502	Type 1 Concentrate	13992	Type 1 Dilute	923	WM-189 Heel Flush	3333	HLLWE	-60750
Jan-13	55708	-51502	Type 1 Concentrate	13992	Type 1 Dilute	923	WM-189 Heel Flush	3333	HLLWE	-69750
Feb-13	34891	-20817	Type 1 Concentrate	6320	Type 1 Dilute	923	WM-189 Heel Flush	3333	HLLWE	-31393
Mar-13	39189	4298	Type 1 Concentrate	42	Type 1 Dilute	923	WM-189 Heel Flush	3333		
Apr-13	43487	4298	Type 1 Concentrate	42	Type 1 Dilute	923	WM-189 Heel Flush	3333		
May-13	47785	4298	Type 1 Concentrate	42	Type 1 Dilute	923	WM-189 Heel Flush	3333		
Jun-13	52083	4298	Type 1 Concentrate	42	Type 1 Dilute	923	WM-189 Heel Flush	3333		
Jul-13	56381	4298	Type 1 Concentrate	42	Type 1 Dilute	923	WM-189 Heel Flush	3333		
Aug-13	60679	4298	Type 1 Concentrate	42	Type 1 Dilute	923	WM-189 Heel Flush	3333		
Sep-13	64977	4298	Type 1 Concentrate	42	Type 1 Dilute	923	WM-189 Heel Flush	3333		
Oct-13	69230	4253			Type 1 Dilute	920	WM-190 Heel Flush	3333		
Nov-13	73483	4253			Type 1 Dilute	920	WM-190 Heel Flush	3333		
Dec-13	77736	4253			Type 1 Dilute	920	WM-190 Heel Flush	3333		
Jan-14	81990	4253			Type 1 Dilute	920	WM-190 Heel Flush	3333		
Feb-14	86243	4253			Type 1 Dilute	920	WM-190 Heel Flush	3333		
Mar-14	90496	4253			Type 1 Dilute	920	WM-190 Heel Flush	3333		
Apr-14	94749	4253			Type 1 Dilute	920	WM-190 Heel Flush	3333		
May-14	99003	4253			Type 1 Dilute	920	WM-190 Heel Flush	3333		
Jun-14	103256	4253			Type 1 Dilute	920	WM-190 Heel Flush	3333		
Jul-14	107509	4253			Type 1 Dilute	920	WM-190 Heel Flush	3333		
Aug-14	111762	4253			Type 1 Dilute	920	WM-190 Heel Flush	3333		
Sep-14	116016	4243			Type 1 Dilute	920	WM-190 Heel Flush	3333		

Figure 3 Tank Farm Waste Processing Summary



ENGINEERING DESIGN FILE

1. Project File No. _____ 2. Project/Task INTEC Tank Farm Facility Deactivation – Conceptual Design

3. Subtask Environmental Engineering

4. Title: Base-Case Risk Evaluation for Residual Inventories in the Tank Farm Facility

5. Summary: This summary briefly defines the problem or activity to be addressed in the EDF, gives a summary of the activities performed in addressing the problem and states the conclusions, recommendations, or results arrived at from this task.

The Tank Farm Facility (TTF) will be taken out of service and closed. This Engineering Design File (EDF) presents an assessment of the risks associated with closure of the 11 ~300,000 gallon tanks (numbered 180 through 190) at the TFF. The closure plan specifies that as much activity will be removed from the tanks as possible, and that the remaining liquid and solid material in the tanks (i.e., the heels) will be grouted to reduce its mobility. These tank heels represent most of the residual inventory associated with the closed tanks. Some additional activity is located in the sand pads beneath tanks 185 and 187. The incremental lifetime cancer incidence risk caused by migration of radioactive material in- and outside of the tanks is presented in this Engineering Design File (EDF) to document the preliminary assessment of residual risks and serve as a base case assessment for the TFF closure project. The risk is calculated for ingestion of contaminated groundwater – no other pathways would cause exposure of individuals. Radiological doses were also calculated to support an ALARA analysis of closure options.

6. Distribution (complete package):

Distribution (summary package only):

7. Review (R) and Approval (A) Signatures: (Minimum reviews and approvals are listed. Additional reviews/approvals may be added as necessary.)

	R/A	Printed Name	Signature	Date
Author	R	Paul Ritter	Paul Ritter	9/27/00
Independent Verification	R	Art Rood.	Art Rood by Paul Ritter	
Requestor	A	Edward [illegible]	[illegible]	9/27/00

Risk Evaluation for Residual Inventories in the Tank Farm Facility

The Tank Farm Facility (TFF) is located within the Idaho Nuclear Technology and Engineering Center (INTEC) [formerly the Idaho Chemical Processing Plant (ICPP)] at the Idaho National Engineering and Environmental Laboratory (INEEL). In accordance with applicable regulations, the TFF will be taken out of service and closed. The closed tanks will contain residual inventories of radioactive and hazardous materials. The "worst-case" residual inventory of a tank was estimated using process knowledge and modeling. Risks associated with TFF closure were evaluated for individuals consuming water from wells 22 m and 745 m from the edge of the TFF at any time during a 10,000 year period after closure.

Fission/activation products, particularly ^{129}I and ^{99}Tc, cause most of the lifetime carcinogenic incidence risk during the first 1000 years (i.e., to calendar year 3000) post-closure. After that time, the predominant cause of risk is ^{239}Pu. The maximum risk posed by closure of the tanks using the proposed method is 1.8×10^{-4}, assuming all 11 tanks contain the "worst-case" inventory. This risk is slightly greater than the upper end of the EPA point-of-departure window for acceptable risks (1×10^{-4} to 1×10^{-6}). Hazardous metals pose a very small risk in absolute terms, and are also small risks relative to those caused by the radioactive material inventory in the tanks and pads.

The risks per tank presented above are conservatively biased for the following reasons:

1) The K_d for Pu was assumed to be 22, which almost certainly overestimates the mobility of Pu in INEEL subsurface sediments,

2) The "worst-case" tank inventory was used, rather than a more realistic estimate of typical tank inventories,

3) All activity within the tank is assumed to dissolve and become mobile as soon as water flows through the tank, i.e., at 500 years when the tank is assumed to fail totally. In reality, some activity would be located within the grout or in solid particles, which would prevent surface washing.

Relatively small refinements of either the transport modeling assumptions (item (1) and (2) above) or the inventory estimate would probably be sufficient to reduce the risk below 10^{-4}, but further data-gathering would be required to support these refinements. It is clear that leaving the inventory of a full tank in place at closure could cause potentially large doses in the future, and that a substantial part of the inventory must be removed before closure. The radiological doses presented in EDF-1114, rev. 1 will be used in an ALARA analysis to determine the appropriate cleanup option.

Risk Evaluation for Residual Inventories in the Tank Farm Facility

Paul D. Ritter
Arthur S. Rood
Geoscience Department

July 20, 2000

Introduction

The Tank Farm Facility (TFF) is located within the Idaho Nuclear Technology and Engineering Center (INTEC) [formerly the Idaho Chemical Processing Plant (ICPP)] at the Idaho National Engineering and Environmental Laboratory (INEEL). The TFF consists of nine 300,000-gal and two 318,000-gal stainless steel tanks (numbered 180 through 190), four inactive 30,000-gal stainless steel tanks, valve boxes, encasements, and process and instrumentation piping. The eleven ~300,000 gallon stainless steel tanks are buried 6 feet below grade in concrete vaults. Each tank rests on a sand pad that was placed on the floor of the vault. The TFF has been used to store and transfer high level liquid radioactive waste generated by various operations at INTEC.

In accordance with the Hazardous Waste Management Act (HWMA) of the Idaho Administrative Procedures Act [IDAPA] 16.01.05.009 and Title 40 Code of Federal Regulations [CFR] Part 265, Resource Conservation and Recovery Act (RCRA), the TTF will be taken out of service and closed. The closure plan specifies that as much material will be removed from the tanks as possible, and that the remaining liquid and solid material in the tanks (i.e., the heels) will be grouted to reduce its mobility. These tank heels represent most of the residual inventory associated with the closed tanks. Some additional activity is located in the sand pads beneath tanks 185 and 187. This Engineering Design File (EDF) presents an assessment of the risks posed by the residual inventory of radioactive and hazardous material after closure of the 11 large tanks.

Several risk assessments have been performed at various stages of the closure project to support the operational planning and review processes. Incremental lifetime cancer incidence risks have been calculated for ingestion of contaminated groundwater – no other pathways would cause exposure of individuals (per Stepan et al., 1997). Preliminary (Becker 1998) and base case (Rood and Ritter, 1999) assessments of risk caused by migration of radioactive material have been performed using the inventory and closure process information that was available at the time. The risk and radiological dose estimates presented in this Engineering Design File (EDF) are based on the more refined information that is currently available. Inventories and some of the modeling assumptions have been changed from the previous assessment, and these changes are discussed below. Also, the risks posed by the residual inventory of hazardous metals have been evaluated, and radiological doses have been calculated to support ALARA analysis of alternative closure options. These options are 1) closure of tanks without emptying or cleaning, 2) closure using the proposed emptying and cleaning processes, and 3) closure per 2), with additional cleaning using robotics.

Conceptual Model

This EDF describes modeling of contaminant releases from the tanks and sand pads, contaminant transport in the vadose zone (VZ) and Snake River Plain Aquifer (SRPA), and ingestion and carcinogenic risk calculations for hypothetical receptors located downgradient from the Tank Farm. The conceptual model for release and transport of radionuclides from the Tank Farm heels is illustrated in Figures 1 and 2. The inventory of the "worst-case" tank and its pad, as estimated from results of sample analyses and process history (Staiger and Millet 2000). This inventory was used for the risk assessment.

The TFF closure plan calls for grouting of the tanks and tank vaults to stabilize these structures and reduce infiltration, and if possible, to intimately mix or entirely encapsulate the heel in grout. The portion of the heel inventory that is contained within the grout would be released slowly by diffusion, reducing the risk to individuals after closure. The tank grouting process was tested, primarily to determine the effectiveness of "corralling" the heel with a specific sequence of grout pours so that most of the heel may be removed by pumping. The testing also provided an opportunity to observe mixing/encapsulation of the residual heel. The extent of grout/heel mixing was not evaluated quantitatively, but it appeared that only a small fraction of the simulated heel solids mixed with the grout during the tests.

The base case risk assessment was developed before the tests of the tank grouting process. For the base case assessment, it was assumed that inventories would be associated with 2 wasteforms within the tank – the heel and a film on the tank walls. The wall inventory was assumed to be released immediately upon contact with infiltrating water, while the heel inventory was assumed to be released by diffusion. Based on information available as of July 2000, the tank wall inventory was considered negligible relative to the heel inventory, and the heel inventory was not assumed to mix with the grout. Therefore, releases from the tank heel were modeled using the surface rinse option of the Disposal Unit Source Term –Multiple Species (DUST-MS) model (Sullivan 1993, 1996) code. The surface rinse model is appropriate in situations where the contaminant is present on the surface of the wasteform – the contaminant is released as soon as water contacts the waste. This generally results in the highest calculated peak concentrations in the aquifer.

The stainless steel tank was assumed to remain intact for 500 years (per Becker 1998, which references the INTEC Safety Analysis Report). It was assumed to fail completely after 500 years, allowing radionuclides in the grouted tank to be released to the grouted concrete vault surrounding the tanks. The grouted vault was assumed to provide no containment of radionuclides in the sand pad or the tank. Therefore, the activity in the sand pad and tanks was assumed to migrate directly into the VZ beneath the tank beginning at 0 and 500 years, respectively. For aquifer transport modeling, the releases from the single modeled tank were assumed to be spread over a rectangle with the total area of the 11 TFF tanks, 2006 m^2. The shape of the rectangle was determined by finding the proportions of the smallest rectangle that could be drawn around all of the tanks and finding the length and width of a similar rectangle having an area of 2006 m^2.

The grouted heels and underlying sand were modeled as identical wasteforms in two containers. The container associated with the sand pad inventory was assumed to fail immediately, and the container associated with the grouted heel was assumed to fail 500 years after closure. Hydrological transport parameters (infiltration, porosity, hydraulic conductivity,

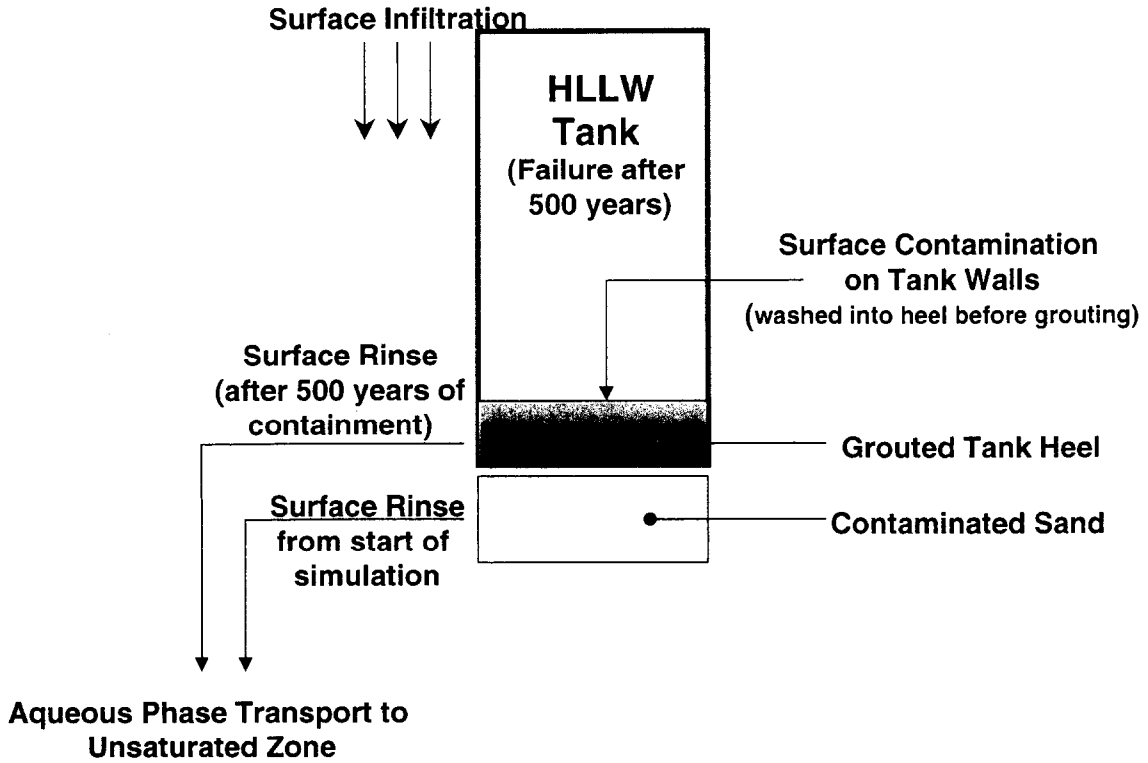


Figure 1. Conceptual model for release from Tank Farm Heels and contaminated sand layer, and subsequent transport to VZ

and moisture content) used for VZ and source term modeling were based on the characteristics of INEEL surface soils, as described in the Radioactive Waste Management Complex (RWMC) Performance Assessment (Maheras et al. 1994).

Nuclides released from the two containers would enter the VZ (Figure 2) beneath the tanks. In the VZ, advection would advance the contaminant plume toward the aquifer. During advective transport, the plume would be dispersed. At the interface of the VZ and the aquifer, contaminated pore water mixes with aquifer water. The volume of VZ pore water was assumed to be negligible compared to the volumetric flow in the aquifer. Therefore, only the mass fluxes of contaminants entering the aquifer were modeled. Transport through fractured basalt was assumed to be instantaneous, therefore, only transport through the sedimentary interbeds was explicitly modeled. This assumption is consistent with the corresponding assumptions of the Track 1 and 2 Site Risk Assessment Methodology (DOE 1995, 1996) and the RWMC Performance Assessment (Maheras et al. 1994).

The aquifer was assumed to be a homogeneous isotropic porous medium with constant unidirectional flow and no sources or sinks. Three-dimensional dispersion in the aquifer was modeled. The average concentration in the first 15-m of the aquifer was obtained and used to calculate lifetime carcinogenic risk at two receptor locations; one at the INTEC fence line (745 m downgradient) and the other at the edge of the Tank Farm facility (22 m downgradient).

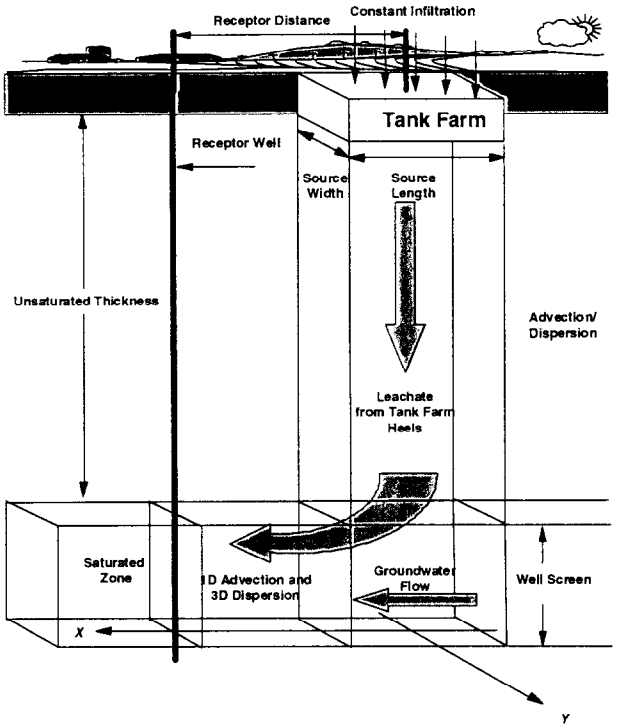


Figure 2. Conceptual model for contaminant transport in the VZ and aquifer.

Source Term Modeling

Releases from the HLLW Tanks were modeled using the DUST-MS model (Sullivan 1993, 1996). DUST-MS can be used to account for time-dependent waste container failure and releases from waste forms caused by molecular diffusion, surface rinsing, and solubility limited leaching. DUST-MS allows for simulation of ingrowth and differential transport of radioactive progeny. In the DUST-MS simulations we defined two identical waste forms in two containers that fail at 0 and 500 years. These modelled containers correspond to the sand pad and tank, respectively. The containers were modelled at adjacent positions within a single material type. Releases of radionuclides from the grouted tank and sand pads to the infiltrating water were assumed to be caused by the surface rinse mechanism described previously.

Descriptive information for the tanks, INEEL hydrological parameters, and computational options for DUST-MS are provided Table 1. Note that the Darcy velocity and moisture content values in Table 1 apply to the underlying sand, grouted tanks and vaults. All materials are assumed to have the same properties as surface soils at the INEEL. This assumption is equivalent to placing the radionuclide inventories in soil at the specified depth and allowing them to dissolve and leach with infiltrating water. Also, the concrete vault floor was assumed to be breached and provide no barrier to migration.

DUST-MS employs independent partitioning coefficients (K_d) for waste forms and materials. The partitioning coefficients of both the waste forms and the material were assigned the values obtained from the INEL Track 2 Guidance (DOE 1994), except for ^{237}Np. The values of the partitioning coefficients in the INEL Track 2 Guidance are believed to be lower bounding,

minimizing the modelled source-to-receptor transport time. These values have been used in all assessments of CERCLA sites at the INEEL. The K_d for neptunium was not included in DOE (1994), so a value was obtained from an evaluation of sorption coefficients for the Waste Area Group (WAG) 7 Baseline Risk Assessment (Dicke 1998). The K_d values used in this assessment are listed in Tables 2 and 3.

Table 1. Data and model parameter values used for the analysis.

Parameter	Value	Comments
Total area of Tank Farm (cm^2)	2.006×10^7 actual	based on tank geometry
[1]Source length parallel to aquifer (m)	25.7	GWScreen parameter
[1]Source width perpendicular to aquifer (m)	77.5	GWScreen parameter
Number of finite difference nodes	100	DUST-MS parameter
Geometry of grouted tank heel	Cylindrical	based on tank geometry
Radius of tank heel (cm)	762	based on tank geometry
Height of tank heel (cm)	30.5	Assumed
Failure time of tank (years)	500	INTEC TFF SAR value
Geometry of underlying sand	Cylindrical	based on tank geometry
Radius of underlying sand (cm)	762	based on tank geometry
Height of underlying sand (cm)	30.5	Assumed
Failure time of underlying sand (years)	0	Assumed
Boundary condition top	No-flux	DUST-MS parameter
Boundary condition bottom	Zero concentration	DUST-MS parameter
Time step minimum (years)	0.1	DUST-MS parameter
Time step maximum (years)	0.3	DUST-MS parameter
Darcy velocity ($cm\ s^{-1}$)	3.17×10^{-7}	DOE (1995)
Sediment moisture content (by volume)	0.341	based on DOE (1995)

[1]The GWSCREEN facility dimensions were derived assuming that the releases enter the aquifer through a 2001 m^2 rectangular area. The shape of the rectangle is similar to the shape of a rectangle that just contains the footprints of all 11 tanks in the TFF.

Contaminant Inventories

Residual radioactive material and hazardous metals are present in the heels of all of the tanks, and in the sand pads beneath tanks 185 and 187. The inventories were estimated (Staiger and Millet 2000) assuming that the ratio of solids to liquids in the tanks is 1:1. This was considered to be an overly conservative estimate of the ratio[1]. The TFF project management recommended using a ratio of 1:3 for a more realistic inventory estimate. Based on previous evaluations (Stepan et. al, 1997), a relatively small subset of the radionuclides in the TFF inventory causes essentially all of the long-term risk associated with closure of the TFF. Tables 2 and 3 show the inventories and contaminant-specific transport parameters for the radionuclides and hazardous metals addressed in this risk assessment.

Vadose Zone Transport

Either DUST-MS or GWScreen Version 2.5 may be used to model 1-D advection and dispersion in the vadose zone. For this evaluation, DUST-MS was used to model contaminant transport through the vadose zone. In the previous analysis (Rood and Ritter 1999),

[1] Personal communication with the TFF technical and program management staff.

GWSCREEN version 2.5 was used. GWSCREEN simulates the transport of radioactive progeny at the same rate as their parent. This assumption is generally considered conservative when evaluating peak (maximum) concentrations and doses. However, this assumption also leads to an unrealistic depiction of concentration of radioactive progeny over time for some decay chain members.

Table 2. Radionuclide inventories and transport parameters for DUST-MS source term analysis

Radionuclide	Half-Life (years)	K_d[a] (mL g^{-1})	Full worst-case tank inventory (Ci)	Tank and Sand Pad Inventories (Ci)	
				In Tanks after cleaning	In Sand Pads
^{241}Am	432	8.0[b]	1.9E+02	1.8E+00	1.7E-01
^{3}H	12.3	0.0	1.1E+03	2.7E-02	8.1E-01
^{129}I	1.57×10^7	0.0	3.8E-01	9.6E-03	9.5E-04
^{237}Np	2.14×10^6	8.0	9.2E+00	6.2E-03	1.3E-03
^{238}Pu	87.74	6.0[c]	2.2E+03	4.2E+01	6.7E-01
^{239}Pu	24,100	22.0	1.1E+03	3.2E+00	7.6E-02
^{240}Pu	6,560	22.0	7.6E+01	1.9E+00	3.0E-02
^{241}Pu	14.4	8.0[b]	4.1E+03	1.0E+02	6.0E-01
^{242}Pu	3.76×10^5	22.0	6.6E-01	3.4E-03	2.3E-06
^{99}Tc	2.13×10^5	0.0	1.4E+02	9.6E+01	5.7E-01
^{234}U	2.45×10^5	6.0	3.0E+00	1.5E-01	4.8E-03
^{235}U	7.038×10^8	6.0	4.0E-01	5.7E-04	3.2E-05
^{236}U	2.34×10^7	6.0	1.1E-01	6.5E-03	7.6E-05
^{238}U	4.47×10^9	6.0	5.7E-01	2.6E-04	1.8E-06

Table 3. Inventories and transport parameters for hazardous metals in the tank and sand pads

Metal	K_d[a] (mL g^{-1})	Tank and Sand Pad Inventories (grams)	
		In Tanks	In Sand Pads
As	3.0	7.5E+02	6.7E-03
Ba	50.0	2.7E+04	1.6E+01
Cd	6.0	2.1E+01	6.7E-01
Cr	1.2	2.9E+03	0
Hg	100	3.4E+03	4.9E+03
Ni	100	9.2E+02	0
Pb	100	1.4E+03	8.5E-07
Se	4.0	2.0E+02	2.5E+00
Ag	90.0	1.4E+02	2.8E-01

DUST-MS was chosen for this assessment because it allows independent partitioning of radionuclides in decay series, thereby allowing for simulation of *differential* transport of radioactive progeny. This more realistic representation of transport of radioactive progeny is advantageous for modeling many of the transuranic radioisotopes because of the relatively large differences in distribution coefficients for these elements and their progeny, and the significant contribution of the progeny to the total risk caused by the parent.

As discussed in the conceptual model section, only sedimentary interbeds were considered in determining the thickness of the VZ. Transport properties in the VZ (infiltration, moisture content, and partition coefficients) were set equal to the corresponding values for surface soils at the INEEL (Tables 2 and 3). Site-specific dispersivity data are not available for the VZ at INEEL. The dispersivity (Δx) was assumed equal to 1/10th the VZ thickness -- a generally acceptable method for approximating the dispersivity in the absence of site-specific information.

Activity flux (Ci y^{-1}) into the VZ as a function of time is shown in Figure 3 for several nuclides. The release initially decreases exponentially, and the slope is a function of the sorption coefficient. The flux then spikes at year 500 when the containment of the tank fails.

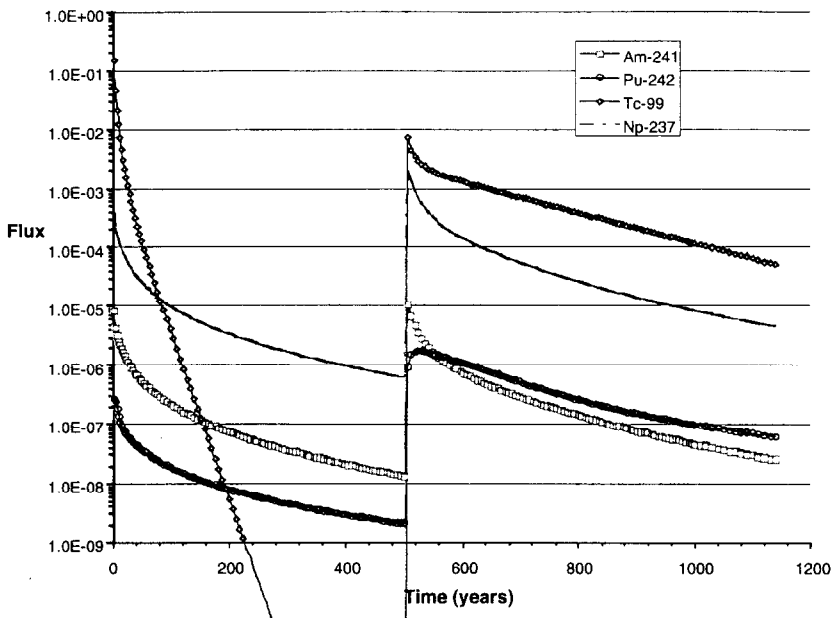


Figure 3. Typical modeled activity mass flux from the tanks to the underlying VZ as a function of time

A comparison between the cumulative flux to the top of the aquifer and the total initial inventory in the tank farm is presented in Table 4. Except for ^{240}Pu, over 90% of the initial inventory was estimated to have been released (or decayed) in the 0–1,000 year time frame. Lower release fractions were noted for nuclides with higher sorption coefficients and short half-lives. The fact that the fraction released to the VZ for nuclides with zero sorption and long half-lives (such as ^{129}I and ^{99}Tc) was nearly 98% suggests that the model is mass balanced.

Aquifer Transport

Either the DUST-MS or GWScreen Version 2.5 codes may be used to model contaminant transport through an aquifer. The GWSCREEN Version 2.5 code was used to calculate transport in the aquifer because, in contrast to DUST-MS, it may be used to simulate 3D dispersion in the aquifer. GWSCREEN Version 2.5 does not model the independent partitioning of radionuclides in decay chains. However, this is not an important consideration because the K_ds of all elements are very low in the Snake River Plain Aquifer (SRPA).

Table 4. Initial nuclide inventories in tanks (assuming 1:1 ratio of solid to liquid) and underlying sand and cumulative flux to the vadose zone calculated with the DUST-MSmodel.

Nuclide	Initial Inventory (Ci)[b]	DUST-MS Cumulative Flux from Source(Ci)[a]	Percent of initial inventory released
^{241}Pu	206	0.105	0.05%
^{241}Am	3.79	0.371	9.8%
^{237}Np	0.0135	0.013	96%
^{242}Pu	6.39×10^{-3}	6.23×10^{-3}	98%
^{238}U	5.20×10^{-4}	5.09×10^{-4}	98%
^{234}U	0.296	0.287	97%
^{238}Pu	83.9	4.01	4.8%
^{239}Pu	6.36	6.08	96%
^{235}U	1.16×10^{-3}	1.10×10^{-3}	95%
^{240}Pu	3.82	3.4	89%
^{236}U	1.4×10^{-3}	1.34×10^{-3}	96%
^{3}H	0.86	0.732	85%
^{129}I	0.0202	0.0196	97%
^{99}Tc	19.8	19.2	97%

a. Total activity leaving the tank farm surface soils and entering the VZ in 10,000 years.

b. This table was derived for an inventory based on 1:1 heel solids to liquids ratio. The inventory values are approximately 2X greater than the inventories used to estimate risk, but these tabled values may be used to make more accurate estimates of the percent release of the inventory.

The SRPA is primarily fractured basalt. Magnuson and Sondrup (1998) calculated a scaling factor between sediment K_d values and basalt K_d values. The scaling factor accounted for the lower number of available sorption sites and available surface area in fractured basalt compared to sediment. The scaling indicates that basalt K_d values are very small, and are negligible compared to sediment K_d values that were less than 1000 mL g^{-1}. The K_ds for all elements were set equal to zero, and all elements have the same partitioning behaviour. Therefore progeny travel at the same rate as their parent, and in-growth and transport of radioactive progeny in the aquifer are simulated realistically using GWSCREEN.

The contaminant fluxes at the top of the aquifer were used as input for the saturated groundwater flow model of GWSCREEN. Aquifer flow properties were taken from DOE (1996), except for the aquifer mixing thickness. In TRACK 2 assessments, the receptor was assumed to be on the downgradient edge of the source, similar to the position of the receptor at 22 m distance from the closed TFF. The 2D aquifer model of GWSCREEN was used in the TRACK 2 assessments because at such close range from a small source, a 15-m well screen positioned at the top of the aquifer would intercept the entire plume. For the present assessment, a second receptor was modeled at 745 m from the source (at the downgradient INTEC fence line). It is unreasonable to assume that the plume would remain confined within a 15-m thickness after 745 m of flow through the SRPA. Therefore, we used the GWSCREEN 3D model to account for vertical dispersion through the full depth of the aquifer. The aquifer thickness parameter was set at 76 m (Maheras *et al.*, 1994, Magnuson and Sondrup, 1998). The average concentration across the top 15 m of the aquifer was used to calculate intake by the receptor.

Receptor Scenario and Dose/Risk Calculations

A single exposure scenario was considered for both receptors. The receptors at 22 m and 745 m were assumed to consume wellwater at a rate of 2 L per day for 350 days per year for 30 years. The incremental lifetime cancer incidence risks were calculated for the receptors using the 30-year average integrated groundwater concentration and cancer risk factors (slope factors) from EPA (1997). The incremental lifetime cancer incidence risk is:

$$R = \sum_{i=1}^{n} \frac{\int_{t_1}^{t_2} C_i(t)\, dt}{t_2 - t_1} WI\ EF\ ED\ SF_i \qquad (1)$$

where

R	=	incremental lifetime cancer incidence risk for a parent nuclide from the entire decay chain
$C(t)$	=	groundwater concentration as a function of time for i^{th} decay chain member (Ci L^{-1})
t_1	=	the beginning of the 30 year period of maximum concentration (y)
t_2	=	the end of the 30 year period of maximum concentration (y)
WI	=	water ingestion rate (2 L d^{-1})
EF	=	exposure frequency (350 days per year)
ED	=	exposure duration (y)
SF	=	slope factor for the ith decay chain member (Ci^{-1})

Note that Equation (1) is the risk for the entire decay chain of a given parent nuclide. Risks are reported in terms of the total risk delivered by a parent nuclide that includes risk contributions from all radioactive progeny. We have not combined the risk from daughter products derived from different decay chains, but include daughter contributions to the total risk caused by the parent nuclide.

The EPA Slope Factors for radionuclides (1997) are presented in Table 5. In all cases we used the slope factors designated as "+D" so that risks from radioactive progeny that are in secular equilibrium with the parent were included in the slope factor. Only decay chain members that generally do not achieve equilibrium with their parent were modeled explicitly. The limiting concentrations for hazardous metals (Table 6) were taken from the INEL Track 2 Guidance (DOE 1994). The Track 2 Guidance concentrations were derived from hazard index values that are identical to the current values in the EPA Integrated Risk Information System database. Radiological dose conversion factors (DCFs) are from DOE EH-0071, 1988 (DOE 1988).

Results

Results for risk and dose calculations are presented in Tables 7, 8, and 9. Table 7 summarizes the results for hazardous metals at 22 m and 745 m. Tables 8 and 9 summarize the radiological dose and risk calculations.

Fission/activation products, in particular, ^{129}I and ^{99}Tc, cause most of the lifetime carcinogenic incidence risk during the first 1000 years (i.e., to calendar year 3000) post-closure. After that time, risk is dominated by actinides, especially ^{239}Pu (Figures 4, 5, and 6). Maximum total risk posed by a single tank with a "worst case" inventory was 1.6×10^{-5} for the receptor at 745 m, 3500 years in the future. Maximum total risk posed by a single tank with a "worst case"

Table 5. Carcinogenic slope factors used in risk assessment.

Nuclide (Progeny)	Slope Factor (Ci^{-1})	Nuclide (Progeny)	Slope Factor (Ci^{-1})
^{238}Pu	295	^{241}Pu	333
(^{234}U)	44.4	(^{241}Am)	328
(^{230Th})	37.5	(^{237}Np)	300
(^{228}Ra)	296	(^{233}U)	44.8
(^{210}Pb)	1010	(^{229}Th)	356
^{239}Pu	316	^{242}Pu	300
(^{235}U)	45.2	(^{238}U)	62.0
(^{231}Pa)	149.5	[see ^{238}Pu chain]	---
^{240}Pu	315	^{3}H	0.072
(^{236}U)	42.1	^{129}I	184
(^{232}Th)	32.8	^{99}Tc	1.4
(^{228}Ra)	248		
(^{228Th})	231		

Table 6. Limiting hazard index concentrations for metals in drinking water (DOE 1994).

Metal	HI=1 Concentration (mg/m^3)	Metal	HI=1 Concentration (mg/m^3)
Se	200	Ba	3000
As	10	Cr	200
Pb	None listed	Cd	20
Hg	10	Ag	200
Ni	700		

inventory was 1.2×10^{-4} for the receptor at 22 m, 3500 years in the future. This risk is slightly greater than the upper end of the EPA point-of-departure window for acceptable risks (1×10^{-4} to 1×10^{-6}). Risks for multiple tanks would be in direct proportion to the increased inventory that would be available for release and transport. Risks posed by actinides occur at a later time because these nuclides are more highly sorbed in the VZ compared to the fission/activation products, thereby retarding their movement and resulting in longer VZ travel times. Hazardous metals pose a very small risk in absolute terms. Risks from hazardous metals are neglible relative to the risks caused by radioactive materials.

Inherent in these results are the assumptions previously described. The risk per tank presented above is conservatively biased for the following reasons:

(1) The K_d for Pu was assumed to be 22, which almost certainly overestimates the mobility of Pu in INEEL subsurface sediments,

(2) The "worst-case" tank inventory was used, rather than a more realistic estimate of typical tank inventories,

(3) All activity within the tank is assumed to be released by the surface wash mechanism. In reality, some activity would be located within the grout or in solid particles, which would prevent surface washing.

The risk posed by closure of the tanks using the proposed method would be 1.8×10^{-4} if all 11 tanks contain the "worst-case" inventory. This exceeds the 10^{-4} risk threshold requiring additional cleanup, but only by a small factor. Relatively small refinements of either the transport

modeling assumptions (item (1) and (2) above) or the inventory estimate would probably be sufficient to reduce the risk below 10^{-4}, but further data-gathering will be required to support these refinements. It is clear that closure with a full tank could cause potentially large doses in the future, and that some cleanup is required before closure. The radiological doses presented in Table 9 will be used in an ALARA analysis to determine the appropriate cleanup option.

Table 7. Summary of average concentrations of hazardous metals released from the TFF following closure by the proposed methods. Concentrations are compared to the hazard index (HI) values presented in Table II-1 of the Track 2 Guidance.

COC	Concentration for the receptor at 745 m (mg/m^3)	Peak risk in any 30 y period after 2000 (start date)	Hazard Index (mg/m^3)	Ratio of peak conc to HI	COC	Concentration for the receptor at 22 m (mg/m^3)	Peak risk in any 30 y period after 2000 (start date)	Hazard Index (mg/m^3)	Ratio of peak conc to HI
Se	1.59E-06	1085	200	7.94E-09	Se	1.26E-05	1085	200	6.30E-08
Ni	3.13E-07	13785	700	4.47E-10	Ni	2.48E-06	13785	700	3.55E-09
Hg	1.97E-06	13985	10	1.97E-07	Hg	1.56E-05	13985	10	1.56E-06
Cr	6.76E-05	685	200	3.38E-07	Cr	5.37E-04	685	200	2.68E-06
Cd	7.06E-08	1285	20	3.53E-09	Cd	5.60E-07	1285	20	2.80E-08
Ba	7.87E-05	7185	3000	2.62E-08	Ba	1.49E-04	7185	3000	4.95E-08
As	2.99E-06	1585	10	2.99E-07	As	2.37E-05	1585	10	2.37E-06
Pb[1]	4.89E-07	13785	10	4.89E-08	Pb	3.88E-06	13785	10	3.88E-07
Ag	5.52E-08	12385	200	2.76E-10	Ag	4.38E-07	12385	200	2.19E-09

1) A relatively restrictive HI value of 10 is entered for lead in Table 7, although there is no HI value listed for lead in the Track 2 Guidance or the IRIS database.

Table 8. Maximum risk to an individual occuring during any 30 year period after closure of a single "worst-case" tank inventory and per Ci released for receptors located 22 m and 745 m downgradient from the closed TFF.

Nuclide	Unit Risk for the receptor at **745 m** (1/Ci)	Unit Risk for the receptor at **22 m** (1/Ci)	Maximum risk per worst case tank for the **745 m** receptor **BASE CASE**	Maximum risk per worst case tank for the **22 m** receptor **BASE CASE**	Maximum risk per worst case tank for the receptor at **745 m** **EXTRA WASH**	Maximum risk per worst case tank for the receptor at **22 m** **EXTRAWASH**	Maximum risk per worst case tank for the receptor at **745 m** **FULL TANK**	Maximum risk per worst case tank for the receptor at **22 m** **FULL TANK**
Am-241	2.0×10^{-9}	1.6×10^{-8}	3.7×10^{-9}	3.0×10^{-8}	1.8×10^{-9}	1.5×10^{-8}	3.8×10^{-7}	3.1×10^{-6}
H-3	1.7×10^{-9}	1.6×10^{-8}	4.8×10^{-11}	4.3×10^{-10}	2.4×10^{-11}	2.1×10^{-10}	1.9×10^{-6}	1.7×10^{-5}
I-129	1.1×10^{-4}	7.6×10^{-4}	1.0×10^{-6}	7.4×10^{-6}	5.1×10^{-7}	3.7×10^{-6}	4.1×10^{-5}	2.9×10^{-4}
Np-237	1.3×10^{-5}	9.6×10^{-5}	7.8×10^{-8}	6.0×10^{-7}	3.9×10^{-8}	3.0×10^{-7}	1.2×10^{-4}	8.9×10^{-4}
Pu-238	8.7×10^{-10}	6.9×10^{-9}	3.6×10^{-8}	2.9×10^{-7}	1.8×10^{-8}	1.4×10^{-7}	1.9×10^{-6}	1.5×10^{-5}
Pu-239	5.0×10^{-6}	4.0×10^{-5}	1.6×10^{-5}	1.2×10^{-4}	7.9×10^{-6}	6.2×10^{-5}	5.4×10^{-3}	4.3×10^{-2}
Pu-240	1.1×10^{-6}	8.1×10^{-6}	2.0×10^{-6}	1.5×10^{-5}	1.0×10^{-6}	7.7×10^{-6}	8.1×10^{-5}	6.1×10^{-4}
Pu-241	8.5×10^{-10}	6.7×10^{-9}	8.8×10^{-8}	6.9×10^{-7}	4.4×10^{-8}	3.4×10^{-7}	3.5×10^{-6}	2.7×10^{-5}
Pu-242	4.8×10^{-6}	3.8×10^{-5}	1.6×10^{-8}	1.3×10^{-7}	8.2×10^{-9}	6.5×10^{-8}	3.1×10^{-6}	2.5×10^{-5}
Tc-99	7.8×10^{-7}	6.2×10^{-6}	7.6×10^{-6}	6.0×10^{-5}	3.8×10^{-6}	3.0×10^{-5}	1.1×10^{-4}	8.9×10^{-4}
U-234	2.4×10^{-6}	1.9×10^{-5}	3.5×10^{-7}	2.8×10^{-6}	1.8×10^{-7}	1.4×10^{-6}	7.4×10^{-6}	5.9×10^{-5}
U-235	2.6×10^{-6}	2.1×10^{-5}	1.5×10^{-9}	1.2×10^{-8}	7.4×10^{-10}	6.0×10^{-9}	1.0×10^{-6}	8.5×10^{-6}
U-236	3.6×10^{-7}	2.8×10^{-6}	5.0×10^{-10}	3.9×10^{-9}	2.5×10^{-10}	1.9×10^{-9}	3.8×10^{-8}	3.0×10^{-7}
U-238	3.5×10^{-6}	2.8×10^{-5}	9.3×10^{-10}	7.5×10^{-9}	4.6×10^{-10}	3.7×10^{-10}	2.0×10^{-6}	1.6×10^{-5}
Peak Risk	n/a	n/a	1.6×10^{-5}	1.2×10^{-4}	3.3×10^{-5}	6.2×10^{-5}	5.4×10^{-3}	4.3×10^{-2}

Table 9. Maximum dose (rem) to an individual occuring during any 30 year period after closure of a single "worst-case" tank inventory receptors located 22 m and 745 m downgradient from the closed TFF. The dose conversion factors (DCFs) used to generate these results are from DOE 1988.

Nuclide	Maximum dose per worst case tank for the **745 m** receptor (rem) **BASE CASE**	Maximum dose per worst case tank for the **22 m** receptor (rem) **BASE CASE**	Maximum dose per worst case tank for the **745 m** receptor (rem) **EXTRA WASH**	Maximum dose per worst case tank for the **22 m** receptor (rem) **EXTRA WASH**	Maximum dose per worst case tank for the **745 m** receptor (rem) **FULL TANK**	Maximum dose per worst case tank for the **22 m** receptor (rem) **FULL TANK**
Am-241	1.6×10^{-6}	1.3×10^{-5}	8.0×10^{-7}	6.5×10^{-6}	1.6×10^{-4}	1.3×10^{-3}
H-3	2.1×10^{-8}	1.8×10^{-7}	1.0×10^{-8}	9.3×10^{-8}	8.1×10^{-4}	7.2×10^{-3}
I-129	4.5×10^{-4}	3.2×10^{-3}	2.2×10^{-4}	1.6×10^{-3}	1.8×10^{-2}	1.3×10^{-1}
Np-237	3.4×10^{-5}	2.6×10^{-4}	1.7×10^{-5}	1.3×10^{-4}	5.1×10^{-2}	3.9×10^{-1}
Pu-238	1.6×10^{-5}	1.2×10^{-4}	7.9×10^{-6}	6.2×10^{-5}	8.3×10^{-4}	6.5×10^{-3}
Pu-239	6.9×10^{-3}	5.4×10^{-2}	3.4×10^{-3}	2.7×10^{-2}	2.4×10^{0}	$1.9 \times 10^{+1}$
Pu-240	8.8×10^{-4}	6.7×10^{-3}	4.4×10^{-4}	3.4×10^{-3}	3.5×10^{-2}	2.7×10^{-1}
Pu-241	3.8×10^{-5}	3.0×10^{-4}	1.9×10^{-5}	1.5×10^{-4}	1.5×10^{-3}	1.2×10^{-2}
Pu-242	7.1×10^{-6}	5.7×10^{-5}	3.6×10^{-6}	2.8×10^{-5}	1.4×10^{-3}	1.1×10^{-2}
Tc-99	3.3×10^{-3}	2.6×10^{-2}	1.6×10^{-3}	1.3×10^{-2}	4.9×10^{-2}	3.9×10^{-1}
U-234	1.5×10^{-4}	1.2×10^{-3}	7.7×10^{-5}	6.1×10^{-4}	3.2×10^{-3}	2.6×10^{-2}
U-235	6.4×10^{-7}	5.3×10^{-6}	3.2×10^{-7}	2.6×10^{-6}	4.5×10^{-4}	3.7×10^{-3}
U-236	2.2×10^{-7}	1.7×10^{-6}	1.1×10^{-7}	8.4×10^{-7}	1.7×10^{-5}	1.3×10^{-4}
U-238	4.0×10^{-7}	3.2×10^{-6}	2.0×10^{-7}	1.6×10^{-6}	8.6×10^{-4}	6.9×10^{-3}
Peak Risk	6.9×10^{-3}	5.4×10^{-2}	3.4×10^{-3}	2.7×10^{-2}	2.4×10^{0}	$1.9 \times 10^{+1}$

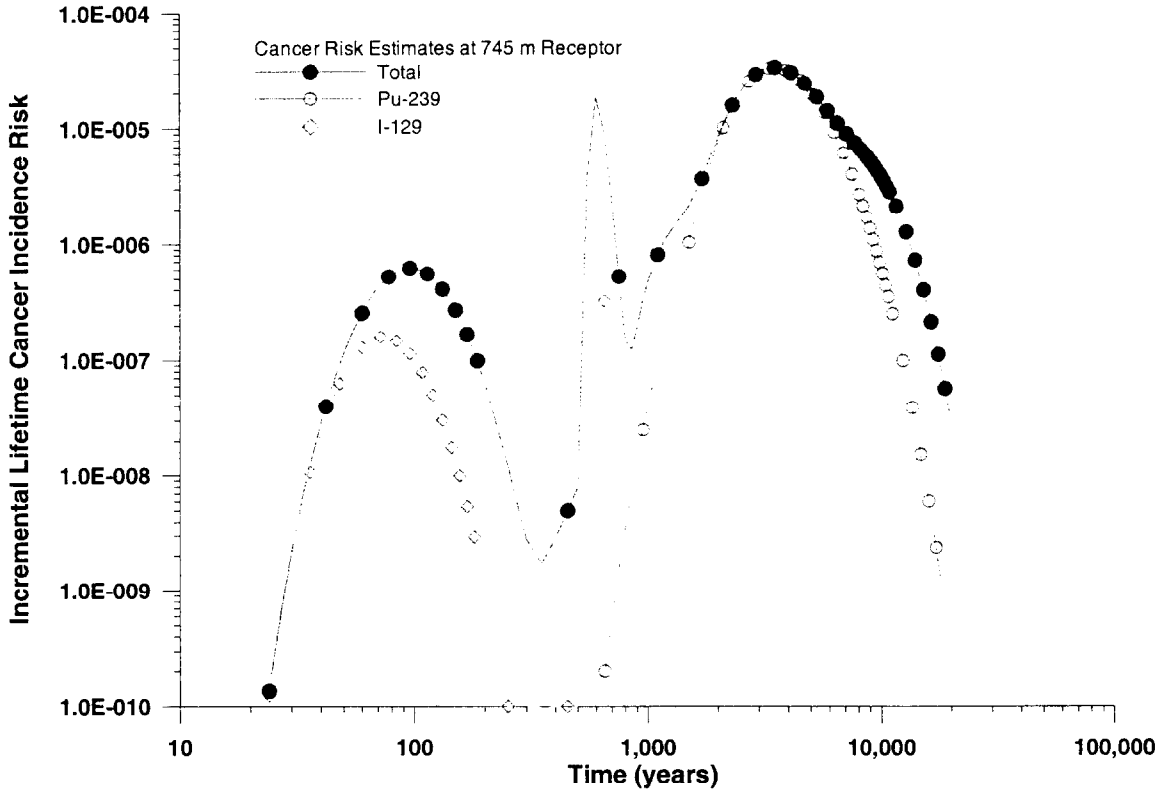


Figure 4. Lifetime cancer incidence risk posed by radionuclides in the TFF for a receptor who draws water from a well located 745 m downgradient from the Tank Farm. The key radionuclides I-129 and Pu-239 are shown separately. The "Total" line represents all radionuclides.

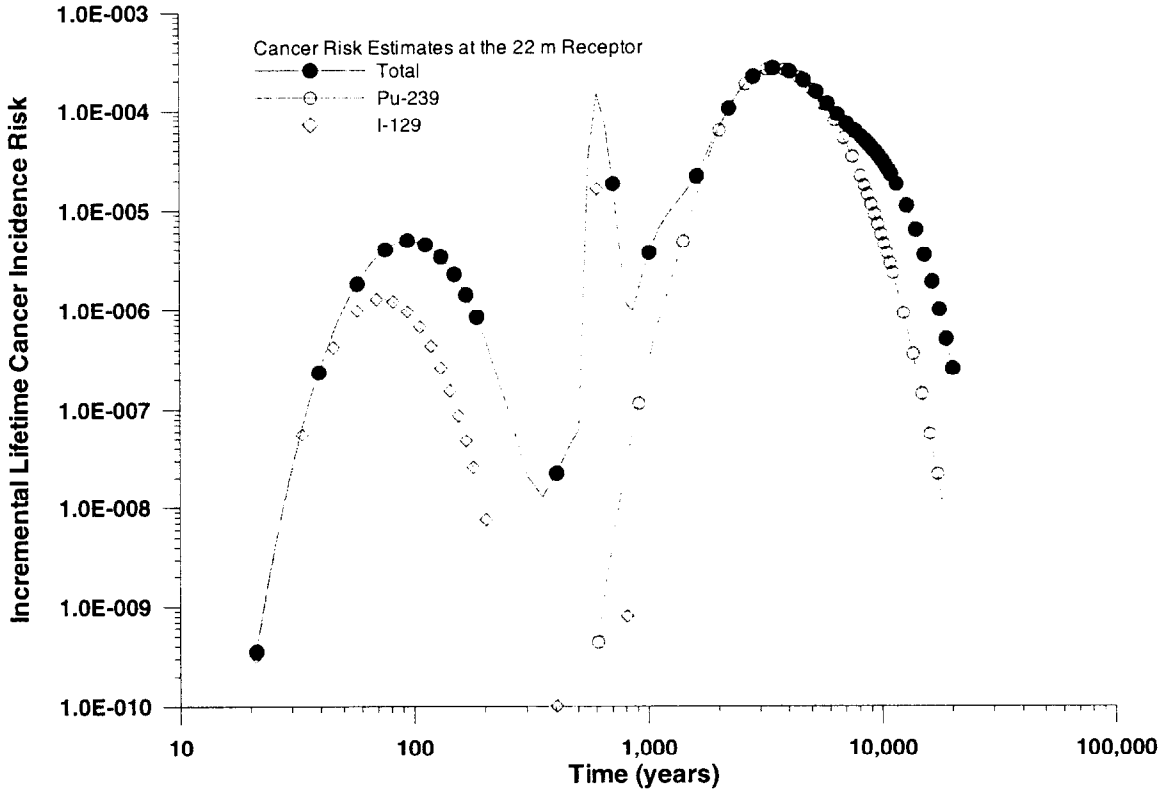


Figure 5. Lifetime cancer incidence risk posed by radionuclides in the TFF for a receptor who draws water from a well located 22 m downgradient from the Tank Farm. The key radionuclides I-129 and Pu-239 are shown separately. The "Total" line represents all radionuclides.

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EDF-1195

ENGINEERING DESIGN FILE

1. Project File No. 015722 2. Project/Task INTEC Tank Farm Closure Project

3. Subtask Remote Systems – LDUA

4. Title: Compatibility of Using the LDUA (Light Duty Utility Arm) for Remote Sampling in TFF Tanks WM-182 & 183

5. Summary: This summary briefly defines the problem or activity to be addressed in the EDF, gives a summary of the activities performed in addressing the problem and states the conclusions, recommendations, or results arrived at from this task.

For purposes of the TFF Closure Project, the LDUA can provide a suitable means to accomplish several activities to support successful project completion. The activities could include detailed tank inspections in the areas accessible by the LDUA through a specific riser and obtaining samples from the tank heel residual. This EDF will address using the LDUA as the sampling mechanism for obtaining samples from tank heels in WM-182 and WM-183.

6. Distribution (complete package):

Distribution (summary package only):

7. Review (R) and Approval (A) Signatures: (Minimum reviews and approvals are listed. Additional reviews/approvals may be added as necessary.)

	R/A	Printed Name	Signature	Date
Author	R	Stephen M. Berry	S. M. Berry	8-4-99
Independent Verification	R	Maurice J. Ross	S M Berry for M. J. Ross per telecon	9/27/00
Requestor	A	Ed Anderson	[illegible]	9/27/00

Summary

This Engineering Design File (EDF) provides information on the compatibility of using the Light Duty Utility Arm (LDUA) on the Tank Farm Facility (TFF) at INTEC for purposes of sampling tank heel in tanks WM-182 and WM-183.

Background

The closure of the TFF at INTEC requires that "RCRA Qualified " liquid and solid samples be obtained from tank heels to prove what is remaining in the tanks prior to closure. A Sampling Plan is being developed by Portage Environmental Inc., that basis the obtaining of these "samples" by using the LDUA equipment. This has generally been accepted based on the fact that the LDUA has proven very successful early this year in obtaining samples from WM-188.

The Light Duty Utility Arm, more commonly known as the LDUA, is a mobile, long reach manipulator arm system designed to enter TFF tanks to perform several activities as follows: 1) to perform surveillance activities in the form of video inspection, 2) or with the aid of exchangeable end effectors, perform nondestructive examinations of tank structure, and 3) perform sample retrieval from tank heel liquids/solids at the bottom of the vessel. To accomplish these tasks, the LDUA is designed as a telescoping mast system with an articulating arm at the end that can be lowered down into a tank through a typical 12-inch riser opening. The LDUA is mounted on a trailer that can be uncoupled at the work site if desired. Several support trailers with additional equipment and a control trailer are also part of the overall system for field deployment.

To support the LDUA activities at the tank riser interface, an End Effector Exchange System, better known as E3S, has been designed to support attachment and removal of the different end effectors. The end effectors are stored in containers that are used with the E3S to properly locate and index the various end effectors on and off of the LDUA. The raising and lowering of the telescoping mast of the LDUA to change end effectors and retrieve samples requires the temporary installation of a confinement tent structure over the riser area of the tank with appropriate ventilation controls to provide contamination control. This can be especially important if the spray wash down system does not clean the LDUA and end effectors to a "free release" clean condition from a radiological standpoint.

The LDUA is hydraulically powered and electronically controlled via several stations at a trailer mounted console system located some distance (outside the TFF fence) from the riser entrance point to the tank. The LDUA can be tele-operated or during certain activities with proper input, completely computer controlled. This latter case may be advantageous in certain situations where collision avoidance with tank structure/walls would be desirable during operations with the LDUA inside the tank.

Basis of Approach

For purposes of the INTEC Tank Farm Closure Project, the LDUA can provide a suitable means to accomplish several activities to support successful project completion. Surveillance activities with video camera(s) operated by the LDUA can be of practical benefit for initial inspections and an aid to planning the deactivation activities for a given tank. The LDUA also provides a proven and successful means for obtaining samples from tank heel residual, as has been already proven for tank WM-188.

Location and layouts for using the LDUA on tanks WM-182 and WM-183 have not been yet been completed. At present, no accessible riser(s) have been identified for these tanks, unless existing equipment such as corrosion coupons can be removed before introduction of the LDUA. The weight restrictions on the tank farm for categories A, B, C, and D should not be a problem for locating and setting up the LDUA, provide the obstacles hindering movement can be successfully navigated by operators deploying this equipment. A consideration in favor for the LDUA is that to accomplish tank closure, the concrete bunkers surrounding risers that will be used for tank washing and grout filling will have the top sections removed to grade level before the temporary enclosure buildings are set into place. This approach significantly reduces the loading factor on the vault structure surrounding the tank(s) and provides an enhanced safety margin for the new equipment such as the LDUA that will be located adjacent to or over the tank(s).

Tank Heel Sampling

The preferred and previously verified method of tank heel residual sampling will be to use the LDUA with the sample end effector. A confinement tent structure similar to what has been used for WM-188 will be required for the sampling program. A method for handling potentially radioactively "hotter" samples will be required for tank WM-183 based on past process knowledge. The existing modified "polybottle" with its stainless steel insert would not provide adequate shielding for personnel standing close by during sampling operations. The LDUA and respective sampling end effector should be adequate to perform the actual sampling operation. However, modifications and/or additions to the E3S will be required to accommodate the heavier loads anticipated for the Central Research Laboratory (CRL) shielded canister shields lid. In addition, modifications to the load out set-up for handling the shielded canister lid will be required once the sample container has been placed in the shielded canister. The present configuration of the E3S system is not adequate to handle the approximately 50# shielded canister lid. Therefore, a small jib boom will be required to be in place and remotely operated specifically for placing the shield lid down onto the shielded canister.

In addition, modifications may be required to the sample transfer hand cart to allow this unit to accommodate the CRL shielded canister in lieu of the modified polybottle used for transporting WM-188 samples to the Remote Analytical Laboratory (RAL) at INTEC. These modifications should be straight forward, but must be completed before sampling can begin in support of the closure of the tanks (WM-182 and WM-183).

To receive these potentially hotter samples from WM-183 (and possibly WM-182), the RAL Waste Transfer Cart (WTC) Project must be completed and operational for RAL to receive these samples. At present, work is underway to mockup and test the new WTC which was completed several years ago, but not installed at RAL. Once testing has been successfully completed, the new WTC will be scheduled for installation at RAL. This effort must be completed before samples from WM-182 and WM-183 are sent to RAL for analysis.

Conclusions

The LDUA system is compatible for initial inspections and tank heel sample retrieval for the INTEC Tank Farm Closure Project. Several modifications to handling the potentially "hotter" samples must be completed before sampling begins and the new WTC must be installed to accept these samples into RAL.

EDF-1187

1187431.02
08/12/98
Rev. 03

ENGINEERING DESIGN FILE

Functional File No. _____
EDF No. 1187

FOR REFERENCE ONLY

1. Project File No. 015722 2. Project/Task INTEC TANK FARM FACILITY DEACTIVATION CONCEPTUAL DESIGN

3. Subtask ELECTRICAL STUDIES

4. Title: INTEC, FARM CLOSURE, CONCEPTUAL DESIGN STUDIES.

5. Summary: ELECTRICAL LOADS PER NEC 1999, SHORT CIRCUIT CALC PER SKM SOFTWARE AND BUSSMAN SOFTWARE, VOLTAGE DROP PER ZOTEK SOFTWARE, INTEC DATA BASE LOADING DATA, AND RAYTHEON 1994 STUDIES FOR COMPARISON.

6. Distribution (complete package):

Distribution (summary package only):

7. Review (R) and Approval (A) Signatures: (Minimum reviews and approvals are listed. Additional reviews/approvals may be added as necessary.)

	R/A	Printed Name	Signature	Date
Author	R	Kent E. Wells	Kent E. Wells	July 20, 1999
Independent Verification	R	Ken Graff	KEG for EEA	7/20/99
Requestor	A	Ed Anderson	E. Anderson	7/20/99

DESIGN STUDIES

CALCULATED LOADING DATA
PCC-NEC-773
AND
TANK FARM

07/20/99

TANK FARM CLOSURE
INSTRUMENTATION TRAILER

BUILDING SQ FT= 400

CONCEPT DESIGN THIS OPTION SELECTED

GROUP LOAD	LOAD DESCRIPTION	QUANTITY NO SQ FT (SF) CU FT (CF) W/TON ETC	UNIT LOAD W/UNIT W/SF W/CF W/TON ETC	CONNECTED LOAD (CL) , VA	EST. DEMAND FACTOR (DF)	EST DEMAND LOAD (DL) kva	EST POWER FACTOR (PF)	REQUIRED CAPACITY IN KVA EACH GROUP
1	LIGHTING, NEC TABLE 220-3(a)	400	3.5	1400	100%	1400	0.9	1400
2	RECEPTACLES, NEC TABLE 220-3(A)	400	1	400	100%	400	0.9	400
3	HEATING LOAD, MECH EST.	400	20	8000	100%	8000	1	8000
4	AC, NON COINIDENT LOAD	-	-	-	100%	-	-	
5	AIR HANDLING, MECH EST		-	-	100%	-	-	-
6	HOT WATER, MECH EST.	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7	INSTRUMENTATION LOAD ASSUMED			5400		5400	0.9	5400

SYSTEM LOSS

TOTAL CONNECTED LOAD (TCL) AND GROSS DEMAND LOAD (GDL)	15200
ESTIMATED DIVERSITY FACTOR (DIF)	1
SPARE CAPACITY (SC) FOR GROWTH (20__% X GDL IN VA)	3040
GROSS SYSTEM CAPACITY TO BE PROVIDEE (GSC=(a/b)+c)	18240
GROSS SYSTEM AMPS @ 480 VOLTS	21.94

ASSUMPTIONS

1. INSTRUMENTATION TRAILER IS 400 SQ FT
2. INSTRUMENTATION TRAILER FEEDER IS REMOTE, FEED FROM TFF STATIOB "B"
3. MINIMUM SIZE OF THE FEEDER BASED 100% NONCONTINUOUS AND 125% OF THE CONTINUOUS LOAD
4. MINIMUM SIZE OF THE FEEDER BASED ON GROSS AMPS AND NEC, TABLE 400-5(A) IS 4-4 AWG SO CORD.
5. HEATING, LIGHTING AND RECEPTACLES ARE CONTINUOUS LOADS BASED ON NEC.
6. ESTIMATE FROM MECHANICAL ENGINEER IS 20 WATT/SQFT
7. ESTIMATE FROM MECHANICAL ENGINEER NO HOT WATER HEATING

TANK FARM CLOSURE
TYPICAL SHED

BUILDING SQ FT= 400

CONCEPT DESIGN THIS OPTION SELECT

GROUP LOAD	LOAD DESCRIPTION	QUANTITY NO SQ FT (SF) CU FT (CF) W/TON ETC	UNIT LOAD W/UNIT W/SF W/CF W/TON ETC	CONNECTED LOAD (CL), VA	EST. DEMAND FACTOR (DF)	EST DEMAND LOAD (DL) kva	EST POWER FACTOR (PF)	REQUIRED CAPACITY IN KVA EACH GROUP
1	LIGHTING, NEC TABLE 220-3(a), INDUSTRIAL/COMMERICAL	260	2	520	100%	520	0.9	520
2	RECEPTACLES, NEC TABLE 220-3(A)	260	1	260	100%	260	260	260
3	HEATING LOAD, MECH EST.	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4	AC, NON COINIDENT LOAD	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5	AIR HANDLING, MECH EST, 1/2 HP	1	1176	1176	100%	1176	1176	1176
6	HOT WATER, MECH. EST.	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7	INSTRUMENTATION LOAD ASSUMED	N/A	N/A	N/A	N/A	N/A	N/A	N/A

SYSTEM LOSS

TOTAL CONNECTED LOAD (TCL) AND GROSS DEMAND LOAD (GDL)	1956
ESTIMATED DIVERSITY FACTOR (DIF)	1
SPARE CAPACITY (SC) FOR GROWTH (20 % X GDL IN VA)	391.2
GROSS SYSTEM CAPACITY TO BE PROVIDE (GSC=(a/b)+c)	2347.2
GROSS SYSTEM AMPS @ 480 VOLTS	2.82
GROSS SYSTEM AMPS @ 208 VOLTS	6.51

ASSUMPTIONS

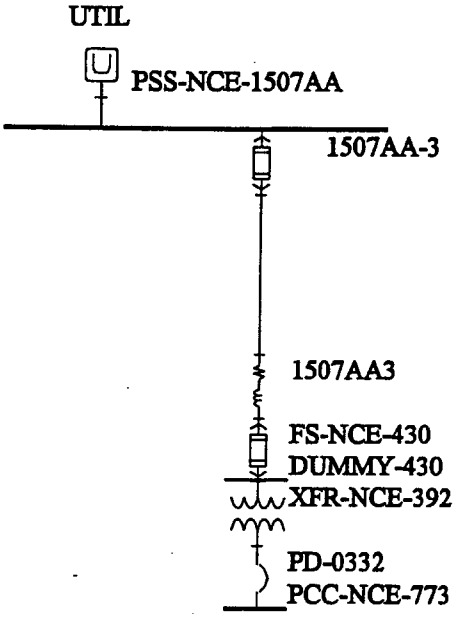
1. SHED IS 260 SQ FT
2. SHED, FEED FROM TFF STATIOB "B"
3. MINIMUM SIZE OF THE FEEDER BASED 100% NONCONTINUOUS AND 125% OF THE CONTINUOUS LOAD
4. MINIMUM SIZE OF THE FEEDER BASED ON GROSS AMPS AND NEC, TABLE 400-5(A)
IS 4-12 AWG SO CORD. A&E STD REQUIRES #12 MINIMUM. WILL USE 50 AMP , 4-4AWG SO CORD.
5. HEATING, LIGHTING AND RECEPTACLES ARE CONTINUOUS LOADS BASED ON NEC.

ESTIMATED LOAD FOR TANK FARM REMOVAL
TANK FARM REMOVAL PROJECT

ITEM NUMBER	DESCRIPTION	NUMBER OF ITEMS	CONNECTED KVA	SUBTOTAL
1	INST AND SHOWER TRAILER	1	11520.00	11520
2	TRAILERS FOR TANK TOP	4	1956.00	7824
3	PORTABLE POWER	1	10000.00	10000
4	5 HP VENT MOTOR	1	5000.00	5000
5	LDUA ASSUME 80% OF CABLE AMPACITY	1	80000.00	80000
6				
	TOTAL VA			114344
	TOTAL AMPS AT 480VAC			137.538491

PCC-NEC-773
AND
TANK FARM
SHORT CIRCUIT STUDIES

07/20/99


UTIL
PSS-NCE-1507AA
1507AA-3
1507AA3
FS-NCE-430
DUMMY-430
XFR-NCE-392
PD-0332
PCC-NCE-773

EUSU model report with generators off-line, load center tie breakers open
and SUB10 & 15 tie breakers open

Fri Jun 11 11:07:03 1999 Page 1

ALL INFORMATION PRESENTED IS FOR REVIEW, APPROVAL
INTERPRETATION AND APPLICATION BY A REGISTERED ENGINEER ONLY

SKM POWER*TOOLS FOR WINDOWS
INPUT DATA REPORT
COPYRIGHT SKM SYSTEMS ANALYSIS, INC. 1995-1997

ALL PU VALUES ARE EXPRESSED ON A 100 MVA BASE.

Fri Jun 11 11:07:03 1999 Page 2
EUSU model report with generators off-line, load center tie breakers open
and SUB10 & 15 tie breakers open

FEEDER INPUT DATA

FEEDER FROM NAME	FEEDER TO NAME	QTY /PH	VOLTS L-L	LENGTH		FEEDER SIZE	DESCRIPTION TYPE	DUCT	INSUL
PSS-NCE-1507AA	DUMMY-430	1	13800	17.0	FT	500	C	N	XLP
+/- Impedance:	0.0284 + J	0.0421	OHMS/M	Length	0.00025 + J 0.00038				PU
ZO Impedance:	0.0451 + J	0.1071	OHMS/M	Length	0.00040 + J 0.00096				PU

Fri Jun 11 11:07:03 1999 Page 3
EUSU model report with generators off-line, load center tie breakers open
and SUB10 & 15 tie breakers open

TRANSFORMER INPUT DATA

PRIMARY RECORD NO NAME		VOLTS L-L	* SECONDARY RECORD NO NAME		VOLTS L-L	FULL-LOAD KVA	NOMINAL KVA
DUMMY-430	D	13800.0	PCC-NCE-773	YG	480.00	1500.00	1500.00
Pos. Seq. Z%:		0.597 + J	5.97	0.398 + j	3.98 PU		
Zero Seq. Z%:		0.597 + J	5.97	0.398 + j	3.98 PU		

Taps Pri. 0.000 % Sec. 0.000 % Phase Shift (Pri. Leading Sec.): 0.000 Deg.

Fri Jun 11 11:07:03 1999 Page 4
EUSU model report with generators off-line, load center tie breakers open
and SUB10 & 15 tie breakers open

GENERATION CONTRIBUTION DATA

CONTRIBUTION NAME	BUS NAME	VOLTAGE L-L	MVA	X"d	X/R
UTIL	PSS-NCE-1507AA	13800.0	291.67		
Three Phase	Contribution:		12203.0 AMPS		6.15
Single Line to Ground Contribution:			788.00 AMPS		0.0490
Pos Sequence Impedance (100 MVA Base)			0.0551 + J	0.3384 PU	
Zero Sequence Impedance (100 MVA Base)			15.80 + J	0.1027 PU	

EUSU model report with generators off-line, load center tie breakers open
and SUB10 & 15 tie breakers open

DATE: 6:11:1999
TIME: 11: 7: 4.81

ALL INFORMATION PRESENTED IS FOR REVIEW, APPROVAL
INTERPRETATION AND APPLICATION BY A REGISTERED ENGINEER ONLY

SKM POWER*TOOLS FOR WINDOWS
A_FAULT SHORT CIRCUIT ANALYSIS REPORT
COPYRIGHT SKM SYSTEMS ANALYSIS, INC. 1996-1997

F A U L T S T U D Y S U M M A R Y
(FOR APPLICATION OF LOW VOLTAGE BREAKERS)
PRE FAULT VOLTAGE: 1.0000
MODEL TRANSFORMER TAPS: NO

BUS RECORD NO NAME	VOLTAGE L-L	A V A I L A B L E 3 PHASE	X/R	F A U L T LINE/GRND	D U T I E S (KA) X/R
PSS-NCE-1507AA	13800.	12.203	6.15	0.788	0.05
DUMMY-430	13800.	12.188	6.13	0.788	0.05
PCC-NCE-773	480.	27.698	9.53	28.446	9.67

3 FAULTED BUSES, 4 BRANCHES, 1 CONTRIBUTIONS
UNBALANCED FAULTS REQUESTED

*** SHORT CIRCUIT STUDY COMPLETE ***

STATION "A"

Bussmann®

Worldwide Circuit Protection Solutions

Short Circuit Calculation Results

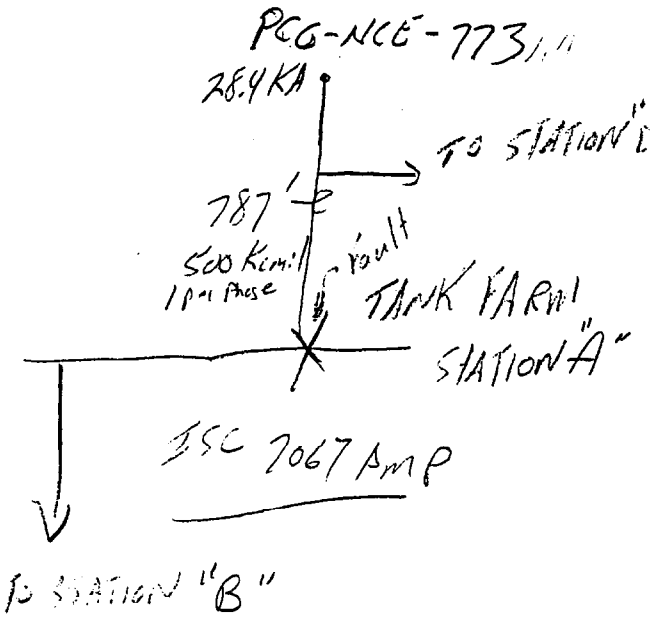
7/15/99
2:27 PM

Three Phase Transformer
Fault at the End of a Run of Cable

Three Single Conductors
Copper Cable
Non-Magnetic Conduit
Wire Size 500

787 ft Length of Run
1 Conductors Per Phase
28446 amp Line to Line Short Circuit Current at Beginning of Run
480 V Line to Line Voltage

Three Phase Line to Line Short Circuit Current = 7067.716 AMPS



INSTRUMENTATION TRAILER
TRANSFORMER ISC

Bussmann®

Worldwide Circuit Protection Solutions

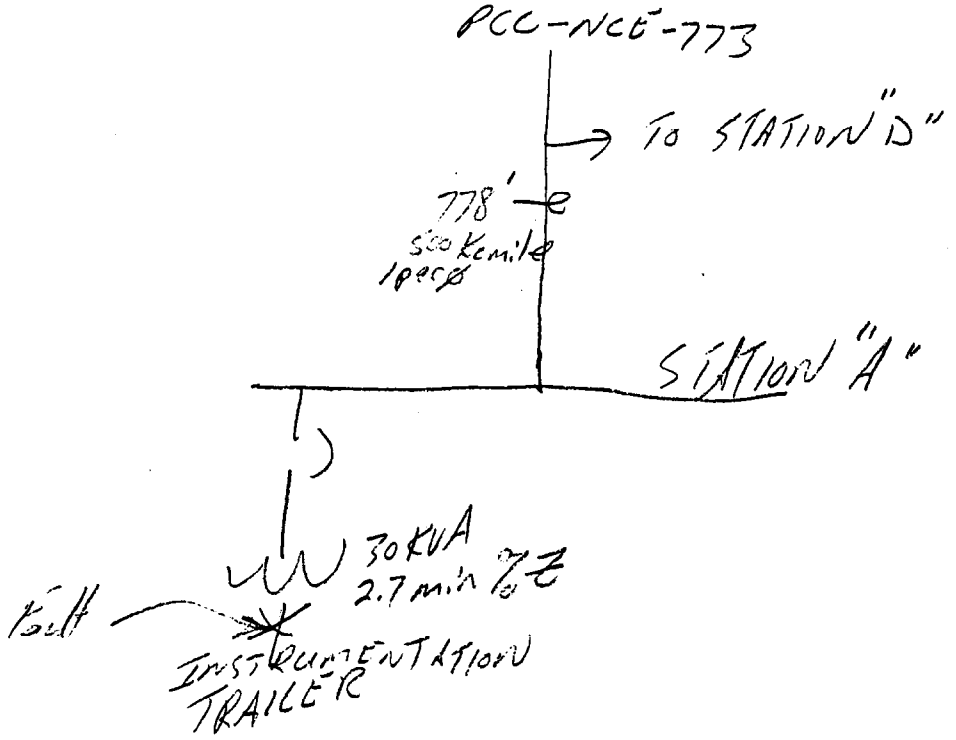
Short Circuit Calculation Results

7/16/99
1:32 PM

Three Phase Transformer
Fault on Load Side of Transformer when Short Circuit Current on Primary is Known

30 KVA
480 V Primary Line to Line Voltage
208 V Secondary Line to Line Voltage
2.7%Z
7067Short Circuit Current Available on Primary Transformer

Three Phase Line to Line Short Circuit Current = 2593.709 AMPS



STATION "B"

Bussmann®

Worldwide Circuit Protection Solutions

Short Circuit Calculation Results

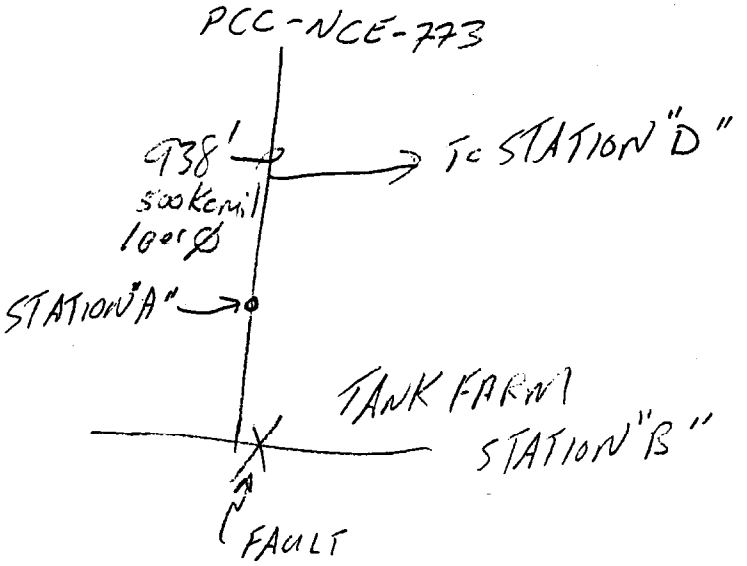
7/15/99
2:31 PM

Three Phase Transformer
Fault at the End of a Run of Cable

Three Single Conductors
Copper Cable
Non-Magnetic Conduit
Wire Size 500

938 ft Length of Run
1 Conductors Per Phase
28446 amp Line to Line Short Circuit Current at Beginning of Run
480 V Line to Line Voltage

Three Phase Line to Line Short Circuit Current = 6177.014 AMPS



STATION "C"

Bussmann®

Worldwide Circuit Protection Solutions

Short Circuit Calculation Results

7/15/99
2:39 PM

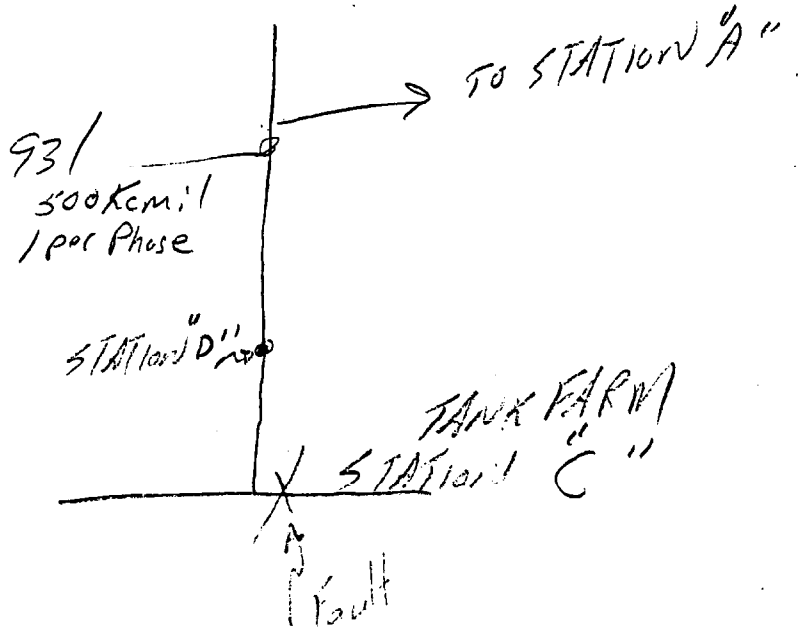
Three Phase Transformer
Fault at the End of a Run of Cable

Three Single Conductors
Copper Cable
Non-Magnetic Conduit
Wire Size 500

931 ft Length of Run
1 Conductors Per Phase
28446 amp Line to Line Short Circuit Current at Beginning of Run
480 V Line to Line Voltage

Three Phase Line to Line Short Circuit Current = 6213.313 AMPS

PCC-NCE-773



STATION "D"

Bussmann®

Worldwide Circuit Protection Solutions

Short Circuit Calculation Results

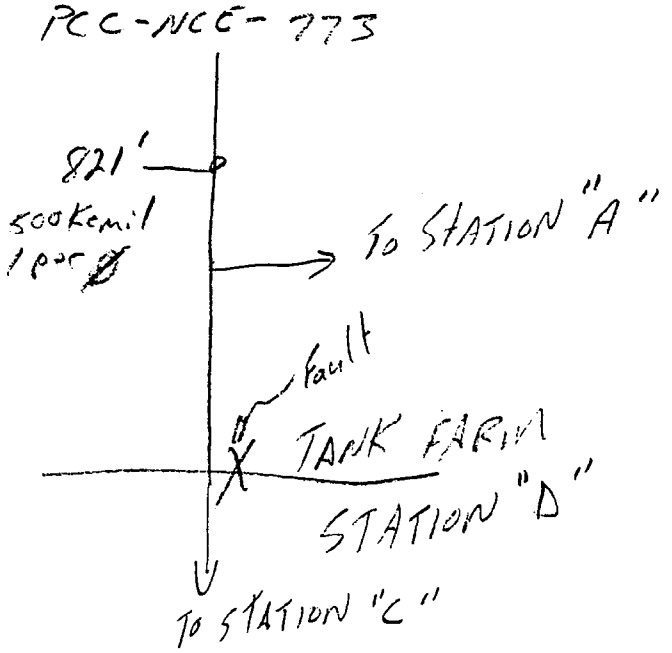
7/15/99
2:36 PM

Three Phase Transformer
Fault at the End of a Run of Cable

Three Single Conductors
Copper Cable
Non-Magnetic Conduit
Wire Size 500

821 ft Length of Run
1 Conductors Per Phase
28446 amp Line to Line Short Circuit Current at Beginning of Run
480 V Line to Line Voltage

Three Phase Line to Line Short Circuit Current = 6845.458 AMPS



TANK FARM
VOLTAGE DROP STUDIES

07/20/99

Voltage Drop AT STATION "A"
TANK FARM

WireGuide99

THE WIRE GUIDE
OLTEK SOFTWARE™

Voltage Drop Report

Copper Wire
75°C THW/RHW/USE
75°C Wire Term Rating
3 Phase AC
PVC Conduit

Solve for Voltage Drop

AC Voltage	480
Amperage	138
Amperage Per Cable	138
Ambient Temperature	30 °C
Wire Operating Temp	75 °C
One Way Length (FT)	787
Wire Size	#500
Quantity Per Phase	1
AC Resistance (Ohms)	0.0368

5.07885 V
1.05809 %

Solve for Length

AC Voltage
Amperage
Amperage Per Cable
Ambient Temperature
Wire Operating Temp
Voltage Drop
Wire Size
Quantity Per Phase
AC Resistance (Ohms)

Solve for Wire Size

AC Voltage
Amperage
Amperage Per Cable
Ambient Temperature
Wire Operating Temp
One Way Length (FT)
Voltage Drop
AC Resistance (Ohms)

For parallel runs, each conductor is assumed to have equal resistance.
For parallel runs, each conduit is assumed to have not more than three current carrying conductors each.
V Drop = (2)(Amps)(Length)(R2)(Cos(30°)) where R2 = (R1 from NEC)(1+(0.00323)(WireOperTemp(°C)-75))

Visit Zoltek Software on the Internet at http://www.zoltek-services.com or call 800-965-8351.

VoltaDROP AT STATION "B"
TANK FARM

WireGuide99

THE WIRE GUIDE
ZOLTEK SOFTWARE™

Voltage Drop Report

Copper Wire
75°C THW/RHW/USE
75°C Wire Term Rating
3 Phase AC
PVC Conduit

Solve for Voltage Drop

AC Voltage	480
Amperage	138
Amperage Per Cable	138
Ambient Temperature	30 °C
Wire Operating Temp	75 °C
One Way Length (FT)	938
Wire Size	#500
Quantity Per Phase	1
AC Resistance (Ohms)	0.04386

6.05331 V
1.2611 %

Solve for Length

AC Voltage
Amperage
Amperage Per Cable
Ambient Temperature
Wire Operating Temp
Voltage Drop
Wire Size
Quantity Per Phase
AC Resistance (Ohms)

Solve for Wire Size

AC Voltage
Amperage
Amperage Per Cable
Ambient Temperature
Wire Operating Temp
One Way Length (FT)
Voltage Drop
AC Resistance (Ohms)

For parallel runs, each conductor is assumed to have equal resistance.
For parallel runs, each conduit is assumed to have not more than three current carrying conductors each.
V Drop = (2)(Amps)(Length)(R2)(Cos(30°)) where R2 = (R1 from NEC)(1+(0.00323)(WireOperTemp(°C)-75))

Visit Zoltek Software on the Internet at http://www.zoltek-services.com or call 800-965-8351.

Voltage DROP STATION "C"
TANK FARM

WireGuide99

THE WIRE GUIDE
OLTEK SOFTWARE™

Voltage Drop Report

Copper Wire
75°C THW/RHW/USE
75°C Wire Term Rating
3 Phase AC
PVC Conduit

Solve for Voltage Drop

AC Voltage	480
Amperage	138
Amperage Per Cable	138
Ambient Temperature	30 °C
Wire Operating Temp	75 °C
One Way Length (FT)	931
Wire Size	#500
Quantity Per Phase	1
AC Resistance (Ohms)	0.04353

6.00814 V
1.25169 %

Solve for Length

AC Voltage
Amperage
Amperage Per Cable
Ambient Temperature
Wire Operating Temp
Voltage Drop
Wire Size
Quantity Per Phase
AC Resistance (Ohms)

Solve for Wire Size

AC Voltage
Amperage
Amperage Per Cable
Ambient Temperature
Wire Operating Temp
One Way Length (FT)
Voltage Drop
AC Resistance (Ohms)

For parallel runs, each conductor is assumed to have equal resistance.
For parallel runs, each conduit is assumed to have not more than three current carrying conductors each.
V Drop = (2)(Amps)(Length)(R2)(Cos(30°)) where R2 = (R1 from NEC)(1+(0.00323)(WireOperTemp(°C)-75))

Visit Zoltek Software on the Internet at http://www.zoltek-services.com or call 800-965-8351.

Voltage Drop STATION D
TANK FARM 1

WireGuide99

THE WIRE GUIDE
OLTEK SOFTWARE™

Voltage Drop Report

Copper Wire
75°C THW/RHW/USE
75°C Wire Term Rating
3 Phase AC
PVC Conduit

Solve for Voltage Drop

AC Voltage	480
Amperage	138
Amperage Per Cable	138
Ambient Temperature	30 °C
Wire Operating Temp	75 °C
One Way Length (FT)	821
Wire Size	#500
Quantity Per Phase	1
AC Resistance (Ohms)	0.03839

5.29826 V
1.1038 %

Solve for Length

AC Voltage
Amperage
Amperage Per Cable
Ambient Temperature
Wire Operating Temp
Voltage Drop
Wire Size
Quantity Per Phase
AC Resistance (Ohms)

Solve for Wire Size

AC Voltage
Amperage
Amperage Per Cable
Ambient Temperature
Wire Operating Temp
One Way Length (FT)
Voltage Drop
AC Resistance (Ohms)

For parallel runs, each conductor is assumed to have equal resistance.
For parallel runs, each conduit is assumed to have not more than three current carrying conductors each.
V Drop = (2)(Amps)(Length)(R2)(Cos(30°)) where R2 = (R1 from NEC)(1+(0.00323)(WireOperTemp(°C)-75))

Visit Zoltek Software on the Internet at http://www.zoltek-services.com or call 800-965-8351.

INTEC DATA BASE

XFR-NEC-392
AND
PCC-NEC-773

LOADING DATA

07/20/99

Equipment Configuration Database Systems
Transformer
XFR-NCE-392

Revision Number	Last Revised Date	Status	Date of Status
3	3/5/98	Active	5/1/98

Comments: VERIFIED 02/04/92; TAPS-5, 2 +, 2 -, FROM PCC-STA-550A #5 VIA PSS

- **Location Information**
- **Electrical Information**
- **Physical Information**
- **Drawing References**

Print Data Only

« To Transformer Detail Sel. | « To Transformer Selection | « To Device Type Selection
« To INTEC Elec Directory | « To ECDS Areas | « To ECDS Home Page

For Intranet Application errors contact Charles Barrand.

For database information/changes contact Tom Woods.

Location Information

North Coordinates	East Coordinates	Building Number (or located near bldg.)
695972	297441	1750

Location: N TB-2

Return to Top of Page

« To Transformer Detail Sel | « To Transformer Selection | « To Device Type Selection
« To INTEC Elec Directory | « To ECDS Areas | « To ECDS Home Page

For Intranet Application errors contact Charles Barrand.

For database information/changes contact Tom Woods.

Electrical Information

Pri. Volts 13,800	**Sec. Volts** 480	**Pri. Current** 62	**Sec. Current** 1,804
Pri. Winding DELTA	**Sec. Winding** WYE	**Lightning Arrestor Type**	**Lightning Arrestor Voltage**
Meas. Pri. Volts 0	**Meas. Sec. Volts** 0	**Meas. Pri. Current** 0	**Meas. Sec. Current** 0
Self Cooled KVA 1,500.00	**Fan Cooled KVA** 1,680.00	**Connected KVA** 1,149.00	**Remaining KVA** 348.00
Inrush Current 0	**Pri. Tap Changer** 13,800	**Sec. Tap Changer** 480	**Fuse Size**
Secondary Fuse Size	**Line Power Cable No.**	**Load Power Cable No.**	**Phase** 3

Return to Top of Page

« To Transformer Detail Sel | « To Transformer Selection | « To Device Type Selection
« To INTEC Elec Directory | « To ECDS Areas | « To ECDS Home Page

For Intranet Application errors contact Charles Barrand.

For database information/changes contact Tom Woods.

Physical Information

Manufacture McGRAW EDISON	**Model Number** UNKNOWN	**Serial Number** C-45662-1-	**Series**
Insulation Class	**Per Cent Impedence** 5	**Max Temp Rise** 55 C	**Type Cool** OAFC
Oil Filled Type MINERAL	**Oil Weight** 7620		
Indoors No	**Self Cooled** Yes	**Fan Cooled** No	**Liquid Cooled** No
Oil Drain Size	**Pressure Relief Device**	**Inert Gas**	**Oil Capacity** 528

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To INTEC Elec Directory | To ECDS Areas | To ECDS Home Page

For Intranet Application errors contact Charles Barrand.

For database information/changes contact Tom Woods.

Drawing References

Drawing	Drawing Number
Building One Line	056181 057286

VD Storage Location:

Plot Plan:	Area Code:
055705	055714

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PCC-NCE-773

Date Printed: 7/12/1999

REVISION NUM.: 17	LAST REV. DATE: 5/25/99	NORTH COORD. : 695950.5	EAST COORD.: 297432.1
BUILDING NUMBER: 1750	LOCATION: NE PLNT		
MANUFACTURER: GENERAL ELECTRIC		MODEL NUMBER: AKD-8	

Volts Rated	Current Rated	KVA Rated	ISC Rated
480	2,000	1,663	42,000

Bus	Left: PCC-NCE-773
Remaining KVA	1,080
# of Circuits	22
Measured Volts	0
Measured Current	578
Measured KVA	0
Measured Date	
Comments	
Restricted Current	1,800
Restricted KVA	1,497
ISC Available	0
Connected KVA	417
Phases	03
Rotation	A,B,C CW

Plot Plan: 055705	Area Code: 055714
Drawing	**Drawing Number**
One Line	057286
One Line	057089
Building	056181

PCC-NCE-773 Circuits

Date Printed: 7/12/1999

***** Main Breaker Size [2000] *****

Ckt	Fuse or Bkr	# Poles	No. of Wires	Wire Size	Load Kva	Feed To	Description
			0		100	???-???-	
1			0		0		METERING SECTION
2	2000	03	3	500	0		MAIN BREAKER
3			0		0		PT SECTION
4	135	03	3	1	68	XFR-NCE-323	TO DSW-NCE-764 654
4			0		0		
5	300	03	3	1	1	XFR-YDK-674	TO PCC-YDK-1582
5			0		0		
6	300	03	3	1	132	DSW-NCE-160	TO PCC-NCE-160 664
7	330	03	3	350	113	PCC-NCE-762	PWR PNL, RM 127 699
8		03	0		0		SPACE
9			0		0	DSW-NCE-1	FEED TO FS-WM-C40 AT STATION "C" THEN TO PCC-WM-302 AND ALSO FS-WM-186 THEN TO PCC-WM-296
9	600	03	6	500	0	FS-NCE-9	TO XFR-TR-35 THEN TO LP-YDK-1062
10	300	03	6	500	48	DSW-NCE-1678	XFR-NCE-1678
11	300	03	3	350	0		TO ?

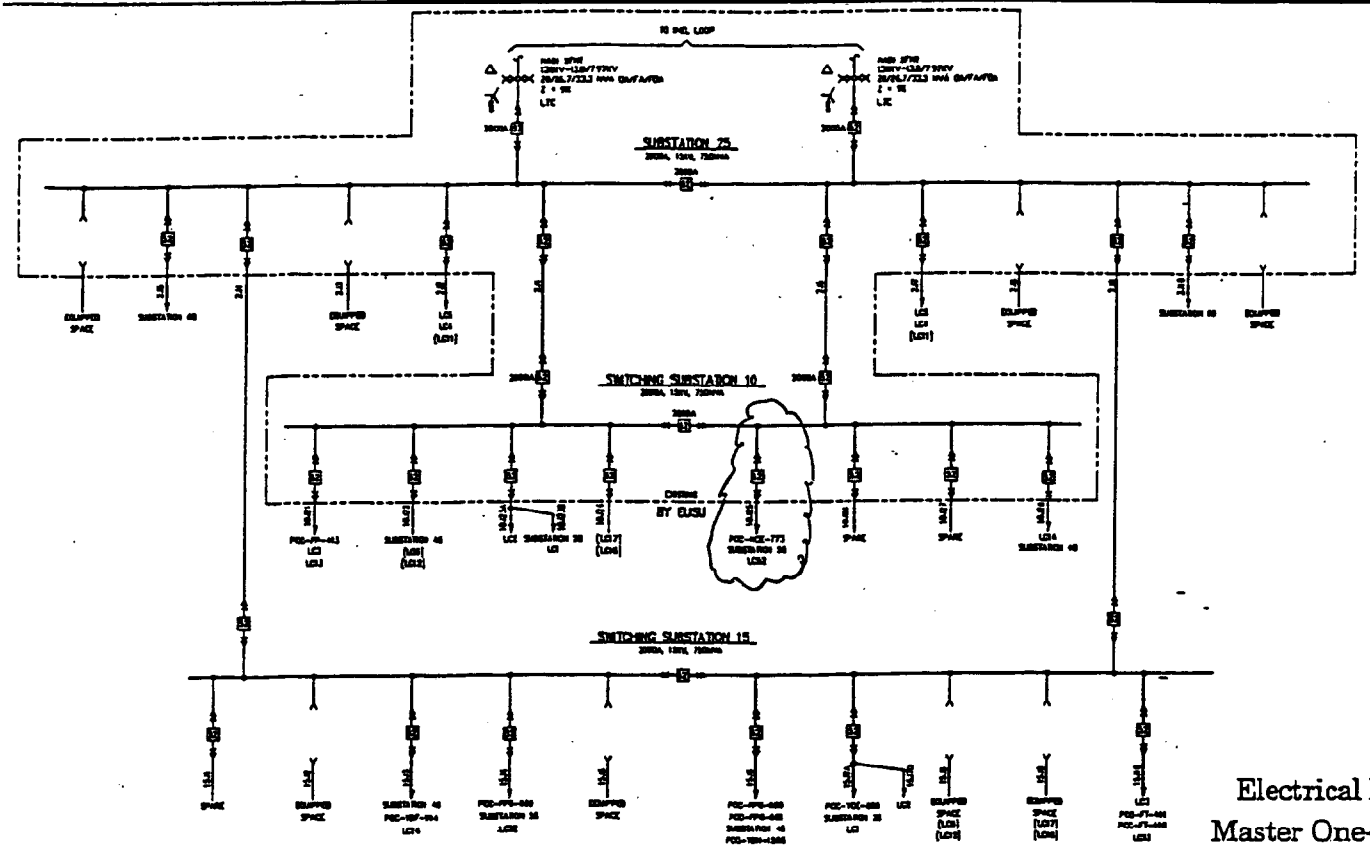
RAYTHEON
DESIGN STUDIES
ICPP
ELECTRICAL AND UTILITY SYSTEMS
UPGRADE PROJECT
CONCEPTUAL DESIGN REPORT
1994

SHORT CIRCUIT
AND
LOADING DATA
PCC-NEC-773

07/20/99

ited States Department of Energy
Idaho Operations Office

ICPP Electrical and Utility Systems Upgrade Project
Conceptual Design Report



Electrical Distribution
Master One-Line Diagram

May 1994

Volume VI

Raytheon
Engineers & Constructors

PCC-NCE-773

APPENDIX M

ELECTRICAL LOAD FLOW ANALYSIS

Raytheon Engineers & Constructors	CALCULATION SUMMARY & CONTROL SHEET Page 1 of 2	CALCULATION SET NO. 17-05			
		PRELIM. X	FINAL X	VOID	REVISION
PROJECT: ICPP ELECTRICAL & UTILITY SYSTEMS UPGRADE PROJECT, CONCEPTUAL DESIGN		DISCIPLINE	ELECTRICAL		
		J.O.	9354.171		

STRUCTURE OR SYSTEM: Normal and Standby Power DESIGN CLASSIFICATION:

SUBJECT: Load Flow Analysis

COMPLETED BY Wallace Nuttall DATE 4/15/94

CHECKED BY James [illegible] DATE 4-25-94

APPROVED BY R. G. Rathman DATE 5/9/94
SDE OR MGR OF STAFF GROUP

DISTRIBUTION

REASON FOR REVISION:

TOTAL NUMBER OF SHEETS IN THIS ISSUE 6

SHEETS REVISED, ADDED, OR DELETED

PROBLEM STATEMENT:

1. Determine power flow, voltage drop, cable loading, and transformer loading for the normal and standby power configurations.
2. Load Flow Analysis is to be done for the 13.8 kV system, the 2400V system, major 480V buses, the facilities directed in the statement of work, and any facilities that have their distribution system modified by the EUSU project.
3. Load Flow Analysis is to be done for the normal power system and the system when supplied only by site generation.

SUMMARY CONCLUSIONS:

The details of the Load Flow Analysis have been printed out from the DAPPER program. Any buses or feeders with excessive voltage drop have been flagged by the program. Excessive voltage drops were corrected as much as possible by using taps on transformers, with the result that the electrical distribution system can be operated with the proposed design with acceptable voltage regulation. Cable loading on the 15kV distribution system has been summarized in the 15kV Cable Loading Table.

Raytheon Engineers & Constructors	GENERAL COMPUTATION SHEET	CALCULATION-SET NO. 17-05			REV.	COMP. BY	CHK'D BY
		PRELIM. X	FINAL	VOID	0	WW DATE 4/15/94	DATE 4-22-94
PROJECT: INEL ICPP Electrical & Utility System Upgrade Project		SHEET 1 OF 4				DATE	DATE
SUBJECT: Load Flow Analysis		J.O. 9354.171					

Problem Statement

Determine power flow, voltage drop, cable loading, and transformer loading for the normal and standby power configurations. Load Flow Analysis is to be done for the 13.8kV system, the 2400V system, major 480V buses, the facilities directed in the statement of work, and any facilities that have their distribution system modified by the EUSU project. Load Flow Analysis is to be done for the normal power system and the system when supplied only by site generation.

Results and Conclusions

The results of the Load Flow Analysis have been printed out from the DAPPER program. Excessive voltage drops were corrected as much as possible by using taps on transformers. Cable loading on the 15kV distribution system has been summarized in the 15kV Cable Loading Table.

Design Data

The data base for the DAPPER program input has been modeled after the WINCO existing and RE&C proposed one line diagrams. Load information was obtained from the WINCO Electrical and Utility Load Requirements, revision 3 dated 12/29/93. This load data has been further organized in the RE&C document Load List by Source as Expected in 1997.

Assumptions

The following is a list of significant assumptions made to expedite the load flow analysis:

1. The demand factor for normal loads (any load that is not on standby power) is 40%.

2. The demand factor for standby loads is 49%.

3. The impedance of 2500 kVA transformers is 5.75% unless otherwise specified.

4. The secondary of the main utility transformers will have automatic load tap changers.

5. The power factor for all loads is 80%.

Discussion

Load Flow Configurations

There are two cases for the load flow/demand analysis studies:

- Normal Configuration

  The plant is receiving power from the INEL 138 kV loop through the two main transformers. The standby generators are disconnected. The Substation 25 tie breaker is closed and all other bus tie breakers are open. Both normal and standby loads are connected with a demand factor of 40% for normal loads and 49% for standby loads.

- Standby Configuration

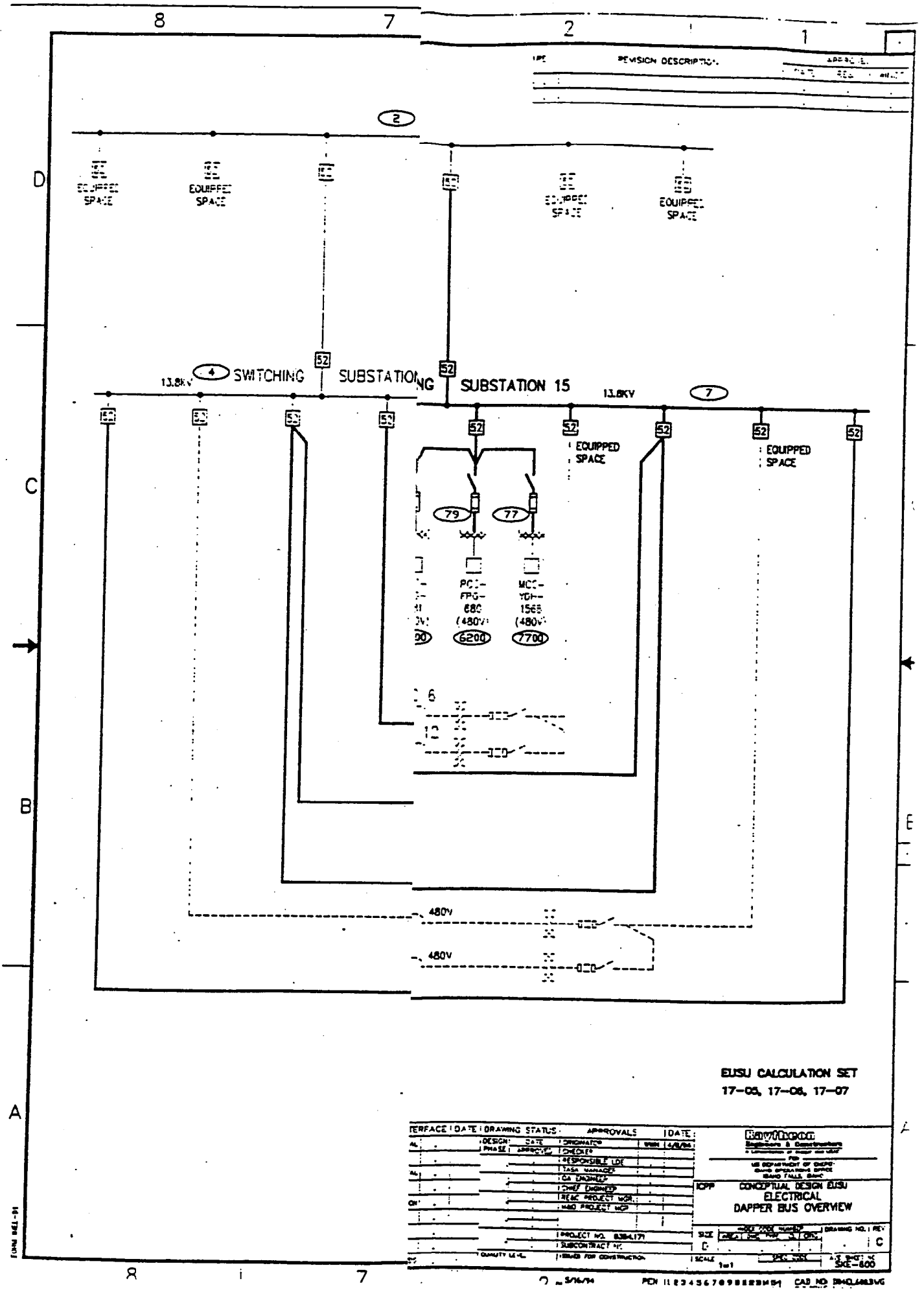
  The plant is running on standby generation. The two main transformers are disconnected. Substation 60 has four 2000 kVA generators connected, Substation 55 has two 1250 kVA generators connected, and the generator on Substation 45 is disconnected to model a worst case condition with the largest generator out of service. The Substation 25 tie breaker is closed and all other bus tie breakers are open. Only standby loads are connected with a demand factor of 49%.

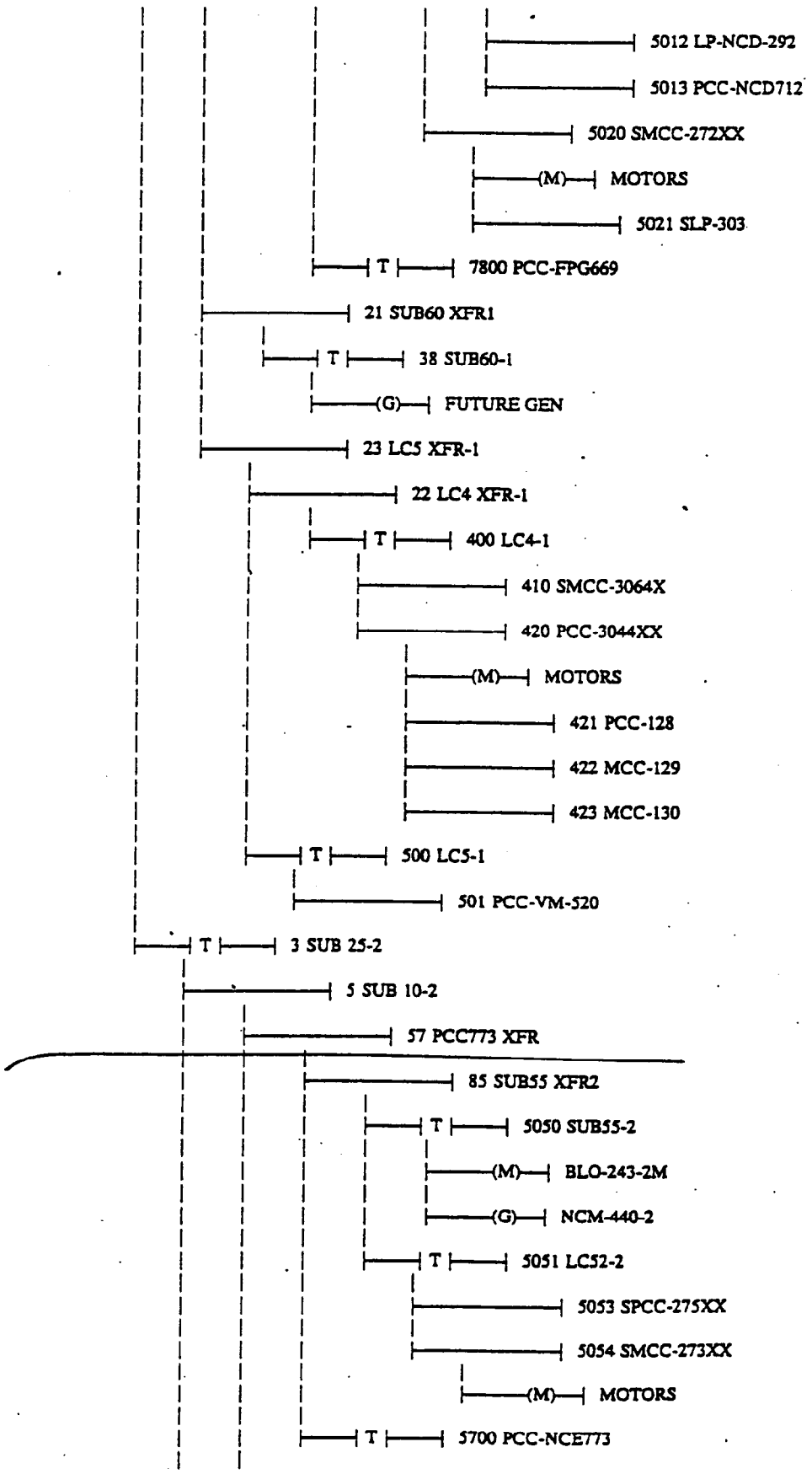
15 kV System

The 15 kV distribution system has minimal voltage drop concerns due to the large cable used in the underground ductbank system. 500 kcmil cable has been used to assure that all cables can handle up to 300 amps of load after derating for underground ductbank conditions. However, most of these cables carry substantially less current in normal operating conditions, resulting in negligible voltage drop across feeder cables.

The use of automatic load tap changers on the main transformers further improves system voltage by maintaining the voltage during heavy loading conditions. No further modifications to the 15kV system are necessary for voltage drop considerations.

The current configuration is adequate for the worst case loading on all 15 kV feeder cables. Reference the 15 kV Cable Loading Table for a summary of these cables and


REVISION DESCRIPTION
EQUIPPED SPACE
EQUIPPED SPACE
EQUIPPED SPACE
EQUIPPED SPACE
13.8KV
SWITCHING
SUBSTATION
SUBSTATION 15
13.8KV
EQUIPPED SPACE
EQUIPPED SPACE
79
77
6200
7700
480V
480V
EUSU CALCULATION SET
17-05, 17-06, 17-07
CONCEPTUAL DESIGN EUSU
ELECTRICAL
DAPPER BUS OVERVIEW
SKE-600


5012 LP-NCD-292
5013 PCC-NCD712
5020 SMCC-272XX
(M)
MOTORS
5021 SLP-303
T
7800 PCC-FPG669
21 SUB60 XFR1
T
38 SUB60-1
(G)
FUTURE GEN
23 LC5 XFR-1
22 LC4 XFR-1
T
400 LC4-1
410 SMCC-3064X
420 PCC-3044XX
(M)
MOTORS
421 PCC-128
422 MCC-129
423 MCC-130
T
500 LC5-1
501 PCC-VM-520
T
3 SUB 25-2
5 SUB 10-2
57 PCC773 XFR
85 SUB55 XFR2
T
5050 SUB55-2
(M)
BLO-243-2M
(G)
NCM-440-2
T
5051 LC52-2
5053 SPCC-275XX
5054 SMCC-273XX
(M)
MOTORS
T
5700 PCC-NCE773

INEL ICPP ELECTRICAL & UTILITY SYSTEM UPGRADE PROJECT CONCEPTUAL DESIGN

DEMAND LOAD ANALYSIS ON NORMAL POWER CONFIGURATION (FILE DLAN)

UNITED ENGINEERS AND CONSTRUCTORS

DATE: 11 APR 94
TIME: 5 54 PM

ALL INFORMATION PRESENTED IS FOR REVIEW, APPROVAL, INTERPRETATION
AND APPLICATION BY A REGISTERED ENGINEER ONLY

DAPPER (DEMAND LOAD ANALYSIS MINI/MICRO VERSION 3.5 LEVEL 2.1)
COPYRIGHT SKM SYSTEMS ANALYSIS, INC. 1983

DEMAND LOAD ANALYSIS ON NORMAL POWER CONFIGURATION (FILE DLAN)

UNITED ENGINEERS AND CONSTRUCTORS

LOAD SUMMARY

****

LOAD SCHEDULE FOR 4 SUB 10-1 13800. VOLTS LINE TO LINE
SOURCE OF PWR 2 SUB 25-1

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
GENERAL LOADS	14.0	.6	5.6	.2	5.6	.2	-80.0
BRANCH LOADS							
47 SUB20 XFR1	2383.6	99.7	982.8	41.1	1022.7	42.8	-80.0
51 LC2 XFR-1	2147.9	89.9	902.2	37.7	963.3	40.3	-80.0
82 PCC413 XFR	6620.2	277.0	2854.0	119.4	3158.8	132.2	-80.0
87 SUB45 XFR1	2929.8	122.6	1431.1	59.9	1575.6	65.9	-80.0
TOTALS	14095.5	589.7	6175.7	258.4	6726.1	281.4	-80.0

LOAD SCHEDULE FOR 5 SUB 10-2 13800. VOLTS LINE TO LINE
SOURCE OF PWR 3 SUB 25-2

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
GENERAL LOADS	14.0	.6	5.6	.2	5.6	.2	-80.0
BRANCH LOADS							
57 PCC773 XFR	2558.9	107.1	1163.1	48.7	1303.9	54.6	-80.0
62 LC14 XFR-2	.0	.0	.0	.0	WARNING: LOAD IS ZERO		
TOTALS	2572.9	107.6	1168.7	48.9	1309.5	54.8	-80.0

LOAD SCHEDULE FOR 6 SUB 15-1 13800. VOLTS LINE TO LINE
SOURCE OF PWR 2 SUB 25-1

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
BRANCH LOADS							
59 SUB40 XFR1	3283.8	137.4	1450.0	60.7	1475.7	61.7	-80.0
78 PCC669 XFR	3021.9	126.4	1339.3	56.0	1467.9	61.4	-80.0
TOTALS	6305.7	263.8	2789.3	116.7	2943.6	123.2	-80.0

DEMAND LOAD ANALYSIS ON NORMAL POWER CONFIGURATION (FILE DLAN)

UNITED ENGINEERS AND CONSTRUCTORS

LOAD SUMMARY

****

LOAD SCHEDULE FOR 5700 PCC-NGE773 480. VOLTS LINE TO LINE
SOURCE OF PWR 57 PCC773 XFR

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
GENERAL LOADS	659.0	792.7	263.6	317.1	263.6	317.1	-80.0
FUTURE	57.9	69.6	23.2	27.9	23.2	27.9	-80.0
TOTALS	716.9	862.3	286.8	344.9	286.8	344.9	-80.0

LOAD SCHEDULE FOR 6000 PCCYDE808 480. VOLTS LINE TO LINE
SOURCE OF PWR 58 PCC808 XFR

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
GENERAL LOADS	1245.5	1498.1	498.2	599.2	498.2	599.2	-80.0
TOTALS	1245.5	1498.1	498.2	599.2	498.2	599.2	-80.0

LOAD SCHEDULE FOR 6200 PCCFPG680 480. VOLTS LINE TO LINE
SOURCE OF PWR 79 PCC680 XFR

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
GENERAL LOADS	1054.7	1268.6	421.9	507.4	421.9	507.4	-80.0
FUTURE	100.0	120.3	40.0	48.1	40.0	48.1	-80.0
TOTALS	1154.7	1388.9	461.9	555.6	461.9	555.6	-80.0

LOAD SCHEDULE FOR 6300 PCC-FP-413 480. VOLTS LINE TO LINE
SOURCE OF PWR 82 PCC413 XFR

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
FUTURE	535.2	643.7	214.1	257.5	214.1	257.5	-80.0
BRANCH LOADS							
6301 MCC-FP-357	110.5	132.9	44.2	53.2	44.2	53.2	-80.0
6305 MCC-FI-358	312.4	375.8	125.0	150.3	125.0	150.3	-80.0
6308 MCC-FM-365	488.8	587.9	195.5	235.2	195.5	235.2	-80.0
6320 SMCC-FV363	772.0	928.6	378.3	455.0	480.2	577.6	-80.0
TOTALS	2218.9	2668.9	957.0	1151.1	1059.0	1273.7	-80.0

LOAD FLOW ANALYSIS ON NORMAL POWER CONFIGURATION (FILE LFAN)

RAYTHEON ENGINEERS AND CONSTRUCTORS

BALANCED VOLTAGE DROP AND LOAD FLOW ANALYSIS (BRANCH LOAD REPORT)

****

VOLTAGE EFFECT ON LOADS MODELED TRANSFORMER VOLTAGE DROP MODELED
VOLTAGE DROP CRITERIA: BRANCH = 4.00 % BUS = 5.00
PER UNIT DRIVING VOLTAGE = 1.0000

```
LOAD BUS:   57 PCC773 XFR DESIGN VOLTAGE: 13800 LOAD VOLTAGE: 13851 %VD:  -.4
-------------------------                        VOLTAGE ANGLE:  -3.1 DEGREES
LOAD FROM:    5 SUB 10-2     FEEDER AMPS:    49 VOLTAGE DROP:   16. %VD:  .11
PROJECTED POWER FLOW:   935. KW   716. KVAR  1178. KVA    PF:   .79   LAGGING
LOSSES THRU FEEDER:       1. KW       1. KVAR       1. KVA
```

```
LOAD BUS:   58 PCC808 XFR DESIGN VOLTAGE: 13800 LOAD VOLTAGE: 13833 %VD:  -.2
-------------------------                        VOLTAGE ANGLE:  -3.1 DEGREES
LOAD FROM:    7 SUB 15-2     FEEDER AMPS:    92 VOLTAGE DROP:   22. %VD:  .16
PROJECTED POWER FLOW:  1736. KW  1347. KVAR  2197. KVA    PF:   .79   LAGGING
LOSSES THRU FEEDER:       2. KW       3. KVAR       4. KVA
```

```
LOAD BUS:   59 SUB40 XFR1 DESIGN VOLTAGE: 13800 LOAD VOLTAGE: 13846 %VD:  -.3
-------------------------                        VOLTAGE ANGLE:  -3.1 DEGREES
LOAD FROM:    6 SUB 15-1     FEEDER AMPS:    61 VOLTAGE DROP:   16. %VD:  .12
PROJECTED POWER FLOW:  1157. KW   893. KVAR  1461. KVA    PF:   .79   LAGGING
LOSSES THRU FEEDER:       1. KW       2. KVAR       2. KVA
```

```
LOAD BUS:   60 SUB40 XFR2  *** NO LOAD SPECIFIED ***
```

```
LOAD BUS:   61 LC14 XFR-1 DESIGN VOLTAGE: 13800 LOAD VOLTAGE: 13845 %VD:  -.3
-------------------------                        VOLTAGE ANGLE:  -3.1 DEGREES
LOAD FROM:   59 SUB40 XFR1   FEEDER AMPS:    29 VOLTAGE DROP:    1. %VD:  .01
PROJECTED POWER FLOW:   554. KW   425. KVAR   698. KVA    PF:   .79   LAGGING
LOSSES THRU FEEDER:       0. KW       0. KVAR       0. KVA
```

```
LOAD BUS:   62 LC14 XFR-2  *** NO LOAD SPECIFIED ***
```

```
LOAD BUS:   77 PCC1568XFR DESIGN VOLTAGE: 13800 LOAD VOLTAGE: 13852 %VD:  -.4
-------------------------                        VOLTAGE ANGLE:  -3.1 DEGREES
LOAD FROM:   79 PCC680 XFR   FEEDER AMPS:    13 VOLTAGE DROP:    2. %VD:  .01
PROJECTED POWER FLOW:   250. KW   190. KVAR   314. KVA    PF:   .80   LAGGING
LOSSES THRU FEEDER:       0. KW       0. KVAR       0. KVA
```

LOAD FLOW ANALYSIS ON NORMAL POWER CONFIGURATION (FILE LFAN)

RAYTHEON ENGINEERS AND CONSTRUCTORS

BALANCED VOLTAGE DROP AND LOAD FLOW ANALYSIS (BRANCH LOAD REPORT)

****

VOLTAGE EFFECT ON LOADS MODELED TRANSFORMER VOLTAGE DROP MODELED
VOLTAGE DROP CRITERIA: BRANCH = 4.00 % BUS = 5.00
PER UNIT DRIVING VOLTAGE = 1.0000

LOAD BUS: 5051 LC52-2 DESIGN VOLTAGE: 480 LOAD VOLTAGE: 476 %VD: .8
VOLTAGE ANGLE: -3.7 DEGREES
LOAD FROM: 85 SUB55 XFR2 TRANSF AMPS: 832 VOLTAGE DROP: 6. %VD: 1.17
PROJECTED POWER FLOW: 548. KW 413. KVAR 686. KVA PF: .80 LAGGING
LOSSES THRU TRANSF: 1.9 KW 10.8 KVAR 11.0 KVA

LOAD BUS: 5053 SPCC-275XX DESIGN VOLTAGE: 480 LOAD VOLTAGE: 475 %VD: 1.0
VOLTAGE ANGLE: -3.7 DEGREES
NET BRANCH DIVERSITY LOAD: 93. KW 70. KVAR
LOAD FROM: 5051 LC52-2 FEEDER AMPS: 142 VOLTAGE DROP: 1. %VD: .14
PROJECTED POWER FLOW: 93. KW 70. KVAR 117. KVA PF: .80 LAGGING
LOSSES THRU FEEDER: 0. KW 0. KVAR 0. KVA

LOAD BUS: 5054 SMCC-273XX DESIGN VOLTAGE: 480 LOAD VOLTAGE: 472 %VD: 1.8
VOLTAGE ANGLE: -3.9 DEGREES
NET BRANCH DIVERSITY LOAD: 451. KW 338. KVAR
LOAD FROM: 5051 LC52-2 FEEDER AMPS: 690 VOLTAGE DROP: 5. %VD: .95
PROJECTED POWER FLOW: 451. KW 338. KVAR 563. KVA PF: .80 LAGGING
LOSSES THRU FEEDER: 3. KW 5. KVAR 6. KVA

LOAD BUS: 5700 PCC-NCE773 DESIGN VOLTAGE: 480 LOAD VOLTAGE: 478 %VD: .4
VOLTAGE ANGLE: -3.5 DEGREES
NET BRANCH DIVERSITY LOAD: 228. KW 171. KVAR
LOAD FROM: 57 PCC773 XFR TRANSF AMPS: 344 VOLTAGE DROP: 4. %VD: .76
PROJECTED POWER FLOW: 228. KW 171. KVAR 285. KVA PF: .80 LAGGING
LOSSES THRU TRANSF: .5 KW 2.9 KVAR 2.9 KVA

LOAD BUS: 6000 PCCYDE808 DESIGN VOLTAGE: 480 LOAD VOLTAGE: 470 %VD: 2.1
VOLTAGE ANGLE: -4.3 DEGREES
NET BRANCH DIVERSITY LOAD: 382. KW 286. KVAR
LOAD FROM: 58 PCC808 XFR TRANSF AMPS: 587 VOLTAGE DROP: 11. %VD: 2.35
PROJECTED POWER FLOW: 382. KW 286. KVAR 477. KVA PF: .80 LAGGING
LOSSES THRU TRANSF: 2.8 KW 15.2 KVAR 15.5 KVA

DEMAND LOAD ANALYSIS ON STANDBY POWER CONFIGURATION (FILE DLAS)

RAYTHEON ENGINEERS AND CONSTRUCTORS

LOAD SUMMARY

****

LOAD SCHEDULE FOR 5054 SMCC-273XX 480. VOLTS LINE TO LINE
SOURCE OF PWR 5051 LC52-2

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
STANDBY LOADS	1150.0	1383.2	563.5	677.8	704.4	847.2	-80.0
TOTALS	1150.0	1383.2	563.5	677.8	704.4	847.2	-80.0

LOAD SCHEDULE FOR 5700 PCC-NCE773 480. VOLTS LINE TO LINE
SOURCE OF PWR 57 PCC773 XFR

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
GENERAL LOADS	659.0	792.7	.0	.0	.0	.0	-80.0
FUTURE	57.9	69.6	.0	.0	.0	.0	-80.0

*** WARNING *** DESIGN LOAD IS ZERO KVA

LOAD SCHEDULE FOR 6000 PCCYDE808 480. VOLTS LINE TO LINE
SOURCE OF PWR 58 PCC808 XFR

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
GENERAL LOADS	1245.5	1498.1	.0	.0	.0	.0	-80.0

*** WARNING *** DESIGN LOAD IS ZERO KVA

LOAD SCHEDULE FOR 6200 PCCFPG680 480. VOLTS LINE TO LINE
SOURCE OF PWR 79 PCC680 XFR

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
GENERAL LOADS	1054.7	1268.6	.0	.0	.0	.0	-80.0
FUTURE	100.0	120.3	.0	.0	.0	.0	-80.0

*** WARNING *** DESIGN LOAD IS ZERO KVA

LOAD FLOW ANALYSIS ON STANDBY POWER CONFIGURATION (FILE LFAS)

RAYTHEON ENGINEERS AND CONSTRUCTORS

BALANCED VOLTAGE DROP AND LOAD FLOW ANALYSIS (BRANCH LOAD REPORT)

****

VOLTAGE EFFECT ON LOADS MODELED TRANSFORMER VOLTAGE DROP MODELED
VOLTAGE DROP CRITERIA: BRANCH = 4.00 % BUS = 5.00
PER UNIT DRIVING VOLTAGE = 1.0200

```
LOAD BUS: 5021 SLP-303    DESIGN VOLTAGE:   480 LOAD VOLTAGE:   477 %VD:   .6
-------------------------                       VOLTAGE ANGLE:  -1.5 DEGREES
                NET BRANCH DIVERSITY LOAD:     25. KW     19. KVAR
LOAD FROM: 5020 SMCC-272XX   FEEDER AMPS:    39 VOLTAGE DROP:    0. %VD:  .05
PROJECTED POWER FLOW:    25. KW    19. KVAR    32. KVA    PF:   .80   LAGGING
LOSSES THRU FEEDER:       0. KW       0. KVAR       0. KVA

LOAD BUS: 5050 SUB55-2    DESIGN VOLTAGE:  2400 LOAD VOLTAGE:  2453 %VD: -2.2
-------------------------                       VOLTAGE ANGLE:   -.2 DEGREES
                NET BRANCH DIVERSITY LOAD:    157. KW    118. KVAR
               ** REGULATED BUS GENERATOR:   1000. KW    800. KVAR

LOAD BUS: 5051 LC52-2     DESIGN VOLTAGE:   480 LOAD VOLTAGE:   477 %VD:   .5
-------------------------                       VOLTAGE ANGLE:  -1.6 DEGREES
LOAD FROM:   85 SUB55 XFR2   TRANSF AMPS:   688 VOLTAGE DROP:    5. %VD:  .97
PROJECTED POWER FLOW:   454. KW   343. KVAR   569. KVA    PF:   .80   LAGGING
LOSSES THRU TRANSF:      1.3 KW    7.4 KVAR    7.5 KVA

LOAD BUS: 5053 SPCC-275XX  *** NO LOAD SPECIFIED ***

LOAD BUS: 5054 SMCC-273XX DESIGN VOLTAGE:   480 LOAD VOLTAGE:   473 %VD:  1.5
-------------------------                       VOLTAGE ANGLE:  -1.7 DEGREES
                NET BRANCH DIVERSITY LOAD:    451. KW    338. KVAR
LOAD FROM: 5051 LC52-2       FEEDER AMPS:   688 VOLTAGE DROP:    5. %VD:  .95
PROJECTED POWER FLOW:   451. KW   338. KVAR   564. KVA    PF:   .80   LAGGING
LOSSES THRU FEEDER:       3. KW       5. KVAR       6. KVA

LOAD BUS: 5700 PCC-NCE773  *** NO LOAD SPECIFIED ***

LOAD BUS: 6000 PCCYDE808   *** NO LOAD SPECIFIED ***
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SHORT CIRCUIT ANALYSIS ON NORMAL POWER WITH GENERATION (FILE FAULTGON)

RAYTHEON ENGINEERS AND CONSTRUCTORS

T H R E E P H A S E F A U L T R E P O R T
PRE FAULT VOLTAGE: 1.0000
MODEL TRANSFORMER TAPS: YES

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5011 PCC-NCD279 FAULT:     9268.  RMS SYM AMPS,      7705. KVA     X/R:      .641
                VOLTAGE:    480.  IMPEDANCE TO GND=   .02518 + J   .01613  OHMS
                CONTRIBUTIONS: 5010 MCC-274          9268. AMPS    X/R:      .641

5012 LP-NCD-292 FAULT:     9268.  RMS SYM AMPS,      7705. KVA     X/R:      .641
                VOLTAGE:    480.  IMPEDANCE TO GND=   .02518 + J   .01613  OHMS
                CONTRIBUTIONS: 5010 MCC-274          9268. AMPS    X/R:      .641

5013 PCC-NCD712 FAULT:    10645.  RMS SYM AMPS,      8850. KVA     X/R:      .719
                VOLTAGE:    480.  IMPEDANCE TO GND=   .02114 + J   .01520  OHMS
                CONTRIBUTIONS: 5010 MCC-274         10645. AMPS    X/R:      .719

5020 SMCC-272XX FAULT:    45799.  RMS SYM AMPS,     38076. KVA     X/R:     5.142
                VOLTAGE:    480.  IMPEDANCE TO GND=   .00116 + J   .00594  OHMS
                CONTRIBUTIONS:        MOTORS           480. AMPS    X/R:    15.000
                              5001 LC52-1           45323. AMPS    X/R:     5.106

5021 SLP-303    FAULT:    32164.  RMS SYM AMPS,     26741. KVA     X/R:     1.323
                VOLTAGE:    480.  IMPEDANCE TO GND=   .00520 + J   .00687  OHMS
                CONTRIBUTIONS: 5020 SMCC-272XX      32164. AMPS    X/R:     1.323

5050 SUB55-2    FAULT:    12848.  RMS SYM AMPS,     53409. KVA     X/R:     6.494
                VOLTAGE:   2400.  IMPEDANCE TO GND=   .01641 + J   .10659  OHMS
                CONTRIBUTIONS:        BLO-243-2M       565. AMPS    X/R:    15.000
                                      NCM-440-2       3003. AMPS    X/R:    20.000
                               85 SUB55 XFR2          9305. AMPS    X/R:     5.168

5051 LC52-2     FAULT:    45898.  RMS SYM AMPS,     38159. KVA     X/R:     5.372
                VOLTAGE:    480.  IMPEDANCE TO GND=   .00110 + J   .00594  OHMS
                CONTRIBUTIONS:   85 SUB55 XFR2      45424. AMPS    X/R:     5.337
                              5054 SMCC-273XX         477. AMPS    X/R:    14.233

5053 SPCC-275XX FAULT:    33786.  RMS SYM AMPS,     28089. KVA     X/R:     2.135
                VOLTAGE:    480.  IMPEDANCE TO GND=   .00348 + J   .00743  OHMS
                CONTRIBUTIONS: 5051 LC52-2          33786. AMPS    X/R:     2.135

5054 SMCC-273XX FAULT:    28500.  RMS SYM AMPS,     23695. KVA     X/R:     2.748
                VOLTAGE:    480.  IMPEDANCE TO GND=   .00332 + J   .00914  OHMS
                CONTRIBUTIONS:        MOTORS           480. AMPS    X/R:    15.000
                              5051 LC52-2           28040. AMPS    X/R:     2.708

5700 PCC-NCE773 FAULT:    30648.  RMS SYM AMPS,     25480. KVA     X/R:     5.375
                VOLTAGE:    480.  IMPEDANCE TO GND=   .00165 + J   .00889  OHMS
                CONTRIBUTIONS:   57 PCC773 XFR      30648. AMPS    X/R:     5.375
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SHORT CIRCUIT ANALYSIS ON NORMAL POWER WITH GENERATION (FILE FAULTGON)

RAYTHEON ENGINEERS AND CONSTRUCTORS

F A U L T S T U D Y S U M M A R Y
PRE FAULT VOLTAGE: 1.0000
MODEL TRANSFORMER TAPS: YES

BUS NO	RECORD NAME	VOLTAGE L-L	AVAILABLE FAULT DUTIES 3 PHASE	LINE/GRND
5006	LP-NCM-291	480.	17275.	14676.
5007	LP-NCM-293	480.	11554.	9666.
5008	PCC-NCM299	480.	32441.	28994.
5010	MCC-274	480.	22177.	17871.
5011	PCC-NCD279	480.	9268.	7517.
5012	LP-NCD-292	480.	9268.	7517.
5013	PCC-NCD712	480.	10645.	8618.
5020	SMCC-272XX	480.	45799.	45908.
5021	SLP-303	480.	32164.	29225.
5050	SUB55-2	2400.	12848.	12092.
5051	LC52-2	480.	45898.	47850.
5053	SPCC-275XX	480.	33786.	31300.
5054	SMCC-273XX	480.	28500.	24642.
5700	PCC-NCE773	480.	30648.	31517.
6000	PCCYDE808	480.	17661.	17934.
6200	PCCFPG680	480.	18437.	18682.
6300	PCC-FP-413	480.	19431.	19505.
6301	MCC-FP-357	480.	18854.	18658.
6302	LP-FP-383	480.	11454.	10193.
6303	LP-FS-392	480.	13117.	11812.
6304	LP-FO-372	480.	10422.	8969.
6305	MCC-FI-358	480.	15170.	13788.
6306	LP-FL-379	480.	10562.	9147.
6307	MCC-FI1163	480.	4104.	3454.
6308	MCC-FM-365	480.	16169.	15023.
6309	MCC-FM-362	480.	11660.	10207.
6320	SMCC-FV363	480.	17415.	16562.
6321	SLP-FV-405	480.	8078.	6936.
6322	SLP-FR-389	480.	10547.	9196.
6350	PCC-FT-411	480.	18458.	18512.
6351	MCC-FT-359	480.	18050.	17914.
6352	LP-FT-398	480.	12757.	11539.
6353	MCC-FT-360	480.	16235.	15393.
6354	LP-FT-399	480.	10141.	8866.
6355	LP-FR-387	480.	11761.	10420.
6356	MCC-FV-361	480.	16438.	15682.
6357	LP-FI-368	480.	11811.	10489.
6358	LP-FH-366	480.	10159.	8896.
6359	LP-FV-402	480.	10159.	8896.
6360	PCC-FP1151	480.	11811.	10489.
6370	SMCC-FV364	480.	15845.	14771.
6371	SLP-FI-370	480.	7776.	6661.

SHORT CIRCUIT ANALYSIS ON NORMAL POWER NO STANDBY GENERATION (FILE FAULTGOF)

RAYTHEON ENGINEERS AND CONSTRUCTORS

T H R E E P H A S E F A U L T R E P O R T
PRE FAULT VOLTAGE: 1.0000
MODEL TRANSFORMER TAPS: YES

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5012 LP-NCD-292 FAULT:     9241.  RMS SYM AMPS,      7683. KVA      X/R:      .646
                VOLTAGE:    480.  IMPEDANCE TO GND=   .02519 + J   .01628  OHMS
                CONTRIBUTIONS: 5010 MCC-274          9241. AMPS     X/R:      .646

5013 PCC-NCD712 FAULT:    10608.  RMS SYM AMPS,      8819. KVA      X/R:      .726
                VOLTAGE:    480.  IMPEDANCE TO GND=   .02115 + J   .01534  OHMS
                CONTRIBUTIONS: 5010 MCC-274         10608. AMPS     X/R:      .726

5020 SMCC-272XX FAULT:    44723.  RMS SYM AMPS,     37182. KVA      X/R:     5.217
                VOLTAGE:    480.  IMPEDANCE TO GND=   .00117 + J   .00609  OHMS
                CONTRIBUTIONS:        MOTORS           480. AMPS    X/R:    15.000
                              5001 LC52-1           44247. AMPS     X/R:     5.179

5021 SLP-303    FAULT:    31709.  RMS SYM AMPS,     26362. KVA      X/R:     1.348
                VOLTAGE:    480.  IMPEDANCE TO GND=   .00521 + J   .00702  OHMS
                CONTRIBUTIONS: 5020 SMCC-272XX      31709. AMPS     X/R:     1.348

5050 SUB55-2    FAULT:     9652.  RMS SYM AMPS,     40124. KVA      X/R:     5.456
                VOLTAGE:   2400.  IMPEDANCE TO GND=   .02588 + J   .14120  OHMS
                CONTRIBUTIONS:        BLO-243-2M       565. AMPS    X/R:    15.000
                               85 SUB55 XFR2          9092. AMPS     X/R:     5.246

5051 LC52-2     FAULT:    44716.  RMS SYM AMPS,     37177. KVA      X/R:     5.421
                VOLTAGE:    480.  IMPEDANCE TO GND=   .00112 + J   .00609  OHMS
                CONTRIBUTIONS:         85 SUB55 XFR2  44242. AMPS     X/R:     5.385
                              5054 SMCC-273XX          477. AMPS     X/R:    14.233

5053 SPCC-275XX FAULT:    33170.  RMS SYM AMPS,     27577. KVA      X/R:     2.169
                VOLTAGE:    480.  IMPEDANCE TO GND=   .00350 + J   .00759  OHMS
                CONTRIBUTIONS: 5051 LC52-2          33170. AMPS     X/R:     2.169

5054 SMCC-273XX FAULT:    28057.  RMS SYM AMPS,     23326. KVA      X/R:     2.781
                VOLTAGE:    480.  IMPEDANCE TO GND=   .00334 + J   .00929  OHMS
                CONTRIBUTIONS:        MOTORS           480. AMPS    X/R:    15.000
                              5051 LC52-2           27596. AMPS     X/R:     2.739

5700 PCC-NCE773 FAULT:    30116.  RMS SYM AMPS,     25038. KVA      X/R:     5.414
                VOLTAGE:    480.  IMPEDANCE TO GND=   .00167 + J   .00905  OHMS
                CONTRIBUTIONS:         57 PCC773 XFR  30116. AMPS     X/R:     5.414
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6000 PCCYDE808  FAULT:    17496.  RMS SYM AMPS,     14546. KVA      X/R:     5.480
                VOLTAGE:    480.  IMPEDANCE TO GND=   .00284 + J   .01558  OHMS
                CONTRIBUTIONS:         58 PCC808 XFR  17496. AMPS     X/R:     5.480
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SHORT CIRCUIT ANALYSIS ON NORMAL POWER NO STANDBY GENERATION (FILE FAULTGOF)

RAYTHEON ENGINEERS AND CONSTRUCTORS

U N B A L A N C E D F A U L T R E P O R T
PRE FAULT VOLTAGE: 1.0000
MODEL TRANSFORMER TAPS: YES

LOCATION VOLTAGE	FAULT DUTIES	AMPERES (RMS)	X/R FAULT	EQUIVALENT (PU) IMPEDANCE	ASYM. INTERRUPTING CURRENT (RMS)
47	3 PHASE:	11356.	5.	Z1= .3684	14528. AMPS MOMENTARY
SUB20 XFR1	SLG DUTY:	1545.	0.	Z2= .3684	11368. AMPS AT 3 CYCLES
13800. VOLTS	LN/LN	9835.		Z0= .7928E+01	11356. AMPS AT 5 CYCLES
	LN/LN/GND	10217.	(	787. GND RETURN A)	11356. AMPS AT 8 CYCLES
48	3 PHASE:	10883.	5.	Z1= .3844	13552. AMPS MOMENTARY
SUB20 XFR2	SLG DUTY:	1536.	0.	Z2= .3844	10888. AMPS AT 3 CYCLES
13800. VOLTS	LN/LN	9425.		Z0= .7947E+01	10883. AMPS AT 5 CYCLES
	LN/LN/GND	9804.	(	785. GND RETURN A)	10883. AMPS AT 8 CYCLES
49	3 PHASE:	11179.	5.	Z1= .3743	14179. AMPS MOMENTARY
LC1 XFR-1	SLG DUTY:	1542.	0.	Z2= .3743	11187. AMPS AT 3 CYCLES
13800. VOLTS	LN/LN	9681.		Z0= .7935E+01	11179. AMPS AT 5 CYCLES
	LN/LN/GND	10062.	(	786. GND RETURN A)	11179. AMPS AT 8 CYCLES
50	3 PHASE:	10718.	5.	Z1= .3903	13251. AMPS MOMENTARY
LC1 XFR-2	SLG DUTY:	1533.	0.	Z2= .3903	10722. AMPS AT 3 CYCLES
13800. VOLTS	LN/LN	9282.		Z0= .7953E+01	10718. AMPS AT 5 CYCLES
	LN/LN/GND	9659.	(	784. GND RETURN A)	10718. AMPS AT 8 CYCLES
51	3 PHASE:	13368.	10.	Z1= .3130	19160. AMPS MOMENTARY
LC2 XFR-1	SLG DUTY:	1575.	0.	Z2= .3130	13652. AMPS AT 3 CYCLES
13800. VOLTS	LN/LN	11577.		Z0= .7867E+01	13390. AMPS AT 5 CYCLES
	LN/LN/GND	11970.	(	796. GND RETURN A)	13368. AMPS AT 8 CYCLES
52	3 PHASE:	12503.	7.	Z1= .3346	16873. AMPS MOMENTARY
LC2 XFR-2	SLG DUTY:	1562.	0.	Z2= .3346	12563. AMPS AT 3 CYCLES
13800. VOLTS	LN/LN	10828.		Z0= .7893E+01	12504. AMPS AT 5 CYCLES
	LN/LN/GND	11216.	(	792. GND RETURN A)	12503. AMPS AT 8 CYCLES
57	3 PHASE:	10617.	5.	Z1= .3940	13133. AMPS MOMENTARY
PCC773 XFR	SLG DUTY:	1532.	0.	Z2= .3940	10621. AMPS AT 3 CYCLES
13800. VOLTS	LN/LN	9195.		Z0= .7955E+01	10617. AMPS AT 5 CYCLES
	LN/LN/GND	9572.	(	784. GND RETURN A)	10617. AMPS AT 8 CYCLES
58	3 PHASE:	11164.	5.	Z1= .3747	14078. AMPS MOMENTARY
PCC808 XFR	SLG DUTY:	1541.	0.	Z2= .3747	11171. AMPS AT 3 CYCLES
13800. VOLTS	LN/LN	9668.		Z0= .7937E+01	11164. AMPS AT 5 CYCLES
	LN/LN/GND	10049.	(	786. GND RETURN A)	11164. AMPS AT 8 CYCLES

SHORT CIRCUIT ANALYSIS ON NORMAL POWER NO STANDBY GENERATION (FILE FAULTGOF)

RAYTHEON ENGINEERS AND CONSTRUCTORS

U N B A L A N C E D F A U L T R E P O R T
PRE FAULT VOLTAGE: 1.0000
MODEL TRANSFORMER TAPS: YES

LOCATION VOLTAGE	FAULT DUTIES	AMPERES (RMS)	X/R FAULT	EQUIVALENT (PU) IMPEDANCE	ASYM. INTERRUPTING CURRENT (RMS)
5021	3 PHASE:	31709.	1.	Z1= 3.7933	32007. AMPS MOMENTARY
SLP-303	SLG DUTY:	28980.	1.	Z2= 3.7933	31709. AMPS AT 3 CYCLES
480. VOLTS	LN/LN	27460.		Z0= .4882E+01	31709. AMPS AT 5 CYCLES
	LN/LN/GND	31439.	(26646. GND RETURN A)		31709. AMPS AT 8 CYCLES
5050	3 PHASE:	9652.	5.	Z1= 2.4923	12798. AMPS MOMENTARY
SUB55-2	SLG DUTY:	10012.	5.	Z2= 2.4923	10022. AMPS AT 3 CYCLES
2400. VOLTS	LN/LN	8359.		Z0= .2224E+01	10012. AMPS AT 5 CYCLES
	LN/LN/GND	9840.	(10399. GND RETURN A)		10012. AMPS AT 8 CYCLES
5051	3 PHASE:	44716.	5.	Z1= 2.6899	60116. AMPS MOMENTARY
LC52-2	SLG DUTY:	46987.	5.	Z2= 2.6899	47036. AMPS AT 3 CYCLES
480. VOLTS	LN/LN	38726.		Z0= .2300E+01	46988. AMPS AT 5 CYCLES
	LN/LN/GND	45859.	(49500. GND RETURN A)		46987. AMPS AT 8 CYCLES
5053	3 PHASE:	33170.	2.	Z1= 3.6262	34953. AMPS MOMENTARY
SPCC-275XX	SLG DUTY:	30947.	2.	Z2= 3.6262	33170. AMPS AT 3 CYCLES
480. VOLTS	LN/LN	28726.		Z0= .4411E+01	33170. AMPS AT 5 CYCLES
	LN/LN/GND	32616.	(28996. GND RETURN A)		33170. AMPS AT 8 CYCLES
5054	3 PHASE:	28057.	3.	Z1= 4.2871	30847. AMPS MOMENTARY
SMCC-273XX	SLG DUTY:	24418.	3.	Z2= 4.2871	28057. AMPS AT 3 CYCLES
480. VOLTS	LN/LN	24298.		Z0= .6204E+01	28057. AMPS AT 5 CYCLES
	LN/LN/GND	26448.	(21614. GND RETURN A)		28057. AMPS AT 8 CYCLES
5700	3 PHASE:	30116.	5.	Z1= 3.9939	39759. AMPS MOMENTARY
PCC-NCE773	SLG DUTY:	31140.	5.	Z2= 3.9939	31170. AMPS AT 3 CYCLES
480. VOLTS	LN/LN	26081.		Z0= .3600E+01	31140. AMPS AT 5 CYCLES
	LN/LN/GND	30635.	(32236. GND RETURN A)		31140. AMPS AT 8 CYCLES
6000	3 PHASE:	17496.	5.	Z1= 6.8747	22795. AMPS MOMENTARY
PCCYDE808	SLG DUTY:	17820.	5.	Z2= 6.8747	17838. AMPS AT 3 CYCLES
480. VOLTS	LN/LN	15152.		Z0= .6500E+01	17820. AMPS AT 5 CYCLES
	LN/LN/GND	17660.	(18156. GND RETURN A)		17820. AMPS AT 8 CYCLES
6200	3 PHASE:	18256.	6.	Z1= 6.5886	23810. AMPS MOMENTARY
PCCFPG680	SLG DUTY:	18558.	6.	Z2= 6.5886	18579. AMPS AT 3 CYCLES
480. VOLTS	LN/LN	15810.		Z0= .6267E+01	18558. AMPS AT 5 CYCLES
	LN/LN/GND	18427.	(18871. GND RETURN A)		18558. AMPS AT 8 CYCLES

SHORT CIRCUIT ANALYSIS ON STANDBY POWER (FILE FAULTSTB)

RAYTHEON ENGINEERS AND CONSTRUCTORS

THREE PHASE FAULT REPORT
PRE FAULT VOLTAGE: 1.0000
MODEL TRANSFORMER TAPS: YES

50 LC1 XFR-2	FAULT: 4085.	RMS SYM AMPS, 97648. KVA		X/R: 8.366
	VOLTAGE: 13800.	IMPEDANCE TO GND= .23146 + J	1.93648 OHMS	
	CONTRIBUTIONS:	48 SUB20 XFR2	4085. AMPS	X/R: 8.366
51 LC2 XFR-1	FAULT: 4409.	RMS SYM AMPS, 105389. KVA		X/R: 12.988
	VOLTAGE: 13800.	IMPEDANCE TO GND= .13872 + J	1.80168 OHMS	
	CONTRIBUTIONS:	4 SUB 10-1	4409. AMPS	X/R: 12.988
52 LC2 XFR-2	FAULT: 4301.	RMS SYM AMPS, 102805. KVA		X/R: 10.868
	VOLTAGE: 13800.	IMPEDANCE TO GND= .16974 + J	1.84465 OHMS	
	CONTRIBUTIONS:	7 SUB 15-2	4301. AMPS	X/R: 10.868
57 PCC773 XFR	FAULT: 4073.	RMS SYM AMPS, 97352. KVA		X/R: 8.372
	VOLTAGE: 13800.	IMPEDANCE TO GND= .23202 + J	1.94240 OHMS	
	CONTRIBUTIONS:	5 SUB 10-2	3963. AMPS	X/R: 8.281
		85 SUB55 XFR2	110. AMPS	X/R: 13.794
58 PCC808 XFR	FAULT: 4145.	RMS SYM AMPS, 99069. KVA		X/R: 8.932
	VOLTAGE: 13800.	IMPEDANCE TO GND= .21389 + J	1.91037 OHMS	
	CONTRIBUTIONS:	7 SUB 15-2	4041. AMPS	X/R: 8.852
		48 SUB20 XFR2	104. AMPS	X/R: 13.679
59 SUB40 XFR1	FAULT: 4132.	RMS SYM AMPS, 98754. KVA		X/R: 8.793
	VOLTAGE: 13800.	IMPEDANCE TO GND= .21791 + J	1.91607 OHMS	
	CONTRIBUTIONS:	6 SUB 15-1	4003. AMPS	X/R: 8.710
		4000 SUB40-1	129. AMPS	X/R: 12.438
60 SUB40 XFR2	FAULT: 4098.	RMS SYM AMPS, 97952. KVA		X/R: 8.593
	VOLTAGE: 13800.	IMPEDANCE TO GND= .22473 + J	1.93118 OHMS	
	CONTRIBUTIONS:	62 LC14 XFR-2	4098. AMPS	X/R: 8.593
61 LC14 XFR-1	FAULT: 4103.	RMS SYM AMPS, 98078. KVA		X/R: 8.522
	VOLTAGE: 13800.	IMPEDANCE TO GND= .22629 + J	1.92849 OHMS	
	CONTRIBUTIONS:	59 SUB40 XFR1	4103. AMPS	X/R: 8.522
62 LC14 XFR-2	FAULT: 4126.	RMS SYM AMPS, 98627. KVA		X/R: 8.869
	VOLTAGE: 13800.	IMPEDANCE TO GND= .21635 + J	1.91876 OHMS	
	CONTRIBUTIONS:	5 SUB 10-2	4126. AMPS	X/R: 8.869
77 PCC1568XFR	FAULT: 4201.	RMS SYM AMPS, 100407. KVA		X/R: 9.534
	VOLTAGE: 13800.	IMPEDANCE TO GND= .19785 + J	1.88633 OHMS	
	CONTRIBUTIONS:	79 PCC680 XFR	4201. AMPS	X/R: 9.534
78 PCC669 XFR	FAULT: 4388.	RMS SYM AMPS, 104894. KVA		X/R: 12.366
	VOLTAGE: 13800.	IMPEDANCE TO GND= .14634 + J	1.80963 OHMS	
	CONTRIBUTIONS:	6 SUB 15-1	3909. AMPS	X/R: 12.452

SHORT CIRCUIT ANALYSIS ON STANDBY POWER (FILE FAULTSTB)

RAYTHEON ENGINEERS AND CONSTRUCTORS

THREE PHASE FAULT REPORT

PRE FAULT VOLTAGE: 1.0000
MODEL TRANSFORMER TAPS: YES

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5053 SPCC-275XX FAULT:    28548.  RMS SYM AMPS,     23734. KVA     X/R:     2.516
                VOLTAGE:    480.  IMPEDANCE TO GND=    .00359 + J   .00902  OHMS
                CONTRIBUTIONS: 5051 LC52-2          28548. AMPS    X/R:     2.516

5054 SMCC-273XX FAULT:    24645.  RMS SYM AMPS,     20490. KVA     X/R:     3.133
                VOLTAGE:    480.  IMPEDANCE TO GND=    .00342 + J   .01071  OHMS
                CONTRIBUTIONS:       MOTORS           480. AMPS    X/R:    15.000
                              5051 LC52-2          24179. AMPS    X/R:     3.082

5700 PCC-NCE773 FAULT:    26003.  RMS SYM AMPS,     21618. KVA     X/R:     5.957
                VOLTAGE:    480.  IMPEDANCE TO GND=    .00176 + J   .01051  OHMS
                CONTRIBUTIONS:    57 PCC773 XFR     26003. AMPS    X/R:     5.957
--------------------------------------------------------------------------

6000 PCCYDE808  FAULT:    16022.  RMS SYM AMPS,     13320. KVA     X/R:     5.802
                VOLTAGE:    480.  IMPEDANCE TO GND=    .00294 + J   .01705  OHMS
                CONTRIBUTIONS:    58 PCC808 XFR     16022. AMPS    X/R:     5.802

6200 PCCFPG680  FAULT:    16651.  RMS SYM AMPS,     13843. KVA     X/R:     5.923
                VOLTAGE:    480.  IMPEDANCE TO GND=    .00277 + J   .01641  OHMS
                CONTRIBUTIONS:    79 PCC680 XFR     16651. AMPS    X/R:     5.923

6300 PCC-FP-413 FAULT:    17480.  RMS SYM AMPS,     14533. KVA     X/R:     6.104
                VOLTAGE:    480.  IMPEDANCE TO GND=    .00256 + J   .01565  OHMS
                CONTRIBUTIONS:    82 PCC413 XFR     16885. AMPS    X/R:     5.980
                              6320 SMCC-FV363         598. AMPS    X/R:    14.529

6301 MCC-FP-357 FAULT:    17015.  RMS SYM AMPS,     14146. KVA     X/R:     5.649
                VOLTAGE:    480.  IMPEDANCE TO GND=    .00284 + J   .01604  OHMS
                CONTRIBUTIONS: 6300 PCC-FP-413      17015. AMPS    X/R:     5.649

6302 LP-FP-383  FAULT:    10931.  RMS SYM AMPS,      9088. KVA     X/R:      .973
                VOLTAGE:    480.  IMPEDANCE TO GND=    .01817 + J   .01768  OHMS
                CONTRIBUTIONS: 6301 MCC-FP-357      10931. AMPS    X/R:      .973

6303 LP-FS-392  FAULT:    12332.  RMS SYM AMPS,     10253. KVA     X/R:     1.420
                VOLTAGE:    480.  IMPEDANCE TO GND=    .01294 + J   .01837  OHMS
                CONTRIBUTIONS: 6301 MCC-FP-357      12332. AMPS    X/R:     1.420

6304 LP-FO-372  FAULT:     9935.  RMS SYM AMPS,      8260. KVA     X/R:     1.281
                VOLTAGE:    480.  IMPEDANCE TO GND=    .01717 + J   .02198  OHMS
                CONTRIBUTIONS: 6305 MCC-FI-358       9935. AMPS    X/R:     1.281

6305 MCC-FI-358 FAULT:    13972.  RMS SYM AMPS,     11616. KVA     X/R:     3.801
                VOLTAGE:    480.  IMPEDANCE TO GND=    .00505 + J   .01918  OHMS
                CONTRIBUTIONS: 6300 PCC-FP-413      13972. AMPS    X/R:     3.801
```

SHORT CIRCUIT ANALYSIS ON STANDBY POWER (FILE FAULTSTB)

RAYTHEON ENGINEERS AND CONSTRUCTORS

U N B A L A N C E D F A U L T R E P O R T
PRE FAULT VOLTAGE: 1.0000
MODEL TRANSFORMER TAPS: YES

LOCATION VOLTAGE	FAULT DUTIES	AMPERES (RMS)	X/R FAULT	EQUIVALENT (PU) IMPEDANCE	ASYM. INTERRUPTING CURRENT (RMS)
48	3 PHASE:	4108.	9.	Z1= 1.0184	5753. AMPS MOMENTARY
SUB20 XFR2	SLG DUTY:	773.	0.	Z2= 1.0184	4158. AMPS AT 3 CYCLES
13800. VOLTS	LN/LN	3558.		Z0= .1580E+02	4111. AMPS AT 5 CYCLES
	LN/LN/GND	3752.	(	395. GND RETURN A)	4108. AMPS AT 8 CYCLES
49	3 PHASE:	4141.	9.	Z1= 1.0103	5845. AMPS MOMENTARY
LC1 XFR-1	SLG DUTY:	774.	0.	Z2= 1.0103	4202. AMPS AT 3 CYCLES
13800. VOLTS	LN/LN	3586.		Z0= .1579E+02	4145. AMPS AT 5 CYCLES
	LN/LN/GND	3781.	(	395. GND RETURN A)	4141. AMPS AT 8 CYCLES
50	3 PHASE:	4085.	8.	Z1= 1.0241	5696. AMPS MOMENTARY
LC1 XFR-2	SLG DUTY:	772.	0.	Z2= 1.0241	4130. AMPS AT 3 CYCLES
13800. VOLTS	LN/LN	3538.		Z0= .1581E+02	4088. AMPS AT 5 CYCLES
	LN/LN/GND	3732.	(	395. GND RETURN A)	4085. AMPS AT 8 CYCLES
51	3 PHASE:	4409.	13.	Z1= .9489	6589. AMPS MOMENTARY
LC2 XFR-1	SLG DUTY:	783.	0.	Z2= .9489	4645. AMPS AT 3 CYCLES
13800. VOLTS	LN/LN	3818.		Z0= .1572E+02	4444. AMPS AT 5 CYCLES
	LN/LN/GND	4016.	(	398. GND RETURN A)	4411. AMPS AT 8 CYCLES
52	3 PHASE:	4301.	11.	Z1= .9727	6265. AMPS MOMENTARY
LC2 XFR-2	SLG DUTY:	779.	0.	Z2= .9727	4433. AMPS AT 3 CYCLES
13800. VOLTS	LN/LN	3725.		Z0= .1575E+02	4314. AMPS AT 5 CYCLES
	LN/LN/GND	3921.	(	397. GND RETURN A)	4301. AMPS AT 8 CYCLES
57	3 PHASE:	4073.	8.	Z1= 1.0272	5679. AMPS MOMENTARY
PCC773 XFR	SLG DUTY:	772.	0.	Z2= 1.0272	4118. AMPS AT 3 CYCLES
13800. VOLTS	LN/LN	3527.		Z0= .1581E+02	4075. AMPS AT 5 CYCLES
	LN/LN/GND	3721.	(	395. GND RETURN A)	4073. AMPS AT 8 CYCLES
58	3 PHASE:	4145.	9.	Z1= 1.0094	5846. AMPS MOMENTARY
PCC808 XFR	SLG DUTY:	774.	0.	Z2= 1.0094	4205. AMPS AT 3 CYCLES
13800. VOLTS	LN/LN...	3589.		Z0= .1579E+02	4148. AMPS AT 5 CYCLES
	LN/LN/GND	3784.	(	395. GND RETURN A)	4145. AMPS AT 8 CYCLES
59	3 PHASE:	4132.	9.	Z1= 1.0126	5812. AMPS MOMENTARY
SUB40 XFR1	SLG DUTY:	773.	0.	Z2= 1.0126	4188. AMPS AT 3 CYCLES
13800. VOLTS	LN/LN	3578.		Z0= .1580E+02	4135. AMPS AT 5 CYCLES
	LN/LN/GND	3772.	(	395. GND RETURN A)	4132. AMPS AT 8 CYCLES

SHORT CIRCUIT ANALYSIS ON STANDBY POWER (FILE FAULTSTB)

RAYTHEON ENGINEERS AND CONSTRUCTORS

U N B A L A N C E D F A U L T R E P O R T

PRE FAULT VOLTAGE: 1.0000
MODEL TRANSFORMER TAPS: YES

LOCATION VOLTAGE	FAULT DUTIES	AMPERES (RMS)	X/R FAULT	EQUIVALENT (PU) IMPEDANCE	ASYM. INTERRUPTING CURRENT (RMS)
5050	3 PHASE:	7856.	6.	Z1= 3.0622	11309. AMPS MOMENTARY
SUB55-2	SLG DUTY:	8645.	6.	Z2= 3.0622	8663. AMPS AT 3 CYCLES
2400. VOLTS	LN/LN	6803.		Z0= .2224E+01	8645. AMPS AT 5 CYCLES
	LN/LN/GND	8382.	(	9610. GND RETURN A)	8645. AMPS AT 8 CYCLES
5051	3 PHASE:	36342.	6.	Z1= 3.3097	52894. AMPS MOMENTARY
LC52-2	SLG DUTY:	40457.	6.	Z2= 3.3097	40538. AMPS AT 3 CYCLES
480. VOLTS	LN/LN	31473.		Z0= .2300E+01	40458. AMPS AT 5 CYCLES
	LN/LN/GND	39034.	(	45622. GND RETURN A)	40457. AMPS AT 8 CYCLES
5053	3 PHASE:	28548.	3.	Z1= 4.2133	30808. AMPS MOMENTARY
SPCC-275XX	SLG DUTY:	28142.	2.	Z2= 4.2133	28548. AMPS AT 3 CYCLES
480. VOLTS	LN/LN	24723.		Z0= .4411E+01	28548. AMPS AT 5 CYCLES
	LN/LN/GND	29162.	(	27714. GND RETURN A)	28548. AMPS AT 8 CYCLES
5054	3 PHASE:	24645.	3.	Z1= 4.8805	27765. AMPS MOMENTARY
SMCC-273XX	SLG DUTY:	22603.	3.	Z2= 4.8805	24645. AMPS AT 3 CYCLES
480. VOLTS	LN/LN	21343.		Z0= .6204E+01	24645. AMPS AT 5 CYCLES
	LN/LN/GND	23870.	(	20872. GND RETURN A)	24645. AMPS AT 8 CYCLES
5700	3 PHASE:	26003.	6.	Z1= 4.6257	36391. AMPS MOMENTARY
PCC-NCE773	SLG DUTY:	28079.	6.	Z2= 4.6257	28122. AMPS AT 3 CYCLES
480. VOLTS	LN/LN	22519.		Z0= .3600E+01	28079. AMPS AT 5 CYCLES
	LN/LN/GND	27305.	(	30514. GND RETURN A)	28079. AMPS AT 8 CYCLES
6000	3 PHASE:	16022.	6.	Z1= 7.5074	21643. AMPS MOMENTARY
PCCYDE808	SLG DUTY:	16772.	6.	Z2= 7.5074	16795. AMPS AT 3 CYCLES
480. VOLTS	LN/LN	13875.		Z0= .6500E+01	16772. AMPS AT 5 CYCLES
	LN/LN/GND	16473.	(	17596. GND RETURN A)	16772. AMPS AT 8 CYCLES
6200	3 PHASE:	16651.	6.	Z1= 7.2237	22549. AMPS MOMENTARY
PCCFPG680	SLG DUTY:	17420.	6.	Z2= 7.2237	17446. AMPS AT 3 CYCLES
480. VOLTS	LN/LN	14420.		Z0= .6267E+01	17421. AMPS AT 5 CYCLES
	LN/LN/GND	17130.	(	18264. GND RETURN A)	17420. AMPS AT 8 CYCLES
6300	3 PHASE:	17480.	6.	Z1= 6.8809	23596. AMPS MOMENTARY
PCC-FP-413	SLG DUTY:	18150.	6.	Z2= 6.8809	18181. AMPS AT 3 CYCLES
480. VOLTS	LN/LN	15138.		Z0= .6120E+01	18150. AMPS AT 5 CYCLES
	LN/LN/GND	17928.	(	18872. GND RETURN A)	18150. AMPS AT 8 CYCLES

SHORT CIRCUIT ANALYSIS ON STANDBY POWER (FILE FAULTSTB)

RAYTHEON ENGINEERS AND CONSTRUCTORS

F A U L T S T U D Y S U M M A R Y
PRE FAULT VOLTAGE: 1.0000
MODEL TRANSFORMER TAPS: YES

BUS NO	RECORD NAME	VOLTAGE L-L	AVAILABLE FAULT DUTIES 3 PHASE	LINE/GRND
2	SUB 25-1	13800.	4493.	785.
3	SUB 25-2	13800.	4493.	785.
4	SUB 10-1	13800.	4454.	784.
5	SUB 10-2	13800.	4439.	784.
6	SUB 15-1	13800.	4443.	783.
7	SUB 15-2	13800.	4428.	783.
21	SUB60 XFR1	13800.	4485.	785.
22	LC4 XFR-1	13800.	4264.	778.
23	LC5 XFR-1	13800.	4425.	783.
24	XFR-PWP	13800.	3946.	767.
31	SUB60 XFR2	13800.	4478.	785.
32	LC4 XFR-2	13800.	4264.	778.
33	LC5 XFR-2	13800.	4425.	783.
38	SUB60-1	4160.	14353.	
39	SUB60-2	4160.	12146.	
47	SUB20 XFR1	13800.	4164.	775.
48	SUB20 XFR2	13800.	4108.	773.
49	LC1 XFR-1	13800.	4141.	774.
50	LC1 XFR-2	13800.	4085.	772.
51	LC2 XFR-1	13800.	4409.	783.
52	LC2 XFR-2	13800.	4301.	779.
57	PCC773 XFR	13800.	4073.	772.
58	PCC808 XFR	13800.	4145.	774.
59	SUB40 XFR1	13800.	4132.	773.
60	SUB40 XFR2	13800.	4098.	773.
61	LC14 XFR-1	13800.	4103.	772.
62	LC14 XFR-2	13800.	4126.	774.
77	PCC1568XFR	13800.	4201.	776.
78	PCC669 XFR	13800.	4388.	782.
79	PCC680 XFR	13800.	4354.	781.
80	LC3 XFR-1	13800.	4356.	781.
81	LC3 XFR-2	13800.	4379.	782.
82	PCC413 XFR	13800.	4388.	782.
83	FIS-FT-13	13800.	4347.	781.
84	SUB55 XFR1	13800.	4341.	780.
85	SUB55 XFR2	13800.	3985.	768.
87	SUB45 XFR1	13800.	4269.	777.
88	SUB45 XFR2	13800.	4140.	774.
89	LC13 XFR-1	13800.	4293.	779.
90	LC13 XFR-2	13800.	4315.	780.
93	PCC681 XFR	13800.	4222.	777.
100	LC1-1	480.	36351.	40465.

SHORT CIRCUIT ANALYSIS ON STANDBY POWER (FILE FAULTSTB)

RAYTHEON ENGINEERS AND CONSTRUCTORS

F A U L T S T U D Y S U M M A R Y
PRE FAULT VOLTAGE: 1.0000
MODEL TRANSFORMER TAPS: YES

BUS NO	RECORD NAME	VOLTAGE L-L	AVAILABLE FAULT DUTIES 3 PHASE	LINE/GRND
5007	LP-NCM-293	480.	11137.	9468.
5008	PCC-NCM299	480.	27404.	26153.
5010	MCC-274	480.	19466.	16622.
5011	PCC-NCD279	480.	8909.	7350.
5012	LP-NCD-292	480.	8909.	7350.
5013	PCC-NCD712	480.	10147.	8388.
5020	SMCC-272XX	480.	35961.	38818.
5021	SLP-303	480.	27568.	26626.
5050	SUB55-2	2400.	7856.	8645.
5051	LCS2-2	480.	36342.	40457.
5053	SPCC-275XX	480.	28548.	28142.
5054	SMCC-273XX	480.	24645.	22603.
5700	PCC-NCE773	480.	26003.	28079.
6000	PCCYDE808	480.	16022.	16772.
6200	PCCFPG680	480.	16651.	17420.
6300	PCC-FP-413	480.	17480.	18150.
6301	MCC-FP-357	480.	17015.	17416.
6302	LP-FP-383	480.	10931.	9926.
6303	LP-FS-392	480.	12332.	11390.
6304	LP-FO-372	480.	9935.	8726.
6305	MCC-FI-358	480.	13972.	13108.
6306	LP-FL-379	480.	10073.	8901.
6307	MCC-FI1163	480.	4066.	3436.
6308	MCC-FM-365	480.	14809.	14215.
6309	MCC-FM-362	480.	11035.	9885.
6320	SMCC-FV363	480.	15851.	15588.
6321	SLP-FV-405	480.	7862.	6833.
6322	SLP-FR-389	480.	10095.	8970.
6350	PCC-FT-411	480.	16688.	17286.
6351	MCC-FT-359	480.	16356.	16766.
6352	LP-FT-398	480.	12008.	11132.
6353	MCC-FT-360	480.	14859.	14543.
6354	LP-FT-399	480.	9711.	8649.
6355	LP-FR-387	480.	11120.	10083.
6356	MCC-FV-361	480.	15032.	14803.
6357	LP-FI-368	480.	11170.	10151.
6358	LP-FH-366	480.	9732.	8681.
6359	LP-FV-402	480.	9732.	8681.
6360	PCC-FP1151	480.	11170.	10151.
6370	SMCC-FV364	480.	14548.	13997.
6371	SLP-FI-370	480.	7570.	6563.
6372	SLP-FO-376	480.	4595.	3889.

Raytheon Engineers & Constructors	GENERAL COMPUTATION SHEET	CALCULATION SET NO. 17-25					BY
		PRELIM.	FINAL	VOID	0	DATE 4-5-94	DATE 4/13/94
		X	X				
PROJECT: INEL/ICPP EUSU		SHEET 2 OF 6				DATE	DATE
SUBJECT: OVERSTRESSED CABLES		J.O. 9354.171					

Maximum calculated cable capacity (KVA) = [Volts(l-l) x Amps x 1.732] /(1000)

Volts(l-l) = 13,800

Amps = 178.6

Maximum calculated cable capacity (KVA) = [(13,800V)x(178.6A)x(1.73)] /(1000)

= 4268 KV

Conclusions:

WN 4/13/94

In FSR II the #4/0 cable was used at an ampacity of 190 amps, this ampacity does not take into account the derating factor for the burial depth of the underground ductbank. The calculated derated ampacity of 178.6 amps does account for this derating and is considered to be high.

Due to the derated cable ampacity being high, the calculated maximum cable capacity of 4269 KVA is high. This load capacity is smaller than the value used in FSR II. This means that the Substation 10 feeder cables will become overstressed faster than what was anticipated in FSR II.

Comparing the calculated cable load capacity with the "Substation 10 cable load" Data received from WINCO, several of the Substation 10 feeders become overstressed in the near future and others become grossly overstressed.

CABLE #	ALT. FEED	LOAD KVA	LOAD SOURCE	BUS ID	DATE ON LINE	LOAD DEFINITION	TOTAL LOAD AS OF 9-92 Cable #	KVA	LOAD W/O 10J1 KVA	LOAD W/O 10J2 KVA	LOAD W/O 10J5 KVA	LOAD W/O 10J6 KVA	LOAD W/O 10J7 KVA	LOAD W/O 10J8 KVA
10J1		590	OFF.BLD.	PCC-YDE-808		EXISTING	10J1	3166			3426	4318		
10J1		1088	SUB40	PCC-DW-556		EXISTING								
10J1		100		PCC-YDE-808	Sep-92	TRNG SUPPORT FAC								
10J1	10J5	132	LC5	SPCC-SAB-1580		EXISTING								
10J1	10J5	100	LC5		Sep-92	ANTI-C/ SFTY EQUP FAC								
10J1	10J5	100	LC5		Sep-92	HAZ CHEM FACILITY								
10J1	10J6	480	LC2	PCC-YDB-542		EXISTING								
10J1	10J6	576	LC1	PCC-YDB-541		EXISTING								
10J2		307		PCC-NCE-773		EXISTING	10J2	4059				5211	4747	4299
10J2	10J6	1152	SUB 20	SPCC-PH-552		EXISTING								
10J2	10J7	640	LC3	PCC-MA-545		EXISTING								
10J2	10J8	1960	SUB30	PCC-WCE-555		EXISTING								
10J3		480	FPR	PCC-FPG-669		EXISTING	10J3	480						
10J4		1460	FAST	PCC-FP-413,411,410		EXISTING	10J4	1460						
10J5		830	FPR	PCC-FPG-680		EXISTING	10J5	1090	1422					
10J5	10J1	100	LC5		Sep-92	ANTI-C/ SFTY EQUP FAC								
10J5	10J1	100	LC5		Sep-92	HAZ CHEM FACILITY								
10J5	10J1	60	LC5	SPCC-SAB-1581		EXISTING								
10J6	10J1	432	LC2	PCC-YDB-543		EXISTING	10J6	2304	3360	3456				
10J6	10J1	720	LC1	PCC-YDB-540		EXISTING								
10J6	10J2	1152	SUB20	SPCC-PH-553		EXISTING								
10J7	10J2	688	LC3	PCC-MA-544		EXISTING	10J7	688		1328				
10J8		1170	CFSGF	SMCC-CFG-569		EXISTING	10J8	1410		3370				
10J8	10J2	240	SUB30	PCC-WCE-554		EXISTING								

435.55
DRAFT 10
Rev. 00

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QA RECORD

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4.	**Addressee Name and Organization:**	N/A
5.	**Author Name and Organization:**	Keith Quigley/BBWI
6.	**Key Words:**	QA Record, EDF-015722-046,EDF-015722-047,EDF-1464, EDF-1473, EDF-1114, EDF-1195, EDF-1187

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HLW-105 - 11

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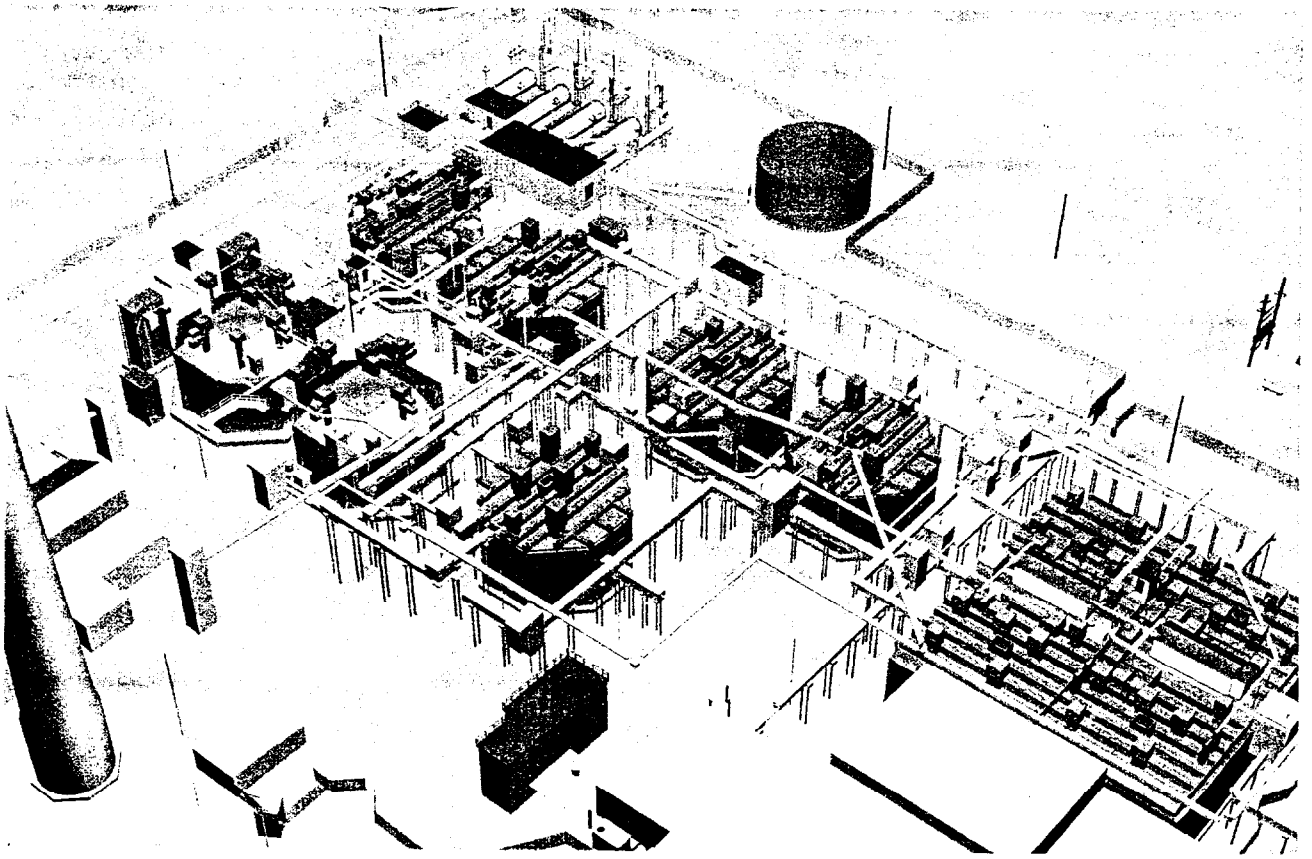
Revision: 0

Project File: 015722

CONCEPTUAL DESIGN REPORT

BOOK 7: LINE LISTS



INTEC TANK FARM FACILITY CLOSURE

INEEL
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BECHTEL BWXT IDAHO, LLC

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HLW-105 - 11

HLW PROGRAM RECORDS INPUT FORM

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Instructions: Fill in **bolded fields** or use N/A when applicable.
See back of form for notes.

1.	**Document ID. Number And Rev:**	HLW-105-11
2.	**Document Date:**	09/29/2000
3.	**Document Title (or description):**	INTEC Tank Farm Facility Closure Conceptual Design Report, Project File No. 015722
4.	**Addressee Name and Organization:**	N/A
5.	**Author Name and Organization:**	Keith Quigley/BBWI
6.	**Key Words:**	TFFC, Book 7, Line Lists, Hard Copy only, found in file.

7. **Uniform Filing Code:** 6153. 105 **Disposition Authority:** ☐ ENV1-k-1 ☐ RD1-A-2 ☒ ENV1-k-2-b ☐ RD1-B-9-b

Retention Schedule:
- ☐ EPI Cutoff annually. Destroy 25 years after cutoff.
- ☒ EPI Cutoff at project completion. Destroy 25 years after project completion.
- ☐ EPI Cutoff after project/program completion, cancellation or termination, or in 5 year blocks. Retrieve to FRC 2 years after termination of project/program. Destroy 25 years after termination of project/program.

8.	**Document Type:**	Report
9.	**File Location:** (Indicate only one)	☐ **WCB-100** ☐ **INTEC-100** ☐ **WCB-104** ☐ **INTEC-104** ☐ **WCB-101** ☐ **INTEC-101** ☒ **WCB-105** ☐ **INTEC-105** ☐ **WCB-102** ☐ **INTEC-102** ☐ **WCB-REF** ☐ **INTEC-REF** ☐ **WCB-103** ☐ **INTEC-103**
	Total Pages of Document: 152	
10.	**If QA Record, Validator sign and date:**	Sign: _____ Date: _____
		(Mark box only if it applies) ☐ *QA Document Pages* _____
	QA Record Classification:	☐ **Non Permanent** ☐ **Lifetime** ☐ **Permanent**
11.	**Scan Document:**	☐ **Scan into EDMS** ☒ **No Scan** ☒ **US/BS**
	Medium:	☒ **Hard Copy** ☐ **Disk** ☐ **Other (Specify)** _____
12.	**Receiver/Verifier**	Sign: Rachel Miller Date: 7-15-02
13.	**Individual Submitting Record** *(Please Print)*	Name: Keith Quigley Date: 07/15/2002

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1. If the document to be submitted bears a number (report number, letter number, etc.), enter it, along with the rev. status.
2. Enter document date.
3. If the document to be submitted has no title, enter a brief subject description.
4. If the document to be submitted is correspondence enter the name of the person to whom the correspondence is addressed, and that person's organization. If the correspondence has multiple addressees, enter "Distribution."
5. Enter the name of the person who signed the letter or authored the report; if no approval signature appears on the document, enter N/A.
6. Enter key subject terms that would be useful in retrieving the document. Do not duplicate information provided in the title field.
7. Mark the disposition Authority and Retention Schedule of the document.

Disposition Authority:		
	ENV1-k-1	(Program Management Files) Cutoff annually. Destroy 25 years after cutoff.
	ENV1-k-2-b	(Project Case Files) Cutoff at project completion. Destroy 25 years after project completion.
	RD1-A-2 (R&D Case Files)	Cutoff after project/program completion, cancellation or termination or in 5 year blocks. Retrieve to FRC 2 years after termination of project/program. Destroy 25 years after termination of project/program.
	RD1-B-9-b (R&D Technical Documents)	Cutoff after project/program completion, cancellation or termination or in 5 year blocks. Retrieve to FRC 2 years after termination of project/program. Destroy 25 years after termination of project/program.

8. Document Types: (more than one may be applicable)

Assessments, Audits, Appraisals
Budgets
Construction Documents
Data Sheets
Electronic Mail
Engineering Design Files
Environmental Monitoring
Fax
Independent Hazard Review
Letter
Logbooks
Minutes
Miscellaneous Documents
Plan
Presentation
Procedure
Reference Material
Report
Sampling Analysis
Sub-Contract Agreements
Training
Waste Characterization Data

9. Indicate the File Location, in which Central File Location the document will reside.

100 - HLW Program/Admin.	103 - Treatment and Storage	Ref - References
101 - Pre-treatment	104 - Vitrified HLW Storage	
102 - Immobilization	105 - Closure and Stabilization	

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