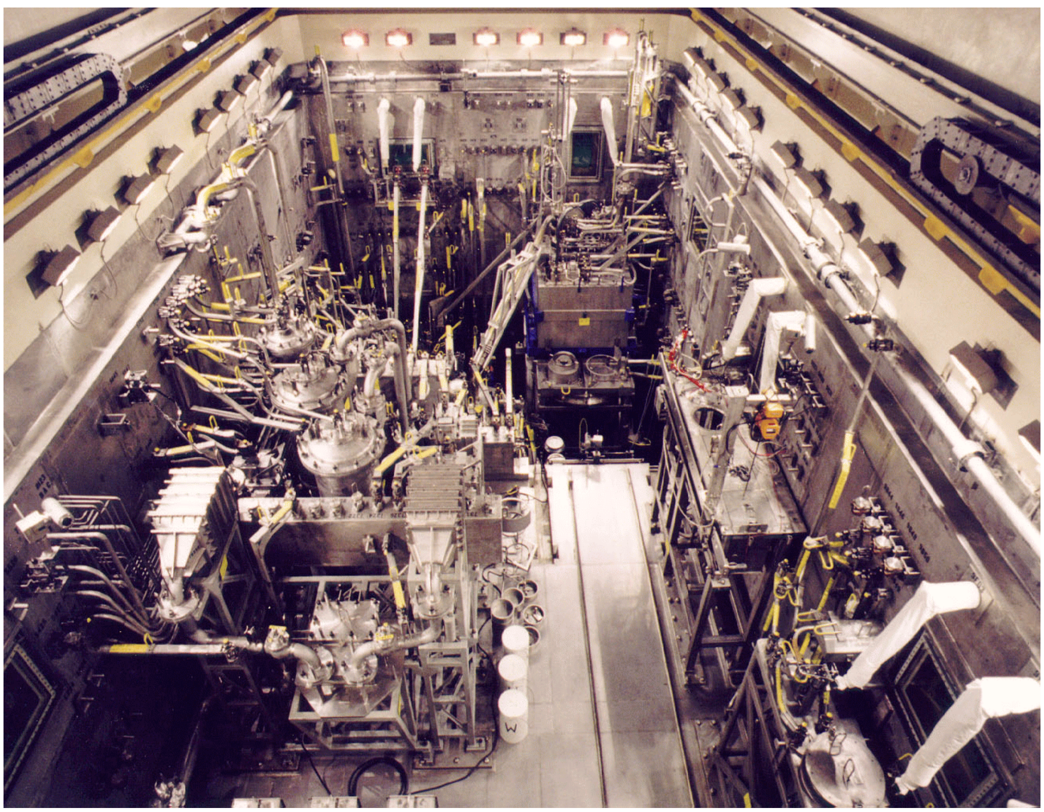
Report on Deployment of Miscellaneous Tank and Piping Cleaning Equipment and Methodology

Tank Focus Area Milestone B.1-1 for
Technical Task Plan (TTP) OH0-0-WT-22



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Preface

This report addresses the deployment of miscellaneous tank and pipe cleaning equipment, the methodology used, initial results of the cleaning and performance of the equipment used in the Vitrification Facility.

Deploy Miscellaneous Tank and Piping Cleaning Equipment
and
Methodology

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1.0 INTRODUCTION

This report describes the results of flushing activities that were accomplished using special equipment procured in FY2001 and additional tools procured in FY2002 . The flushing was performed using dilute nitric acid and water and was conducted to reduce the inventory of residual radionuclides from pipe lines, tanks and equipment that may affect the WVDP performance assessment. The material collected during the flushing was vitrified to the extent practical.

2.0 FLUSHING OVERVIEW

2.1 Flushing Plans for the Vitrification Facility (VF)

Flushing of the VF equipment was originally planned and described in Appendix G of *Technical Basis for Accelerated Completion of HLW Operations at the WVDP*.[1] The timing of the plan was subsequently modified as required to comply with overall Project goals, however the flushing for High Level Waste (HLW) contamination removal for VF equipment and piping has been completed.

Flushing of the VF prior to melter shutdown was accomplished to remove retrievable residual solids and long-lived radionuclides in the systems and incorporate them into the glass form. The following equipment/areas have been flushed:

- Concentrator, Feed Makeup Tank (CFMT)
- Melter Feed Hold Tank (MFHT)
- Submerged Bed Scrubber (SBS)
- Waste Header
- Selected Accessible external surfaces of components in the Vit Cell and the pit itself

2.2 Process Knowledge

The process knowledge used to identify HLW-contaminated equipment begins with HLW that was transferred from the Waste Tank Farm (WTF) to the CFMT. The mixture of this HLW and VF recycle from the SBS was concentrated in the CFMT. Water vapor generated during concentration passed through the CFMT demister to the vessel vent header. The concentrated waste compositions were adjusted using nonradioactive chemicals to make qualified melter feed, and then the CFMT contents were transferred to the MFHT. Feed slurry in the MFHT was metered to the melter for vitrification. Melter off-gases were passed through the SBS where particulate matter larger than approximately 1-µm and soluble salts were removed. SBS effluent passed through several additional components prior to atmospheric release.

Vitrification products (i.e., glass) were transferred to canisters positioned in a turntable below the melter. Filled canisters had lids welded on them to seal them, and were then decontaminated; the decontamination solutions were also recycled to the CFMT.

Other VF areas accumulated HLW residues due to processing and maintenance operations. The procedure for replacement of inserts (e.g., the CFMT bubblers) had included spraying with water to dislodge deposits. Some of these deposits were potentially on the vessels' exterior surfaces and on the pit floor.

HLW was deposited in the waste header due to normal processing activities such as flushing the CFMT and MFHT seal pots, and jetting the pit sump.

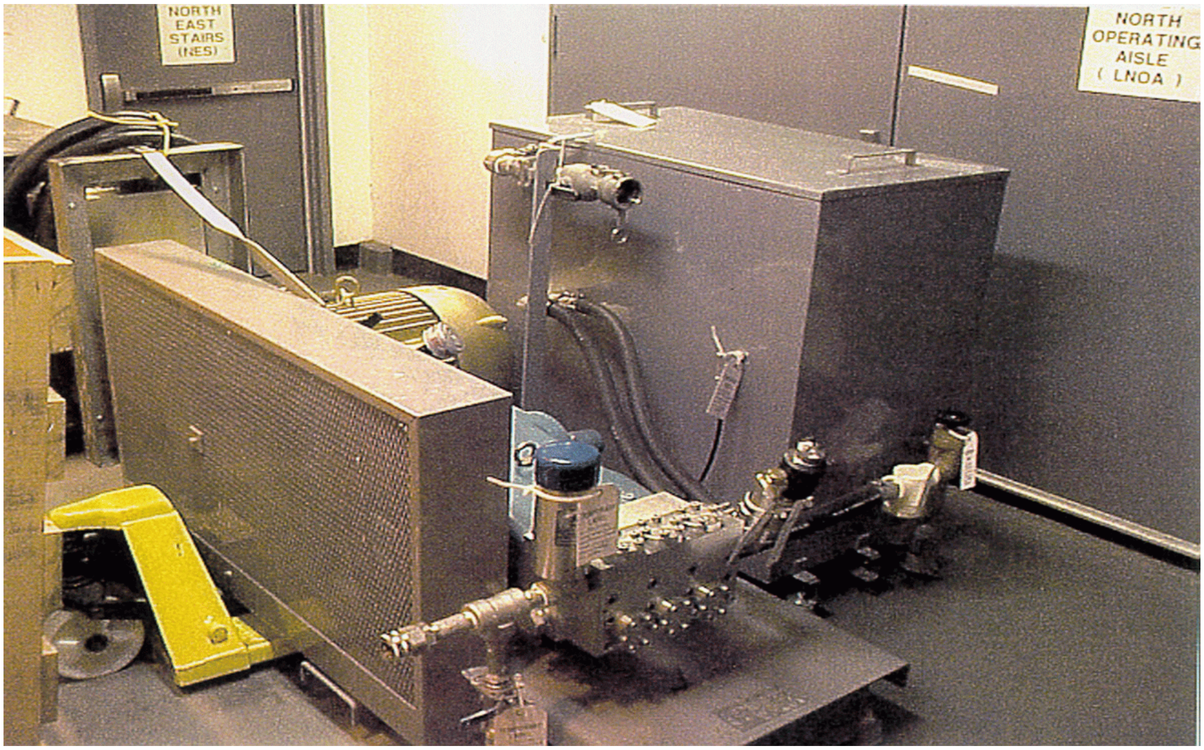
3.0 EQUIPMENT AND HARDWARE

Plans for flushing vitrification tanks and piping included high-pressure water spray, or cleaning by a nitric acid or water soak and/or flush. Soaking the tanks with nitric acid or water required no special material other than the bulk acid. Procurement of various items required for a high-pressure, remote delivery system was completed. Some of the tank nozzles had a heavy slurry coating and nozzle cleaners were designed and fabricated so that tooling and cameras could be inserted if determined to be necessary to deploy the spray equipment.

3.1 Spraying Equipment

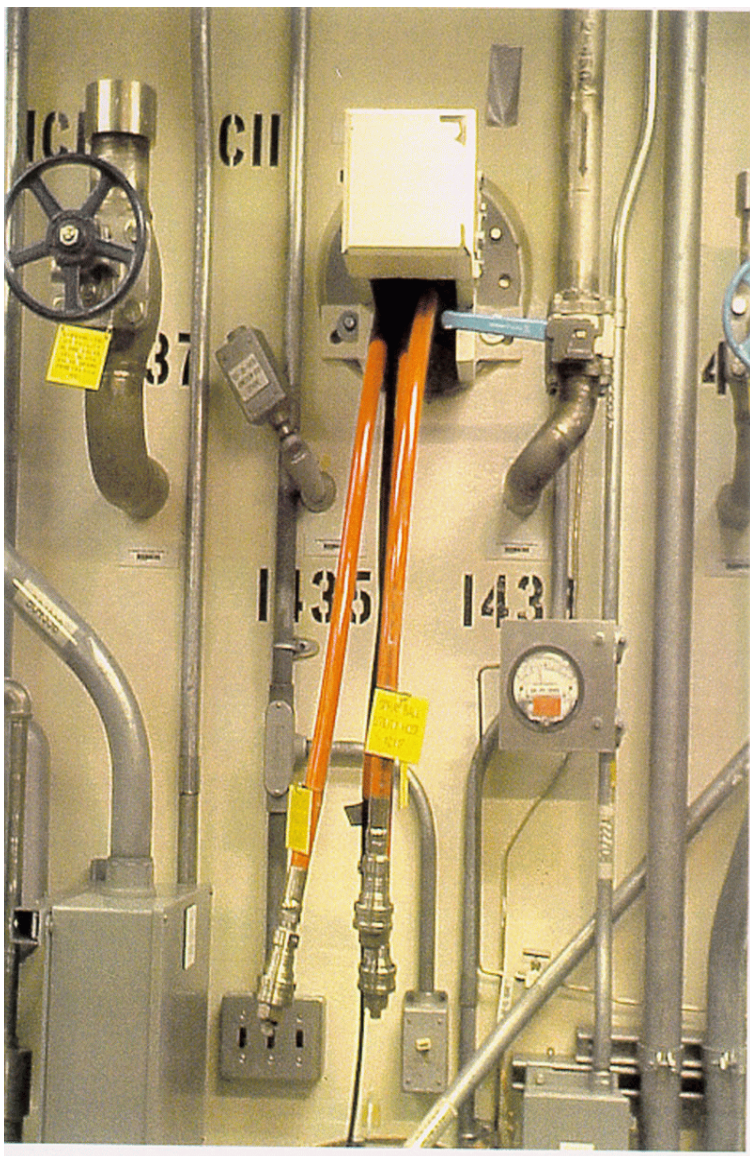
The equipment needed to provide a high pressure water spray includes the pump, hoses and connections, and a fixture with a spray head. Photographs of some of the equipment are provided below.

A CAT model 6831.0110, high-pressure water pump with a capacity of 35 GPM at 1200 psi was procured. The pump is skid mounted, complete with a 200-gal water tank and 50-HP motor with a variable frequency drive (VFD) to adjust pump speed and output.



High Pressure Water Pump
Photo 3-1

A standard high-pressure water hose was procured to deliver water from the pump to the cell wall. Adjacent to the penetration used, valving was provided to isolate flow and to drain the hose. Valved quick connects were used so that all hose sections were isolated when disconnected. Three 1" hoses were threaded through “S” bend 1-1/2" tubes in a standard cell wall penetration utility plug. Quick connects were attached to the hoses and the assembled plug was installed in the penetration. The hose selected for in-cell use was Aeroquip Polyon™ FC375-12, which had a 3/4" inside diameter. It is a hydraulic hose with a single reinforcing braid of Kevlar™ and a 2250 psi maximum operating pressure. It is relatively light and flexible, and in testing did not interfere with remote positioning of the spray tools when suspended from a crane.



High Pressure Hoses Routed
Through Cell Wall
Photo 3-2

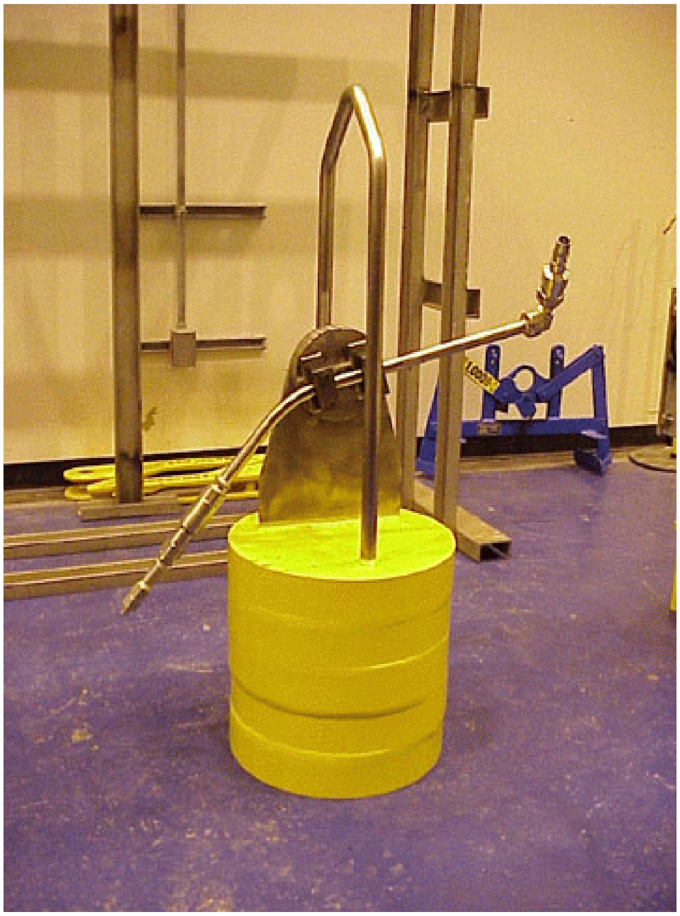
High-pressure Stäubli hose connectors with a push-button release quick connect for in-cell application were utilized for connecting the hoses. These connectors were capable of being assembled and disassembled by In-cell remote manipulators.

For cleaning of the tank internals a rotary spray nozzle was selected from Gamajet® to provide a spherical coverage of the internal surfaces of the vessel. The pump was operated between 500 and 1200 psi with a flowrate between 25 and 35 g.p.m. The nozzle took approximately 24 minutes to make one complete cycle in a tank. The Gamajet® rotating turbine is driven by the cleaning-fluid so that no additional services are necessary. The cleaner was purchased both as a standard item and specially modified to include lead-ins and tapered edges to accommodate remote entry into a 3-inch opening. To deploy the nozzle remotely, several fixtures were designed for adapting to various nozzles on the vessels.

Tank Cleaning Fixture With
Gamma Jet Nozzle
Photo 3-3

Two cleaning fixtures were designed and fabricated to fit in a CFMT 12-inch nozzle. The first incorporated a mounting flange and could be positioned in two orientations to provide two different spay positions. A second unit was modified, based upon field experience, with a change to the flange orientation to allow easier installation and withdrawal from the tank. These units were also used on the MFHT with an additional flange adaptor. An additional 6-inch flange-mounted cleaner was also built to provide coverage in other areas of the MFHT head. Prior to initial deployment in the cell the cleaning fixtures were tested in a mock-up to verify that the assembly, fixture, connectors and hose would hang straight, and could be remotely installed.

A spray wand for cleaning tank and equipment external surfaces was designed, built, and tested. This wand used a fixed position spray nozzle and the same high-pressure pump and hose assemblies. The spray wand was counter balanced to hang from the crane. Preliminary testing using the wand showed that the spray could be controlled, and that high-pressure water would not deflect the wand away from the desired target. Several different nozzle orifice sizes were tested, providing different cleaning capabilities.



Spray Wand for External Cleaning
Photo 3-4

3.2 Nozzle Cleaners

Rotary driven cleaners to scrape the tank nozzle internal surfaces were designed and fabricated in the event material deposits interfered with deployment of the cleaning tools and inspection cameras. These cleaners were wire brushes, driven by the in-cell impact wrench, and would accommodate the 3, 6 and 12-inch nozzles on the CFMT and MFHT. These tools were not deployed as the buildup of material in the nozzles did not affect the deployment of the cleaning and inspection equipment.

3.3 Radiation Probes

Standard radiation probes were purchased to monitor the change in radiation levels around the tanks being flushed. Radiation probe holding fixtures were also built and installed on the MFHT and CFMT heads to support and locate the probes while taking readings. The probes were shielded in an attempt to minimize the effects of the very high levels of background radiation present in the cell.

3.4 Viewing Equipment

One camera and a spare were purchased for in-tank viewing to monitor flushing progress. A Rees R-981radiation-resistant, black-and-white camera was purchased. It is equipped with a non-browning 12:72 mm zoom lens, two 75w underwater lights, and pan/tilt capability. A special holding and positioning fixture was designed and fabricated to adapt the camera for deployment by the process crane hook. Before and after viewing of external surfaces was recorded by conventional photographic equipment. Pictures were taken in the Vit aisle ways through the Vit Cell shield windows.

Rees Camera Assembly
Photo 3-5

4.0 FLUSHING RESULTS

To determine flushing effectiveness the individual evolutions were monitored using a combination of three methods. Radiation probes were used for the waste header line flushes and for the CFMT and MFHT. The camera/video inspections were used during flushing of the pit equipment externals and the CFMT and MFHT. Samples of flush solutions were taken to assist in evaluation of the Waste Header, SBS, CFMT and MFHT flushes.

Separate work orders were prepared for flushing of each piece of equipment described in Paragraph 2 of this report. These documents provided all required activities, precautions and limitations. All flushing activities are complete.

The Waste Header was flushed first as this could be accomplished with installed equipment and could be conducted anytime during the last phases of HLW processing. Prior to conducting the Waste Header and pit flushes a newly designed and fabricated jet assembly was installed to allow transfers from the VF Cell Pit sump to the CFMT (instead of to the Waste Header as was the reference design). The SBS and vitrification Cell Pit area and vessel external surfaces were flushed prior to the CFMT and MFHT as this work could be performed somewhat independently of other activities and because tanks and piping were being used to complete the vitrification of waste. The CFMT was flushed twice, once after the next to last HLW batch processed to check out the equipment needed for the final flushing, and for a second time after the MFHT flushing during the final HLW batch.

The following describes the flushing activities and results.

4.1 CFMT

The CFMT was flushed twice to remove residual solids from tank internals. The tank head space was a particular target area for slurry removal.

For each flush evolution the appropriate tank flushing hardware was assembled in the . Slurry samples were taken before and after the flushes. Results from these samples will be used to assess how much material was dislodged and will be used during future characterization work. The CFMT Sample pump jumpers were removed to provide access to the desired nozzle for cleaning and inspection. The tank was flushed with high pressure demineralized water at approximately 1000 psig, using the Gamajet® spray nozzle. Before and after the water flushes the CFMT was inspected through the use of the Rees camera and radiation probe readings were obtained. Water used for flushing the CFMT was processed as part of HLW stream.

4.1.1 Rad Probe Readings

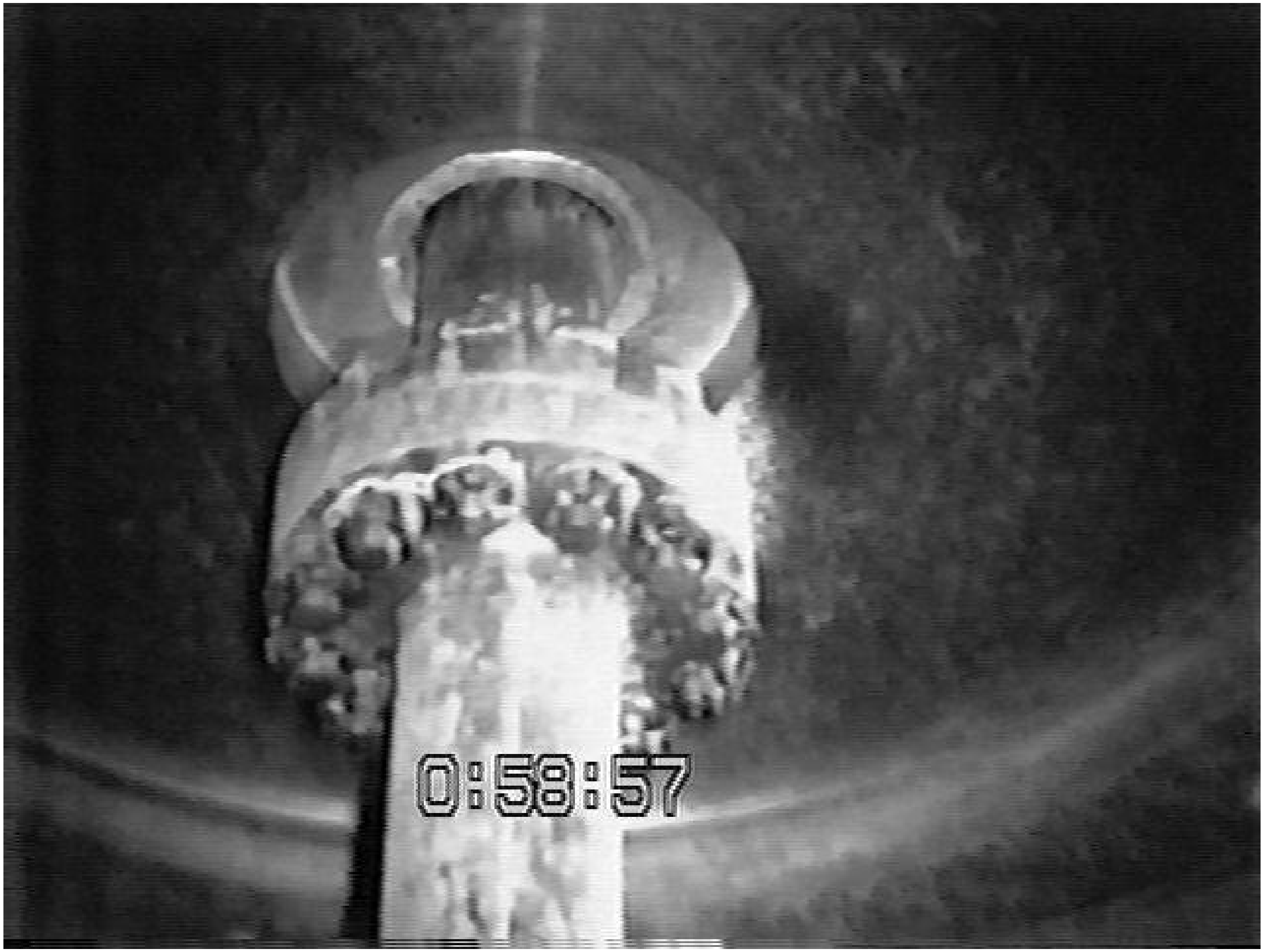
Rad probe readings were taken before and after the flushing of the CFMT and are as follows:

Pre flushing reading ------ 200 R/Hour
Post flushing reading ----- 170 R/Hour

It should be noted that the background radiation from the melter and other vitrification components had a significant effect on dose rate readings. Readings are only an indication of flushing progress.

4.1.2 Video Inspection

The Rees camera was used to inspect the CFMT internals before and after the flushing. The following still pictures were taken from the VHS recorder attached to the Rees camera. The video tape clearly indicated that the targeted areas of the tank were effectively cleaned during flushing:



CFMT Agitator Before Flushing
Photo 4-1

CFMT Agitator After Flushing
Photo 4-2

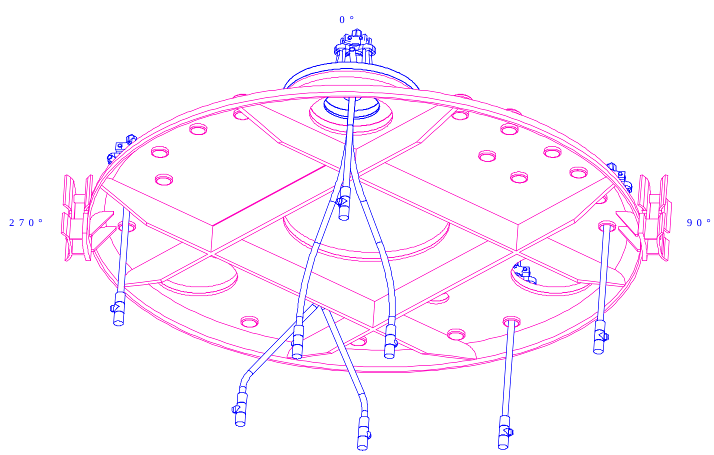
CFMT Internals Before Flushing
Photo 4-3

CFMT Internals After Flushing
Photo 4-4

4.2 MFHT

The MFHT was flushed to remove residual slurry from the tank internals. A total of three cycles of the flushing head were made in two different tank locations to complete the task. The tank head space and "egg crate" support structure were a particular target area for slurry removal.

Most of the tank flushing hardware needed for the MFHT internal surfaces was the same as for the CFMT. Slurry samples of the CFMT were taken before and after the MFHT flushing since flushed slurry from the MFHT was transferred back to the CFMT. These samples will be analyzed to assess how much material was dislodged during future characterization work. The MFHT Sample pump and associated jumpers as well as another utility jumper were removed to provide access to the desired nozzles for cleaning and inspection. The tank was flushed with demineralized water at approximately 1000 psig, using a Gamajet® spray nozzle. Before and after each flushing evolution the MFHT was inspected through the use of the Rees camera and radiation probe readings were obtained. Water used for the flushing of the MFHT was processed as part of the HLW stream.



MFHT Head Showing Potential
Locations for Spray Nozzles
Figure 4-1

4.2.1 Rad Probe Readings

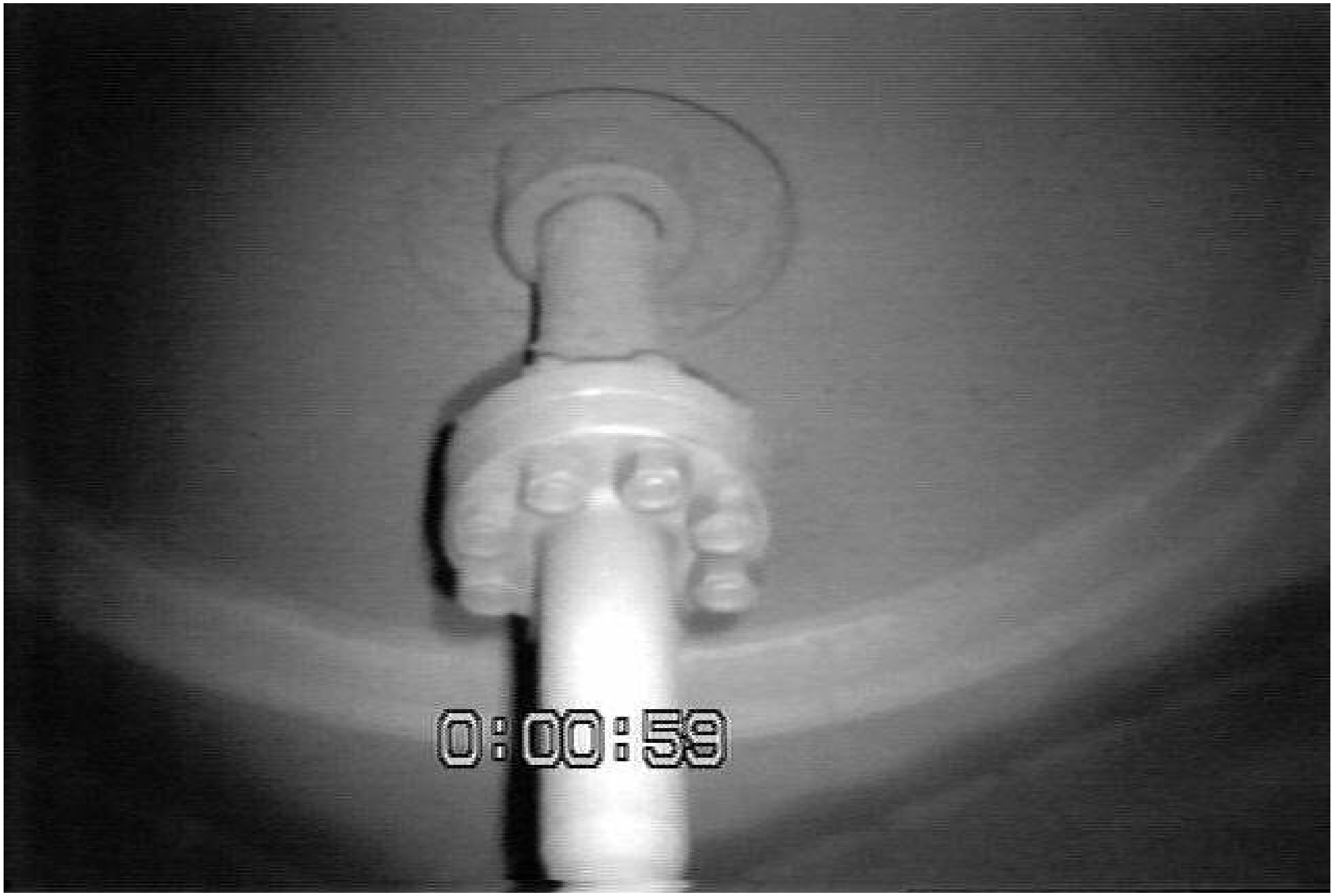
Rad probe readings were taken before and after the flushing of the MFHT and are as follows:

Pre flushing reading -----250 R/Hour
Post flushing reading----- 15 R/Hour

It should be noted that the background radiation from the melter and vitrification components had a significant effect on dose rate readings. Readings are only an indication of flushing progress.

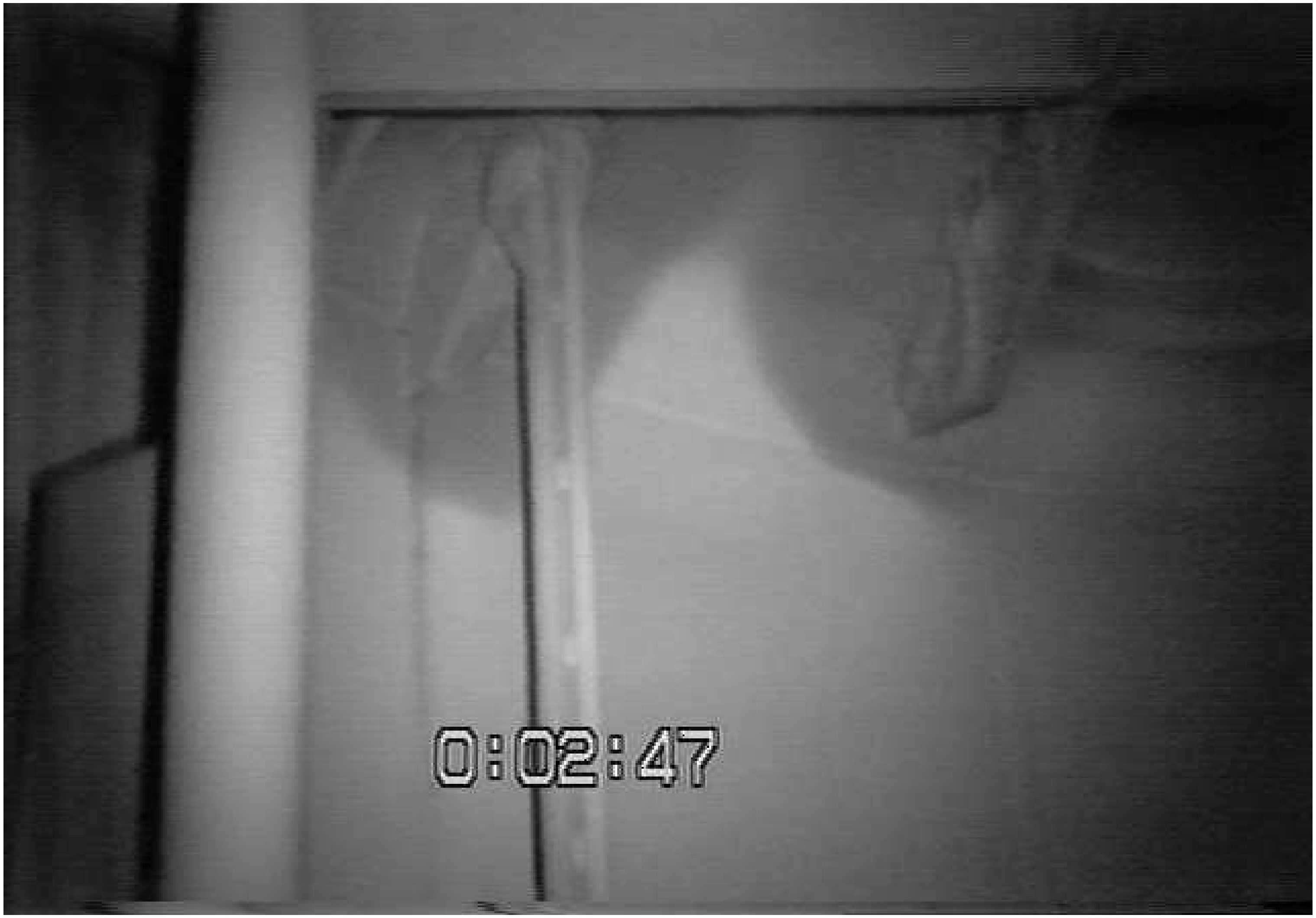
4.2.2 Video Inspection

The Rees camera was used to inspect the MFHT internals before and after the flushing. The following still pictures were taken from the VHS recorder attached to the Rees camera. The tape clearly indicated that the targeted areas of the tank were effectively cleaning during the flushing:



MFHT Agitator Before Flushing
Photo 4-5

MFHT Agitator After Flushing
Photo 4-6



MFHT Internal Baffle Before Flushing
Photo 4-7

MFHT Internal Baffle After Flushing
Photo 4-8

4.3 SBS

An acid soak and water flush of the SBS was conducted using dilute nitric acid. Although no video or radiation probe data was possible, the process indications (specific gravity and pressure differential across the scrubber) indicated that the flushing was effective. In addition samples were taken before and after the SBS flush solution was transferred to the CFMT, which will provide information on the amount of particulate removed from the SBS. The analyzed data will be used later during characterization work.

4.4 Waste Header

To remove accumulated solids in the Waste Header, a series of line flushes were performed. Approximately 16,000 liters of dilute nitric acid (6.8%) was prepared in the Vit Cold Chemical Facility. One half of the nitric acid solution was transferred to the South branch of the waste header and the other half was transferred to the North Branch. The flush solution from the waste header was collected in Tank 8D-4, and subsequently transferred back to the CFMT for processing into a HLW batch. Transfer piping was flushed with demineralized water upon completion of the dilute acid transfers through the waste header. Rad probe readings were taken in the transfer trench prior to and after the flushing.

4.4.1 Rad Probe Readings

Rad probe readings were taken before and after the flushing of the waste header and are as follows:

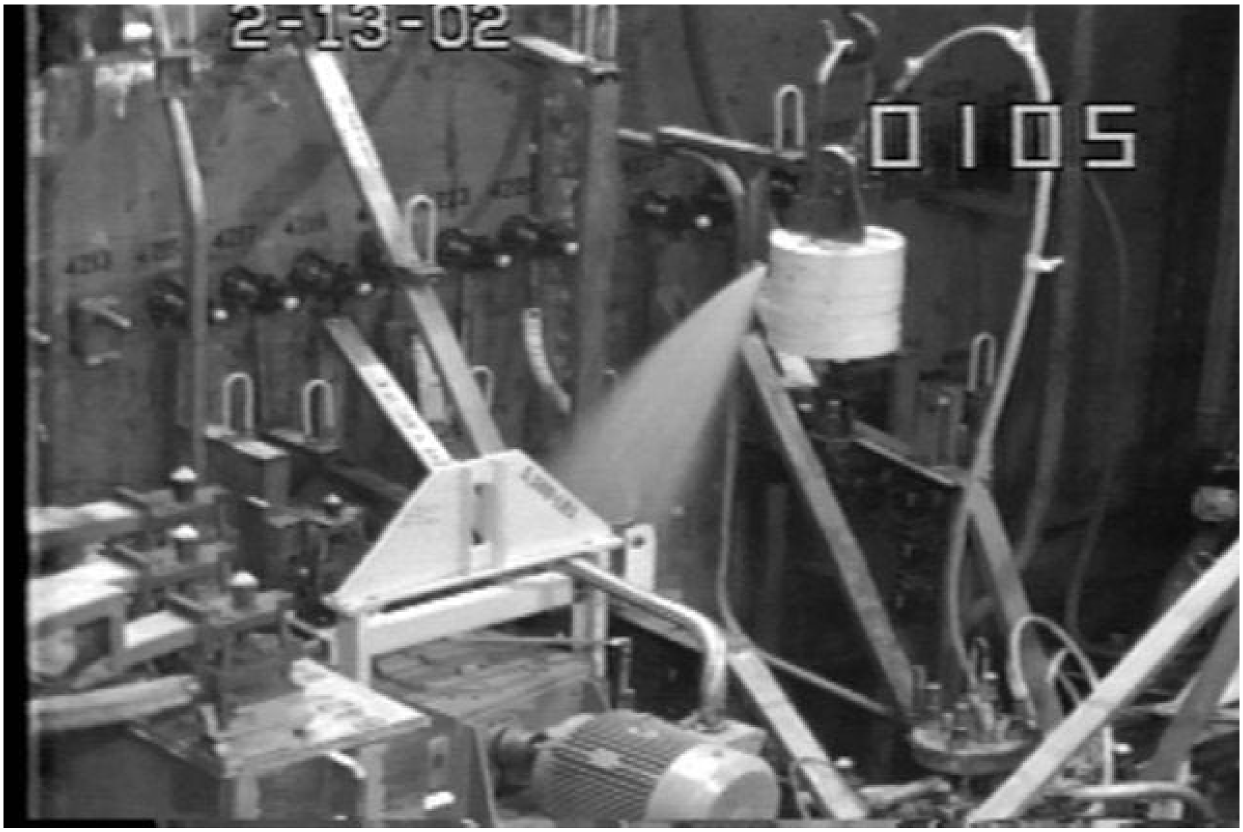
Pre flushing reading------12.6 mR/Hour
Post flushing reading---- 2.8 mR/Hour

It should be noted that the decrease in the trench readings indicates that the piping has less residual material at the completion of flushing. There is some effect from background radiation in the waste tank farm and therefore the radiation probe reading cannot be used to quantify the material remaining in the line.

4.5 Selected Accessible External Surfaces of Components in the Vit Cell Pit

Flushing was accomplished in accordance with specific instructions in an approved work document. A detailed map was developed to enable Operations personnel to follow the desired flush path thereby not compromising existing equipment with the high pressure spray. The high pressure pump and spray wand assembly were utilized with all flush material being collected in the North Sump. The sump contents were jetted to the CFMT for processing in a HLW batch. The flushing evolution was recorded using the in-cell CCTV cameras. In

addition, samples of the CFMT were taken before flushing began and after flushing was completed as a measure of the amount of material removed. The analysis of the samples will be part of the future vitrification cell characterization effort.



Pressure Washing Pit Equipment Externals
Photo 4-9

Conclusion

The Cleaning of Vitrification Facility Concentrator Feed Makeup Tank, Melter Feed Hold Tank, Submerged Bed Scrubber, Waste Header and Selected Accessible external surfaces of components in the Cell Pit and the pit itself was initiated in Fiscal year 2001 and completed in Fiscal year 2002.

Results of the flushing were evaluated. The video inspections conducted of the CFMT and MFHT internal surfaces showed a dramatic improvement in the degree of cleanliness. The internal surfaces of these tanks were essentially free of any visible deposits and it was noted that even the fabrication weld beads and polishing marks could be identified. The radiation probe data from the CFMT and MFHT was not conclusive as the background contribution to the readings was limiting. The SBS flushing was effective in reducing the solids content within the vessel and reducing the pressure differential across the bed. Waste header flushing was effective based on the reduction of radiation readings taken on the transfer lines. The resultant effect from external high pressure spraying of the accessible vitrification pit components and the pit floor was difficult to assess as the degree of staining of the base metal masked the capability of the CCTV cameras to determine cleanliness. The tank tops were cleaned off and flushed to the cell floor. The liquid on the cell floor was transferred to the CFMT and sampled. The samples obtained during all the flushing evolutions are being analyzed for future use in cell characterization.

References

1. Letter WD:2001:0441, T. F. Kocialski to A. C. Williams, Completion of FY 2001 Tank Focus Area Milestone B. 1-4 for Technical Task Plan (TTP) OH0-0-WT-22, "Issue Vit Facility Flushing Status Letter Report," dated July 13, 2001