244-CR Vault Liquid Level Assessment and Video Inspection Completion Report

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Abstract: This report documents the work completed in order to meet the requirements of Hanford Federal Facility Consent Order (TPA) milestone M-23-27. The milestone requires the liquid level and video assessment of the tanks and cells of the 244-CR vault.

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LIST OF TERMS

ACES	Access Control/Entry System
DOE	U.S. Department of Energy
DRI	direct reading instrument
ECN	Engineering Change Notice
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
HEPA	high-efficiency particulate air (filter)
NCO	Nuclear Chemical Operator
NOC	Notice of Construction
ppm	parts per million
PTRAEU	portable temporary radioactive air emission unit
PUREX	plutonium uranium extraction plant
PVC	polyvinyl chloride
RWP	radiological work permit
SST	single-shell tank
TPA	Hanford Federal Facility Consent Order (Tri-Party Agreement)

EXECUTIVE SUMMARY

This report documents the work completed in order to meet the requirements of Hanford Federal Facility Consent Order (TPA) milestone M-23-27. The milestone requires the liquid level and video assessment of the tanks and cells of the 244-CR vault.

The 244-CR vault, built in 1952, is located in the southwest corner of the 241-C tank farm complex in the 200 East Area of the Hanford Site. The most recent use of the facility was in 1995 when tank CR-003 was used as a receiver tank during the removal of liquid from the single-shell tanks (SST) in 241-C tank farm. Prior to that the facility was used for interim storage and transfer of waste from B Plant, the Plutonium Uranium Extraction Plant (PUREX), and Hot Semi-Works including PUREX acidified sludge waste, and fission product crudes between PUREX and B Plant. The 244-CR vault was originally built for uranium sludge recovery and distribution for the 241-C tank farm in support of the uranium metal recovery program.

The 244-CR vault is a two-level, underground, reinforced concrete structure. The lower level consists of four cells, each equipped with a concrete sump. Each cell houses a steel tank. Tanks CR-001, located in Cell 1, and CR-011, located in Cell 11, are nominally 40,000 gallon operating capacity. Tanks CR-002, located in Cell 2, and CR-003, located in Cell 3, are both nominally 10,000 gallon operating capacity. The cells housing tanks CR-011 and CR-001 are each 26 ft long by 22 ft wide and 29 ft 6 in. tall. The cells housing tanks CR-002 and CR-003 are each 20 ft long by 16 ft wide and 19 ft 6 in. tall. Access to the tanks and cells is possible through risers located within riser pits that are at grade level. A pump pit, that runs the length of the vault and is covered by cover blocks, is also located at grade level.

The activities required to complete TPA Milestone M-23-27 can be considered as three discrete groups of activities. These groups of activities are 1) facility equipment removal; 2) liquid level assessment and volume estimate; and, 3) video inspection.

The facility equipment removal consisted of removing in-tank and in-sump equipment from risers to gain access to allow level assessment and video inspection of the tanks and cells. Except for the riser pit over tank CR-003, a riser extension, which extends above the top of the riser pit, was attached to the flange of a tank riser and sump riser in each riser pit. The riser extension was left in place and outfitted to accommodate possible future ENRAF® level measurement instrument installation. Level assessment and video inspection of tank CR-003 was performed through a different riser than the riser identified for installation of a riser extension. Installation of the riser extension, 6 in x 4 in reducer and 4 in ball valve on the risers connected to tank CR-003 and cell 3 will occur at a later date.

Liquid level, pH, temperature, and sludge level of the waste present in each cell and tank was measured by inserting instruments through risers. The estimated volume of waste, including

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liquid and solid/sludge volumes, and the measured waste pH and temperature are provided on Figure ES-1. The findings revealed that less liquid was present in the tanks than anticipated, with tank CR-011 having no visible free liquid at all. Conversely, it was found that all four of the sumps contain some liquid. The video inspection of the cells show wet streaks on the tops of the tanks below the riser pits. Based on this it is thought that the liquid found in the cell sumps is primarily rainfall and snowmelt that has entered the vault through openings at grade. These openings include joints between plates over the riser pits or cover blocks over the pump pit. Though previously sealed, the foam was removed from the riser pits and portions of the pump pit between 1997 and 2002 to allow access for video inspection in support of interim stabilization.

Video inspection of the tanks and cells was performed to visually assess their general condition. Video inspections of the tanks and cells of 244-CR vault were performed from a single access point through risers which allowed access to the tanks and cells of the facility. Because the tanks take up a significant portion of the area of the cell, only a portion of the cell could be seen via the video camera. The video inspection of the tanks and cells did not indicate any visual evidence of significant structural problems with the tanks or cells. A raw water line in cell 3 and raw water lines to spray rings on tanks CR-002 and CR-003 show corrosion through the pipe wall. Signs of corrosion are present on some of the carbon steel support columns near the water line, most notably for tank CR-003. Information from the video inspection was used to modify the estimated volume of waste present in tanks CR-001 and CR-002 and Cell 3.

The path forward for the 244-CR vault includes planning for the sampling and removal of the liquid from the sumps and installation of level monitoring equipment on the tanks and sumps.

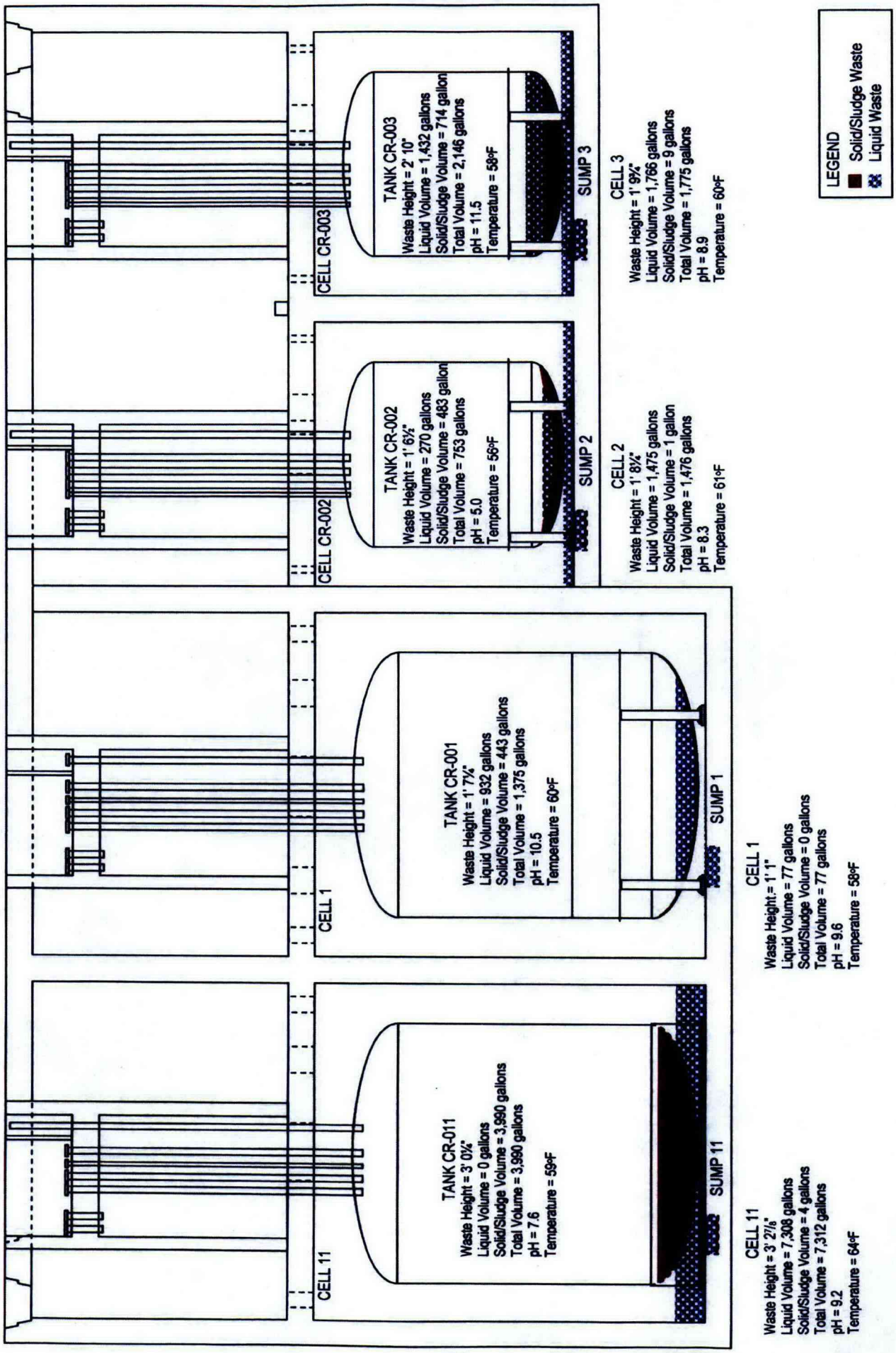

Figure ES-1. 244-CR Vault Waste pH, Temperature, and Volume Estimates.

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244-CR VAULT LIQUID LEVEL ASSESSMENT AND VIDEO INSPECTION COMPLETION REPORT

1.0 INTRODUCTION

This report documents the work performed and the information collected during the 244-CR Vault liquid level assessment and video inspection. This work was primarily performed during calendar year 2004. The removal of equipment from the facility necessary to collect the level and video information is described. The results of the level assessment for each tank and cell of 244-CR vault are discussed and tabulated. A review of the video inspection is also provided. Finally, the final configuration of the facility at the completion of the liquid level and video inspection activity is provided.

1.1 PURPOSE

The purpose of this report is to document the work completed in order to meet the requirements of Hanford Federal Facility Consent Order (TPA) milestone M-23-27 as documented in TPA change number M-23-02-02 (HFFACO 2003). These activities consist of liquid level and video assessment of the tanks and cells of the 244-CR vault. These activities are also a subset of the activities required for interim stabilization of the facility which was deferred pending the results of this assessment.

This report addresses the actions taken to assess the liquid levels in the tanks and sumps as well as documenting the results of the assessment. This report also addresses the actions taken in performing a video assessment of the tanks and cells to assure that the waste is being stored in a manner that is protective of human health and the environment. The modifications that have been made and the physical state of the facility at the completion of the liquid level assessment and video inspection are described.

This report does not address further monitoring that may need to be performed or interim stabilization (see RPP-6029 and RPP-10495) that may be required. Those decisions will be made by the TPA parties (i.e., Washington State Department of Ecology, U. S. Environmental Protection Agency, and U. S. Department of Energy) and are beyond the scope of this report.

1.2 HANFORD FEDERAL FACILITY CONSENT ORDER CHANGE NUMBER M-23-02-02 AND MILESTONE M-23-27

The TPA milestone M-23-27 was established on June 30, 2003, through Change Number M-23-02-02 (HFFACO 2003). The milestone establishes the date for completing level assessment and video inspection for 244-CR vault. Milestone M-23-27 specifically states:

> *Complete liquid level assessments for 244-CR CR-001, 244-CR CR-002, 244-CR CR-011, 244-CR Cell 1, 244-CR Cell 2, 244-CR Cell 3. Assessments will include liquid level measurements using a manual tape or more accurate method, volume estimates, and a video inspection of the tanks and surrounding vault sufficient to determine if the waste is being stored in manner that is protective of human health and the environment.*

Although 244-CR vault Cell 11[1] is not listed in the milestone text, the assessment that was performed included Cell 11 as preparation for possible future stabilization and closure of the 241-C tank farm (CH2M-0301219 R1, *Contract Number DE-AC27-99RL14047; Transmittal of Regulatory Letter: Denial of Hanford Federal Facility Agreement and Consent Order Change Request M-23-02 Requesting Revisions to the M-23 Milestone Series Dated April 16, 2003*).

Hanford Federal Facility Agreement and Consent Order change number M-23-02-02 also identifies, in wording outside Interim Milestone M-23-27, that subsequent to completing level assessment and video inspection for 244-CR vault, further monitoring will be performed and decisions will be made by the parties (i.e., Washington State Department of Ecology, U. S. Environmental Protection Agency, and U. S. Department of Energy) regarding interim stabilization.

> *Further leak detection and monitoring actions in the identified tanks and structures will be in accordance with the M-23-23 F&R* [functions and requirements] *based on the results of the assessments. The Parties will make decisions regarding timing and necessity of interim stabilization of these tanks and structures, based on the results of the assessments and the retrieval commitments established during M-45-00C negotiations.*

1.3 END POINT CRITERIA

The end point criteria for this effort, which includes completion of the milestone, and the scope of this report can be categorized into six activities.

1. Complete liquid level assessments for 244-CR vault tanks CR-001, CR-002, CR-003, and CR-011 using manual tape or more accurate method.
2. Complete liquid level assessments for 244-CR vault Cell 1, Cell 2, Cell 3, and Cell 11 using manual tape or more accurate method.

[1] The tanks, cells and sumps of 244-CR vault are described by slightly different naming conventions in various documents. For example the documented safety analysis (RPP-13033) refers to the tanks as 244-CR-TK-001, 244-CR-TK-002, 244-CR-TK-003, and 244-CR-TK-011. The facility drawings identify the tanks as TK-CR-001, TK-CR-002, TK-CR-003, and TK-CR-011 and specify the cell sumps as sump CR-001, sump CR-002, sump CR-003, and sump CR-011 or CR-001 sump, CR-002 sump, CR-003 sump and CR-011 sump, but do not specify the cells. The interim stabilization project plan, RPP-6029, the level assessment and video inspection activity plan, RPP-20188, and the TPA milestone use CR-001, CR-002, CR-003 and CR-011 to describe the tanks and 1, 2, 3, and 11 to describe the cells of 244-CR vault. This report will use the convention used in the TPA milestone and previous planning documentation.

3. Complete liquid volume estimates for 244-CR vault tanks CR-001, CR-002, CR-003, and CR-011.
4. Complete liquid volume estimates for 244-CR vault Cell 1, Cell 2, Cell 3, and Cell 11.
5. Complete video inspections for 244-CR vault tanks CR-001, CR-002, CR-003, and CR-011 sufficient to determine if the waste is being stored in a manner that is protective of human health and the environment.
6. Complete video inspections for 244-CR vault Cell 1, Cell 2, Cell 3, and Cell 11 sufficient to determine if the waste is being stored in a manner that is protective of human health and the environment.

1.4 GENERAL FACILITY BACKGROUND AND CONFIGURATION

The 244-CR vault is located in the southwest corner of the 241-C tank farm complex in the 200 East Area of the Hanford Site. The 244-CR vault was built in 1952 to support the uranium metal recovery program, which began in the early 1950s. The vault and associated tanks were used as the uranium sludge recovery and distribution vault for the 241-C tank farm. The 244-CR vault was also used for the interim storage and transfer of waste from B Plant, the Plutonium Uranium Extraction Plant (PUREX), Hot Semi-Works including PUREX acidified sludge waste, and for fission product crudes between PUREX and B Plant. The most recent use of the facility was as a receiver tank during the removal of liquid from the single-shell tanks (SST) in 241-C tank farm. These transfers occurred in 1995 using tank CR-003.

The 244-CR vault is a two-level, underground, reinforced concrete structure. The lower level consists of four cells, each equipped with a concrete sump. The exterior walls and dividing walls between the cells are 2 ft thick. Each cell houses a steel tank. Tank CR-011 is a nominally 40,000-gal stainless steel tank. Tank CR-001 is a nominally 40,000-gal carbon steel tank. Tanks CR-002 and CR-003 are both nominally 10,000-gal stainless steel tanks. The cells housing tanks CR-011 and CR-001 are each 26 ft long by 22 ft wide and 29 ft 6 in. tall. The cells housing tanks CR-002 and CR-003 are each 20 ft long by 16 ft wide and 19 ft 6 in. tall. A plan view of the 244-CR vault is shown in Figure 1-1. A section of the 244-CR vault is shown in Figure 1-2.

The upper level of 244-CR vault includes three pump pits and four riser pits. There is one pump pit above the cell housing tank CR-011 and one pump pit above the cell housing tank CR-001. The final pump pit covers the cells containing tanks CR-002 and CR-003. The exterior walls and dividing walls between these three pump pits are 2 ft thick. A 12-in.-thick by 12-in.-high curb divides the pump pit over tanks CR-002 and CR-003 in half. Each of these pump pits have access holes in the floor above each tank for an agitator and pump. The pump pit above tank CR-001 also has an access hole for a jet. Each of these pump pits also has ventilation inlet points along the southwest wall and has ventilation discharge and floor drain holes located in the floor. The pump pits above tanks CR-011 and CR-001 are each 26 ft long by 8 ft wide. The pump pit above tanks CR-002 and CR-003 is 42 ft long by 8 ft wide. All three pump pits are nominally 19 ft 4 in. tall to the bottom of 2-ft-thick cover blocks placed over the pits at grade level.

There is one riser pit above each of the four cells housing the four tanks. The northeast wall of each riser pit is a common wall with the southwest wall of the pump pits. The other

three exterior walls of each of the four riser pits is 1 ft thick. A floor 2 ft thick is 5 ft below the top of each riser pit. This floor contains pipe penetrations that pass through the floor into the tank below or into the cell below. Pipe penetrations into the tanks were originally used for instrumentation (level and temperature), sampling, and chemical addition into the tank. Pipe penetrations into the cell below were originally used for instrumentation (level) in the cell's sump. The top of the riser pit, above the 2-ft-thick floor, was divided into two sections via a 4-in.-thick concrete wall. The smaller of these sections contained the penetrations used for sampling the tanks. Over the cell containing tank CR-011, the larger of these sections is 7 ft 8 in. long by 5 ft wide, and the smaller of these sections is 1 ft 6 in. long by 5 ft wide. Over the cell containing tank CR-001, the larger of these sections is 7 ft 10 in. long by 5 ft wide, and the smaller of these sections is 1 ft 4 in. long by 5 ft wide. The dimensions of the riser pits over the cells containing tanks CR-002 and CR-003 are identical. For these riser pits, the larger of these sections is 6 ft 10 in. long by 2 ft 6 in. wide, and the smaller of these sections is 1 ft 4 in. long by 2 ft 6 in. wide. All of the riser pits are covered with metal plates that span the width of the pits.

In 1996, the riser pits, pump pits and other pits in the surrounding area (e.g., old filter pit) had been covered with foam for the purpose of radiological stabilization of the 244-CR vault. This also helped to prevent intrusion of rain and snowmelt. The foam was previously installed on the pits, via engineering change notice (ECN) 707851 under work package 2E-96-00534/W. Since that time, activities associated with interim stabilization of the 244-CR vault were started and suspended on at least two occasions. As part of these activities foam was removed from areas through which access to the riser pits or tanks below was required. In September 1997 foam was removed from around the edges where the access plates covered the riser pit above tank CR-001. This work was performed under work package 2E-97-01248/W. No foam was removed from the riser pit above tank CR-002 under this same work package. It is not clear from work package 2E-97-01248, whether foam was removed, or to what extent foam was removed, from the riser pits above tanks CR-003 and CR-011 at that time. However, work instructions in a later work package to remove foam at 244-CR vault, 2W-02-00769, was written in a way that infers foam removal may not have been necessary at the riser pits above tanks CR-001, CR-003 and CR-011. Foam was removed at the riser pit above tank CR-002 via work package 2W-02-00769 during September 2002. Additional foam removal at the riser pits above tanks CR-001, CR-003 and CR-011 was also performed during September 2002 via work package 2W-02-00769. Foam was removed from the riser pits in order to perform video inspections of the pits as part of the planned interim stabilization of the 244-CR vault. This video inspection of the pits was performed December 2002 under work package 2W-02-01006/W.

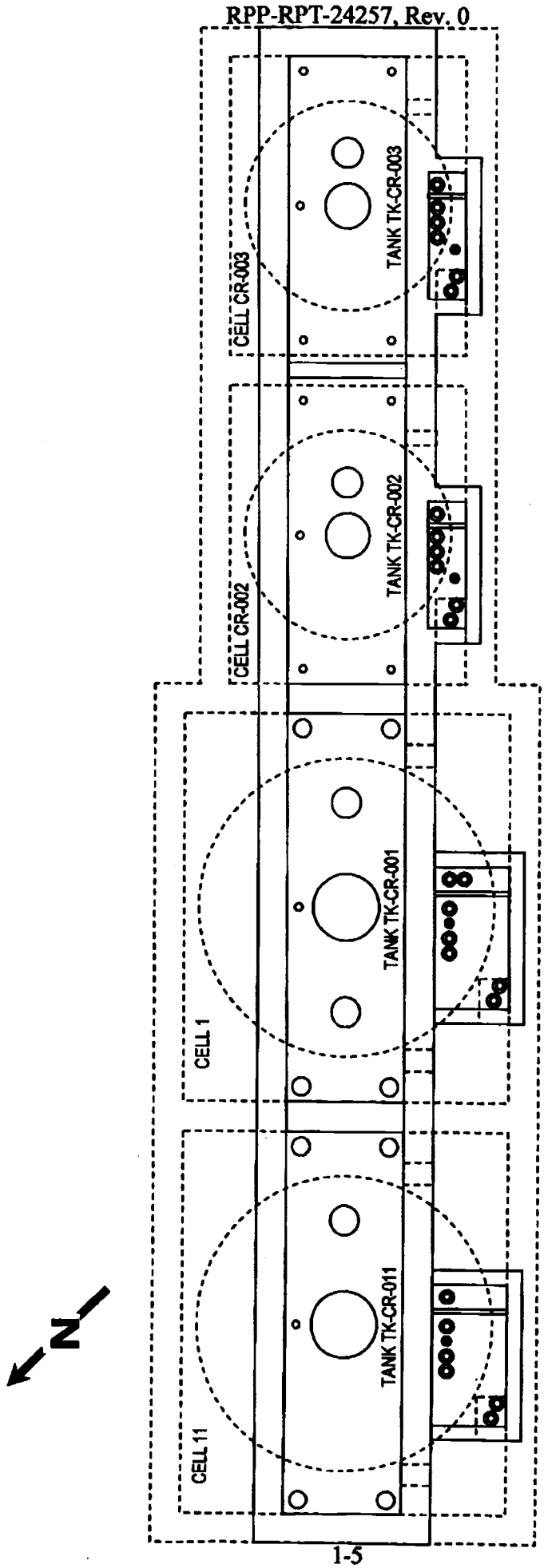

Figure 1-1. 244-CR Vault Plan View at Grade.

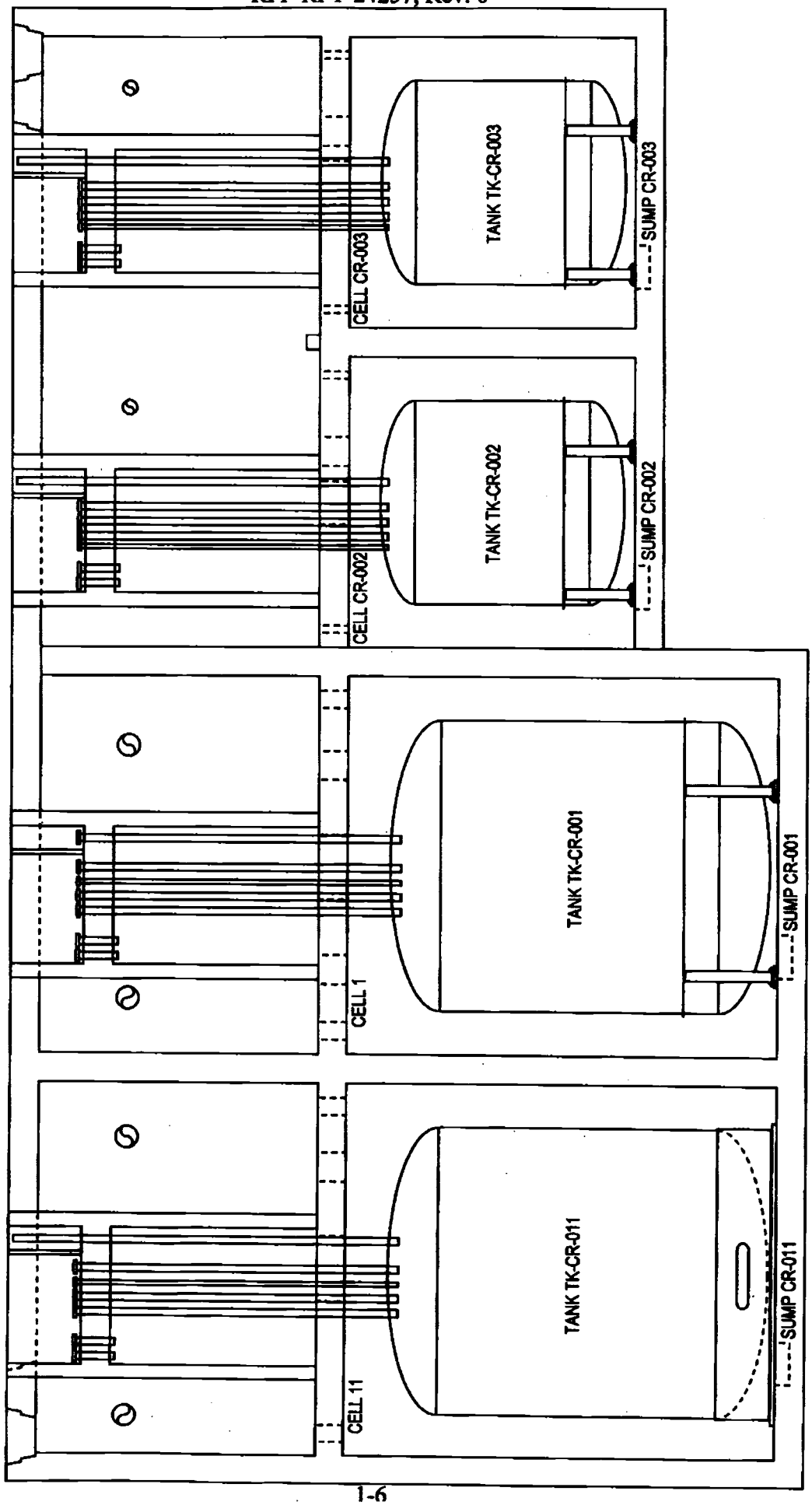

Figure 1-2. 244-CR Vault Section View Looking Northeast.

2.0 ACTIVITY EXECUTION

In order to complete TPA Milestone M-23-27, the task can be considered as three discrete groups of activities. These groups of activities were 1) facility equipment removal; 2) liquid level assessment and volume estimate; and, 3) video inspection. The planned approach for performing the work in these three groups of activities was documented in the *244-CR Vault Liquid Level Assessment and Video Inspection Task Plan* (RPP-20188). The execution of the approach differed in certain aspects from the strategy described in CHG 2004 but resulted in the same successful outcome. The general approach for equipment removal, liquid level assessment, and video inspection are discussed below. Specific details of facility equipment removal, liquid level assessment, and video inspection for each tank and cell are provided in Sections 3.0, 4.0, and 5.0, respectively.

2.1 FACILITY EQUIPMENT REMOVAL

The facility equipment removal work encompassed all work performed prior to the video inspection and liquid level assessment. Part of the required facility equipment removal work included construction and placement of an open-top tent over each riser pit area. The open-top tent was used to prevent potential contamination spread from the riser pit to the environment. A portable temporary radioactive air emission unit (PTRAEU) was installed with flexible ducting to ventilate the riser pit area within the open-top containment tent. Prior to operation of the PTRAEU, differential pressure gauge testing and high-efficiency particulate air (HEPA) filter testing was performed to ensure the PTRAEU operated within required limits. Two open-top containment tents were used for this activity. The open-top containment tents were initially placed over the riser pits associated with tanks CR-002 and CR-011. When work activities were completed at the riser pits over tanks CR-002 and CR-011, the tents were relocated to the riser pits associated with tanks CR-003 and CR-001, respectively. Because just the ducting was moved and not the PTRAEUs, no additional differential pressure gauge or HEPA filter testing was required when the tents were moved.

The spread of contamination was controlled for work within the riser pits, by applying fixative to pit surfaces. After fixing contamination and removing the pit covers, various pieces of excess equipment and debris in the pit that would interfere with the removal of in-tank or in-sump equipment were removed. Decontamination and size reduction of the long length equipment removed from the tanks and cells was performed to reduce dose and accommodate standard waste containers.

In-tank and in-sump equipment was removed from various risers to gain access for level assessment and video inspection of the tanks and cells. As part of equipment removal, a riser extension, which extends above the top of the riser pit, was attached to the flange of the riser within the pit. New covers were installed over each riser pit. Integral to each riser extension are four nozzles located slightly above grade with the end of the nozzle inside the riser extension. These nozzles were used to spray the equipment with water, decontaminating the equipment as it was removed. This riser extension was left in place and outfitted with a 6 in x 4 in reducer and 4

in ball valve. The ball valve provided the interface point for installing a top hat assembly for level assessment, video inspection and possible future ENRAF® level measurement instrument installation. At the time level assessment and video inspection of Cell 3 and tank CR-003 was performed, riser extensions were not placed on the risers in the riser pit. Level assessment and video inspection of the inside of tank CR-003 was performed through the sample riser that had previously contained the manual tape used for level measurement. Mechanical failure of the reel for the manual tape resulted in the decision to cut the tape and allow it to drop into the tank. The riser accessing Cell 3 did not have installed equipment with the exception of two small diameter cables. This allowed access for level assessment and video inspection without the need for equipment removal. Installation of riser extensions, 6 in x 4 in reducer and 4 in ball valve on the risers connected to tank CR-003 and Cell 3 has not occurred as of the date of issue of this report. Current plans are to remove chemical process piping from the spare instrument riser to tank CR-003 and install riser extensions on that riser and the open riser to Cell 3. Planning calls for installing these extensions before any subsequent work is performed such as waste sampling or ENRAF® installation.

2.2 LIQUID LEVEL ASSESSMENT AND VOLUME ESTIMATE

After removing in-tank and in-sump equipment from a riser pit and installing the riser extensions, reducers and ball valves, the distance to the liquid and sludge interface and the waste pH and temperature was taken for the cell sumps and tanks. Generally at each riser pit, measurements were performed for the cell sump first and then, once these were completed, measurements were performed for the tank.

Prior to performing any liquid level measurements, radiation levels and flammable gas concentrations were measured to confirm operating conditions were safe to proceed. Radiation and contamination levels were established over each open riser. Flammable gas concentrations were measured within the vault and tank headspace. Once the radiation levels and flammable gas concentrations were determined to be safe, a top hat was placed on the top of the 4 in ball valve above the riser extension. The length of the top hat was documented. Liquid level, pH and temperature, and sludge level could be measured in any order. Liquid level was measured by lowering a zip cord down through the top hat until contact with the liquid surface (or conductive medium) was indicated by positive deflection of the conductivity meter. The length of the extended zip cord representing the distance from the top of the top hat to the top of the liquid surface was recorded. The zip cord was then removed from the riser.

Waste pH was measured by using a pH probe with integral temperature element. Prior to use, the pH probe was tested with pH 4.0, 7.0 and 10.0 buffer solutions per the manufacturer's instructions. After testing the pH probe was lowered through the top hat until it was submerged or in contact with the waste. Two pH readings were taken to confirm the probe measurement was static and a temperature reading was recorded. The pH probe was then removed from the riser.

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Sludge level was measured by lowering a sludge weight at the end of a tape down through the top hat until the sludge weight comes to rest on the sludge or a hard surface. The tape connected to the sludge weight is then raised and lowered as needed to determine the sludge interface. The length of the tape attached to the sludge weight, representing the distance from the top of the top hat to the top of the sludge surface was recorded. The sludge weight was then removed from the riser.

2.3 VIDEO INSPECTION

After completing the pH and temperature, liquid level, and sludge level measurements at a riser pit for a particular tank and cell sump, the video inspection of the tank and its surrounding cell was performed. Video inspection could be performed either prior to the level and pH measurements or after these measurements were taken.

Prior to installing the video camera through the top hat on the riser, radiation levels and flammable gas concentrations were measured to confirm operating conditions were safe to proceed. Radiation and contamination levels were established over each riser opening. Flammable gas concentrations were measured within the vault and tank headspace. Once the radiation levels and flammable gas concentrations were determined to be safe, the video inspection of the cell or tank could begin.

Video inspection was performed by lowering the video camera with integral light source through the top hat until the camera was within the headspace of the cell or tank. The camera pan tilt and zoom was operated at different elevations within the cell or tank to cover the visible portions of the cell and/or tank. Video inspections within each tank assessed the condition of the tank interior while video inspections within each cell assessed the condition of the tank exterior and the cell interior. The condition could only be evaluated for those areas and surfaces of the cell and/or tank visible from the single riser used for camera access. After completing the video inspection, the video camera was removed from the riser.

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3.0 FACILITY EQUIPMENT REMOVAL

Equipment was removed from risers within the riser pits of 244-CR vault, as necessary, to allow access to the tanks and cells of the facility. Miscellaneous debris and equipment was removed from the pit to allow removal of installed equipment in those risers. Equipment removal was performed using ventilation within open top tents installed to maintain contamination control. Ventilation controls were provided in accordance with the conditions and limitations associated with the Notice of Construction (NOC) (AIR 02-1255).

3.1 TANK CR-001 AND CELL 1 SUMP

Equipment removal from the riser pit associated with tank CR-001 and Cell 1 sump was performed under work package 2W-03-01229/M, *244-CR Vault, Prepare Pit CR-001*. The riser pit was opened and inactive equipment and miscellaneous debris was removed from the pit as required for personnel access and to allow installation of riser extensions. The debris and equipment was removed to facilitate access to and removal of the tank thermocouple from riser 8724 and cell sump level measuring dip tube assembly from riser 8745. Equipment removal from riser 8724 and 8745 was documented on ECN-721268-R0, *244-CR Vault Riser Preparation for Installation of Liquid Level Detectors*, and ECN-721268-R1, *244-CR Vault Riser Preparation for Installation of Liquid Level Detectors*. Figure 3-1 shows an approximate graphic representation of the risers within the riser pit associated with tank CR-001 and Cell 1 with text describing what is present at each riser prior to equipment removal.

All equipment removal work at the riser pit was performed with a bullpen inside an open top tent. A railing was installed around the pit to provide fall protection for when the pit covers were removed. Plastic sheeting was installed on the railing as a splash guard. The PTRAEU was started up prior to removing the pit covers and continued to operate while pit covers were removed. Industrial hygiene performed surveys for flammable gas levels as well as ammonia and organic vapors within the pit before the pit cover was removed. These surveys were at least 3 feet below the pit edge, with access provided through existing penetrations in the cover or by partially opening the steel cover over the pit if an adequate penetration was not available. The survey of the riser pit, recorded in direct reading instrument (DRI) survey number 04-2451, indicated that the flammable gas level was 0% of the lower flammability limit of hydrogen, the ammonia concentration was 0 ppm, and the organic vapor concentration was 0 ppm. Prior to removing the pit covers, a fixative was applied inside the pit to reduce the spread of contamination during equipment cutting, size reduction, and removal from the pit. Health physics technicians performed surveys on the pit covers for removable contamination and wrapped the pit covers in plastic for disposal.

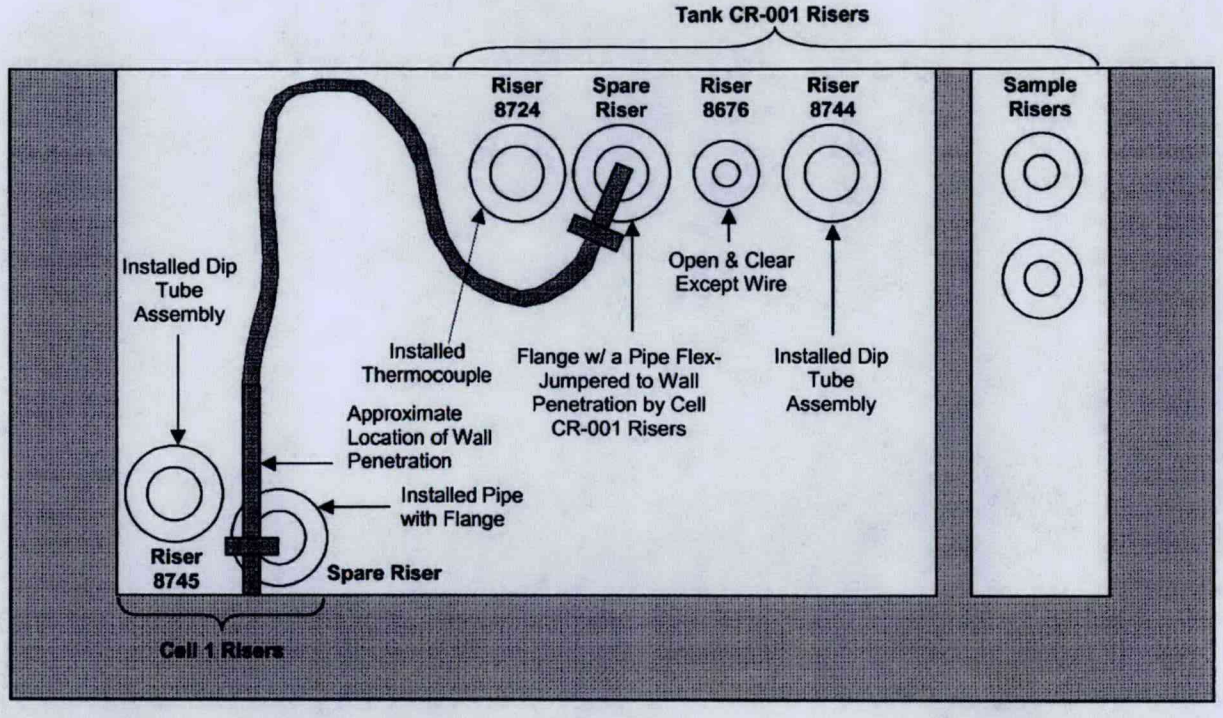


Figure 3-1. Graphic Representation of Riser Pit CR-001 Prior to Equipment Removal

Electrical sources (e.g., electrical cords, cables, conduit) within the pit were verified to be de-energized prior to removing equipment and debris from the pit. No energized electrical sources were found within the pit. After confirming no energized electrical sources, equipment and debris was removed from the pit to facilitate access to tank riser 8724 and cell riser 8745. Without manned entry into the pit, equipment and debris was cut up, as necessary, and removed from the pit. Removed equipment and debris was sleeved or wrapped in plastic for disposal. After equipment and debris removal, a radiation and contamination survey of the pit was performed. Shielding was placed within the pit, as necessary, to limit personnel dose rates during work activities within the pit.

Access to the pit was required to remove the flange bolts from the tank thermocouple on riser 8724 and cell sump dip tube assembly on riser 8745. Access to the pit was also required to relocate process piping from a submersible pump installed within the spare riser (adjacent to riser 8724). The process piping was lowered and allowed to rest on the spare riser and pipe stands and supports were moved as necessary to allow unobstructed access to riser 8724 for subsequent removal of the tank thermocouple. This piping is shown in figure 3-2. Figure 3-2 also shows the tank thermocouple installed in riser 8724 to the left, prior to its removal, and the open 3-inch riser 8676 to the right of the spare riser.

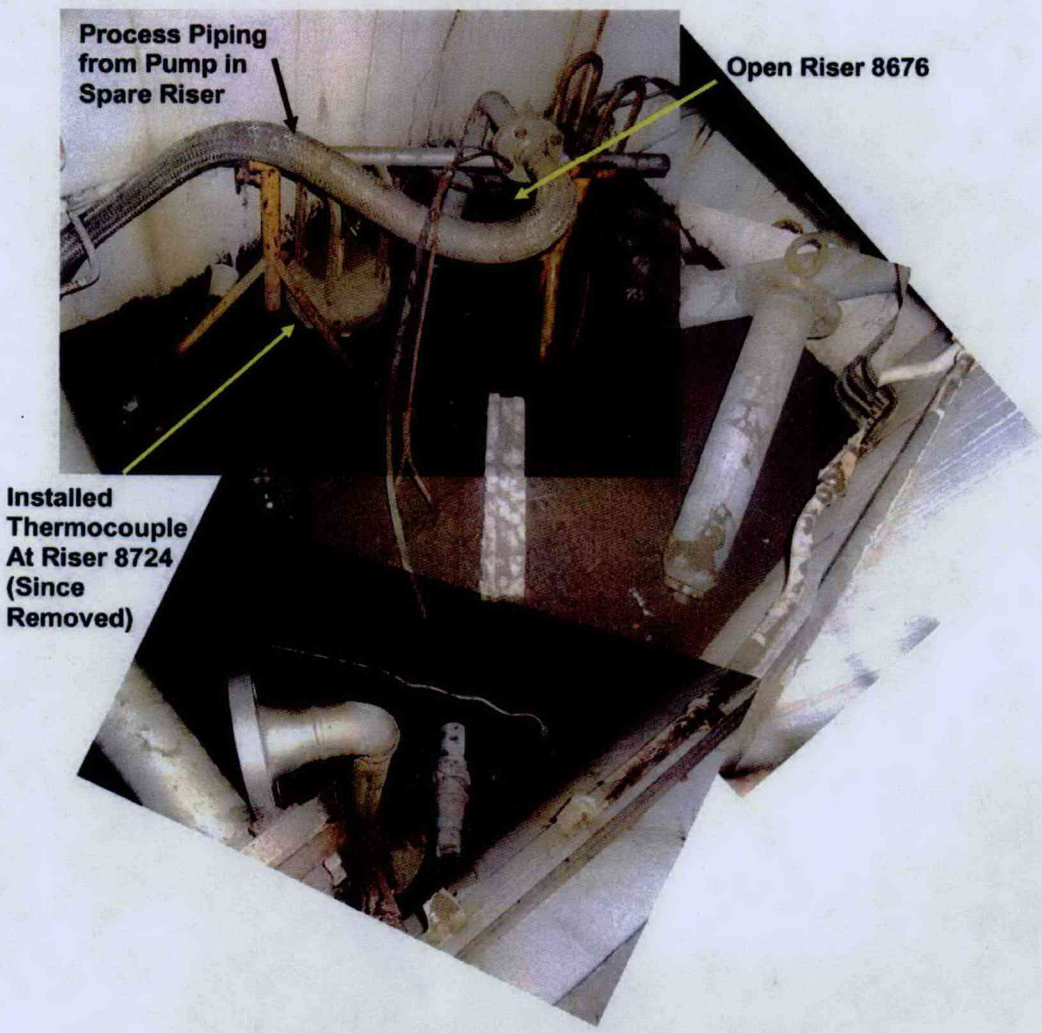


Figure 3-2. Portion of Riser Pit Above Tank CR-001 Prior to Equipment Removal Based on Mosaic of Pictures Taken in 2002

After removing all equipment and debris that would interfere with tank thermocouple and cell sump dip tube assembly removal, Hoisting and Rigging attached a sling to the cell sump dip tube assembly in preparation for assembly and installation of a typical riser extension. The riser extension is 5 ft 6 in long and consists of 6 in schedule 40 pipe with flanges at each end. The riser extension consists of two identical halves that were joined together once the cell sump dip tube assembly was raised up high enough to allow installation of the riser extension. The cell sump dip tube assembly and riser extension was lowered back down onto riser 8745 once the riser extension was assembled. A gasket was installed between the riser and riser extension and the riser extension was bolted in place. The riser extension also has an integral washer assembly with four spray nozzles used to wash down the equipment as it was removed for the cell sump. After installing the riser extension on riser 8745, the riser extension for riser 8724 was installed in the same manner by lifting the tank thermocouple, installing the extension and then lowering and bolting it on the riser. After installing both riser extensions in the riser pit, the temporary

shielding used to allow personnel access into the riser pit was removed and discarded. New ½ in thick aluminum pit cover plates were installed over the riser pit.

A temporary polyvinyl chloride (PVC) "top hat assembly" was installed on the top of each riser extension to accommodate sleeving for sealing the equipment during its subsequent removal. As part of removing the tank thermocouple from riser 8724, measurements were taken for flammable gas, ammonia, and organic vapor concentrations. The surveys during equipment removal from tank CR-001, reported in DRI survey number 04-3549, indicated that the flammable gas level was 0% of the lower flammability limit of hydrogen, the ammonia concentration was 0 ppm, and the volatile organic carbon vapor concentration ranged from 0 to 230 ppb.

Beta shielding (rubber matting) was attached to the equipment where needed to reduce potential radiation exposure during removal of the cell sump dip tube assembly and tank thermocouple. A water source was connected to the washer assembly of the riser extension and tested for leaks. The cell sump dip tube assembly was raised from riser 8745 via crane. The rubber matting and sleeving was taped around the assembly as it was removed from the riser. The radiation levels associated with the assembly were continuously monitored during removal of the cell sump dip tube assembly from the riser. Water was used intermittently during the removal of the assembly. After the assembly was raised approximately 35-40 feet, secondary rigging was attached to the assembly to allow for its subsequent lay down. The cell sump dip tube assembly was raised clear of the riser and left above the riser to drain any liquid from the assembly. The water supply to the washer assembly was secured. In the work record, the recorded amount of water used during removal of the cell sump dip tube assembly was 25 gallons. This water drained to Cell 1. Sleeving surrounding the assembly was horse tailed, cut and separated from the top hat assembly. The assembly was moved to the lay down area, secondary sleeving was installed on the assembly and the lower portion of the assembly placed in a PVC "coffin" with shielding to allow for storage prior to subsequent size reduction for disposal. The PVC equipment removal top hat assembly was removed from the riser extension. After removal of this top hat assembly, a 6 in x 4 in reducing spool, ball valve, and blank flange were installed on the top of the riser extension on riser 8745.

The evolution described for removing the cell sump dip tube assembly from riser 8745 in the previous paragraph, was repeated for removing the tank thermocouple from riser 8724. Water was used continuously during removal of the tank thermocouple rather than intermittently. The radiation levels associated with this thermocouple were the highest recorded after the compensatory measures for radiological control were put in place (see Section 3.2 below regarding thermocouple removal from tank CR-002. Three layers of rubber matting were required to keep the radiation levels below the extremity exposure limit of 24,000 mrem/hr (open window corrected). The thermocouple removed from tank CR-001 required the greatest amount of shielding (rubber matting) in order to reduce the beta radiation levels. The bottom portion of the thermocouple was also shielded with lead around the outside of the PVC "coffin" to reduce whole body dose rates to below 80 mrem/hr at 30 cm. In the work record, the recorded amount of water used during removal of the tank thermocouple was 52 gallons. This water drained to tank CR-001. The PVC equipment removal top hat assembly was removed from the riser extension on riser 8724. After removal of this top hat assembly, a 6 in x 4 in reducing spool, ball

valve, and blind flange were installed on the top of the riser extension on riser 8724. A graphical depiction of a typical riser extension, reducer, ball valve, and blind flange installation on a riser is shown in Figure 3-3

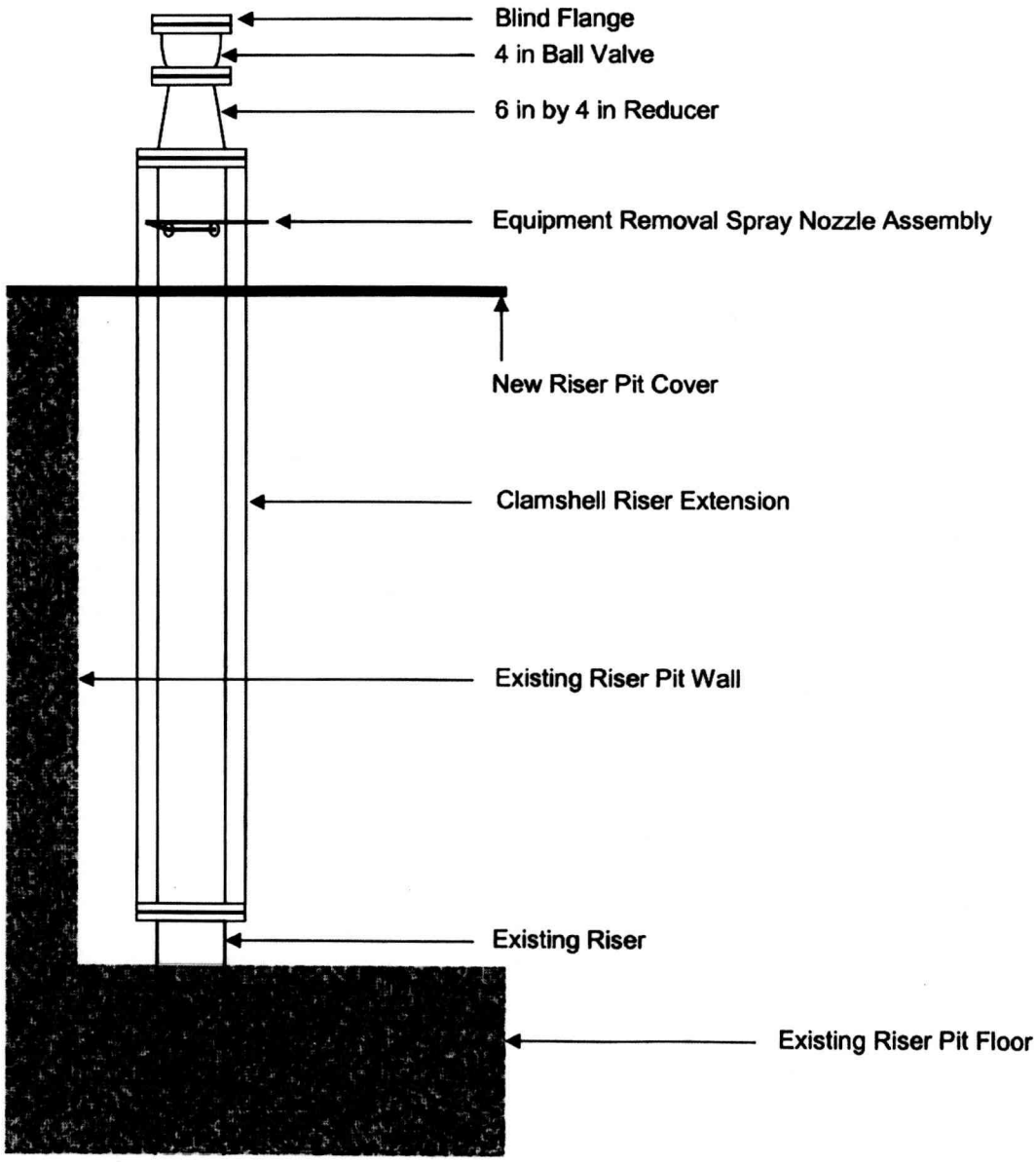


Figure 3-3. Depiction of Typical Riser Extension, Reducer & Ball Valve Installation

3.2 TANK CR-002 AND CELL 2 SUMP

Equipment removal from the riser pit associated with tank CR-002 and Cell 2 was performed under work package 2W-02-00767/M, *244-CR Vault, Prepare Pit CR-002*. The riser pit associated with tank CR-002 and Cell 2 was the first pit from which the installed equipment was removed. The riser pit was opened and inactive equipment and miscellaneous debris was removed from the pit as required for personnel access and to allow installation of riser extensions. The debris and equipment was removed to facilitate access to and removal of the tank thermocouple from riser 8747 and cell sump level measuring dip tube assembly from riser 8748. Equipment removal from riser 8747 and 8748 was documented on ECN-721268-R0, *244-CR Vault Riser Preparation for Installation of Liquid Level Detectors*, and ECN-721268-R1, *244-CR Vault Riser Preparation for Installation of Liquid Level Detectors*. Figure 3-4 shows an approximate graphic representation and a photo-mosaic of the configuration of the riser pit associated with tank CR-002 and Cell 2 prior to equipment removal.

All equipment removal work at the riser pit was performed with a bullpen inside an open top tent. A railing was installed around the pit to provide fall protection for when the pit covers were removed. Plastic sheeting was installed on the railing as a splash guard. The PTRAEU was started up prior to removing the pit covers and continued to operate while pit covers were removed. Industrial hygiene performed surveys for flammable gas levels as well as ammonia and organic vapors within the pit before the pit cover was removed. These surveys were at least 3 feet below the pit edge, with access provided through existing penetrations in the cover or by partially opening the cover if an adequate penetration was not available. Several surveys of the riser pit were performed and recorded on DRI survey numbers 04-1683, 04-1685, 04-1686, and 04-1687. These various surveys of the riser pit indicated that the flammable gas level was 0-2% of the lower flammability limit of hydrogen, the ammonia concentration was 0 ppm, and the organic vapor concentration ranged from 0 to 1200 ppb. Prior to removing the pit covers, a fixative was applied inside the pit to reduce the spread of contamination during equipment cutting, size reduction, and removal from the pit. Health physics technicians performed surveys on the pit covers for removable contamination and wrapped the pit covers in plastic for disposal.

Electrical sources (e.g., electrical cords, cables, conduit) within the pit were verified to be de-energized prior to removing equipment and debris from the pit. No energized electrical sources were found within the pit. After confirming no energized electrical sources, equipment and debris was removed from the pit to facilitate access to tank riser 8747 and cell riser 8748. Without manned entry into the pit, equipment and debris was cut up, as necessary, and removed from the pit. Removed equipment and debris was sleeved or wrapped in plastic for disposal. After equipment and debris removal, a radiation and contamination survey of the pit was performed. Shielding was placed within the pit, as necessary, to limit personnel dose rates during work activities within the pit.

The tubing to the dip tube assembly was cut as required to allow insertion of sample tubing into tank CR-002. A bonded sample tube was installed through the cut dip tube in order to measure flammable gas, ammonia, and organic vapor concentrations within the tank. The initial surveys of tank CR-002, recorded in DRI survey number 04-1684, indicated that the ammonia concentration was 0 ppm, and the organic vapor concentration was 2 ppm.

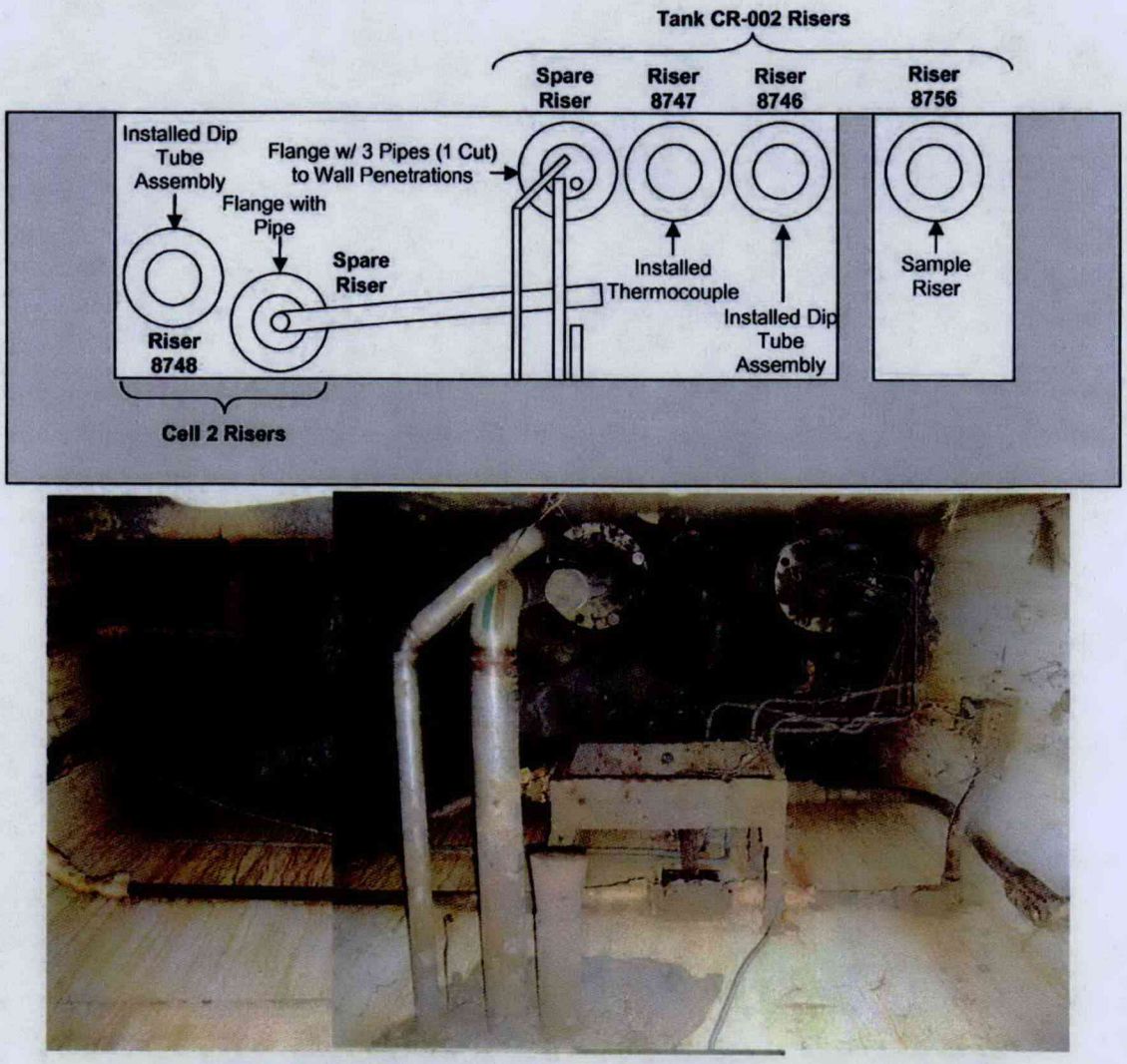


Figure 3-4. Graphic Representation and Photo-Mosaic of Riser Pit Above Tank CR-002 Prior to Equipment Removal

All the flange bolts from the tank thermocouple on riser 8747 and cell sump dip tube assembly on riser 8748 were removed. Conduit that was expected to interfere with the removal of the cell sump dip tube assembly was removed off the walls. Figure 3-4 shows the tank thermocouple installed in riser 8747 and the sump dip tube assembly installed in riser 8748.

After removing all equipment and debris that would interfere with tank thermocouple and cell sump dip tube assembly removal, Hoisting and Rigging attached a sling to the cell sump dip tube assembly in preparation for assembly and installation of a typical riser extension (see description in Section 3.1). The cell sump dip tube assembly was raised up high enough to allow installation of the riser extension. The cell sump dip tube assembly and riser extension were lowered back

down onto riser 8748 once the riser extension was assembled. A gasket was installed between the riser and riser extension and the riser extension was bolted in place. After installing the riser extension on riser 8748, the riser extension for riser 8747 was installed in the same manner by lifting the tank thermocouple, installing the extension and then lowering and bolting it on the riser. After installing both riser extensions in the riser pit, the temporary shielding used to allow personnel access into the riser pit was removed and discarded. New ½ in thick aluminum pit cover plates were installed over the riser pit.

A temporary PVC "top hat assembly" was installed on the top of each riser extension to accommodate sleeving for sealing the equipment during its subsequent removal. While removing the tank thermocouple from riser 8747, measurements were taken for flammable gas. The survey of tank CR-002, recorded in DRI survey number 04-1702, indicated that the flammable gas level was 0% of the lower flammability limit of hydrogen and the organic vapor concentration was 0 ppm. A water source was connected to the washer assembly of the riser extension and tested for leaks. The cell sump dip tube assembly was raised from riser 8748 via crane. The sleeving was taped around the assembly as it was removed from the riser. The radiation levels associated with the assembly were continuously monitored during removal of the cell sump dip tube assembly from the riser. Water was used intermittently during the removal of the assembly. After the assembly was raised approximately 30 feet, secondary rigging was attached to the assembly to allow for its subsequent lay down. The cell sump dip tube assembly was raised clear of the riser and left above the riser to drain any liquid from the assembly. The water supply to the washer assembly was secured. The recorded amount of water used during removal of the cell sump dip tube assembly was 15.8 gallons. This water drained to Cell 2. Sleeving surrounding the assembly was horse tailed, cut and separated from the top hat assembly. The assembly was moved to a flat bed truck for subsequent transfer to the lay down area for cut up in preparation for disposal.

The evolution described for removing the cell sump dip tube assembly from riser 8748 in the previous paragraph, was repeated for removing the tank thermocouple from riser 8747. The recorded amount of water used during removal of the tank thermocouple was 34.5 gallons. This water drained to tank CR-002.

It is worth noting that with approximately seven feet of the tank thermocouple left to pull from the riser, the health physics technician monitoring the thermocouple identifies a rapid increase in radiation readings and the removal of the thermocouple was stopped. Because this was the first tank from which equipment was removed, there was no previous evidence or experience with the radiation levels encountered. The persons in charge, health physics technicians involved, and the radiological control supervisor present conferred on the path forward. The decision was made to continue the pull and put the job in a safe condition based on several considerations including: greater dose to un-sleeve and un-rig the thermocouple; additional time to install shielding; safety risk of leaving a live load on the crane; and, available time to complete the job because personnel were wearing self contained breathing apparatus.

The pull of the thermocouple from the riser resumed, sleeving was horsetailed and taped to the thermocouple, and the thermocouple was moved to a flatbed trailer. Shielding was placed on the lower end of the thermocouple to reduce the general area dose. The PVC equipment removal top

hat assembly was removed from the riser extension on riser 8747. After removal of this top hat assembly, a 6 in x 4 in reducing spool and blank flange were installed on the top of the riser extension on riser 8747.

During the removal of the thermocouple, a Nuclear Chemical Operator (NCO) was exposed to beta radiation levels that exceeded the extremity/skin Administrative Control Level of 15 Rem. The levels encountered exceeded the Radiological Work Permit (RWP) limits. This occurrence is described in detail in occurrence report CHG-TANKFARM-2004-0037. Because of the exposure, the work package was suspended and the NCO was placed on Access Control/Entry System (ACES) hold. The work place was placed in a safe configuration, including foaming over the pit, and a red arrow entry was made to the shift log stating no high risk intrusive work was authorized until corrective actions for the event were implemented. The corrective actions were implemented into a revision of Management Directive (MD-038), "Compensatory Controls For Radiological Control Performance".

Approximately three months later, after incorporating all necessary corrective actions, work recommenced on completing the equipment removal work from the riser pit associated with tank CR-002 and Cell 2. Initial radiological condition surveys were performed around the work area including the risers. The tent enclosure and bullpen were inspected for use, and the PTRAEUs were started. At tank riser 8747, the blind flange was slid to the side of the 6 in x 4 in reducing spool and flammable gas monitoring was performed to verify the concentration was less than 25% of the lower flammability limit within tank CR-002. Radiological condition surveys were performed over the top of the riser. A 4 in ball valve with blank flange (on the upper side not the side connected to the reducer) was installed on the 6 in x 4 in reducing spool. At cell sump riser 8748, radiological conditions were surveyed and the PVC top hat was sleeved and removed from the riser extension. A 6 in x 4 in reducing spool and 4 in ball valve with blank flange were installed on the riser extension. The PTRAEUs were turned off and post-job surveys were performed in the tent enclosure and bullpen.

3.3 TANK CR-003 AND CELL 3 SUMP

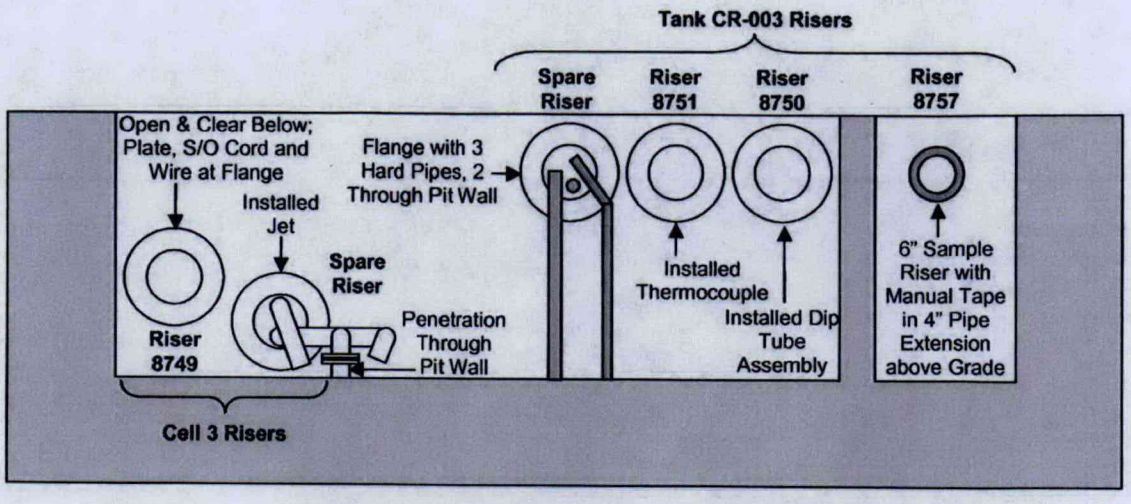
At the time this report was issued, the only equipment removed from the riser pit associated with tank CR-003 and Cell 3 was the manual tape that had been installed to take tank CR-003 level measurements. Work package CLO-WO-04-000140, *244-CR Vault, Perform Video and Liquid Level Readings at CR-003*, removed the manual tape from sample riser 8757 in order to allow video inspection and level assessment of tank CR-003. Riser 8749, which provides access to Cell 3, was already open so no equipment removal was required in order to perform video inspection and level assessment of cell 3. Work package 2W-02-00768/M, *244-CR Vault, Prepare Pit CR-003*, has been developed although field work has not begun (at the time of this report) to remove chemical piping from the 6 in spare instrument riser on tank CR-003. Figure 3-5 shows an approximate graphic representation of the configuration of the riser pit associated with tank CR-003 and Cell 3 prior to equipment removal performed under work packages 2W-02-00768/M.

3.3.1 Manual Tape Removal

Because of time constraints in meeting the deadline for TPA Milestone M-23-27 a decision was made to remove the manual tape installed on tank CR-003 in order to attain the video inspection and level assessment of the tank. The manual tape in riser 8757 was installed on the top of an existing pipe in the sample riser which extended above grade level. Access to the tank could be provided by removing the manual tape and leaving the existing pipe installed in the sample riser. This was much simpler and less time consuming compared to removing the chemical piping from the 6 in "spare" instrument riser. It should be recognized that the pipe in the sample riser was previously installed to mount the manual tape for level measurement of the tank and it is a different design than the clamshell riser extension described previously and shown in Figure 3-3.

The manual tape removal work was performed with a bullpen inside an open top tent. A railing was installed around the pit to provide fall protection. Plastic sheeting was installed on the railing as a splash guard. The PTRAEU was started up prior to removing the manual tape. In order to remove the manual tape box, it was planned to reel the tape into the box. However, the mechanism that reels the tape into the box was not working and the tape could not be retracted into the box. A decision was made, and documented in the work package, to cut the tape and allow it to drop into the tank. Sleeving was installed and the manual tape box was removed from the riser. When the manual tape assembly was clear of the riser, the sleeving was horsetailed and cut to seal the assembly. Health physics technicians performed radiological surveys over the open riser.

The 1 in PVC flanged pipe sleeve was then removed from riser 8757. This PVC pipe sleeve was used as an insulator between the manual tape and the tank riser. A sling was installed on the PVC pipe sleeve to lift it from the riser via a crane. Sleeving was installed for contamination control. After the PVC pipe sleeve was lifted clear of the riser, the sleeving was horsetailed and cut. The PVC pipe sleeve was removed for installation of secondary sleeving and lay down on a flat bed trailer for subsequent cut up and disposal. A top hat assembly was installed on the existing extension on riser 8757. The zip cord used to perform the level measurement was left in place to provide required weekly level monitoring of the tank until permanent monitoring is installed. Permanent monitoring equipment for tank CR-003 is planned to be installed on the spare riser accessing the tank rather than riser 8757. Riser 8757 is a bare pipe with no flange on the top unlike the other pit risers, and therefore the permanent monitoring equipment could not be mechanically coupled to a fixed, rigid riser extension.



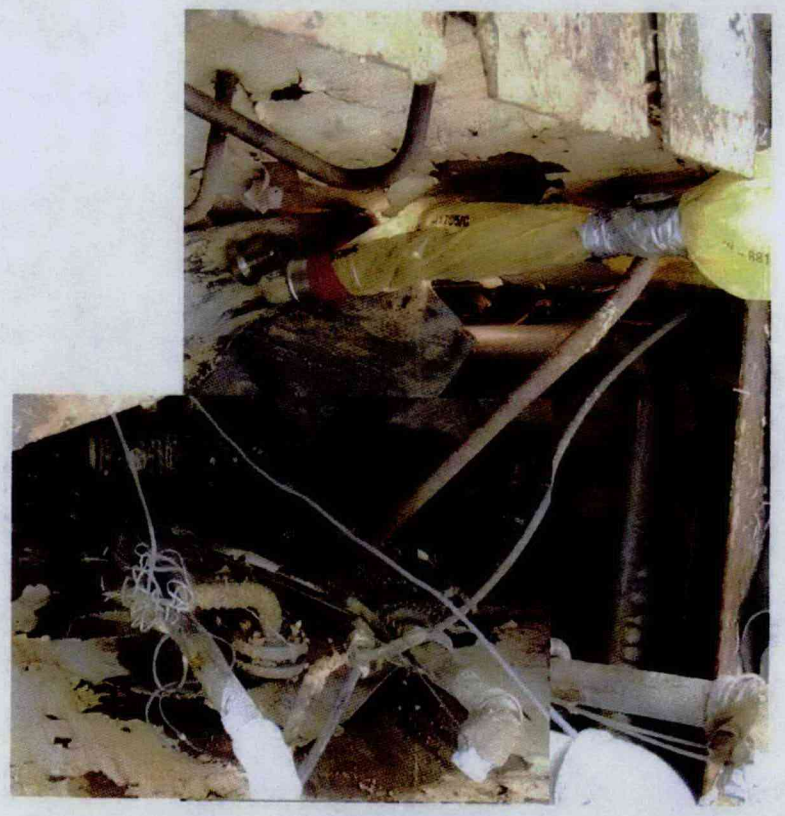


Figure 3-5. Graphic Representation and Photo Mosaic of Riser Pit Above Tank CR-003 Prior to Equipment Removal

3.3.2 Chemical Piping Removal and Riser Extension Installation

Chemical piping removal and riser extension installation at the riser pit associated with tank CR-003 and Cell 3 had not yet occurred at the time this report was issued. Work package 2W-02-00768/M, *244-CR Vault, Prepare Pit CR-003*, has already been planned and developed although field work has not begun (at the time of this report) to remove chemical piping from the 6 in spare instrument riser on tank CR-003 and install riser extensions that allow access to cell 3 and tank CR-003 from above the riser pit. The scope of work package 2W-02-00768/M includes opening the riser pit and removing inactive equipment and miscellaneous debris from the pit, as required, to allow for personnel access and installation of riser extensions. The primary component requiring removal is the chemical piping installed in the spare instrument riser to tank CR-003. Equipment removal from the spare instrument riser to tank CR-003 has been documented (although not field work complete) on ECN-721268-R0, *244-CR Vault Riser Preparation for Installation of Liquid Level Detectors*, and ECN-721268-R1, *244-CR Vault Riser Preparation for Installation of Liquid Level Detectors*, and ECN-722448-R0, *Modify Equipment in 244CR Instrument Pit 003*.

Work package 2W-02-00768/M also provides for installing the riser extensions on the spare instrument riser to tank CR-003 and on riser 8749 to cell 3. Similar to the other riser pit installations, a 6 in x 4 in reducing spool, ball valve, and blank flange will be installed on the top of the riser extensions on riser 8749 and the spare instrument riser to tank CR-003. Similar precautions, limits and prerequisites will be required to perform this work as applied to the other pit removal work. This includes operating ventilation (i.e. PTRAEU), applying fixative to the pit for controlling radioactive contamination, performing direct reading instrument surveys for flammable gas, ammonia and volatile organics, performing radiological surveys, verifying electrical sources in the pit are de-energized, and providing water washing of the chemical piping removed from tank CR-003.

3.4 TANK CR-011 AND CELL 11 SUMP

Equipment removal from the riser pit associated with tank CR-011 and Cell 11 was performed under work package 2W-02-00765/M, *244-CR Vault, Prepare Pit CR-011*. The riser pit was opened and inactive equipment and miscellaneous debris was removed from the pit as required to allow for personnel access and installation of riser extensions. The debris and equipment was removed to facilitate access to and removal of the tank thermocouple from riser 8800 and cell sump level measuring dip tube assembly from riser 8822. Equipment removal from riser 8800 and 8822 was documented on ECN-721268-R0, *244-CR Vault Riser Preparation for Installation of Liquid Level Detectors*, and ECN-721268-R1, *244-CR Vault Riser Preparation for Installation of Liquid Level Detectors*. Field change notice 100230 was written against ECN-721268-R0 to remove conduit attached to the wall of the pit. Figure 3-6 shows an approximate graphic representation of the configuration of the riser pit associated with tank CR-011 and Cell 11 prior to equipment removal performed under work package 2W-02-00765/M.

All equipment removal work at the riser pit was performed with a bullpen inside an open top tent. A railing was installed around the pit to provide fall protection for when the pit covers were

removed. Plastic sheeting was installed on the railing as a splash guard. The PTRAEU was started up prior to removing the pit covers and continued to operate while pit covers were removed. Industrial hygiene performed surveys for flammable gas levels as well as ammonia and organic vapors within the pit before the pit cover was removed. These surveys were at least 3 feet below the pit edge, with access provided through existing penetrations in the cover or by partially opening the cover if an adequate penetration was not available. The initial surveys of the riser pit, recorded on DRI Survey number 04-0908, indicated that the flammable gas level was 0% of the lower flammability limit of hydrogen, the ammonia concentration was 0 ppm, and the volatile organic carbon concentration was 350 ppb. Surveys taken during pit activities showed no change in the flammable gas level or ammonia concentration and a range of volatile organic carbon concentration between 300 and 500 ppb. Prior to removing the pit covers, a fixative was applied inside the pit to reduce the spread of contamination during equipment cutting, size reduction, and removal from the pit. Health physics technicians performed surveys on the pit covers for removable contamination and wrapped the pit covers in plastic for disposal.

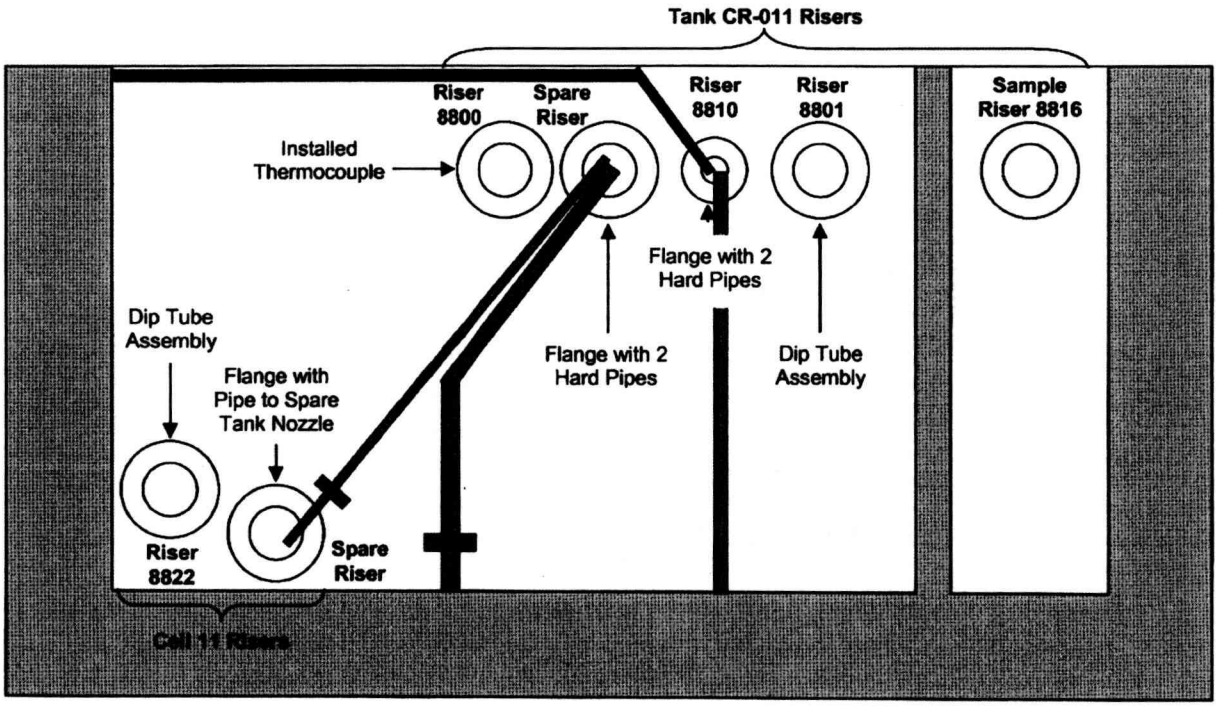


Figure 3-6. Graphic Representation of Riser Pit Above Tank CR-011 Prior to Equipment Removal

The tubing connected to the dip tube assembly installed in riser 8801 was cut as required to allow insertion of sample tubing into tank CR-011. A bonded sample tube was installed through the cut dip tube in order to measure flammable gas, ammonia, and organic vapor concentrations within the tank. The initial surveys of tank CR-011, recorded in DRI survey number 04-2386, indicated that the flammable gas level was 0% of the lower flammability limit of hydrogen.

Electrical sources (e.g., electrical cords, cables, conduit) within the pit were verified to be de-energized prior to removing equipment and debris from the pit. Equipment and debris was removed from the pit to facilitate access to tank riser 8800 and cell riser 8822. Without manned entry into the pit, equipment and debris was cut up, as necessary, and removed from the pit. Removed equipment and debris was sleeved or wrapped in plastic for disposal. After equipment and debris removal, a radiation and contamination survey of the pit was performed. Shielding was placed within the pit as necessary to limit personnel dose rates during work activities within the pit.

Personnel entry into the pit was required to remove the flange bolts from the tank thermocouple on riser 8800 and cell sump dip tube assembly on riser 8822. Hoisting and Rigging placed a sling on the cell sump dip tube assembly in preparation for assembly and installation of a typical riser extension (see description in Section 3.1). The cell sump dip tube assembly was lifted but it was not possible to clear the conduit attached to the wall of the pit approximately 1 ft above the riser flange, see Figure 3-7.

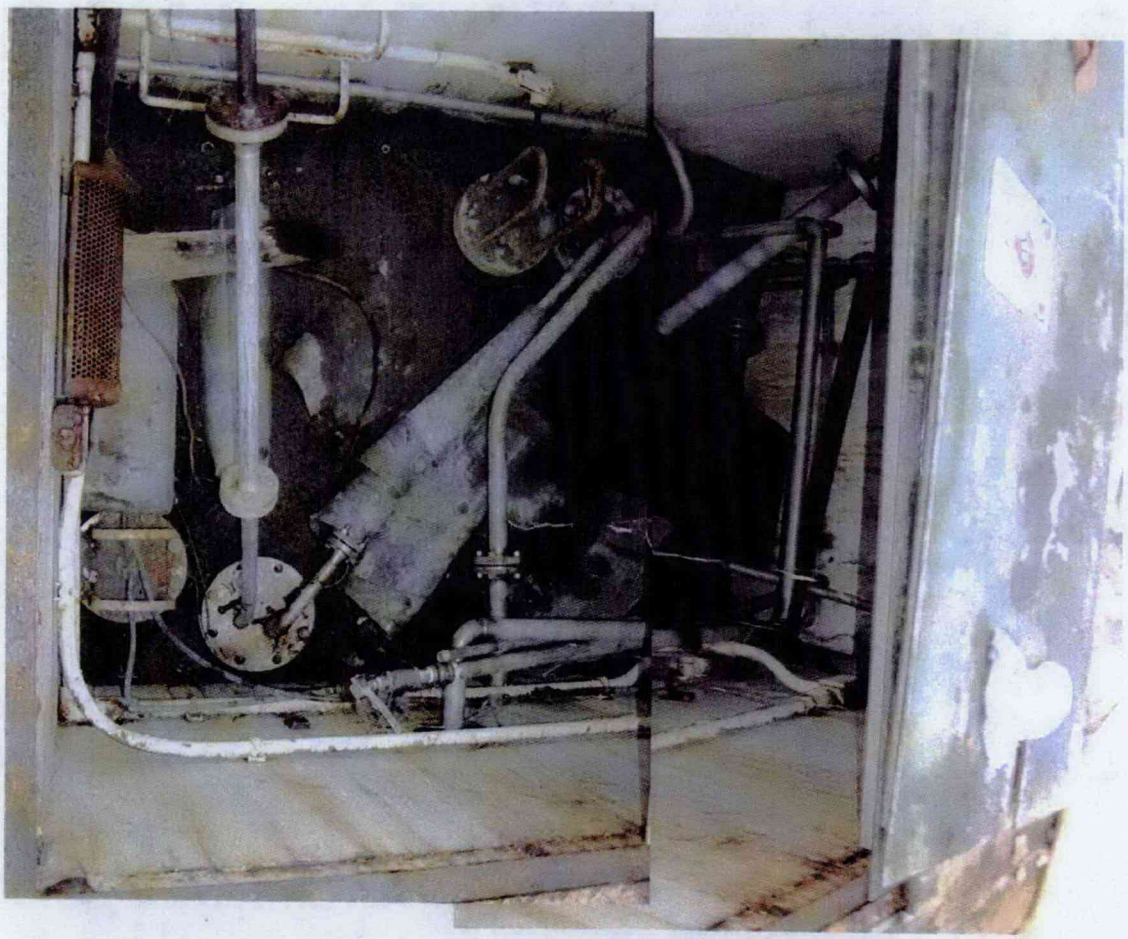


Figure 3-7. Photo Mosaic of Riser Pit Above Tank CR-011 and Cell 11 Showing Conduit Obstructing Removal of Cell 11 Sump Dip Tube Assembly

Field change notice 100230 was written against ECN-721268-R0 to remove the conduit attached to the wall of the pit that was interfering with the removal of the dip tube assembly from riser 8822. After the conduit was removed, the cell sump dip tube assembly was raised and the riser extension was assembled and installed at riser 8822 in the manner previously discussed in Section 3.1. The riser extension on riser 8800 was installed in the same manner by lifting the tank thermocouple, installing the extension and then lowering and bolting it on the riser. The riser extension installation was started after but completed before the riser extension installation at riser 8800 because of the conduit interference at riser 8822. A temporary PVC "top hat assembly" was installed on the top of each riser extension to accommodate sleeving for sealing the equipment during its subsequent removal. After installing both riser extensions in the riser pit, the temporary shielding used to allow personnel access into the riser pit was removed and discarded. New ½ in thick aluminum pit cover plates were installed over the riser pit.

Beta shielding (rubber matting) was put in place where needed to reduce potential radiation exposure during removal of the cell sump dip tube assembly and tank thermocouple. A water source was connected to the washer assembly of the riser extension and tested for leaks. The crane operator attempted to lift the cell sump dip tube assembly but an obstruction prevented the assembly from being lifted. It was determined that the top hat wiper/gasket had created an obstruction preventing removal of the dip tube assembly from the riser. Work was secured and replanned to alleviate the obstruction caused by the wipe gasket. After replanning, the work was restarted. The top hat assembly loosened from the riser extension and the wiper gasket was modified to allow equipment removal from the riser. The top hat assembly was reinstalled on the riser extension and resealed with sleeving. Again, beta shielding (rubber matting) was put in place where needed to reduce potential radiation exposure during removal, a water source was connected to the washer assembly of the riser extension, and the assembly was raised from riser 8822 via crane. The sleeving was taped around the assembly as it was removed from the riser. The radiation levels associated with the assembly were continuously monitored during removal of the cell sump dip tube assembly from the riser. Water was used during the removal of the assembly. After the assembly was raised approximately 30 feet, secondary rigging was attached to the assembly to allow for its subsequent lay down. The cell sump dip tube assembly was raised clear of the riser and left above the riser to drain any liquid from the assembly. The water supply to the washer assembly was secured. The recorded amount of water used during removal of the cell sump dip tube assembly was 36 gallons. This water drained to Cell 11. Sleeving surrounding the assembly was horse tailed, cut and separated from the top hat assembly. The assembly was moved so secondary sleeving could be installed on the assembly and the lower portion of the dip tube assembly placed in a PVC "coffin" with shielding. This allowed for proper storage within radiological limits prior to removal from the facility for subsequent size reduction and disposal of the dip tube assembly. The PVC equipment removal top hat assembly was removed from the riser extension. After removal of this top hat assembly, a 6 in x 4 in reducing spool, ball valve, and blank flange were installed on the top of the riser extension on riser 8822.

The evolution described for removing the cell sump dip tube assembly from riser 8822 in the previous paragraph, was repeated for removing the tank thermocouple from riser 8800. Because of the obstruction of the wiper gasket encountered when attempting to remove the dip tube

assembly from riser 8822, the wiper gasket at riser 8800 was modified at the same time as modifications were made at riser 8822. No problems were encountered with the wiper gasket when removing the thermocouple assembly from riser 8800. Again, water was used during removal of the tank thermocouple. The recorded amount of water used during removal of the tank thermocouple was 108 gallons. This water drained into tank CR-011. The PVC equipment removal top hat assembly was removed from the riser extension on riser 8800. After removal of this top hat assembly, a 6 in x 4 in reducing spool, ball valve, and blank flange were installed on the top of the riser extension on riser 8800.

4.0 LIQUID AND SLUDGE LEVEL ASSESSMENT AND VOLUME ESTIMATE

Liquid level measurements were made for the four tanks and four cell sumps using zip cords. The waste pH and temperature were measured for the four tanks and four cell sumps using portable hand-held commercially available pH probes with integral temperature measurement capability. Sludge measurements were made for the four tanks and four cells using sludge weights.

Letter CH2M-0402428.2 was transmitted to DOE Office of River Protection in December 2004 which included a listing of liquid volumes contained in the 244-CR tanks and cells. The letter also states that the results from the level assessment will be documented in this report. The estimated volume of waste presented in letter CH2M-0402428.2 has been updated in this report. The updates reflect release of calculation RPP-CALC-24219 which provides more accurate representation of the volume of waste for a given waste height. The updates also reflect additional review of the video inspections.

4.1 TANK CR-001 AND CELL 1 SUMP LEVEL ASSESSMENTS

Liquid and sludge level measurement and pH and temperature measurement for tank CR-001 and the sump of Cell 1 was performed under work package 2W-03-01159/S, *244-CR, Install Zip Cord, Sludge Weight at CR-001*. Assessment of the sump of Cell 1 was performed through riser 8745. Assessment of tank CR-001 was performed through riser 8724.

The liquid and sludge level was first assessed for the cell sump at riser 8745. Prior to starting the work, a radiological survey of the general area was performed, a low pressure (<200 psi) water source was connected to the washer assembly on the riser extension, and the PTREAU was started. The ball valve was confirmed closed and the blind flange was removed from the ball valve. The ball valve was then opened and a radiological survey was performed above the open riser. The ball valve was then shut and a PVC top hat was installed above the ball valve. The PVC top hat accommodated sleeving for contamination control during removal of the zip cord, pH probe, and sludge weight. The length of the top hat assembly (or distance from the top of the riser extension to the top of the PVC top hat) installed on riser 8745 was measured and recorded as 44 in. This measured length includes the PVC top hat, the ball valve and 6 in x 4 in reducer. Sleeving was installed on the top hat and the ball valve was opened. A liquid level reading was performed by lowering the zip cord until contact with the liquid surface was indicated by positive deflection of the conductivity meter. The length of the zip cord extended below the top of the PVC top hat was then measured and recorded as 57 ft 9 in. The containment sleeving was sealed to the zip cord. The zip cord was removed from the riser while applying a low pressure water spray through the spray wash assembly and monitoring the radiological conditions at the top hat. After removal of the zip cord, the ball valve was closed, the water supply to the wash assembly was shut off, and the remaining sleeving removed from the top hat.

After measuring the liquid level, the pH and temperature of the waste in the cell was measured. Measurements were taken with a YSI Incorporated (Yellow Springs, Ohio) Model 60 Handheld

pH and Temperature System. Prior to taking pH and temperature measurements the instrument was first tested with pH 4.0, 7.0 and 10.0 buffer solutions to ensure the instrument would function properly. Sleeving was installed on the top hat and the ball valve was opened. The pH measurement was performed by lowering the pH probe through the riser until it was submerged in the waste. Two pH measurements were taken and the average recorded pH measurement was 9.61. The temperature was taken and recorded as 14.3°C (57.7°F). The containment sleeving was sealed to the pH probe. The pH probe was removed from the riser while applying a low pressure water spray through the spray wash assembly and monitoring the radiological conditions at the top hat. After removal of the pH probe, the ball valve was closed, the water supply to the wash assembly was shut off, and the remaining sleeving removed from the top hat.

After measuring the pH and temperature of the waste, the sludge level in the cell was measured. Measurements were taken with a sludge weight. Prior to taking sludge level measurements, sleeving was installed on the top hat and the ball valve was opened. The sludge level measurement was performed by lowering the sludge weight until the sludge weight came to rest on the sludge. The sludge weight was pulled up and down as necessary to determine the sludge level. The length that the sludge weight extended below the top of the PVC top hat was then measured and recorded as 58 ft 10 in. A sludge weight retrieval canister was installed on the top hat. The containment sleeving was sealed to the sludge weight retrieval canister. The sludge weight was removed from the riser while applying a low pressure water spray through the spray wash assembly and monitoring the radiological conditions at the top hat. After removal of the sludge weight into the retrieval canister, the ball valve was closed, the water supply to the wash assembly was shut off, and the sludge weight retrieval canister and associated sleeving was removed from the top hat. After completing the sludge level assessment the PTREAU was turned off and post-job radiological surveys were conducted.

After performing the level assessment for the cell sump, the level assessment for the tank was then performed at riser 8724. The same work steps described in the preceding three paragraphs were repeated for the level assessment of the tank. Additionally, after performing the initial radiological survey and before installing the PVC top hat, flammable gas levels were measured within tank CR-001. The length of the top hat assembly (or distance from the top of the riser extension to the top of the PVC top hat) installed on riser 8724 was measured and recorded as 44 in. This measured length includes the PVC top hat, the ball valve and 6 in x 4 in reducer. The liquid level reading taken with the zip cord was measured and recorded as 55 ft 3½ in. The pH and temperature measurements were then performed with the pH probe. Two pH measurements were taken and the average recorded measurement was 10.54. The temperature was taken and recorded as 15.8°C (57.7°F). The sludge level measurement was then performed with a sludge weight. The length of the sludge weight extended below the top of the PVC top hat was then measured and recorded as 55 ft 6 in.

4.2 TANK CR-002 AND CELL 2 SUMP LEVEL ASSESSMENTS

Liquid and sludge level measurement and pH and temperature measurement for tank CR-002 and the sump of Cell 2 was performed under work package 2W-03-01160/S, *244-CR, Install Zip*

Cord & Sludge Weight at CR-002. Assessment of the sump of Cell 2 was performed through riser 8748. Assessment of tank CR-002 was performed through riser 8747.

The liquid and sludge level was first assessed for the cell sump at riser 8748. The same set of activities described in paragraphs 2 through 4 of section 4.1 for performing level, pH and temperature measurements for Cell 1 were performed for the sump in Cell 2. Information collected specific to the assessment of Cell 2 includes the length of the top hat assembly (or distance from the top of the riser extension to the top of the PVC top hat) installed on riser 8748 which was measured and recorded as 44½ in. This measured length includes the PVC top hat, the ball valve and 6 in x 4 in reducer. The liquid level reading taken with the zip cord was measured and recorded as 47 ft 0 in. The pH and temperature measurements were then performed with the pH probe. Two pH measurements were taken and the average recorded measurement was 8.33. The temperature was taken and recorded as 16.1°C (61.0°F). The sludge level measurement was then performed with a sludge weight. The length of the sludge weight extended below the top of the PVC top hat was then measured and recorded as 48 ft 8 in.

The same work activities performed for the cell were repeated for the level, pH and temperature measurement of the tank. Additionally, after performing the initial radiological survey and before installing the PVC top hat, flammable gas levels were measured within tank CR-002. The length of the top hat assembly (or distance from the top of the riser extension to the top of the PVC top hat) installed on riser 8747 was measured and recorded as 44½ in. This measured length includes the PVC top hat, the ball valve and 6 in x 4 in reducer. The liquid level reading taken with the zip cord was measured and recorded as 45 ft 8 in. The pH and temperature measurements were then performed with the pH probe. Two pH measurements were taken and the average recorded measurement was 4.97. The temperature was taken and recorded as 13.3°C (56.0°F). It is important to note that the pH probe used is designed to take measurements in liquids rather than semi-solids. The operations manual for the YSI Model 60 Handheld pH and Temperature System states that it is important that the probe be inserted into the sample far enough so that both the pH sensor and temperature sensor are covered by the liquid. Video inspection shows that the location where the pH probe was lowered is sludge rather than liquid. Therefore, the pH and the temperature reading should be considered suspect. The sludge level measurement was then performed with a sludge weight. The length of the sludge weight extended below the top of the PVC top hat was then measured and recorded as 45 ft 8 in, the same measurement obtained using the zip cord.

4.3 TANK CR-003 AND CELL 3 SUMP LEVEL ASSESSMENTS

Liquid and sludge level measurement and pH and temperature measurement for tank CR-003 and the sump of Cell 3 was performed under work package CLO-WO-04-000140, *244-CR Vault, Perform Video and Liquid Level Readings at CR-003*. Assessment of the sump of Cell 3 was performed through riser 8749. Assessment of tank CR-003 was performed through riser 8757.

The liquid and sludge level was first assessed for the tank at riser 8757. The same set of activities described in paragraphs 2 through 4 of section 4.1 for performing level, pH and temperature measurements for Cell 1 were generally performed for tank CR-003 and the sump in

Cell 3. A riser extension with reducer and ball valve as described in section 3.1 was not installed on either riser 8749 or 8757 prior to performing the level assessments or pH and temperature measurements. Information collected specific to the assessment of tank CR-003 includes the length of the top hat assembly on the manual tape box riser 8757 which was measured as 27 inches. The distance from the top of the concrete pit to the top of the top hat was also measured and recorded as 39 ½ in. The liquid level reading taken with the zip cord was measured and recorded as 42 ft 6 in. The pH and temperature measurements were then performed with the pH probe. Two pH measurements were taken and the average recorded measurement was 11.46. The temperature was taken and recorded as 14.3°C (57.7°F). The sludge level measurement was then performed with a sludge weight. The length of the sludge weight extended below the top of the PVC top hat was then measured and recorded as 58 ft 8 in.

The same work activities performed for the tank were repeated for the level, pH and temperature measurement of the cell sump through riser 8749. The distance from the top of the sump riser flange to the top of the concrete pit was measured and recorded as 51 ¼ in. distance from the top of the sump riser flange to the top of the top hat assembly installed on riser 8749 was also measured and recorded as 104 ¾ in. The liquid level reading taken with the zip cord was measured and recorded as 46 ft 11 in. The pH and temperature measurements were then performed with the pH probe. Two pH measurements were taken and the average recorded measurement was 8.88. The temperature was taken and recorded as 15.5°C (59.9°F). The sludge level measurement was then performed with a sludge weight. The length of the sludge weight extended below the top of the PVC top hat was then measured and recorded as 48 ft 0 in.

4.4 TANK CR-011 AND CELL 11 SUMP LEVEL ASSESSMENTS

Liquid and sludge level measurement and pH and temperature measurement for tank CR-011 and the sump of Cell 11 was performed under work package 2W-03-01158/S, *244-CR, Install Zip Cord, Sludge Weight at CR-011*. Assessment of the sump of Cell 11 was performed through riser 8822. Assessment of tank CR-011 was performed through riser 8800.

The liquid and sludge level was first assessed for the cell sump at riser 8822. The same set of activities described in paragraphs 2 through 4 of section 4.1 for performing level, pH and temperature measurements for Cell 1 were performed for the sump in Cell 11. Information collected specific to the assessment of Cell 11 includes the length of the top hat assembly (or distance from the top of the riser extension to the top of the PVC top hat) installed on riser 8822 which was measured and recorded as $44^3/_8$ in. This measured length includes the PVC top hat, the ball valve and 6 in x 4 in reducer. The liquid level reading taken with the zip cord was measured and recorded as 55 ft 6 in. The pH and temperature measurements were then performed with the pH probe. Two pH measurements were taken and the average recorded measurement was 9.17. The temperature was taken and recorded as 17.9°C (64.2°F). The sludge level measurement was then performed with a sludge weight. The length of the sludge weight extended below the top of the PVC top hat was then measured and recorded as 58 ft 8 in.

The same work activities performed for the cell were repeated for the level, pH and temperature measurement of the tank. Additionally, after performing the initial radiological survey and

before installing the PVC top hat, flammable gas levels were measured within tank CR-011. The length of the top hat assembly (or distance from the top of the riser extension to the top of the PVC top hat) installed on riser 8800 was measured and recorded as 44½ in. This measured length includes the PVC top hat, the ball valve and 6 in x 4 in reducer. The liquid level reading taken with the zip cord was measured and recorded as 53 ft 11 in. The pH and temperature measurements were then performed with the pH probe. Two pH measurements were taken and the average recorded measurement was 7.62. The temperature was taken and recorded as 14.8°C (58.6°F). It is important to note that the pH probe used is designed to take measurements in liquids rather than semi-solids. The operations manual for the YSI Model 60 Handheld pH and Temperature System states that it is important that the probe be inserted into the sample far enough so that both the pH sensor and temperature sensor are covered by the liquid. Video inspection shows that the location where the pH probe was lowered is sludge rather than liquid. Therefore, the pH and the temperature reading should be considered suspect. The sludge level measurement was then performed with a sludge weight. The length of the sludge weight extended below the top of the PVC top hat was then measured and recorded as 54 ft 0 in.

4.5 TANK AND CELL SUMP VOLUME ESTIMATES

Volume estimates for the waste have been calculated based on level assessment measurements taken for each of the tanks and cell sumps. The level assessment measurements must be used in combination with reference elevation information provided on facility drawings in order to calculate volume estimates. These volume estimates from the level assessment information were also compared with estimates made via visual information from the video inspection on the tanks and cells.

Table 4-1 summarizes the tank and cell sump volume estimates for 244-CR vault. The table also identifies the access location, measured waste pH and temperature in each cell and tank, a breakdown of liquid and sludge/solid volumes for each tank and cell, and the best estimate of the height of waste present. Video inspections performed as part of this activity were used for visual confirmation of waste levels. In a few cases the dimensions from the facility drawings and/or the field measurements did not match the visual information provided by the video inspections. Where appropriate the video information was used to provide what is considered to be a more accurate representation of the volume of waste present. This occurred on three occasions, specifically for tank CR-001, CR-002, and Cell 3.

The volume value is based on converting the level assessment measurements from a height (or depth) measurement to a volume. In order to do this, it is necessary to first determine the waste level within the tank or cell sump based on reference elevations on existing drawings and field measured distances. Figure 4-1 shows the generic measurements and elevations that are used to determine the waste level in the cell sumps. Figure 4-2 shows the generic measurements and elevations that are used to determine the waste level in the tanks. Table 4-2 shows the measured total waste height, measured sludge waste height and measured liquid waste height calculated for each of the four cell sumps. Table 4-3 shows the measured total waste height, measured sludge waste height and measured liquid waste height calculated for each of the four tanks.

Table 4-1. Summary of Estimated Waste Volume, pH and Temperature at 244-CR Vault

Location	Access	Total Volume (gal)	Liquid Volume (gal)	Sludge/Solid Volume (gal)	pH	Temperature (oF)	Waste Height (ft, in)
Tank CR-001	Riser 8724	1375	932	443[A]	10.5	60	1' – 7¼"[A]
Tank CR-002	Riser 8747	753	270	483	5.0	56	1' – 6½"[B]
Tank CR-003	Riser 8757	2146	1432	714	11.5	58	2' – 10"
Tank CR-011	Riser 8800	3990	0	3990	7.6	59	3' – 0¼"
Cell 1	Riser 8745	77	77	0	9.6	58	1' – 1"[C]
Cell 2	Riser 8748	1476	1475	1	8.3	61	1' – 8¼"
Cell 3	Riser 8749	1775	1766	9	8.9	60	1' – 9¾"[D]
Cell 11	Riser 8822	7312	7308	4	9.2	64	3' – 2 7/8"

[A] The waste depth shown is the measured waste depth and does not reflect solid waste adhering to the side of the tank above the measured waste level. The estimated volume of solid waste above the measured waste depth is 198 gallons. The sludge/solid volume includes the estimated amount of solid waste adhering to the tank above the measured waste level.

[B] The waste height based on elevations on facility drawings in combination with field measurements is 1 ft 1 in. Video inspection of the inside of the tank shows waste directly below the riser where the camera was inserted but the bottom of the cooling coils was not covered by waste. Waste directly below the riser would be at a height of 1 ft 9½ in. Waste at the bottom of the cooling coils would be at a height of 1 ft 8½ in. The field measurement has been adjusted for estimating the volume of tank CR-002. The adjusted measurement is 18½ in and the tabulated volume values from Table 2 of RPP-CALC-24219 is 753 gallons.

[C] The measured sludge waste height (via the sludge weight measurement) results in a calculated elevation for the top of the sludge that is below the bottom of the sump. This is likely due to inaccuracies in documented elevations on the facility drawings and/or inaccuracies in measurements. Thus the measured liquid waste height more accurately represents the total waste height.

[D] The measured total waste height and measured liquid waste height results in a calculated height for the waste that is 3 ½ in above the top of the sump. Facility configuration drawing H-2-41888 shows the grout pads used to support the columns of tank CR-003 to end 3 in above the top of the sump. This would mean only a ½ in of waste would be above the grout pads supporting the tank. This is contrary to the visual evidence available from the video inspection performed on December 21, 2004. Thus an estimate of liquid level based on video inspection is utilized to more accurately represent the total waste height than the level measurement listed here. The best estimate of the total waste height, based on video evidence, is 1' – 9¾".

Figure 4-1. Generic Measurements and Elevations to Determine Sump Waste Level

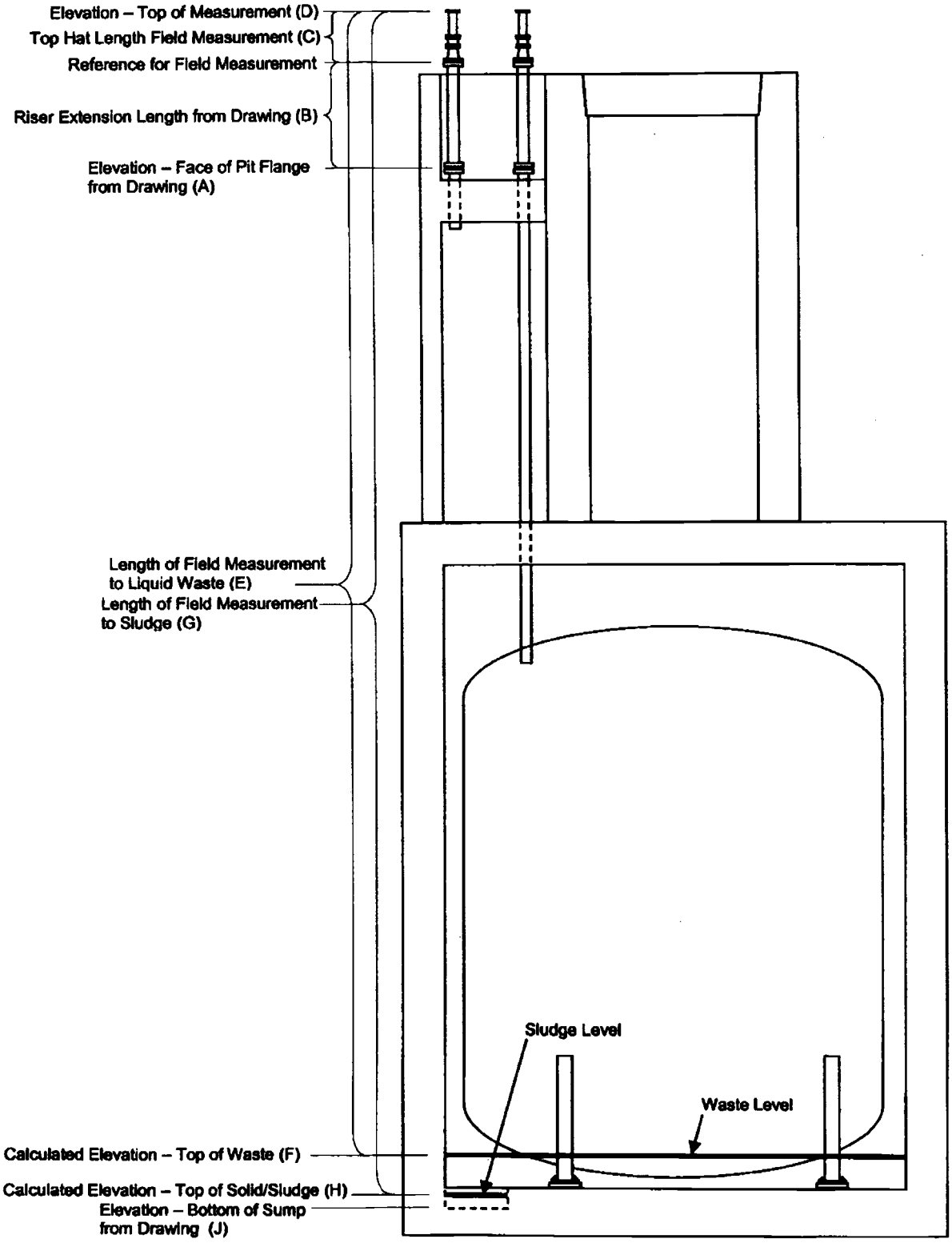


Figure 4-2. Generic Measurements and Elevations to Determine Tank Waste Level

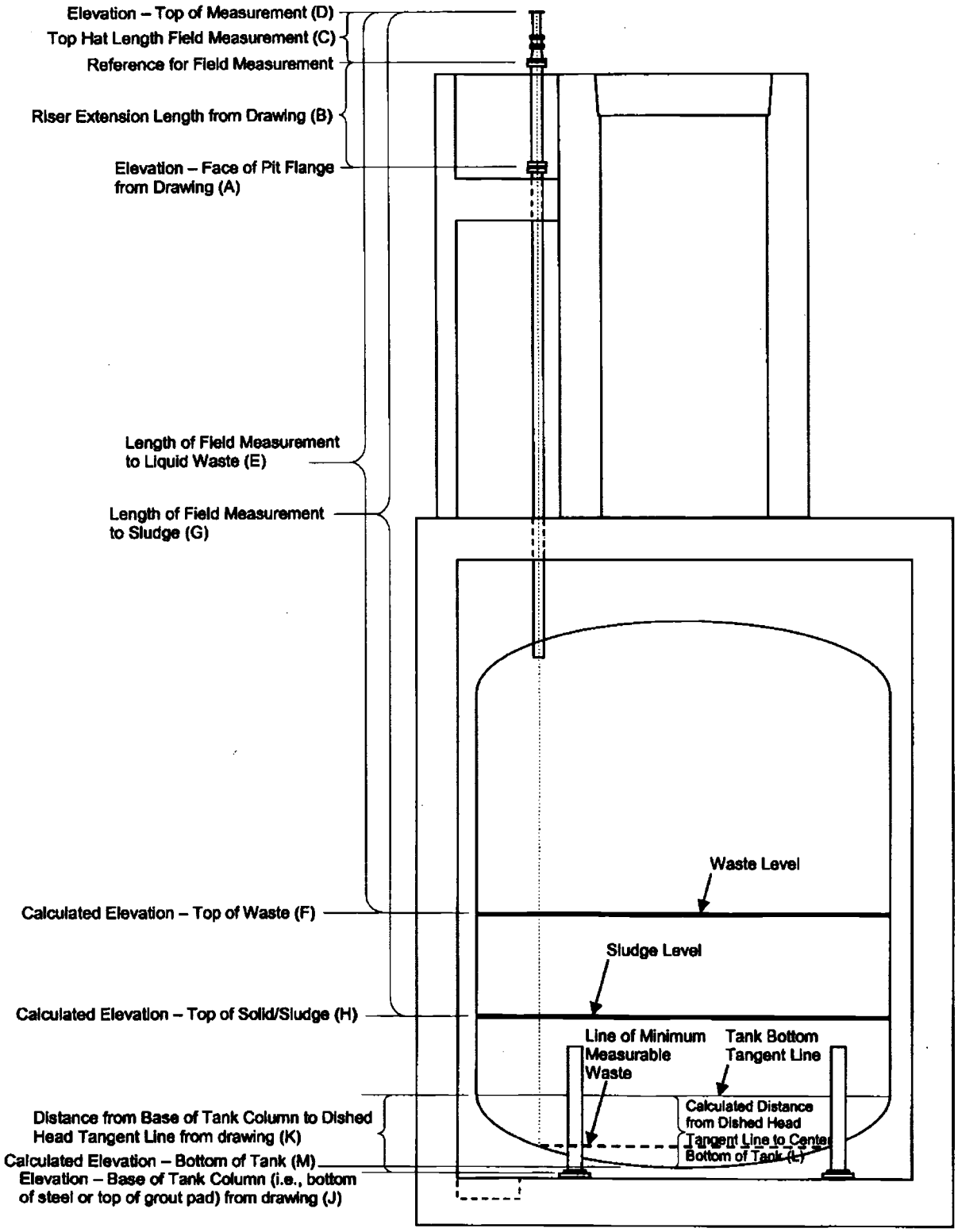


Table 4-2. Measured Total, Sludge and Liquid Waste Heights for Each 244-CR Vault Cell

Elevation or Measurement	Specific Cell			
	Cell 1	Cell 2	Cell 3	Cell 11
Elevation – Face of Pit Flange (A) [from drawing]	658' – 6"	658' – 6"	658' – 6"	658' – 6"
Riser Extension Length Measurement (B) [from drawing]	5' – 6"	5' – 6"	N/A[B]	5' – 6"
Top Hat Length Measurement (C) [field measurement]	3' – 8"	3' – 8½"	8' – 8¾"	3' – 8 3/8"
Elevation – Top of Measurement (D)=(A)+(B)+(C) [calculation]	667' – 8"	667' – 8½"	667' – 2¾"	667' – 8 3/8"
Length of Measurement to Liquid Waste (E) [field measurement]	57' – 9"	47' – 0"	46' – 11"	55' – 6"
Elevation - Top of Waste (F)=(D)-(E) [calculation]	609' – 11"	620' – 8½"	619' – 9¾"	612' – 2 3/8"
Length of Measurement to Sludge (G) [field measurement]	58' – 10"	48' – 8"	48' – 0"	58' – 8"
Elevation – Top of Sludge (H)=(D)-(G) [calculation]	608' – 10"	619' – 0½"	619' – 2¾"	609' – 0 3/8"
Elevation – Bottom of Sump (J) [from drawing]	608' – 11½"	619' – 0¼"	619' – 0¼"	608' – 11½"
Measured Total Waste Height (K)=(F)-(J) [calculation]	0' – 11½"	1' – 8¼"	1' – 3½"[C]	3' – 2 7/8"
Measured Sludge Waste Height (L)=(H)-(J) [calculation]	-0' – 1½"[A]	0' – 0¼"	0' – 2½"	0' – 0 7/8"
Measured Liquid Waste Height (M)=(K)-(L) [calculation]	1' – 1"	1' – 8"	1' – 1"[C]	3' – 2"

Footnotes:

[A] Facility drawings identify the elevation of the bottom of the sump as 608 ft 11½ in, which is 58 ft 8½ in below the point where field measurements for level were taken. The length of the field measurement was 58 ft 10 in, which is below the elevation of the bottom of the sump given on facility drawings. This discrepancy is likely due to inaccuracies in documented elevations on the facility drawings, allowable tolerances for installation, and/or inaccuracies in measurements. Thus the measured liquid waste height more accurately represents the total waste height, and therefore was used for volume calculations.

[B] The level measurement was taken through an empty sump riser without a riser extension installed. Rather, a top hat assembly was installed directly on the riser.

[C] The measured total waste height and measured liquid waste height results in a calculated height for the waste that is 3 ½ in above the top of the sump. Facility configuration drawing H-2-41888 shows the grout pads used to support the columns of tank CR-003 to end 3 in above the top of the sump. This would mean only a ½ in of waste would be above the grout pads supporting the tank. This is contrary to the visual evidence available from the video inspection performed on December 21, 2004. Thus an estimate of liquid level based on video inspection is utilized to more accurately represent the total waste height than the level measurement listed here. The best estimate of the total waste height, based on video evidence, is 1' – 9¾".

Table 4-3. Measured Total, Sludge and Liquid Waste Heights for Each 244-CR Vault Tank

Elevation or Measurement	Specific Tank			
	CR-001	CR-002	CR-003	CR-011
Elevation - Face of Pit Flange (A) [from drawing]	658' – 6"	658' – 6"	N/A[A]	658' – 6"
Riser Extension Length Measurement (B) [from drawing]	5' – 6"	5' – 6"	N/A[A]	5' – 6"
Top Hat Length Measurement (C) [field measurement]	3' – 8"	3' – 8½"	3' – 3½"	3' – 8½"
Elevation – Top of Measurement (D)=(A)+(B)+(C) [calculation]	667' – 8"	667' – 8½"	666' – 3½"	667' – 8½"
Length of Measurement to Liquid Waste (E) [field measurement]	55' – 3½"	45' – 8"	42' – 6"	53' – 11"
Elevation - Top of Waste (F)=(D)-(E) [calculation]	612' – 4½"	622' – 0½"	623' – 9½"	613' – 9½"
Length of Measurement to Sludge (G) [field measurement]	55' – 6"	45' – 8"	43' – 10"	54' – 0"
Elevation – Top of Sludge (H)=(D)-(G) [calculation]	612' – 2"	622' – 0½"	622' – 5½"	613' – 8½"
Elevation – Base of Tank Column (J) [from drawing]	610' – 5"	620' – 5"	620' – 5"	610' – 5"
Distance from Base of Tank Column to Dished Head Tangent Line (K) [from drawing]	3' – 9"	2' – 11"	2' – 11"	3' – 9"
Distance from Dished Head Tangent Line to Center Bottom of Tank (L) [calculation]	3' – 4¾"	2' – 4½"	2' – 4½"	3' – 4¾"
Elevation – Bottom of Tank (M)=(J)+(K)-(L) [calculation]	610 – 9¼"	620 – 11½"	620 – 11½"	610 – 9¼"
Measured Total Waste Height (N)=(F)-(M) [calculation]	1' – 7¼"	1' – 1"	2' – 10"	3' – 0¼"
Measured Sludge Waste Height (P)=(H)-(M) [calculation]	1' – 4¾"	1' – 1"	1' – 6"	2' – 11¼"
Measured Liquid Waste Height (Q)=(N)-(P) [calculation]	0' – 2½"	0' – 0"	1' – 4"	0' – 1"

Footnotes:

[A] The level measurement was taken through the sample riser where the manual tape had previously been installed. A riser extension was not installed at this location, rather a top hat assembly was installed directly on the riser. The top hat length was measured from the top of the pit which has an elevation of 663' – 0".

A calculation (RPP-CALC-24219), *244-CR Vault Tank and Cell Volume Calculations*, provides tabulated values of volume for the 244-CR Vault tanks and cells as a function of waste height in the tank or cell. The tabulated volume values are in quarter inch increments. Tabulated volumes are provided starting at the bottom of the cell sump and the center bottom of the tanks. Because all the tanks are dished the center bottom of the tank is the low point of the tank.

4.5.1 Cell 1 Volume Estimate

Table 4-2 shows that the measured sludge waste height for Cell 1 is -1 ½ in, meaning the measurement elevation was below the bottom of the sump floor identified on facility drawings. This could be due to inaccuracies or variations in documented elevations on the facility drawings to actual conditions. Thus the measured liquid waste height of 1 ft 1 in is considered to more accurately represent the total waste height. Using the measured liquid waste height in Table 4-2 above and the tabulated volume values from Table 3 of RPP-CALC-24219, the estimated total volume of waste present in Cell 1 is 77 gallons. The estimated volume of sludge in Cell 1 is 0 gallons. By difference between the estimated total volume of waste and sludge volume, the estimated volume of liquid waste in Cell 1 is 77 gallons. This is considered the best estimate of volume present in Cell 1.

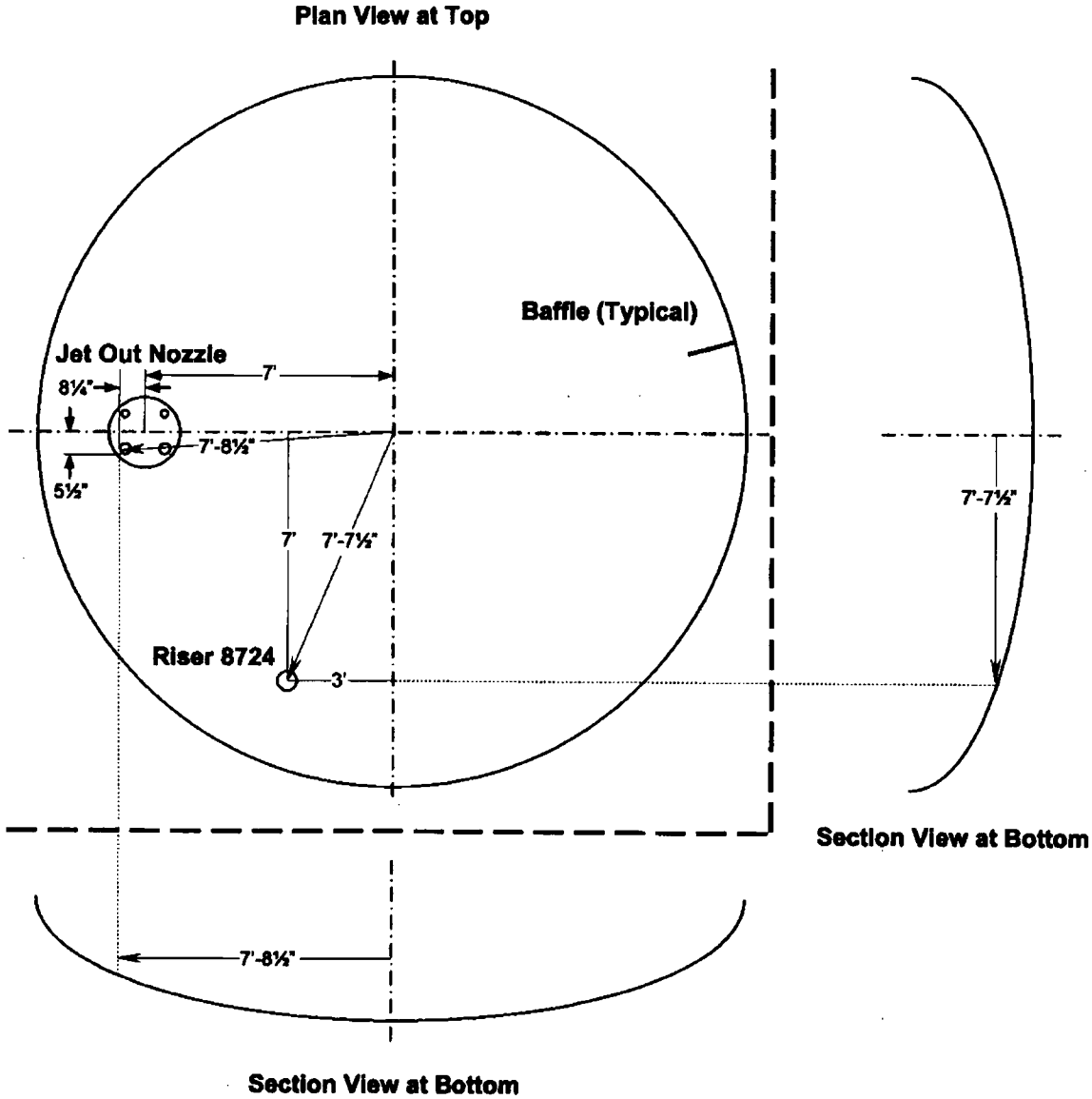
A review of the video inspection of Cell 1 performed December 21, 2004 shows liquid above the level of the sump which is 12 inches deep. This supports the measured liquid waste height being 1 ft 1 in.

4.5.2 Tank CR-001 Volume Estimate

Using the facility elevations from drawings, field measurements, and calculated levels in Table 4-3 above and the tabulated volume values from Table 1 of RPP-CALC-24219, the estimated total volume of waste present in tank CR-001 is 1,177 gallons. The estimated volume of sludge in tank CR-001 is 894 gallons. By difference between the estimated total volume of waste and sludge volume, the estimated volume of liquid waste in tank CR-001 is 283 gallons. However, video inspection of tank CR-001 shows a ring of solid material present on the tank wall above the measured total waste level. This ring of solid material is not accounted for in the estimated volume from level measurements. In the video inspection it appears that the surface of the liquid level in the tank extends so that its edge is directly below riser 8724, the riser used for level measurement.

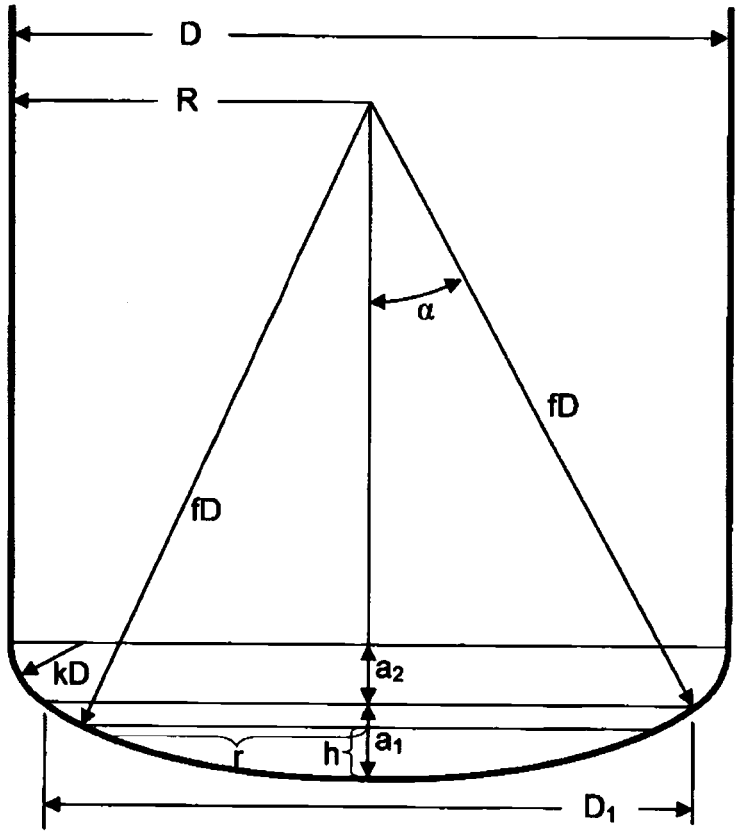
Drawing H-2-41688 shows riser 8724 is a 6 in pipe that enters tank CR-001 at the location depicted in Figure 4-3. The horizontal projection of the center of riser 8724 is 7 ft 7½ in from the center of the dished bottom of tank CR-001. Because the riser is schedule 40 pipe, it's inside diameter is 6.065 in. This means the closest horizontally projected distance from the center of the dished bottom tank to the edge of the riser is approximately 7 ft 4½ in and the farthest horizontally projected distance from the center of the tank is 7 ft 10½ in.

Figure 4-3. Graphical Depiction of Plan and Section Views of Tank CR-001



When the amount of waste present in the tank does not reach the top of the dished bottom, the radius or diameter of waste can be determined using equations for a torispherical dished bottom tank and the Pythagorean theorem. A torispherical dished bottom tank and parameters of interest are represented in Figure 4-4.

Figure 4-4. Parameters for Vertical Cylindrical Tanks with Torispherical Bottoms



The parameters in Figure 4-4 are defined as follows:

a_1	the distance from the lowest part of the tank to the point where the dish-radius and knuckle-radius intersect
a_2	the distance from where the dish-radius and knuckle-radius intersect to where the knuckle-radius and the cylindrical section of the tank intersect
D	the diameter of the cylindrical section of the tank
D_1	the diameter of the torispherical bottom of the tank where the dish-radius and knuckle-radius intersect
f	the dish-radius parameter for the tank torispherical heads or bottoms; fD is the dish radius
h	height of waste present (less than a_1)
k	the knuckle-radius parameter for the tank torispherical heads or bottoms; kD is the knuckle radius
r	radius of waste present (less than a_1)
R	the radius of the cylindrical section of the tank

When the terms f and D are multiplied together the product is the radius of the dished head. For any point on the dished head below the line represented as height a_1, the radius of the waste out to that point can be calculated based on the Pythagorean theorem which states that the sum of the squares of the lengths of the legs of a right triangle is equal to the square of the length of the hypotenuse. For any point below where the knuckle radius and dished radius meet, the hypotenuse of the right triangle of interest is the term fD. The length of the horizontal leg of the right triangle is the term r. The length of the vertical leg of the right triangle is the term fD-h. The radius and height of waste are interdependent. The height of waste, h, can be calculated by solving the following form of the Pythagorean theorem using the terms of interest.

$$fD - h = \sqrt{(fD)^2 - (r)^2} \qquad \text{OR} \qquad h = fD - \sqrt{(fD)^2 - (r)^2}$$

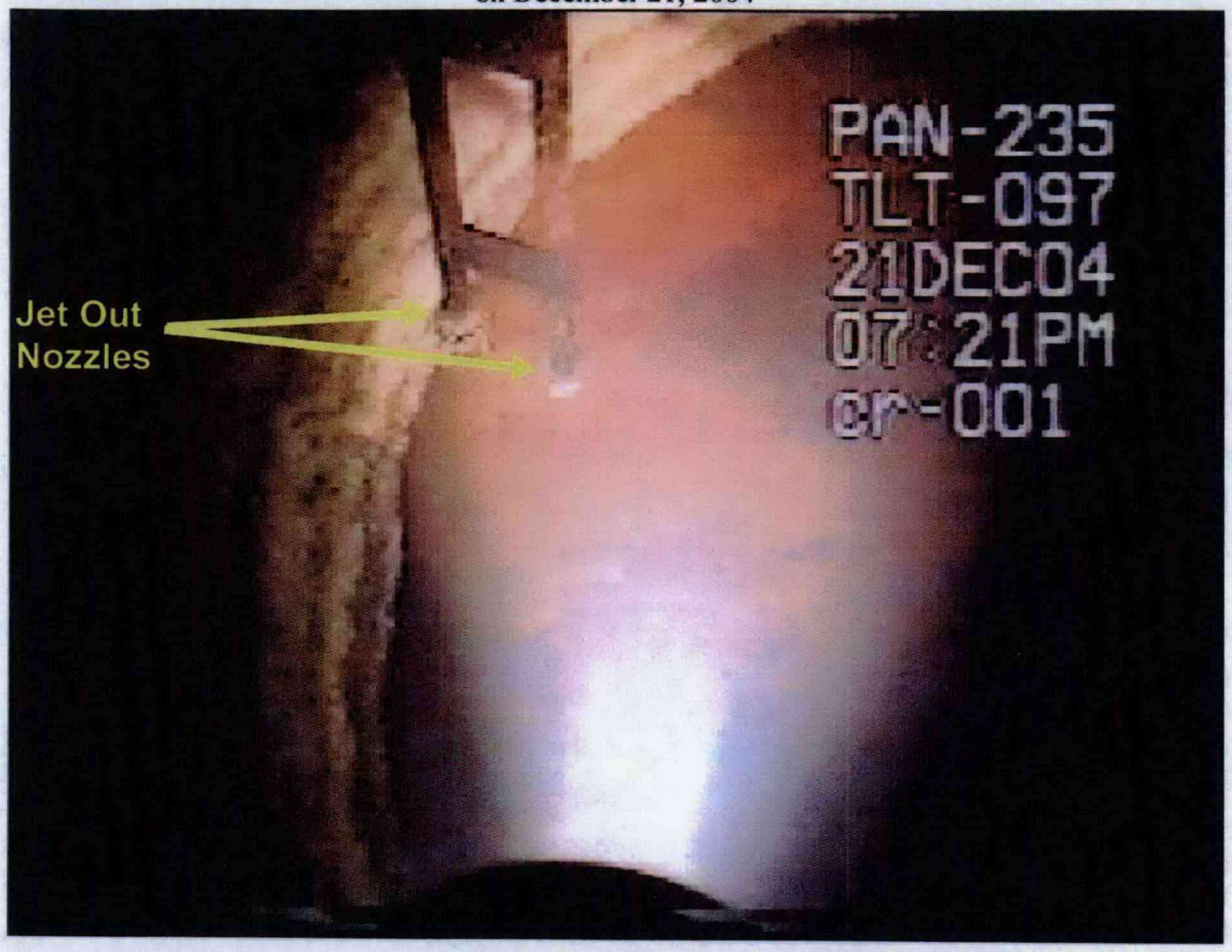
For tank CR-001, drawing H-2-41688 shows the term fD is 240 in, the term D is 240 in, and the term kD is 14.5 in. The above equation can be solved to determine the height of waste for a specific value of r, radius of waste, and substituting 240 in for the term fD. This is only true provided twice the value of r is equal to or less than the value of D_1. The equation for D_1 as specified in Jones 2002 can be written with the parameters in Figure 4-4 as follows

$$D_1 = 2(fD)\frac{1-2k}{2(f-k)}$$

Solving for D_1 with the terms from H-2-41688 from above gives the value 224.57 in. Therefore, the Pythagorean theorem form of determining the height of waste for a given radius of waste is valid provided the radius of waste is less than 112.28 in. Because the horizontal projection of the center of riser 8724 is 7 ft 7½ in from the center of tank CR-001, the above equation for h can be used to determine the height of waste at that point. For a radius of waste, r, equal to 7 ft 7½ in, the height of waste, h, would be equal to 18.13 in. At the point where the horizontal projection of riser 8724 is closest to the bottom center of the tank, the radius of waste, r, is equal to 7 ft 4½ in, and the height of waste, h, would be equal to 16.91 in. At the point where the horizontal projection of riser 8724 is farthest from the bottom center of the tank, the radius of waste, r, is equal to 7 ft 10½ in, and the height of waste, h, would be equal to 19.39 in. The measured total waste level is 19¼ in which is within the range for the minimum waste height that can be measured directly under riser 8724.

Video inspection, see Figure 4-5, also shows that the farther jet at the jet out nozzle is near the edge of the liquid level radius. Figure 4-3 shows that the horizontal projection of the far edge of the farther jet is 7 ft 8½ in from the center of the tank. This is consistent with the measured total waste level.

Figure 4-5. Screen Capture of Jets Below Jet Out Nozzle from Tank CR-001 Video Inspection on December 21, 2004



No simple method was found for estimating the quantity of solid material in the ring around the tank above the measured waste level. The review of the video inspection did not lend itself to providing a means of determining the dimensions of the solid ring of material. Figure 4-6 shows one of the four baffles in the tank, the weld seam where the bottom dished head was welded to the straight portion of the tank, and the ring of solid material above the liquid waste. Subjectively, it appears the distance from the weld bead to the solid material is about ½ the apparent width of the baffle. The baffle is 15 in wide, but because it is viewed at an angle, the apparent width is less than the actual width of the baffle. Based on subjective observations, it is estimated that the top of the solid ring of material is approximately 6 inches below the tangent line of the bottom dish. From RPP-CALC-24219, it is known that the height from the bottom of the tank to the tangent line is 40.70 in, say 40¾ in. This subjective estimate fixes the total height of the solid sludge ring at 34 ¾ in above the tank bottom. The thickness of the solid sludge material also is not known. The solid material does not appear to be present in the local area where the level measurements were taken, and therefore are not useful in determine the sludge height. Again a subjective estimate of the thickness of this solid material must be made. Based on subjective observations it is estimated that the solid material is approximately 2 in thick. The

video inspection does not provide objective evidence whether or not this solid material is present below the liquid level. Because solids are evident in the tank, it is expected that solids are also present below the surface of the liquid. Because the tank has an agitator, it would be expected that solids were transferred into and out of the tank. For these reasons it is anticipated that solids are present below the surface of the liquid. However there is no information available to make an estimate of the amount of solids present below the liquid surface. Therefore, the estimate that the solid material is 2 in thick above the liquid surface will also be applied for estimating the amount of solid material present below the liquid surface. There is no good basis for this approximation other than it is consistent with the observed solid material. A graphic depiction of this subjective estimate of the solid waste present is shown in Figure 4-7.

Figure 4-6. Screen Capture of Baffle, Weld Bead and Solid Material from Tank CR-001 Video Inspection on December 21, 2004

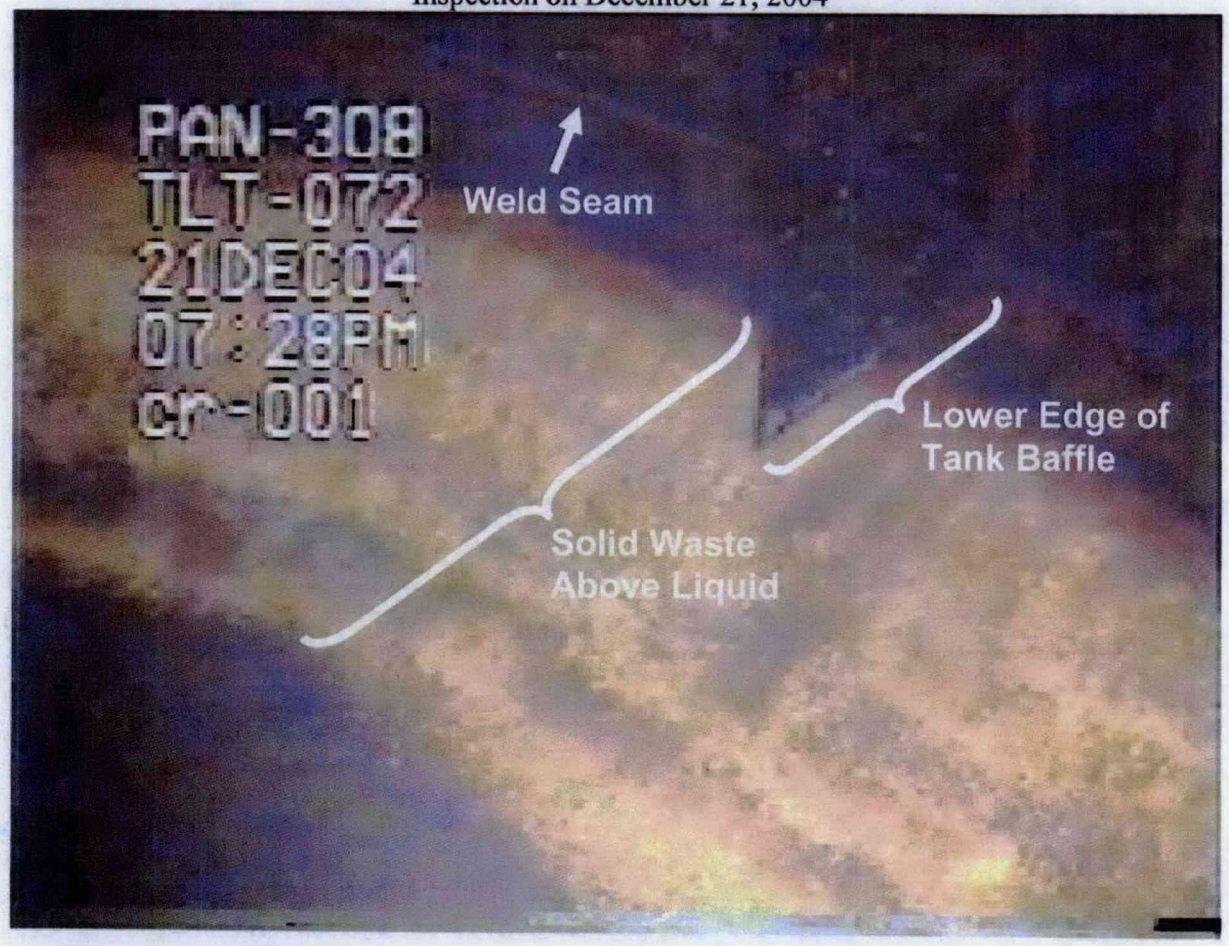
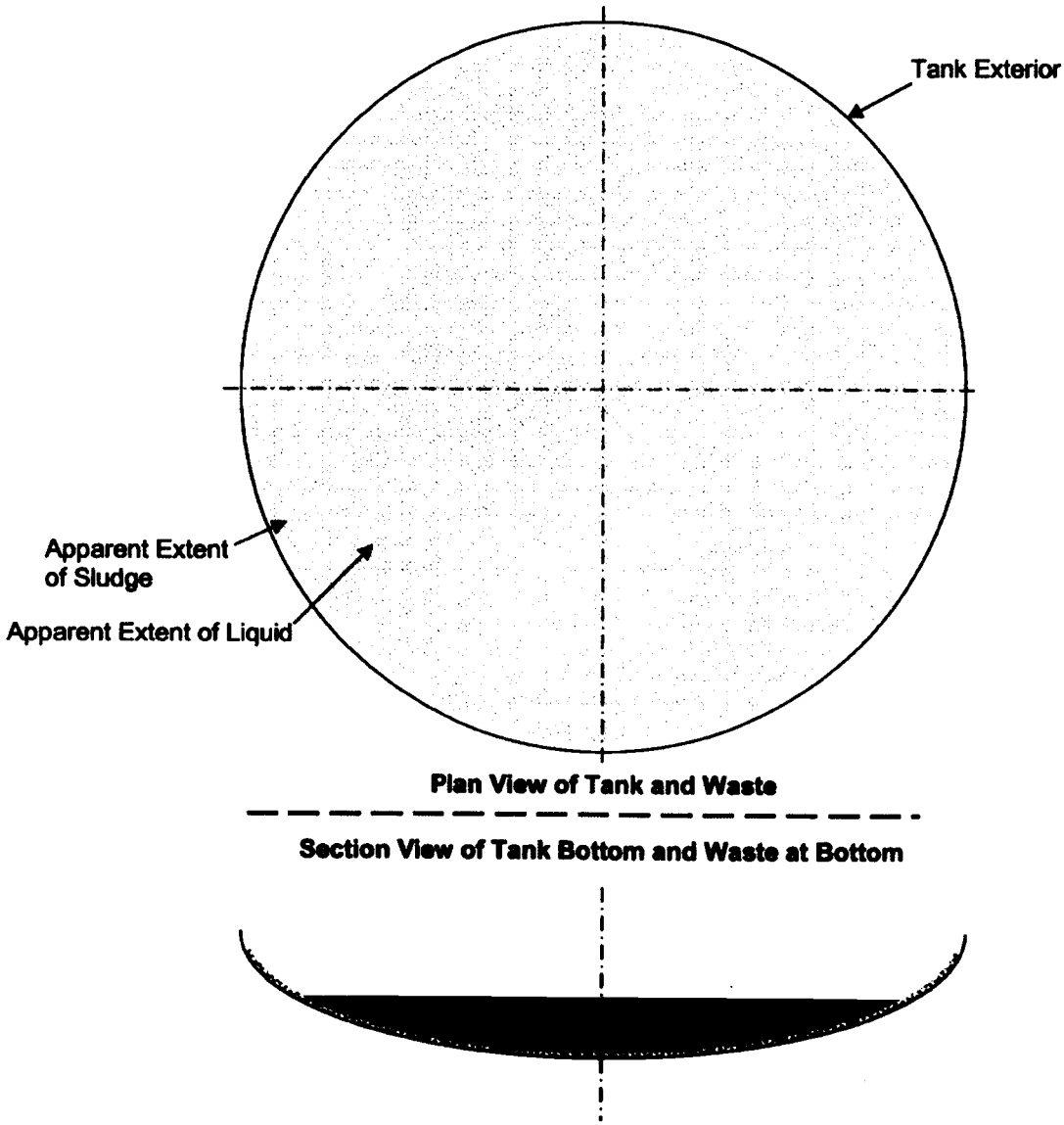


Figure 4-7. Graphical Depiction of Tank CR-001 with Estimated Sludge and Liquid Levels



The volume of solid material present in this 2 in thick section must be determined. It can be determined using the approach presented in PRR-CALC-24219 for determining the volume of the dished portion of the tank. The volume of the 2 in thick section can be calculated as the difference between the volume of a dish with parameters of fD=240 in, D=240 in, kD= 14.5 in, and h= 34¾ in and a dish with parameters of fD=236 in, D=236 in, kD=14.16 in, and h=32¾ in. The differences in the values fD, D, kD and h reflect the 2 in thick sludge. The volume for the first set of parameters is found in RPP-CALC-24219 Table 1 and is 3,701 gallons. The volume

for the second set of parameters can be calculated using the formulas in RPP-CALC-24219 and is 3,258 gallons. The difference then is the best estimate of the sludge present in the tank or 443 gallons.

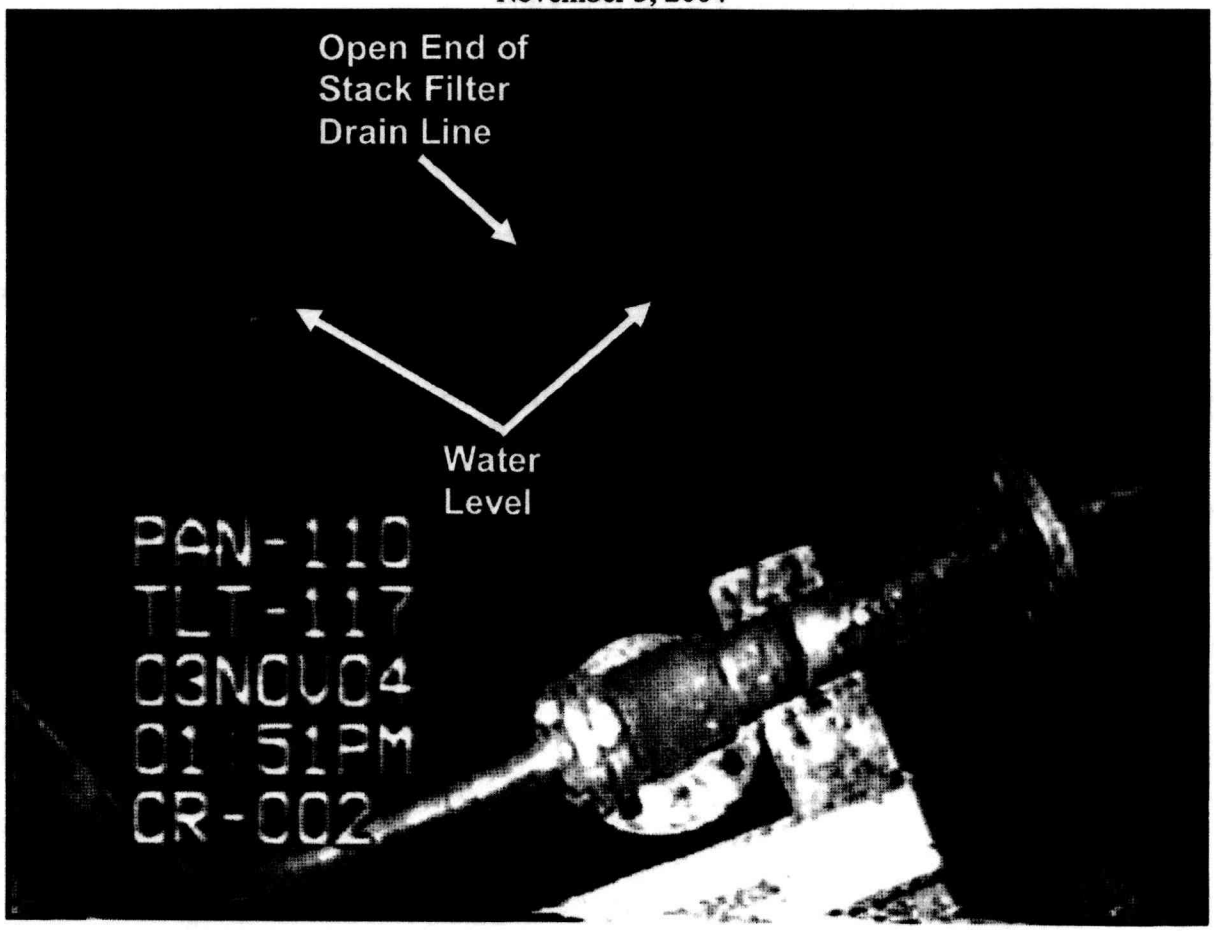
The volume of liquid present also must account for this 2 in thick section of solid material. The amount of solid present below the liquid level can be determined in the same manner as described in the previous paragraph. The volume for the total waste level of 1 ft 7¼ in is 1,177 gallons. The volume for a dish with parameters of fD=236 in, D=236 in, kD=14.16 in, and h=1 ft 5¼ in using the formulas in RPP-CALC-24219 is 932 gallons. The best estimate of the solid volume below the liquid level is then the difference between these two values or 245 gallons. The best estimate of the liquid volume is 932 gallons.

4.5.3 Cell 2 Volume Estimate

Using the facility elevations from drawings, field measurements, and calculated levels in Table 4-2 above and the tabulated volume values from Table 4 of RPP-CALC-24219, the estimated total volume of waste present in Cell 2 is 1,476 gallons. The estimated volume of sludge in Cell 2 is 0.9 gallons. By difference between the estimated total volume of waste and sludge volume, the estimated volume of liquid waste in Cell 2 is 1,475 gallons. This is considered the best estimate of waste volume present in Cell 2.

A review of the video inspection of Cell 2 performed November 3, 2004 shows the end of the horizontal, sloped 4 in stack filter drain line partially submerged in liquid, see Figure 4-8. Drawing H-2-41499 shows the centerline elevation of the low point of this pipe as 620 ft 11 in, which is 22 ¾ in above the elevation of the bottom of the sump. It cannot be determined via examining the video, the exact portion of the end of this 4 in drain line that is submerged. However, it is clear that it is less than halfway submerged. The outside diameter of a 4 in pipe is 4 ½ in. Assuming the centerline elevation of the low point of this pipe is indeed 620 ft 11 in, the video inspection of this drain line would provide an estimated level of waste in the cell between 20 ½ in (point where bottom of pipe is in contact with liquid) and 22 ¾ in (point where pipe is half way submerged). Based on the tabulated volume values from Table 4 of RPP-CALC-24219, an estimated waste level of 20½ to 22¾ in is equivalent to an estimated total volume of 1,526 to 1,975 gallons. Therefore, it should be noted that the video inspection reveals there could possibly be 50 to 500 gallons more waste present in Cell 2 than determined via measuring the waste level. The condition and physical position of this line has not been verified, and, therefore, will not be used to change the estimate of the waste volume present in Cell 2 based on the field measurements.

Figure 4-8. Screen Capture of Stack Filter Drain Line from Cell 2 Video Inspection on November 3, 2004

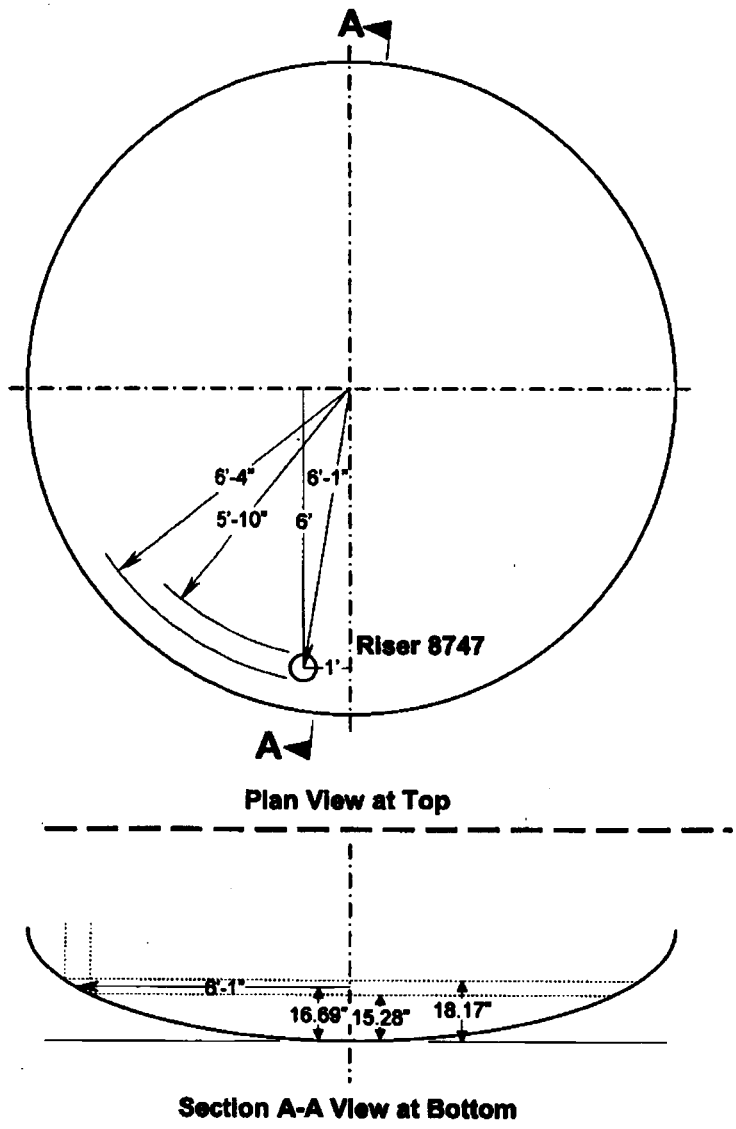


4.5.4 Tank CR-002 Volume Estimate

Using the facility elevations from drawings, field measurements, and calculated levels in Table 4-3 above and the tabulated volume values from Table 4 of RPP-CALC-24219, the estimated total volume of waste present in tank CR-002 is 376 gallons. However, a review of the drawings and tank configuration show that the calculated level in Table 4-3 is not consistent with the geometry of the tank, as explained in the following paragraphs.

Drawing H-2-41497 shows riser 8747 is a 6 in pipe that enters tank CR-002 at the location depicted in Figure 4-9. The horizontal projection from the center of riser 8747 is 6 ft 1 in from the center of the dished bottom of tank CR-002. Because the riser is schedule 40 pipe, its inside diameter is 6.065 in. This means the closest horizontally projected distance from the center of the dished bottom tank to the near edge of the riser opening is 5 ft 10 in. The waste height at the projection of the center of the riser and the nearest and farthest edges from the center of the tank are shown in the section view of Figure 4-9.

Figure 4-9. Graphical Depiction of Plan and Section Views of Tank CR-002 with Riser 8747



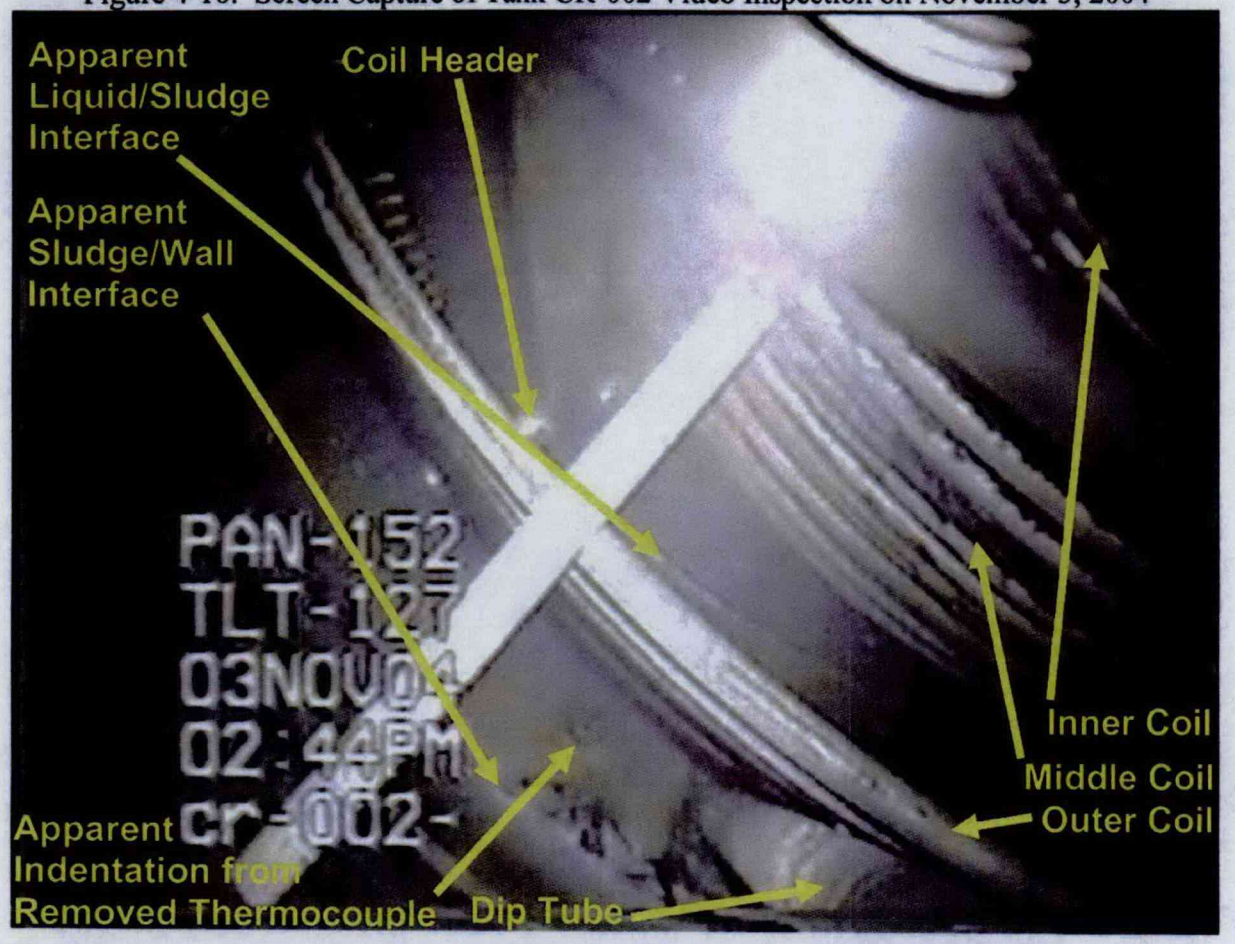
When the amount of waste present in the tank does not reach the top of the dished bottom, the radius or diameter of waste can be determined using equations for a torispherical dished bottom tank and the Pythagorean theorem, as previously discussed in Section 4.5.2. A torispherical dished bottom tank and parameters of interest are represented in Figure 4-4 (see Section 4.5.2). The terms f and D multiplied together is the radius of the dished head. For tank CR-002, drawing H-2-41089 shows the term fD is 168 in, the term D is 168 in, and the term kD is 10.125 in. As stated before, the equation for determining the height of waste for a specific value of r, radius of waste only holds true provided twice the value of r is equal to or less than the value of D_1. Solving for D_1 with the terms from H-2-41089 from above gives the value 157.23 in.

Therefore, the Pythagorean theorem form of determining the height of waste for a given radius of waste is valid provided the radius of waste is less than 78.61 in. Because the horizontal projection of the center of riser 8747 is 6 ft 1 in from the center of tank CR-002, the equation for h specified in Section 4.5.2 can be used to determine the height of waste at that point. For a radius of waste, r, equal to 73 in, the height of waste, h, is equal to 16.69 in (see Figure 4-9). At the point where the horizontal projection of riser 8747 is closest to the bottom center of the tank, the radius of waste, r, is equal to 70 in, and the height of waste, h, is equal to 15.28 in (see Figure 4-9).

If the sludge weight had been lowered directly down the middle of riser 8747, the minimum measured level at that point would have been 16.69 inches, corresponding to the sludge weight contacting the sloped bottom of the tank. Similarly, if the sludge weight had been lowered with the edge of the cable contacting the riser edge closest to the center of the tank, the minimum measured level would have been 15.28 inches. As previously stated and shown in Table 4-3, the measured level of sludge (or bottom of tank) is 13 in, which is 2.28 inches less than the minimum expected measurement.

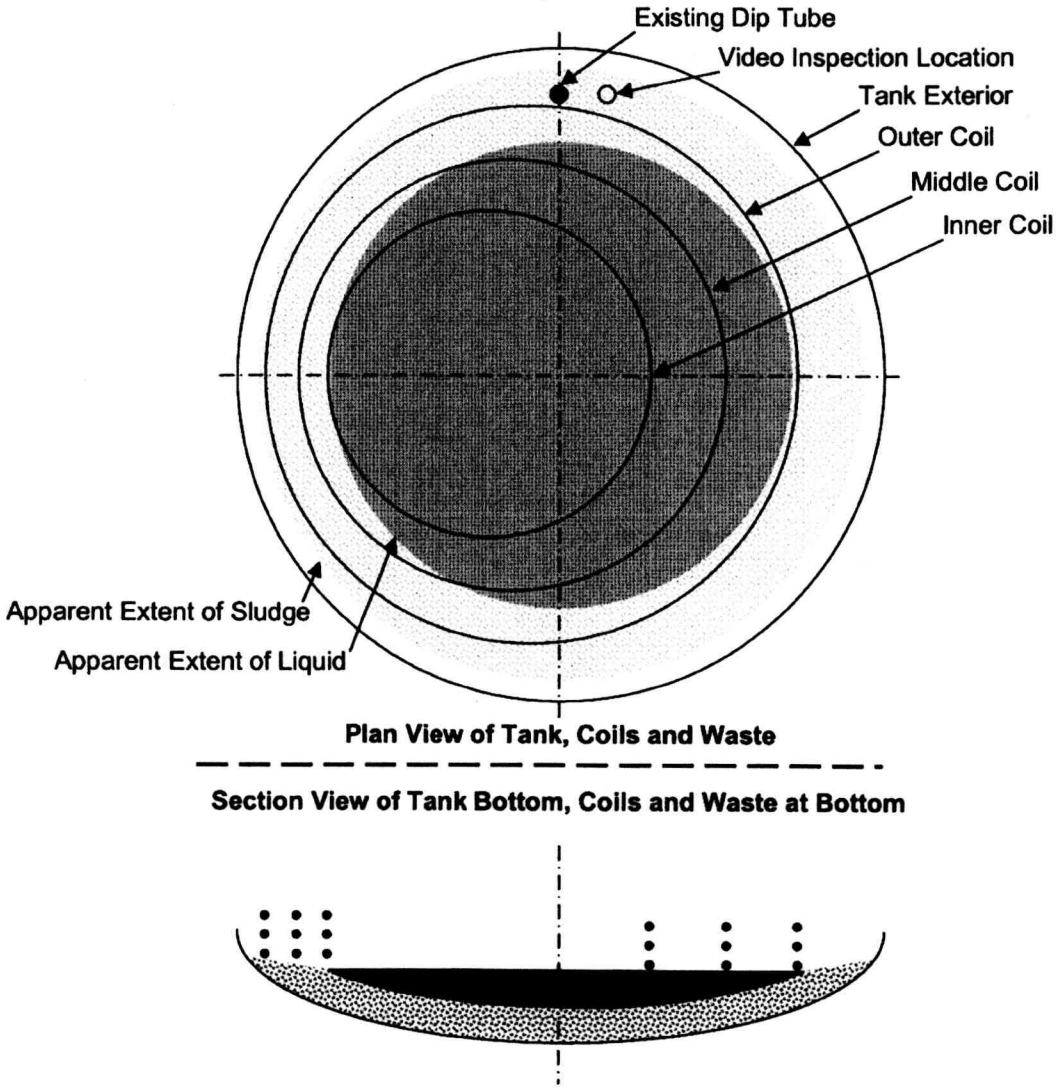
This discrepancy between the measured level and the minimum expected level that could be measured at riser 8747 warranted a close review of the video inspection of the inside of tank CR-002. The physical configuration of the tank and the proximity of the waste to any landmarks was reviewed to determine whether a more accurate estimate of the waste volume could be made. Figure 4-10 is a screen capture from the video taken of tank CR-002 on November 3, 2004. This picture shows that the coil header is visible. Other portions of the video also show that all rings of the coils are visible. From drawing H-2-41089 and H-2-41090, it is known that the bottom elevation of the 1 ½ in schedule 40 coils is 9.95 in, say 10 in, below the tangent line of the bottom head of the tank. From RPP-CALC-24219, it is known that the height from the bottom of the tank to the tangent line is 28.48 in, say 28 ½ in. Based on this information the waste height in the tank would be estimated to be no more than 18 ½ in. Figure 4-10 also shows the sludge/wall interface and the dip tube assembly that is still installed in the tank. Near the dip tube assembly, the distance from the outer coil to the sludge/wall interface appears to be approximately twice the width of the dip tube assembly. Drawing H-2-41534 lists the outer pipe of the dip tube assembly as 4 in schedule 40 pipe, so its outside diameter is 4 ½ in. Drawing H-2-41089 lists the centerline of the dip tube assembly riser as 6 ft 0 in from the tank center. This would put the sludge/wall interface approximately 6 ft 6 ¾ in from the center of the tank. To the nearest quarter inch, waste at a radius of 6 ft 6 ¾ in would result in a waste height in the tank of 19 ½ in. However, a waste height of 19 ½ in would cover the lowest coil which is not supported by the video evidence. This difference in waste height could be explained by the operation of the agitator in the center of the tank that could have pushed solids towards the outside resulting in a dished profile for the top of the sludge rather than a profile that was level across the tank. This dished profile is also supported by an apparent liquid/sludge interface line that can be seen between the middle and outer coil. Because the coil can be clearly seen in the video, the best estimate for the overall waste level in tank CR-002 is 18 ½ in. Using the level of 18 ½ in and the tabulated volume values from Table 2 of RPP-CALC-24219, the estimated total volume of waste present in tank CR-002 is 753 gallons.

Figure 4-10. Screen Capture of Tank CR-002 Video Inspection on November 3, 2004



Based on the discussion above, an estimate of the sludge and liquid volume present in tank CR-002 cannot be supported by the level measurements taken. Instead information from the video inspection is used to develop an estimate of the liquid and sludge waste. The apparent liquid/sludge interface shown in figure 4-10 appears to be approximately midway between the middle and outer coil in the proximity of the removed thermocouple and remaining dip tube. Figure 4-11 shows a plan and section representation of the tank and coils as well as a representation of an estimated liquid pool present in the tank.

Figure 4-11. Graphical Depiction of Tank and Coil of TK-CR-002 with Estimated Sludge and Liquid Levels



The radius of the liquid pool present in the tank is roughly 5 feet. Assuming the same height of waste to radius of waste relationship presented above, the height of waste would be approximately 11 inches. Using this estimated level and the tabulated volume values from Table 2 of RPP-CALC-24219 to approximate the shape of the liquid pool, the estimated volume of liquid waste present in tank CR-002 is 270 gallons. By difference then, the estimated volume of sludge would be 483 gallons.

4.5.5 Cell 3 Volume Estimate

Using the facility elevations from drawings, field measurements, and calculated levels in Table 4-2 above and the tabulated volume values from Table 4 of RPP-CALC-24219, the estimated total volume of waste present in Cell 3 is 529 gallons. The estimated volume of sludge in Cell 3 is 9.4 gallons. By difference between the estimated total volume of waste and sludge volume, the estimated volume of liquid waste in Cell 3 is 520 gallons.

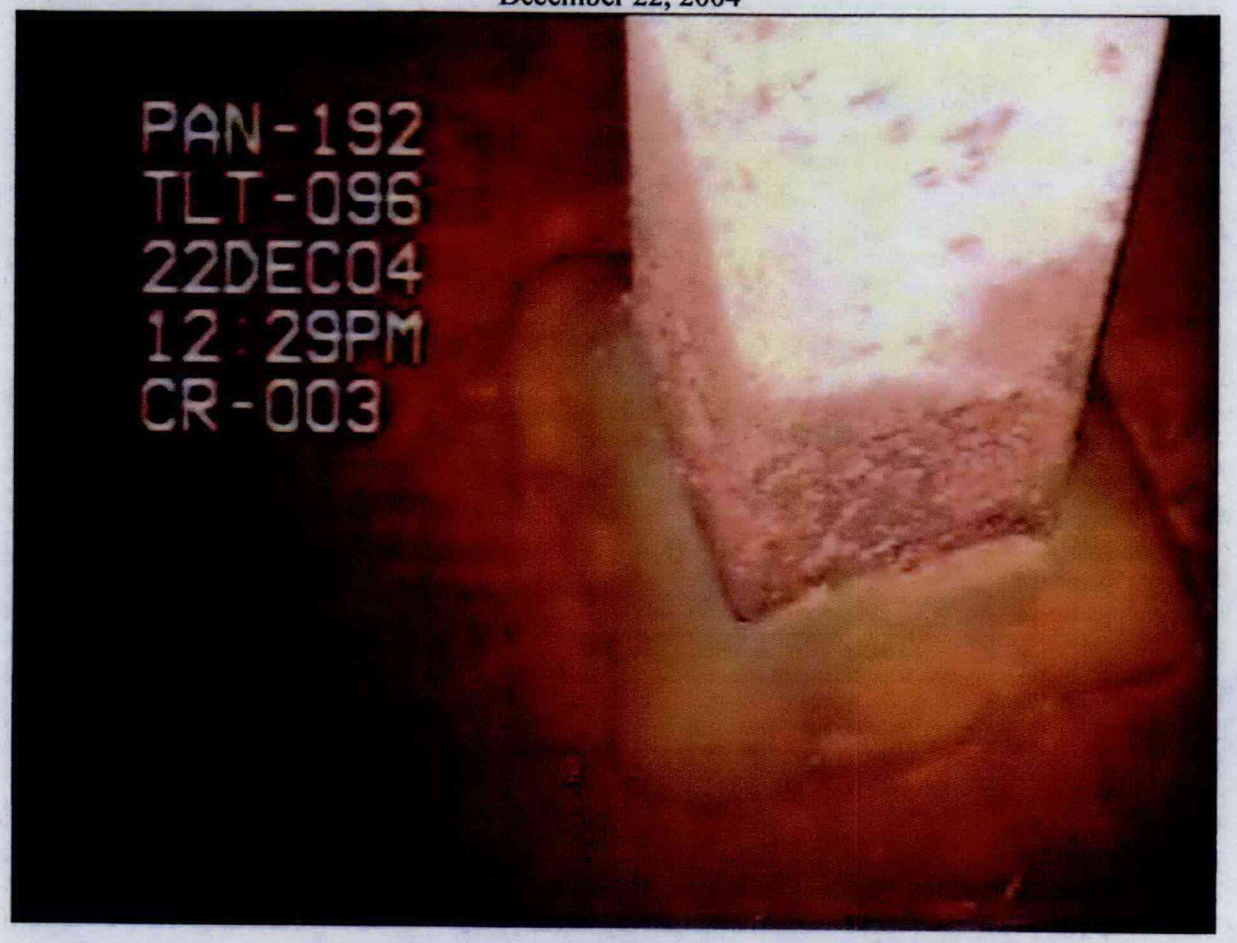
The measured total waste height in Table 4-2 represents a waste height that is 3 ½ in above the top of the sump. Facility configuration drawing H-2-41888 shows the top of the grout pads used to support the columns of tank CR-003 end 3 in above the top of the sump. This would mean that a ½ in of waste would be above the grout pads supporting the tank. However, this is contrary to the visual evidence available from the video inspection performed on December 22, 2004. Thus an estimate of liquid level based on video inspection is expected to more accurately represent the total waste height than the level measurement listed here.

A review of the video inspection of Cell 3 performed December 22, 2004 shows the tank column closest to the sump submerged below water, see Figure 4-12. Figure 4-13 also shows the steel angle used to support one of the exhaust ducts for Cell 3. Drawing H-2-41789 shows the duct supports are 12 in tall and are made of 2 in by 2 in by ¼ in stainless steel angle. The dry portion of the exhaust duct support appears to be roughly twice as long as the width of the support. This would mean approximately 4 in of the duct support is above the water or 8 in of the support is below water. The exhaust duct is near a corner of the cell, so the floor elevation at the duct support should be nearly 620 ft 2 in as shown on H-2-41789. If the duct support is submerged 8 in, then the top of the waste elevation would be 620 ft 10 in. The bottom of the sump elevation is 619' – 0¼", making the waste height 1 ft 9¾in. Based on the tabulated volume values from Table 4 of RPP-CALC-24219, an estimated waste level of 21¾ in is equivalent to a total volume of 1,775 gallons. This is considered the best estimate of total volume present in Cell 3. By difference between the estimated total volume of waste and sludge volume, the estimated volume of liquid waste in Cell 3 is 1,766 gallons. This is considered the best estimate of liquid volume present in Cell 3.

4.5.6 Tank CR-003 Volume Estimate

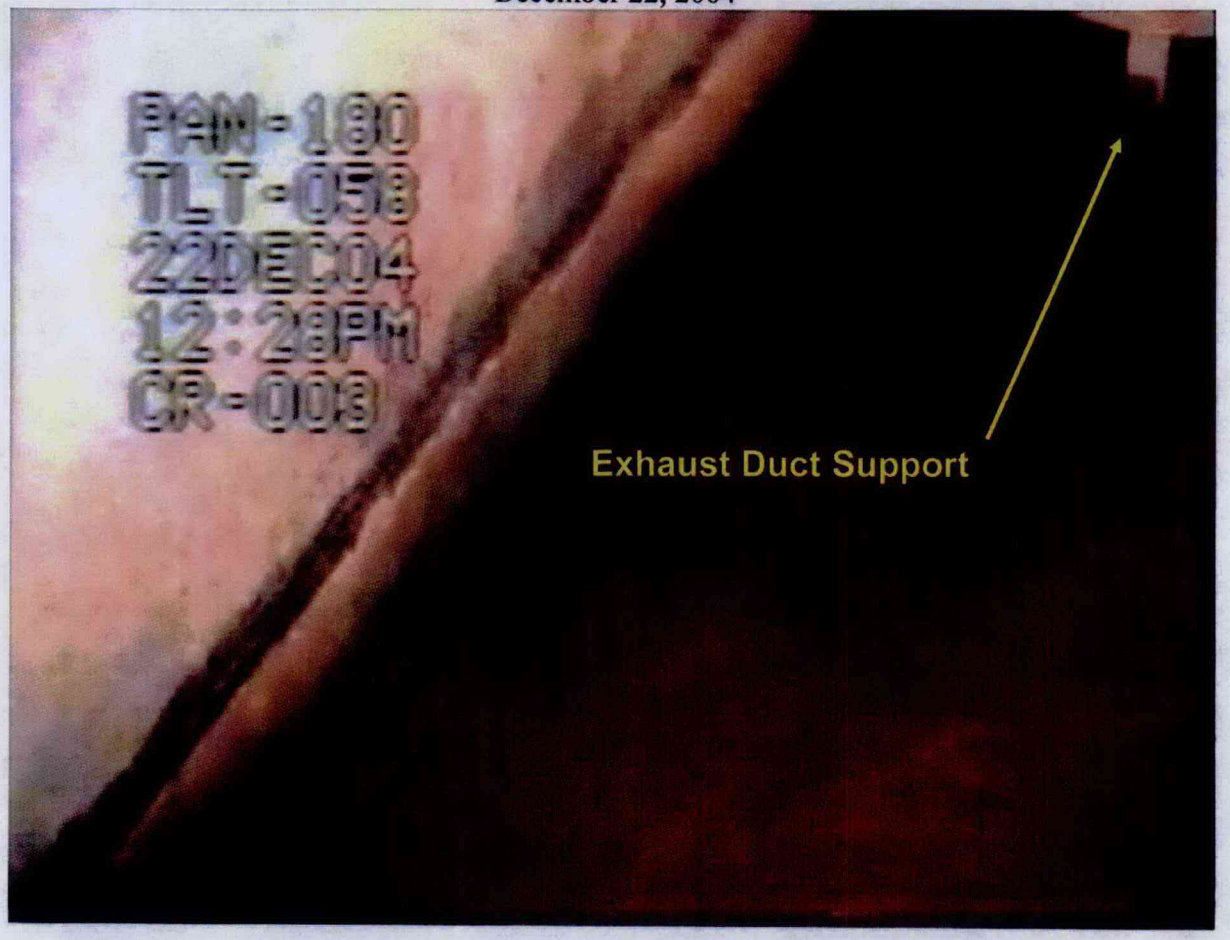
Using the facility elevations from drawings, field measurements, and calculated levels in Table 4-3 above and the tabulated volume values from Table 2 of RPP-CALC-24219, the estimated total volume of waste present in tank CR-003 is 2,146 gallons. The estimated volume of sludge in tank CR-003 is 714 gallons. By difference between the estimated total volume of waste and sludge volume, the estimated volume of liquid waste in tank CR-003 is 1,432 gallons. This is considered the best estimate of volume present in tank CR-003.

Figure 4-12. Screen Capture of Support Column During Video Inspection of Cell 3 on December 22, 2004



A review of the video inspection of tank CR-003 performed December 21, 2004 shows that 4 turns of the inner coil in the tank are submerged, as shown in Figure 4-14. From drawing H-2-41089 and H-2-41090, it is known that the bottom elevation of the 1 ½ in schedule 40 coils (1.95 in outside diameter) is 9.95 in, say 10 in, below the tangent line of the bottom head of the tank at the inlet header. Also, H-2-41090 shows there is a 4 in elevation gain in the coil for each complete turn it makes. The area of the coil viewed is near the return header which is roughly half way around the coil from the inlet header. The top of the 4th coil at this location would be 1.95 in (diameter of pipe) plus 2 in (elevation gain half way around the first turn) plus 12 in (4 in elevation gain for each of next 3 turns) or roughly 16 in above the bottom elevation of the 1 ½ in schedule 40 coils at the inlet header. The bottom of the 5th coil at this same location is 2 in (elevation gain half way around the first turn) plus 16 in (4 in elevation gain for each of next 4 turns) or 18 in above the bottom elevation of the 1 ½ in schedule 40 coils at the inlet header. Thus, the waste level between the 4th and 5th turn of the coil would be 6 to 8 in above the tangent line of the bottom dish of the tank. From RPP-CALC-24219, it is known that the height from the bottom of the tank to the tangent line is 28.48 in, say 28 ½ in. Based on this information the waste height in the tank would be estimated to be roughly between 34 ½ and 36 ½ in. This approximation via the video inspection is close to the measured height of 34 in.

Figure 4-13. Screen Capture of Cell Exhaust Duct Support During Video Inspection of Cell 3 on December 22, 2004



4.5.7 Cell 11 Volume Estimate

The measured total waste height in Table 4-2 above is 3 ft 2 7/8 in. The tabulated volume values from Table 5 of RPP-CALC-24219 are provided in ¼ in increments. The measured total waste height is rounded to the next highest ¼ in or 3 ft 3 in. Using the tabulated values from Table 5 of RPP-CALC-24219, the estimated total volume of waste present in Cell 11 is 7,312 gallons. Rounding the measured sludge waste height in Table 4-2 to 1 in, the estimated volume of sludge in Cell 11 is 4 gallons. By difference between the estimated total volume of waste and sludge volume, the estimated volume of liquid waste in Cell 11 is 7,308 gallons. This is considered the best estimate of volume present in Cell 11.

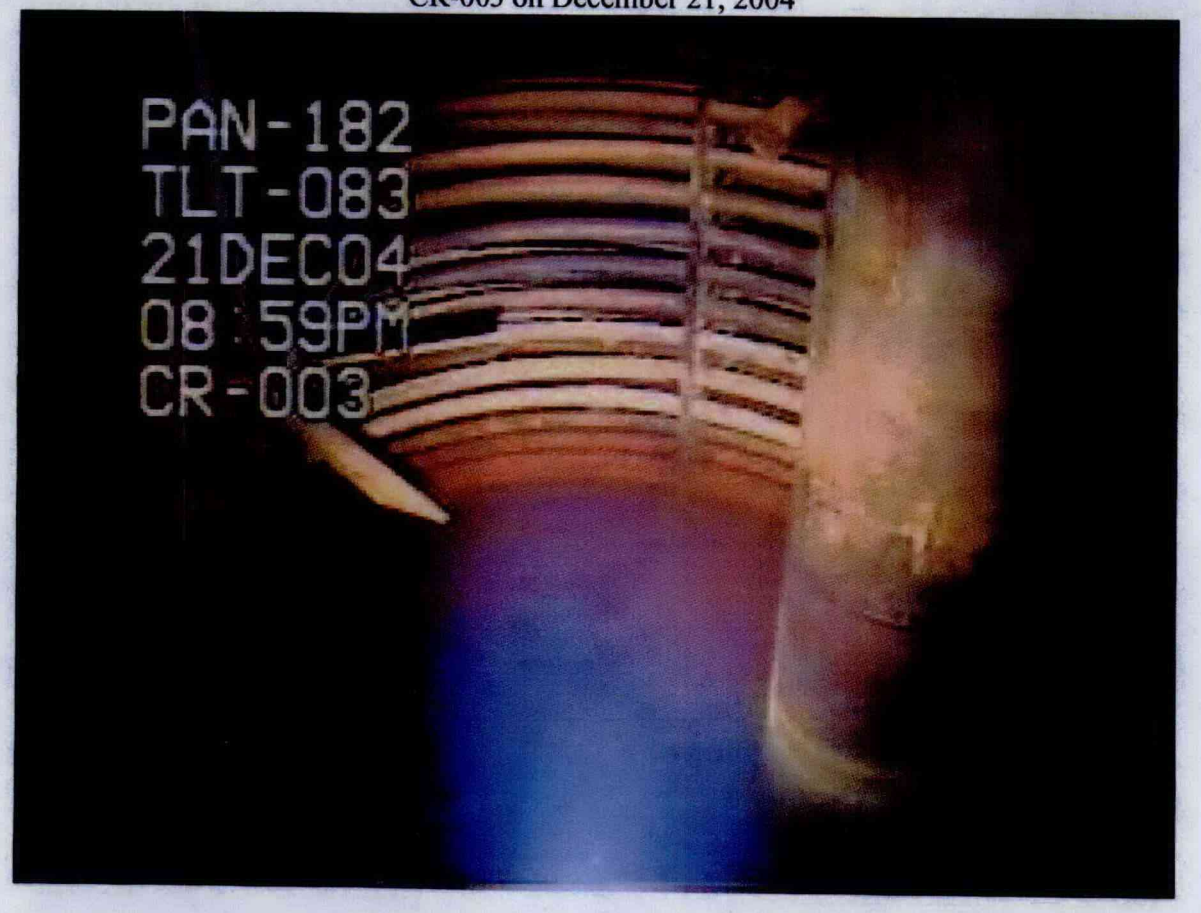
A review of the video inspection of Cell 11 performed December 21, 2004 shows liquid is approximately half way up the skirt supporting tank CR-011. This indication of liquid level would be consistent with the measured total waste height being 3 ft 3 in.

4.5.8 Tank CR-011 Volume Estimate

Using the calculated levels in Table 4-3 above and the tabulated volume values from Table 1 of RPP-CALC-24219, the estimated total volume of waste present in tank CR-011 is 3,990 gallons. The estimated volume of sludge in tank CR-011 is 3,797 gallons. By difference between the estimated total volume of waste and sludge volume, the estimated volume of liquid waste in tank CR-011 is 193 gallons. The estimated total volume of waste is considered the best estimate of total volume present in tank CR-011, but the sludge and liquid volume estimate are not considered the best estimate for those types of waste.

A review of the video inspection of tank CR-011 performed November 21, 2004 shows the surface of the waste to be mottled in color with light and dark patches. The surface appears to be completely solid with no discernible liquid layer anywhere in the tank. The difference of an inch between the liquid level measurement and the sludge level measurement would be indicative of a soft sludge. A soft sludge would yield slightly under the sludge weight resulting in a lower measured depth for the sludge weight than the zip cord which measures conductivity. Because the video evidence supports a single waste level with no separate liquid layer, the best estimate of the sludge level is the total waste level measurement or 3,990 gallons. The best estimate of the liquid volume present is 0 gallons.

Figure 4-14. Screen Capture of Inner Coil, Agitator and Pump During Video Inspection of Tank CR-003 on December 21, 2004



Intentionally left blank.

5.0 VIDEO INSPECTION

The requirement of TPA milestone M-23-27 was for a video inspection of each of the cells and tanks of the facility sufficient to determine whether the waste was being stored in a manner that was protective of human health and the environment. The inspection did not require an integrity assessment meeting the requirements of WAC-173-303, "Dangerous Waste Regulations." The video inspection was limited to visually assessing the general condition of the tanks and cells. Video inspections of the tanks and cells of 244-CR vault were performed from a single access point through empty risers which allowed access to the tanks and cells of the facility. Equipment was removed from these risers, as described in Section 3.0 to allow access for the video inspection.

Copies of the video inspections were placed on a shared area of the Hanford Local Area Network. The location of the video files at the time of this report is \\AP014\244CR-W-535\Videos. The administrator of the shared area is Mary E Compau.

5.1 TANK CR-001 AND CELL 1

Video inspection of tank CR-001 and Cell 1 was performed under work package 2W-03-01163/S, *244-CR, In Tank/Sump Video at CR-001*. Baseline radiological surveys were performed of the work area and the PTRAEUs were turned on prior to starting video inspection work. The video inspection of Cell 1 and the exterior of tank CR-001 was performed through riser 8745 on December 20, 2004. The video inspection of the interior of tank CR-001 was performed through riser 8724 on December 21, 2004.

Because the tank takes up a significant portion of the area of the cell, the portion of the cell at the elevation of the tank that could be viewed was limited to about 2/3 of the northwest wall of the cell, the southwest wall of the cell, and a small portion of the southeast wall. The approximate viewing area for Cell 1 and also Cell 11, when the camera is at the same level as the tank, is shown in Figure 5-1. The view of the southwest wall was limited to the area near the sump because of the proximity of the camera to the wall. Because the camera was so close to the wall the angle of viewing made it difficult to see at distances along the southwest wall.

The video inspection revealed that water is covering only a portion of the cell floor in the proximity of the cell sump. The floor around the sump, on the northwest wall, is covered with what appears to be dirt. The source of this material or how it collected in this location is not known. There appear to be a number of hairline cracks in the northwest wall close to the cell floor. This wall is common to Cell 11. It is assumed that the hairline cracks are superficial. If the cracks penetrated all the way through the wall, then it would be expected that the water present in Cell 11 could seep through the cracks and into Cell 1. If this were the case, the cracks would be expected to be wet indicating water traveling through the cracks. There is a different coloration of the intersection of the northwest wall and the floor than the surrounding wall, floor and material (dirt) on the floor. The intersection appears to have material that is yellow in color.

It is not clear if this is residue from waste processed through the facility or from some other source. The significance of this material is not known.

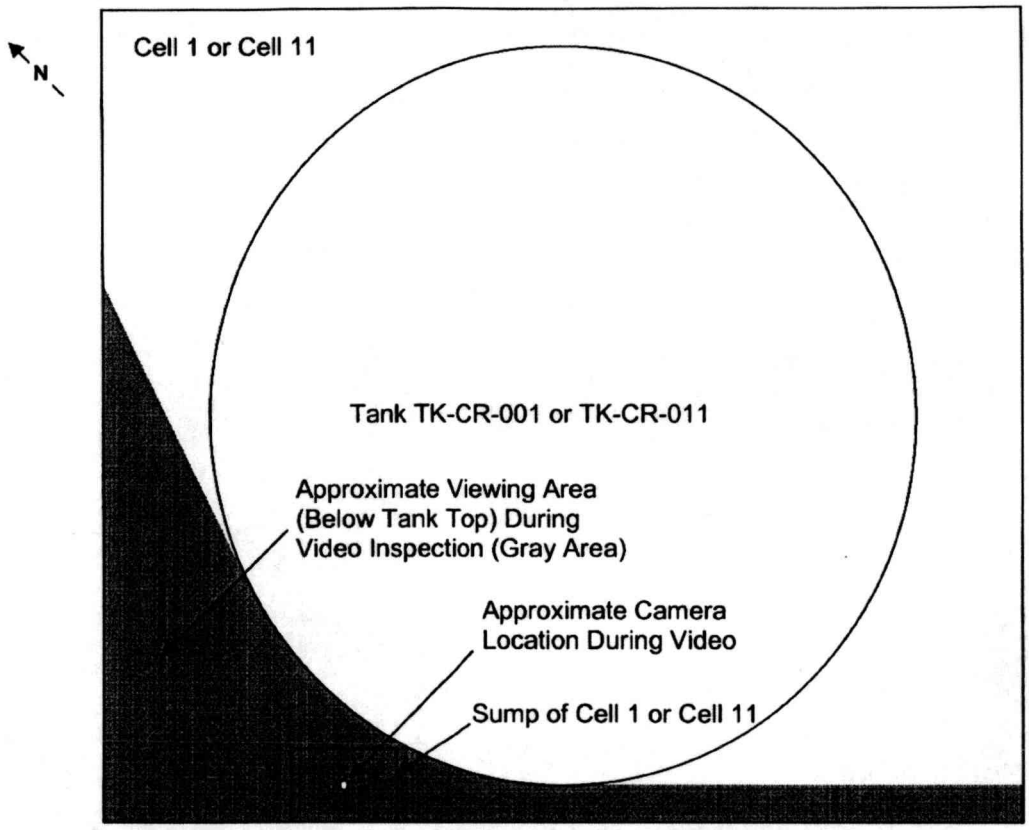


Figure 5-1. Graphic Representation of Approximate Viewing Area Below the Top of Tank TK-CR-001/TK-CR-011 During Video Inspection of Cell 1/Cell 11

This tank is the only tank within 244-CR vault that is carbon steel, the others being stainless steel. The tank appears to have a layer of corrosion present over the entire surface. There is no evidence of failure of the tank due to significant corrosion or chemical attack of the tank exterior.

One column supporting the tank could be seen in the video inspection. There was no visual evidence of cracks in the weld connecting the column to the tank. The base of the column, where the column is anchored to the floor could be completely seen as it is above the water level. This column has two support members that are connected to the northwest and southwest wall respectively. There is no evidence of failure of this column.

The top of the exterior of the tank below the riser pit appears to be wet which may indicate the riser pit is a water intrusion path. These areas of wetness trail down the side of the tank below the riser pit. A small amount of what appears to be dirt or debris is on top of the tank below the riser pit. This could also be increased corrosion of the tank or both increased corrosion and

debris/dirt. It is interesting to note that this cell only contains a small amount of water although the other cells where the tanks are seen to be wet below the riser pit have significant quantities of water present.

The video inspection of the inside of the tank did not indicate any visual evidence of significant structural problems with the tank, agitator, jet assembly or tank baffles. The bottom of the agitator and the tank baffles are above the waste level in the tank. The strainers of the jet assembly intakes are just submerged in the waste in the tank. There is general corrosion on all carbon steel surfaces of the tank, agitator, jet assembly, tank baffles, piping and supports within the tank. A submersible pump can be seen installed in one of the risers from the riser pit. Based on its location and the pit configuration, this pump is installed through the spare riser (see Figure 3-1). The liquid level in the tank appears to be level with the intake of this submersible pump. In the riser pit above tank CR-001, the discharge from the submersible pump is connected via a flexible line to a penetration through the southwest wall. This line could not be found on any facility drawings and it is not currently known where this line goes to.

5.2 TANK CR-002 AND CELL 2

Video inspection of tank CR-002 and Cell 2 was performed under work package 2W-03-01164/S, *244-CR,In Tank/Sump Video at CR-002*. Baseline radiological surveys were performed of the work area and the PTRAEUs were turned on prior to starting video inspection work. The video inspection of Cell 2 and the exterior of tank CR-002 was performed through riser 8747 on November 3, 2004. The video inspection of the interior of tank CR-002 was performed through riser 8748 on November 3, 2004.

Because the tank takes up a significant portion of the area of the cell, the portion of the cell at the elevation of the tank that could be viewed was limited to the northwest wall of the cell, the southwest wall of the cell, and small portions of the northeast and southeast walls. The approximate viewing area for Cell 2 and Cell 3, when the camera is at the same level as the tank, is shown in Figure 5-2. The view of the southwest wall was limited to the area near the sump because of the proximity of the camera to the wall. Because the camera was so close to the wall the angle of viewing made it difficult to see at distances along the southwest wall.

Areas of what appears to be scaling are present throughout the cell. Light to medium scaling and some small popouts were found up high on the southwest wall. There also appears to be light to medium scaling along the northwest wall above the liquid level and near the ceiling. Light to medium scaling was also found on the ceiling of the cell. Light to medium scaling was also seen on the northeast wall near the ceiling. It should be expected that areas of scaling may exist elsewhere in the cell.

The video inspection revealed that water is covering the entire floor. It cannot be determined whether there are any solids on the floor of the cell.

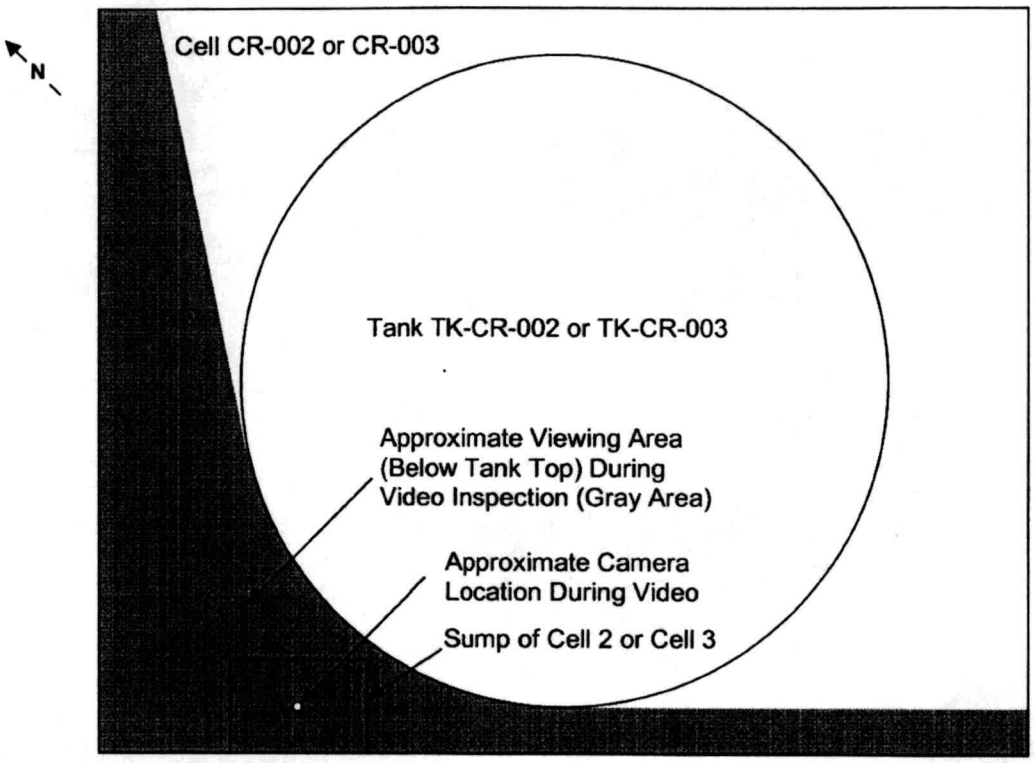


Figure 5-2. Graphic Representation of Approximate Viewing Area Below the Top of Tank TK-CR-002/TK-CR-003 During Video Inspection of Cell 2/Cell 3

There are small discolorations present on the exterior of the tank but nothing that would indicate significant corrosion or chemical attack of the tank exterior. One column supporting the tank could be seen in the video inspection. There was no visual evidence of cracks in the weld connecting the column to the tank. The base of the column, where the column is anchored to the floor could not be seen due to the presence of water in the cell. There appears to be some material present in the water near the column base but the video does not provide clear evidence what it may be.

The top of the exterior of the tank appears to be dry. The welded connection between the 1 ½ in stainless steel pipe to the agitator spray ring and the 1 ½ in carbon steel raw water pipe that supplied raw water to the spray ring appears to have completely failed. Because tank CR-002 was used to dissolve solids with nitric acid, a probable cause for this failure could have been nitric acid fumes inside the tank coming in contact with the inside of the carbon steel pipe. The failed pipe is shown in Figure 5-3.

The video inspection of the inside of the tank did not indicate any visual evidence of significant structural problems with the tank, agitator, pump, coil or the coil supports. Dark colorations are present on the top side of some of the coils and coil supports.

Figure 5-3. Screen Capture of Failed Raw Water Line to Tank CR-002 Agitator Spray Ring During Video Inspection of Cell 2 on November 3, 2004

5.3 TANK CR-003 AND CELL 3

Video inspection of tank CR-003 and Cell 3 was performed under work package CLO-WO-04-000140, *244-CR, Perform Video and Liquid Level Readings at CR-003*. Baseline radiological surveys were performed of the work area and the PTRAEUs were turned on prior to starting video inspection work. The video inspection of Cell 3 and the exterior of tank CR-003 was performed through riser 8749 on December 22, 2004. The video inspection of the interior of tank CR-003 was performed through riser 8757 on December 21, 2004. It is worth noting that a video inspection of Cell 3 and the exterior of tank CR-003 was also previously performed on February 5, 1997.

The camera used to videotape tank CR-003 and Cell 3 in December 2004 had limited tilt capability and could only tilt up approximately 60 degrees from straight down. This limited the amount of the top of the tank that could be inspected. The camera used in the video inspection performed February 5, 1997 was able to tilt to horizontal and view the top of the tank. Because

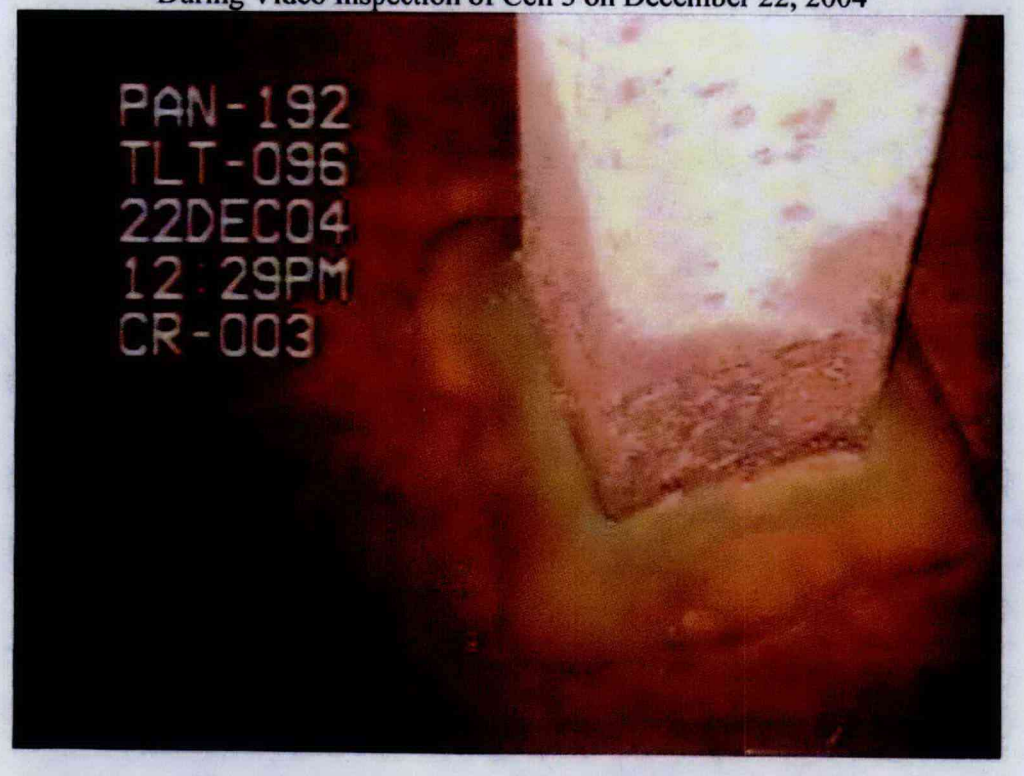
the tank takes up a significant area of the cell, the portion of the cell at the elevation of the tank that could be viewed was limited as shown in Figure 5-2.

There are areas of what appears to be light scaling in the pipe chase below the riser pit and above the cell. There also appears to be some light scaling on areas of the southwest wall.

Water is covering the entire floor of the cell, so the December 2004 video inspection cannot determine whether there are any solids on the floor. However, the video inspection during February 1997 shows only a limited amount of water on the floor around the sump. The video at that time showed what appears to be dirt on the floor.

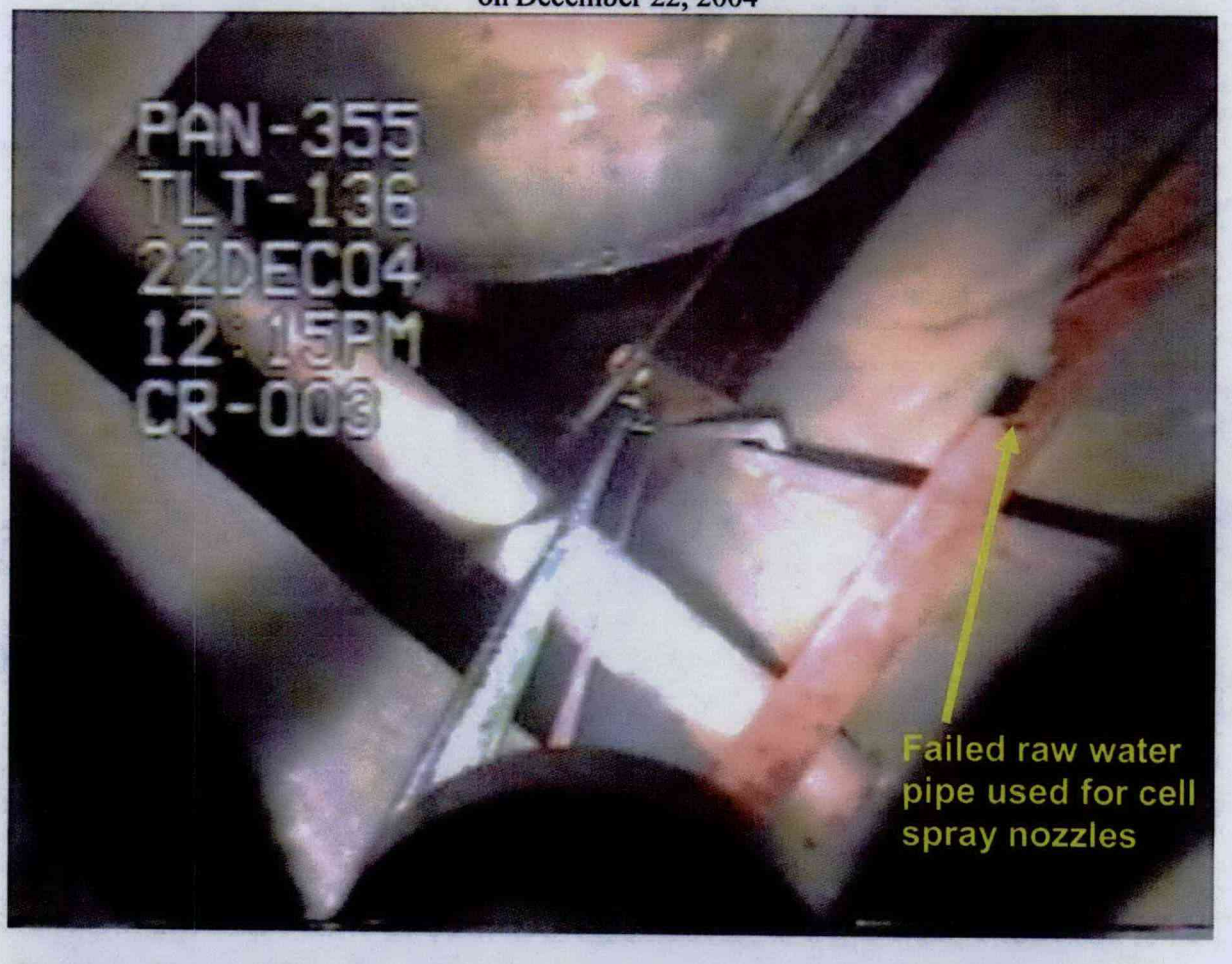
There are small discolorations present on the exterior of the tank but nothing that would indicate significant corrosion or chemical attack of the tank exterior. One column supporting the tank could be seen in the video inspection. There was no visual evidence of cracks in the weld connecting the column to the tank. The base of the column, where the column is anchored to the floor appears to be covered with some foreign material, however, it is possible that the camera was simply out of focus. Assuming that it is not due to the camera being unable to focus on the metal plate underwater, it appears that it could be some sort of slime. If it is some sort of slime, it completely obscures the base of the column and the anchor bolts that support the tank column. The presence of slime could be an indicator of microbiologically influenced corrosion. The base of the column and the material surrounding the column are shown in Figure 5-4.

Figure 5-4. Screen Capture of Tank Column Base and Suspect Material Surrounding the Base During Video Inspection of Cell 3 on December 22, 2004



The raw water pipe used to provide water to the cell spray nozzles has a significant failure. It is not likely that the pipe would have corroded so severely from the presence of raw water inside the pipe and it is more likely that the pipe corroded away from the outside rather than the inside. One likely potential cause for the corroded pipe would be leaking nitric acid from above (e.g., from the riser pit drain) falling onto the pipe. There is no evidence that this was the cause, but it seems likely given the operating history of the facility. The failed pipe is shown in Figure 5-5.

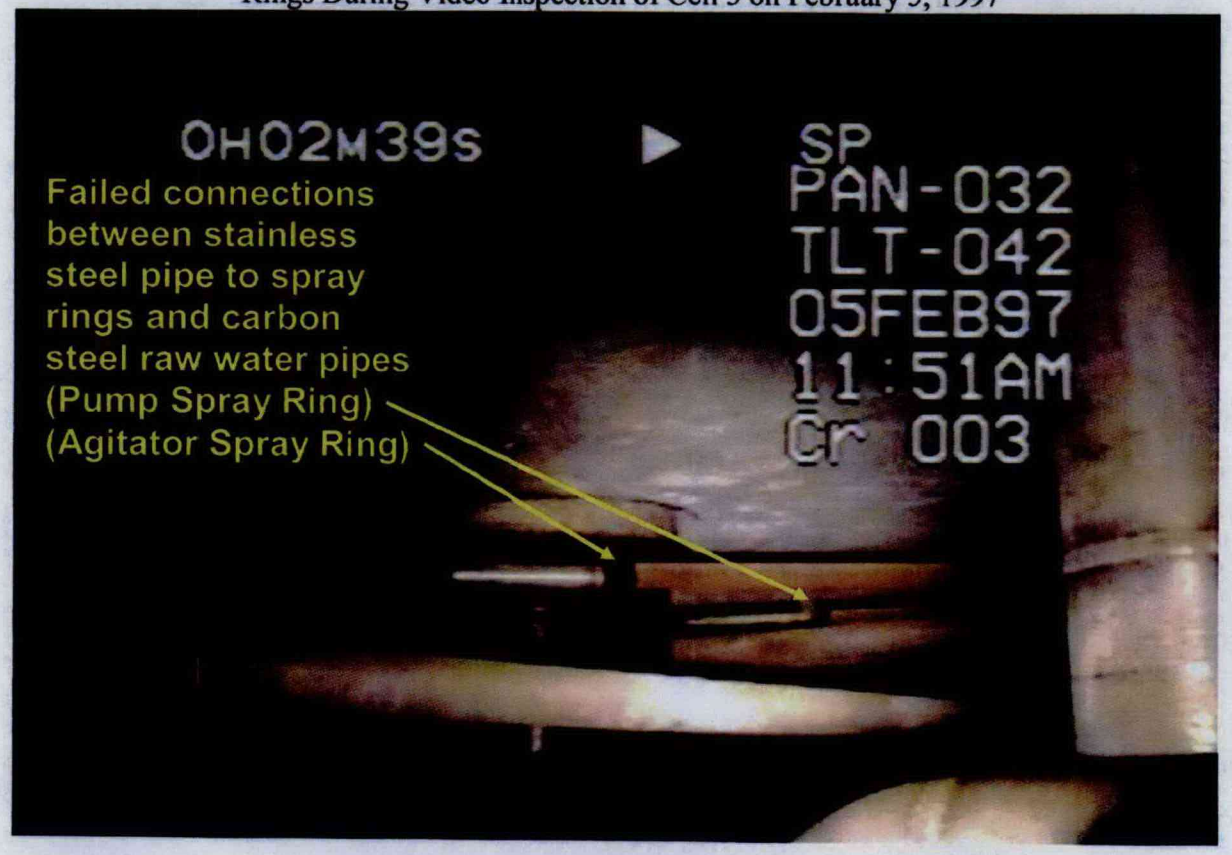
Figure 5-5. Screen Capture of Failed Pipe to Spray Nozzles During Video Inspection of Cell 3 on December 22, 2004



The view of the top of the tank was limited and the northeast wall of the cell was not visible during the December 2004 video inspection due to limited tilt capability of the camera. The video inspection of the cell performed during February 1997 did provide views of the top of the tank and the upper portion of the northeast wall. In that video inspection, there was no visual indication of significant structural problems with the northeast wall or the top of the tank. However, as was the case for tank CR-002, the welded connection between the 1 ½ in stainless steel pipe to the agitator spray ring and the 1 ½ in carbon steel raw water pipe that supplied raw water to the spray ring appears to have completely failed. The February 1997 video inspection also shows that the welded connection between the stainless and carbon steel pipes to the pump spray ring is also completely failed. Because tank CR-003 contained solutions with nitric acid, a probable cause for this failure could have been nitric acid fumes inside the tank coming in

contact with the inside of the carbon steel pipe. Another possible failure mechanisms could have been galvanic corrosion between the stainless steel spray ring and the carbon steel raw water pipe. The failed pipes are shown in Figure 5-6.

Figure 5-6. Screen Capture of Failed Raw Water Line to Tank CR-003 Agitator and Pump Spray Rings During Video Inspection of Cell 3 on February 5, 1997

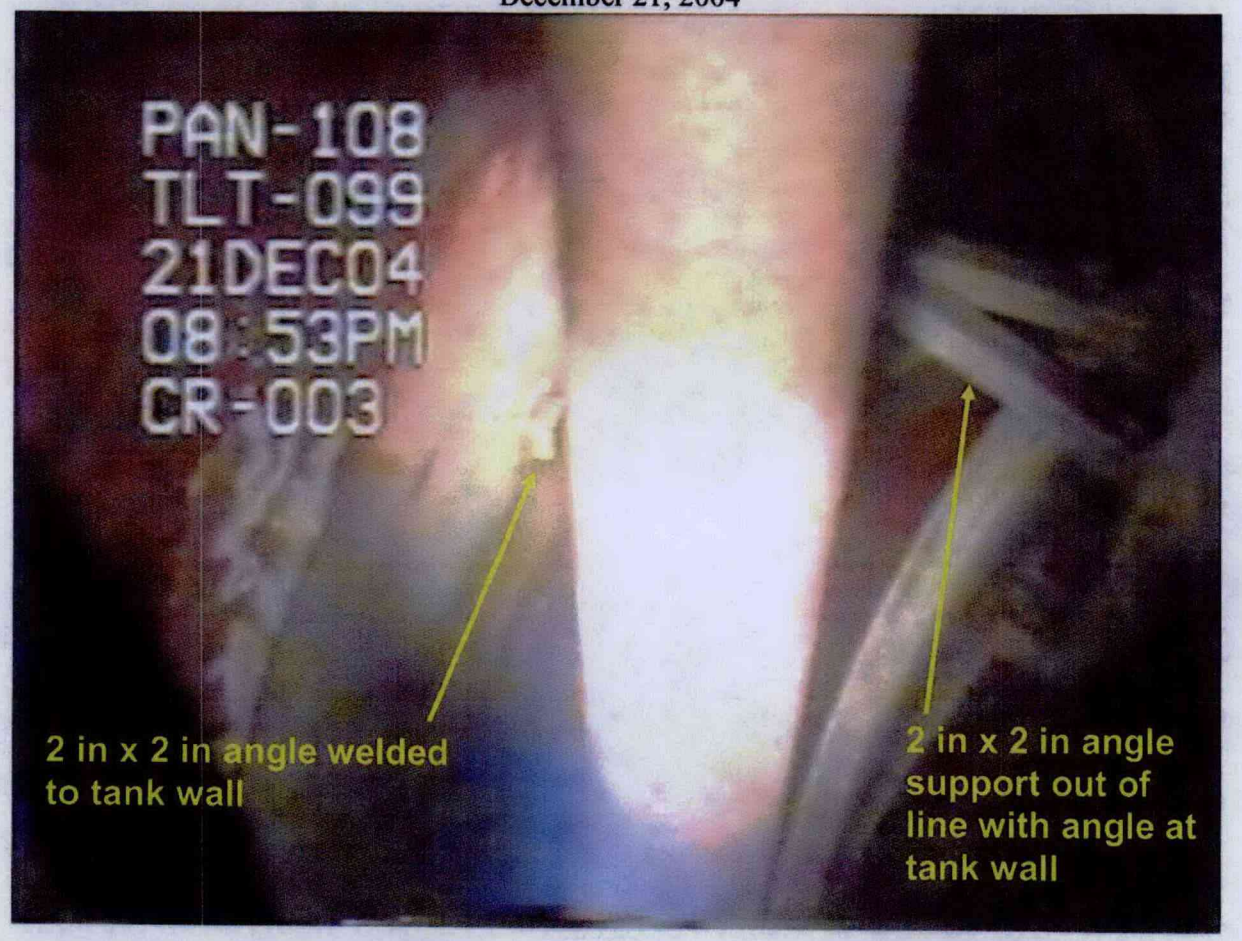


A jet can be seen going into the cell sump from a riser in the riser pit. Although not shown in the video inspection, within the pit there are three pipes that come out of the riser in the pit. Two of these pipes extend above grade and one of the pipes penetrates the wall of the riser pit. It is expected that the pipe penetrating the riser pit wall was the discharge line from the jet although this is not confirmed. This line was not found on any facility drawings and it is not known where this line goes to.

The video inspection of the inside of the tank did not provide any visual evidence of significant structural problems with the tank, agitator or pump. It does appear that one of the 2 in x 2 in x ¼ in horizontal angles supporting the coil was cut and bent out of the way during construction, however, there is no video evidence that this has any structural impact to the coil. The weight of the coils is supported by ½ in thick plates that are welded to the bottom of the tank. The horizontal angle is located directly below the 6 in spare instrument riser. Video inspection shows the 2 in x 2 in angle welded to the wall of the tank only extends out from the wall approximately

an inch. The other end of this 2 in x 2 in angle that is connected to the vertical plates that support the column is at an angle that would not intersect with the portion of the 2 in x 2 in angle connected to the wall of the tank. See Figure 5-7.

Figure 5-7. Screen Capture of Coil Support During Video Inspection of Tank CR-003 on December 21, 2004



5.4 TANK CR-011 AND CELL 11

Video inspection of tank CR-011 and Cell 11 was performed under work package 2W-03-01162/S, *244-CR, In Tank/Sump Video at CR-011*. Baseline radiological surveys were performed of the work area and the PTRAEUs were turned on prior to starting video inspection work. The video inspection of Cell 11, the exterior and interior of tank CR-011 was performed through riser 8822 (cell and tank exterior) and riser 8800 (tank interior) on November 21, 2004.

Because the tank takes up a significant area of the cell, the portion of the cell at the elevation of the tank that could be viewed was limited to about 2/3 of the northwest wall of the cell, the southwest wall of the cell, and a small portion of the southeast wall. The approximate viewing

Because the tank takes up a significant area of the cell, the portion of the cell at the elevation of the tank that could be viewed was limited to about 2/3 of the northwest wall of the cell, the southwest wall of the cell, and a small portion of the southeast wall. The approximate viewing area is shown in Figure 5-1. The portion of the southwest wall that could be viewed was limited to the area near the sump because of the proximity of the camera to the wall. Because the camera was so close to the wall the angle of viewing made it difficult to see at distances along the southwest wall.

Only a few areas of what appears to be scaling are present in the concrete of the cell. The areas that look like scaling were primarily limited to the northwest wall above the liquid level. The video inspection revealed that water is covering the entire floor. It cannot be determined whether there are any solids on the floor of the cell.

There are a number of discolorations present on the exterior of the tank but nothing in the video indicated failure of the tank due to significant corrosion or chemical attack of the tank exterior. Because of the water present in the cell, only the upper portion of the skirt supporting the tank could be seen in the video inspection. The base of the skirt, where the tank is anchored to the floor could not be seen to determine its condition. The top of the exterior of the tank below the riser pit appears to be wet which may indicate the riser pit is a water intrusion path. These areas of wetness trail down the side of the tank below the riser pit.

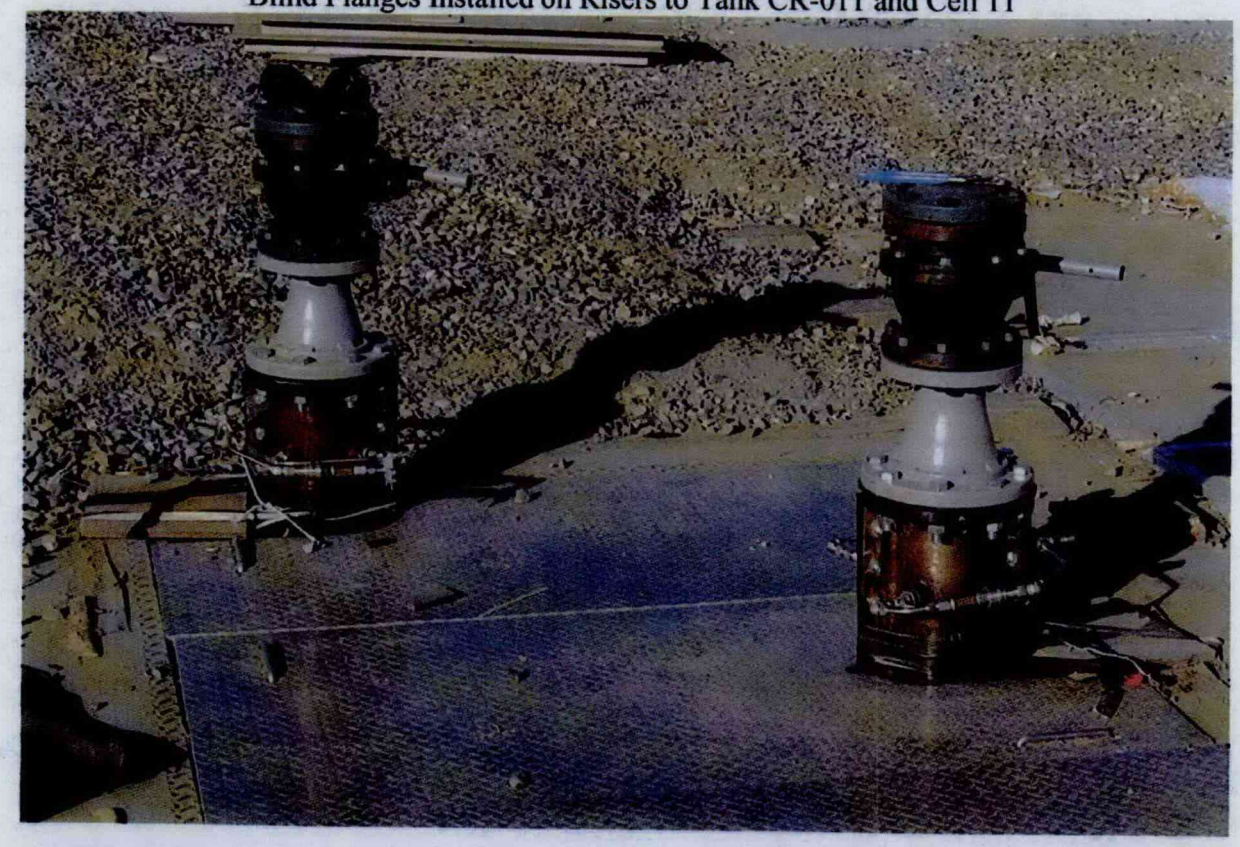
The video inspection of the inside of the tank did not indicate any visual evidence of significant structural problems with the tank, agitator, pump or dip tube assembly in the tank. The bottoms of the agitator, pump, baffles, and dip tube assembly all appear to be above the waste level in the tank. A high water mark is visible in the tank approximately 15 feet above the bottom dished head. The height of the high water mark can be estimated because it is approximately half way between the upper two supports for each baffle. Drawing H-2-41108 shows these two uppermost supports are 13 feet and 17 feet above the bottom dished head. RPP-CALC-24219 shows that this level is at the nominal 40,000 gallon fill capacity of the tank.

6.0 FACILITY STATUS AT COMPLETION

The assessment of the liquid levels within the facility cells and tanks have been completed and are recorded on Table 4-1. Riser extensions have been put in place for tanks CR-001, CR-002, CR-011 and Cell 1, Cell 2, and Cell 11. A photo of the riser extensions in place at the riser pit over tank CR-011 and Cell 11 is provided in Figure 6-1. These riser extensions bring access to the risers above grade in preparation for the installation of level monitoring instrumentation. However, with the discovery of liquid in all four of the cells, a replanning effort has been initiated to install the riser extensions at the riser pit above tank CR-003 and Cell 3 and to remove the liquid from the cells prior to installation of the level monitoring instrumentation.

The zip cord used for level measurement of tank CR-003 via sample riser 8757 was left in place to allow continued weekly level measurements of tank CR-003 as required per TF-OR-ST1-DW, *244-AR, A, AX, C and CR Farm Daily/Weekly Rounds*.

Figure 6-1. Photo of Above-Grade Portion of Riser Extensions, Reducers and Ball Valves with Blind Flanges Installed on Risers to Tank CR-011 and Cell 11



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7.0 BIBLIOGRAPHY

7.1 WORK ORDERS, WORK PACKAGES AND ROUTINE WORK REQUESTS

2W-02-00765/M, *244-CR Prepare Pit CR-011*

2W-02-00767/M, *244-CR Prepare Pit CR-002*

2W-02-00768/M, *244-CR Prepare Pit CR-003*

2W-03-1090/1, *244-CR Containment Tents (CR-002 & CR-011)*

2W-02-01100/M, *244-CR Polyurethane Foam Pit Access Covers*

2W-03-01158/S, *244-CR, Install Zip Cord & Sludge Weight (CR-011)*

2W-03-01159/S, *244-CR, Install Zip Cord & Sludge Weight (CR-001)*

2W-03-01160/S, *244-CR, Install Zip Cord & Sludge Weight (CR-002)*

2W-03-01161/S, *244-CR, Install Zip Cord & Sludge Weight (CR-003)*

2W-03-01162/S, *Perform Video at 244-CR-011*

2W-03-01163/S, *Perform Video at 244-CR (CR-001)*

2W-03-01164/S, *Perform Video at 244-CR-002*

2W-03-01165/S, *Perform Video at 244-CR (CR-003)*

2W-03-01166/1, *PTREAU-2 and PTREAU-3 (CR-002 & CR-011)*

2W-03-01216/1, *Ground Scan*

2W-03-01217/M, *244-CR Electrical Power Installation*

2W-03-01218/M, *244-CR, ENRAF Installation (TK-CR-001)*

2W-03-01219/M, *244-CR, ENRAF Installation (TK-CR-002)*

2W-03-01220/M, *244-CR, ENRAF Installation (TK-CR-003)*

2W-03-01221/M, *244-CR, ENRAF Installation (TK-CR-011)*

2W-03-01222/1, *244-CR Install Containment Tents (CR-001,CR-003)*

2W-03-01229/M, *244-CR Prepare Pit CR-001*

2W-04-00209/W, *244-CR, Re-Calibrate ENRAFS*

2W-04-01245/1, *244-CR, Perform Ground Scan*

2W-04-01265/1, *Fabricate/Assemble Electrical Stands For 244-CR*

2W-04-01713/M, *244-CR, Install Breather Filter*

2W-04-01714/M, *244-CR, Cap Exhaust Stack*

2W-04-01715/M, *244-CR, Electrical Ventilation Isolation*

CLO-WO-04-000140, *244-CR Vault, Perform Video and Liquid Level Readings @ CR-003*

7.2 DRAWINGS

H-14-106410 (drawing), *Riser Extension/Washer Assembly 6-Inch Riser*, 3 sheets, CH2M HILL Hanford Group, Inc., Richland Washington.
2004, Rev. 0, Sheet 1
2004, Rev. 0, Sheet 2
2004, Rev. 0, Sheet 3

H-2-40388 (drawing), 1953, *Piping Equipment Arrangement – Processing Area – Plan & Sections – Waste Metal Removal – Phase 2*, Rev. 1, Hanford Works, General Electric, Richland, Washington.

H-2-41088 (drawing), 1953, *Vessel Assembly & Details – 20'-0" x 19'-2" Tank TK-CR-001, TK-BXR-001, TK-TXR-001*, Rev. 3, Hanford Works, General Electric, Richland, Washington.

H-2-41089 (drawing), 1953, *Vessel Assembly & Details – 14'-0" x 12'-0" Tank – TK-CR-002, TK-CR-003, TK-BXR-002, TK-BXR-003, TK-TXR-002, TK-TXR-003*, Rev. 2, Hanford Works, General Electric, Richland, Washington.

H-2-41108 (drawing), 1953, *Vessel Assembly & Details – 20'-0" x 19'-2" Tank TK-CR-011 & TK-BXR-011*, Rev. 3, Hanford Works, General Electric, Richland, Washington.

H-2-41277 (drawing), 1953, *Structural – Concrete & Steel – Plans & Sections – Stack & Foundation*, Rev. 2, Hanford Works, General Electric, Richland, Washington.

H-2-41496 (drawing), 1964, *Piping Arrangement – Plan – Process Tank Vault – Sheet No. 1*, Rev. 5, Hanford Works, General Electric, Richland, Washington.

H-2-41497 (drawing), 1953, *Piping Arrangement – Plan – Process Tank Vault – Sheet No. 2*, Rev. 1, Hanford Works, General Electric, Richland, Washington.

H-2-41498 (drawing), 1953, *Piping Arrangement – Sections & Elevations – Process Tank Vault – Sh. #1*, Rev. 3, Hanford Works, General Electric, Richland, Washington.

H-2-41499 (drawing), 1961, *Piping Arrangement – Sections & Elevations – Process Tank Vault – Sh. #2*, Rev. 4, Hanford Works, General Electric, Richland, Washington.

H-2-41500 (drawing), 1953, *Piping Arrangement – Sections & Elevations – Process Tank Vault – Sh. #3*, Rev. 1, Hanford Works, General Electric, Richland, Washington.

H-2-41688 (drawing), 1958, *Vessel Assembly & Details – 20'-0" x 19'-2" Tank TK-CR-001, TK BXR-001, TK TXR-001*, Rev. 3, Hanford Atomic Products Operation, General Electric, Richland, Washington.

H-2-41888 (drawing), 1953, *Structural – Concrete – Plans & Details – Process Tank Vault*, Rev. 3, Hanford Works, General Electric, Richland, Washington.

H-2-41889 (drawing), 1953, *Structural – Concrete – Sections and Details – Process Tank Vault – Sheet #1*, Rev. 2, Hanford Works, General Electric, Richland, Washington.

H-2-41982 (drawing), 1953, *Structural – Concrete – Sections and Details – Process Tank Vault – Sheet #2*, Rev. 2, Hanford Works, General Electric, Richland, Washington.

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8.0 REFERENCES

AIR 02-1255, 2002, *Conditions and Limitations for Radioactive Air Emissions Notice of Construction for 244-CR Vault Isolation and Interim Stabilization* (letter from A. W. Conklin to J. B. Hebdon, U.S. Department of Energy, Regulatory Compliance and Analysis Division, and J. E. Rasmussen, U.S. Department of Energy, Office of River Protection, December 31), Washington State Department of Health, Olympia Washington.

CH2M-0301219 R1, 2003, *Contract Number DE-AC27-99RL14047; Transmittal of Regulatory Letter: Denial of Hanford Federal Facility Agreement and Consent Order Change Request M-23-02 Requesting Revisions to the M-23 Milestone Series Dated April 16, 2003* (letter from E. S. Aromi to R. J. Schepens, U.S. Department of Energy, Office of River Protection, August 20), CH2M HILL Hanford Group, Inc., Richland, Washington.

CH2M-0402428.2, 2004, *Contract Number DE-AC27-99RL14047; Completion of Hanford Federal Facility Agreement and Consent Order Milestone M-23-27, "Complete Liquid Level Assessments for the 244-CR Tanks and Cells, and Perform a Video Inspection of the Tanks and Vaults to Determine If the Waste is Besing Stored in a Manner that is Protective of Human Health and the Environment* (letter from E. S. Aromi to R. J. Schepens, U.S. Department of Energy, Office of River Protection, December 27), CH2M HILL Hanford Group, Inc. Richland, Washington

CHG-TANKFARM-2004-0037, 2004, *Nuclear Chemical Operator Extremity Administrative Control Level Exceeded*, July 22, 2004, CH2M HILL Hanford Group, Inc., Richland, Washington.

CHG-0202214 R1, 2002, *Contract Number DE-AC27-99RL14047; Approval of Updated Radioactive Air Emissions Notice of Construction for 244-CR Facility Interim Stabilization Activities, Revision 1* (letter from J. C. Fulton to J. E. Rasmussen, U.S. Department of Energy, Office of River Protection, August 28), CH2M HILL Hanford Group, Inc., Richland, Washington.

Ecology, EPA, and DOE, 1996, *Hanford Federal Facility Agreement and Consent Order*, 6 vols., as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

HFFACO 2003, Federal Facility Agreement and Consent Order Change Control Form Modification of M-23 Milestone to Reflect Agreements Reached in Dispute Resolution to Proposed Ecology Change Request Package M-23-02-02, June 30, 2003.

RPP-6029, 2000, *244-CR Vault Interim Stabilization Project Plan*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-10495, 2002, *244-CR Vault Interim Stabilization Implementation Plan*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-13033, 2003, *Tank Farms Documented Safety Analysis*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-20188, 2004, *244-CR Vault Liquid Level Assessment and Video Inspection Task Plan*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-CALC-24219, 2005, *244-CR Vault Tank and Cell Volume Calculations*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

TF-OR-ST1-DW, 2005, *244-AR, A, AX, C and CR Farm Daily/Weekly Rounds*, Rev. A-2, March 10, CH2M HILL Hanford Group, Inc. Richland, Washington.