SRR-CWDA-2011-00105
Revision 0

Saltstone Disposal Facility
Vault 4 Video Inspection Summary

July 2011

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Prepared for U.S. Department of Energy Under Contract No. DE-AC09-09SR22505

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ACRONYMS

FMF	Fuel Material Facility
I&M	Inspection and Maintenance
NRC	Nuclear Regulatory Commission
PA	Performance Assessment
PTZ	Pan-Tilt-Zoom
PVC	Polyvinyl Chloride
SPF	Salt Processing Facility
SRR	Savannah River Remediation LLC
WWTF	Waste Water Treatment Facility

EXECUTIVE SUMMARY

The continuing integrity of the saltstone monolith is an important factor in its ability to retain radionuclides as modeled by the Saltstone Disposal Facility Performance Assessment (PA). [SRR-CWDA-2009-00017] During the January 27, 2011 public meeting, the Nuclear Regulatory Commission (NRC) raised concerns about the "annulus that forms between the saltstone and the vault walls," and that "the saltstone is fractured". [SRR-CWDA-2011-00018]

On March 10, 2011 (Cells F and L), and on April 13 and 14, 2011 (Cells C, D, E, G, I, and K), Savannah River Remediation LLC (SRR) took video of eight of the nine Vault 4 cells currently containing saltstone from salt solution processing. Cell J was not included in the survey due to on-going grout additions to the cell. The cells were surveyed via video camera as thoroughly as possible from one vantage point with the limitations of zoom, focus, and structural obstructions. The inspection focused on interfaces between the saltstone monolith and the vault walls, evidence of surface cracking or fracturing, and the self-leveling capability of the grout.

Detailed inspection was made of the grout-wall interface on the cell wall closest to the camera and the nearest columns. This inspection covered approximately 20% of the grout-wall interface in detail, and most of the rest at a distance. The interfaces between the monolith and vault wall showed no visible void space with the exception of one of the grout-wall interfaces in Cell L, which evidenced a small void space between the wall and the top of the monolith.

Inspection for surface cracking was, by nature of camera limitations, more detailed closer to the camera. The inspection closely observed approximately 40% of the saltstone surface, with approximately 80% of most cells surveyed to some degree. (Signs blocking the process cameras in Cells F and L combined with less adequate lighting decreased this number to approximately 50%.) The saltstone showed surface cracking in Cell K and minor evidence of surface cracking in Cells C, D, I, and L. Cells E and G showed no evidence of surface cracking. The grout appeared level in all of the cells, although Cell I showed a distinct dip near one of the columns.

1.0 BACKGROUND

Vault 4 construction began in 1988, and included the working slab, floor slab, exterior walls, and interior walls. The current roof was added in 1996 before grout was introduced to the vault in order to provide operational flexibility and reduce potential rainwater intrusion.

Cells B, D, E, F, H, J, K, and L also have sheet drains installed on the walls to limit the build-up of hydrostatic head by removing drainwater and condensate from the cells. The sheet drains were installed to mitigate potential cracking of the vault walls due to hydrostatic head created by drainwater. The sheet drain collects free water that might accumulate in a narrow gap between the vault wall and the saltstone waste form. The sheet drain also acts as a barrier to keep water away from the wall. This drainwater collection system consists of the sheet drains placed against the vault walls and a polyvinyl chloride (PVC) piping system that collects the liquid for transfer back to the Salt Processing Facility (SPF) to be re-fed into the dry feeds mix to form additional grout. [SRR-CWDA-2009-00017]

1.1 Vault 4 Current Configuration

Vault 4 consists of 12 square cells with an interior side length of 98.5 feet per cell. Cell A contains 10,000 drums of Fuel Material Facility (FMF) non-hazardous saltcrete generated from the operation of the Waste Water Treatment Facility (WWTF) at FMF. Cell A also contains the wooden pallets used in the movement of the FMF drums (one pallet to four drums). [ESH-FSS-9000373] The metal 55-gallon drums were completely filled with contaminated waste by combining the liquid FMF WWTF waste with dry concrete mix in a batch mixer and pouring into the drums. The void space in Cell A surrounding the drums is filled with clean grout.

Cells C, G and I were partially filled with grout but are no longer in use due to the lack of a drain water collection system. Cells D, E, F, J, K, and L have drain water collection systems and contain grout. Cells B and H are currently empty cells containing drain water systems that will allow them to be filled in the future. An additional inspection was performed on empty Cells B and H. [SRR-CWDA-2011-00097] Cell F is the only currently non-operational cell that does not yet have a clean operational layer. Cell J is currently in operations mode with on-going grout additions. Table 1.1-1 summarizes the conditions and grout heights of each cell as of April 25, 2011. These conditions are applicable to Cells F and J, surveyed in March, as there was no change in the interim.

Table 1.1-1: Vault 4 Cell Conditions as of April 2011

Cell	Grout Height (ft)	Cell Condition	Cell	Grout Height (ft)	Cell Condition
A	Full	Completely Full	G	21.5	No Future Additions Currently Planned
B	Empty	Empty	H	Empty	Empty
C	15.5	No Future Additions Currently Planned	I	13.2	No Future Additions Currently Planned
D	23.75	No Future Additions Currently Planned	J	19.5	Operations Mode
E	21	No Future Additions Currently Planned	K	23.5	No Future Additions Currently Planned
F	22.75	No Clean Cap	L	23.25	No Future Additions Currently Planned

2.0 OBJECTIVES

The objectives of the Vault 4 video inspection were to assess the visible condition of the saltstone monolith in the viewable cells of Vault 4 with respect to shrinkage of the monolith, saltstone surface cracking, and leveling of the saltstone surface. Video was analyzed for evidence of macro-scale surface cracking, visible shrinkage of the monolith from the vault wall, and significant variation in grout levels within the same cell.

2.1 Video Inspection Approach

Due to exposure rates on the roof of the cells, the conditions of Cells F and L were documented with process cameras rather than the higher quality Inspection and Maintenance (I&M) camera. The process cameras are permanently mounted in 10-inch ports approximately 30- to 40-inches from the inside center edge of the cell for the purpose of monitoring the grout entering the cell. The process cameras are manufactured by Brooks, model 210-0008, with a 22X zoom capability. The I&M camera used was a General Electric Measurement and Control Solutions pan-tilt-zoom (PTZ) camera, the PTZ70. The PTZ70 has a 40X total zoom, with a 10X optical zoom and a 4X digital zoom. It is capable of fitting inside the 3-inch port openings through which the video was taken.

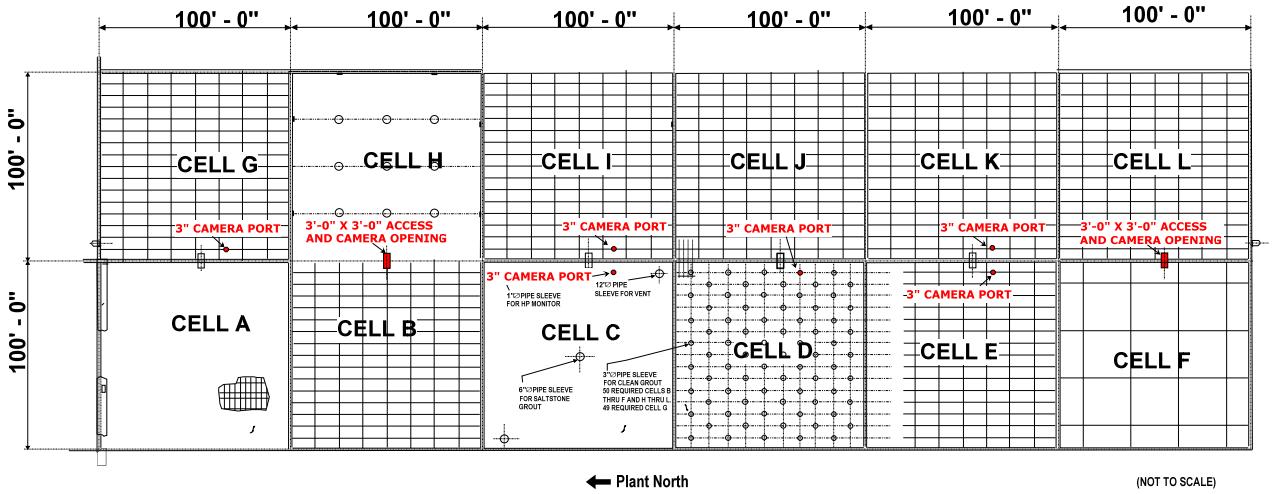
Cell A was not documented because it is completely full of grout with no room for camera insertion. Cell J was not documented in this effort because it is in Operations mode with on-going additions of grout. Cells B and H were not included in this effort because they currently contain no saltstone, but another inspection documented the condition of these empty cells. [SRR-CWDA-2011-00097] The cells, their current conditions at the time of survey, video types, and approximate saltstone ages are included in Table 2.1-1.

Table 2.1-1: Cell and Observation Conditions as of April 2011

Cell	Grout Height (ft)	Condition	Video Type	Latest Pour Date (as of 4/25/11)	Time Since Last Pour
A	Full	Completely Full	N/A	N/A	N/A
B	Empty	Empty	N/A	N/A	N/A
C	15.5	No Future Additions Currently Planned	I & M	5/2003	8 years
D	23.75	No Future Additions Currently Planned	I & M	2/7/2009	2 years, 3 months
E	21	No Future Additions Currently Planned	I & M	12/21/2007	3 years, 4 months
F	22.75	No Clean Cap	Process	01/16/2011	3 months
G	21.5	No Future Additions Currently Planned	I & M	10/2002	8 years, 7 months
H	Empty	Empty	N/A	N/A	N/A
I	13.2	No Future Additions Currently Planned	I & M	5/2003	8 years
J	19.5	Operations Mode	N/A	Operations Mode	N/A
K	23.5	No Future Additions Currently Planned	I & M	3/4/2010	1 year, 1 month
L	23.25	No Future Additions Currently Planned	Process	1/18/2011	3 months

As previously discussed, the process cameras are mounted near the inside edge of Cells F and L, making the camera in Cell F on the eastern edge of the cell, and the camera in Cell L on the western edge of the cell. The I&M videos of Cells C, D, E, G, I, and K were taken via a camera inserted through 3-inch ports on the vault roof. These ports all fall along the centerline of Vault 4, with the ports for Cells C, D, and E on the eastern edge of the cell, and the ports for Cells G, I, and K on the western edge of the cell. Figure 2.1-1 presents the camera location in each cell.

Figure 2.1-1: Vault 4 Camera Locations



3.0 OBSERVATIONS

This section documents the observations gathered from the video footage taken in the cells of Vault 4. It contains stills of the video that display any evidence of shrinkage of the monolith from the vault, cracking on the grout surface, or variations in grout level. Stills of the video images show both specific observations and wide-angle views of the cells.

3.1 Saltstone Shrinkage

Shrinkage of the saltstone monolith from the vault walls and columns could provide fast-flow paths for water in the long-term predictions made by the PA. Such shrinkage was not observed in Cells C, D, E, F, G, I, or K. Figure 3.1-1 shows a representative grout-wall interface, in this case one from Cell E.

Figure 3.1-1: Cell E, East Wall Interface

Similar results were seen for the column-grout interfaces, shown in Figure 3.1-2 for a column in Cell G.

Figure 3.1-2: Cell G, Column-Grout Interface

Cell F was the only observed cell without a layer of clean grout over the saltstone. Due to exposure concerns, this cell was observed using the in-place process camera, which does not produce images with the level of quality produced by the I&M cameras. Based on the images obtained, there was no evidence of shrinkage in Cell F.

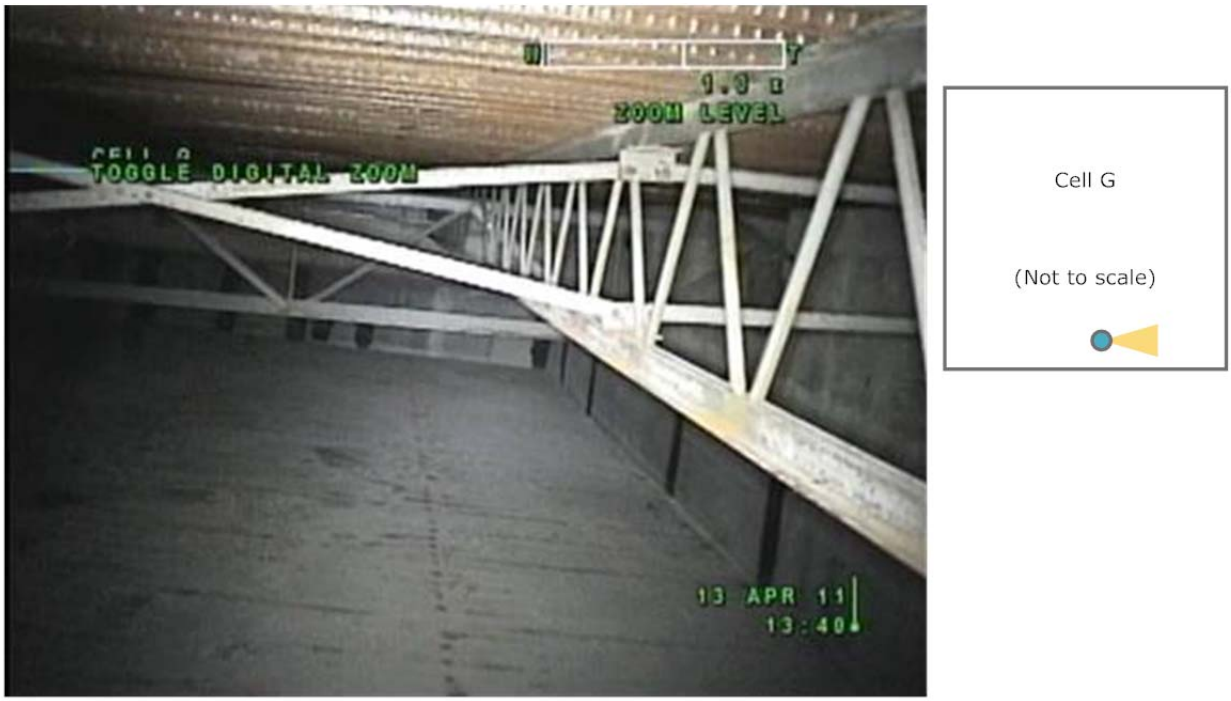
The only observed instance of shrinkage was in Cell L, which evidenced a small void space between the saltstone monolith and a section of the cell wall. Figure 3.1-3 shows a video still of the observed shrinkage in Cell L. The depth and width of this void space is not known. The observed length of the shrinkage between the wall and grout was approximately 10-feet.

Figure 3.1-3: Cell L, West Wall Interface

3.2 Saltstone Surface Cracking

Degradation of the saltstone monolith is a matter of importance for PA modeling efforts. Improved understanding of degradation mechanisms, including cracking, provides insights that will inform PA modeling assumptions. This inspection could only inspect for surface cracking. Cells E, F, and G showed no evidence of surface cracking in this inspection. Cell F was the only inspected cell without an operational layer of clean grout covering the saltstone. Figure 3.2-1 shows a wide-angle view of Cell G.

Figure 3.2-1: Cell G, Wide Angle View



Cells C, D, I, K, and L all show varying evidence and degrees of surface cracking, with Cell K being the most apparent and Cells C, D, I, and L merely evidencing a few white lines on the surface of the grout. All surface cracks observed were in the operational clean layer of grout covering the saltstone surface. The depth and thickness of these cracks is not known. Figures 3.2-2 through 3.2-4 show the cracks observed in Cell K.

Figure 3.2-2: Cell K, West Wall Interface

Figure 3.2-3 shows two "pigs" used to remove grout from transfer lines during processing. Each pig is approximately 3 inches in diameter.

Figure 3.2-3: Cell K, Grout Surface

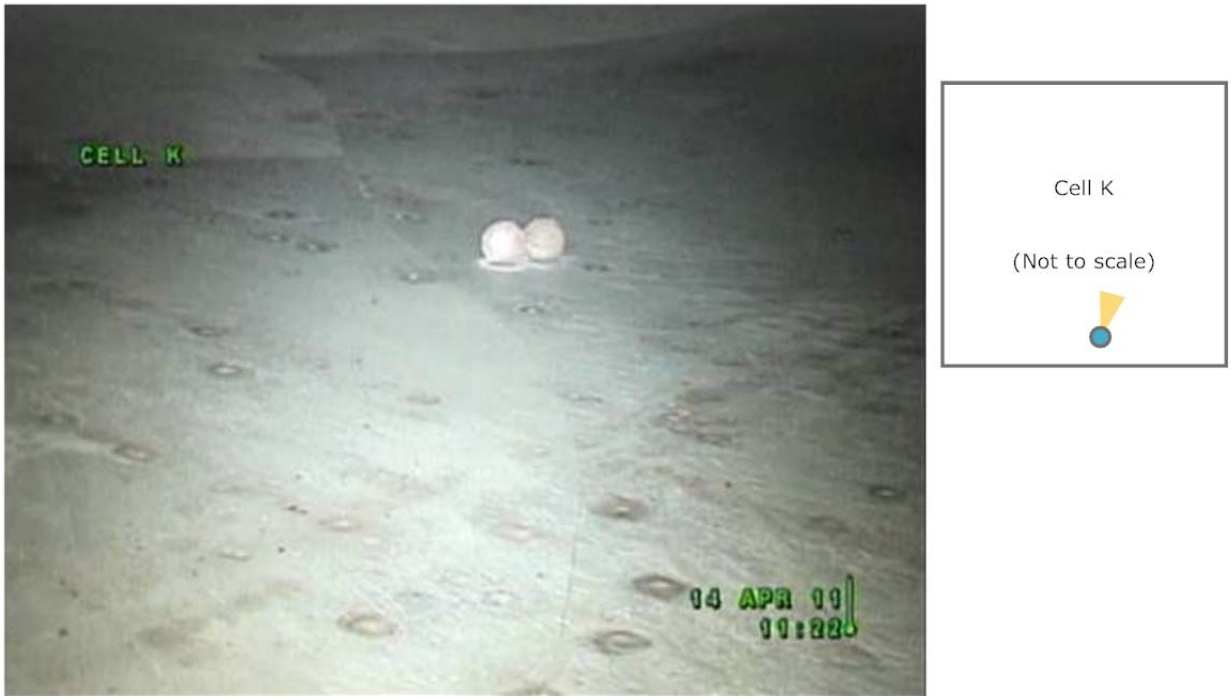


Figure 3.2-4: Cell K, West Wall Grout Surface

Cell D also evidenced some minor indications of surface cracking, as shown in Figure 3.2-5. Evidence of surface cracking in Cell D was much less pronounced than observed in Cell K.

Figure 3.2-5: Cell D, Grout Surface

Cells C, I, and L were less conclusive in evidence of surface cracking than Cells D or K. Cells C, I, and L all show thin white lines in the grout, but video limitations such as resolution and focus made precise characterization difficult. Video stills showing this evidence from Cells C, I, and L are shown in Figure 3.2-6 through Figure 3.2-8.

Figure 3.2-6: Cell C, Grout Surface

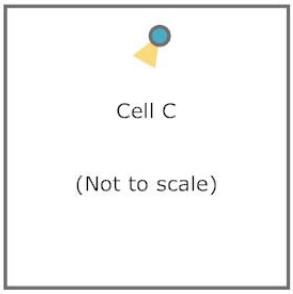


Figure 3.2-7: Cell I, Grout Surface

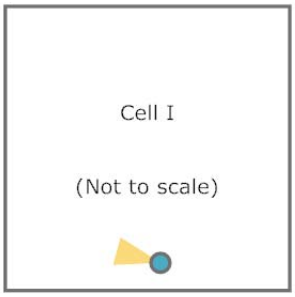


Figure 3.2-8: Cell L, Grout Surface

Cells E, F, and G showed no evidence of surface cracking in this inspection, although a previous inspection did document cracks in Cell G. [SRNL-ESB-2008-00017] No surface cracking was observed in Cell F, the only cell without an operational layer of clean grout covering the saltstone.

3.3 Grout Level

The grout surface was relatively uniform overall. Variations of less than 3 inches in shallow "bumps" and "dips" were common, but only one larger variation was visible. This dip appears in Cell I, and seems to be below the port where the grout was added to the vault, which would account for the level variation. Figure 3.3-1 is a video still from Cell I, showing the dip at the base of a column. The column shown is 10 inches in diameter, which corresponds to an estimated height variation of approximately 10 inches and a diameter of approximately 2.5 feet.

Figure 3.3-1: Cell I, Grout Surface Variation

Figures 3.3-2 through 3.3-4 show examples of wide-angle views from Cells C, E, and G, which show only minor variation and provide representative examples of the other cells.

Figure 3.3-2: Cell C, Grout Surface Level

Figure 3.3-3: Cell E, Grout Surface Level

Figure 3.3-4: Cell G, Grout Surface Level

4.0 CONCLUSIONS

The overall condition of each of the surveyed cells is summarized in Table 4.0-1. This table provides an overview of the conditions visible within the limitations of vantage and camera limitations. In this table, "None" refers to cells where the condition was definitely not observed. "Minor" refers to either inconclusive evidence (in the case of surface cracking) or level variations of less than 3-inches. "Definite" refers to a condition that has been conclusively observed and documented via video stills, or a level variation greater than 3-inches.

Table 4.0-1: Surveyed Cell Conditions

Surveyed Cell	Evidence of Surface Cracking	Evidence of Shrinkage	Evidence of Level Variation
C	Minor	None	Minor
D	Definite	None	None
E	None	None	Minor
F	None	None	None
G	None[1]	None	None
I	Minor	None	Definite
K	Definite	None	None
L	Minor	Definite	None

[1] Previous documentation does show evidence of cracks in Cell G. [SRNL-ESB-2008-00017]

Despite the fact that the surveyed cells evidenced small cracks in the surface, the overall saltstone monolith seems to be intact. The surface cracks observed did not seem to penetrate deeply, some of them only appearing as thin white lines. The shrinkage appearing in Cell L seems to be localized to a single area. The overall grout level seems very even, spreading out well over the entire cell except for the dip in Cell I produced beneath the port where grout was introduced to the cell.

5.0 REFERENCES

ESH-FSS-9000373, Odum, J. V., *Naval Fuel Material Facility (FMF) Settlement Agreement 89-06-SW, Item No. 3 Final Disposal of Saltcrete Drums,* Savannah River Site, Aiken, SC, June 20, 1990.

SRNL-ESB-2008-00017, Dixon, K. L., *Video Survey of Saltstone Vault 4, Cell G,* Savannah River Site, Aiken, SC, Rev. 0, April 25, 2008.

SRR-CWDA-2009-00017, *Performance Assessment for the Saltstone Disposal Facility at the Savannah River Site,* Savannah River Site, Aiken, SC, Rev. 0, October 29, 2009.

SRR-CWDA-2011-00018, *Official Transcript of Proceedings Nuclear Regulatory Commission Public Meeting Saltstone Disposal Facility,* Aiken, SC, January 27, 2011.

SRR-CWDA-2011-00097, Smith, F. M., *Vault 4, Cells B and H Drainwater Piping Anchor Bolt Inspection Summary,* Savannah River Site, Aiken, SC, Rev. 0, July 19, 2011.