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9W-12W, 8H and 10H Cell, Rack Pan, and Air Tunnel Inspections For the Safe Deactivation NCSE

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1.0 Abstract

The cell, rack pan, Warm Canyon Air Tunnel (WCAT) and Hot Canyon Air Tunnel (HCAT) inspections did not reveal significant deposits or accumulation of fissile material. Nor were there any depressions, except the sumps, that exceeded the limits of 2” x 6” in 9W-12W or 20” x 35” in 8H or 10H. After filling the sumps and isolating the liquid sources, the cells, rack pans, and air tunnels meet the requirements for criticality safety as described in the NCSE.

2.0 Introduction

The F-Canyon Deactivation Nuclear Criticality Safety Evaluation (NCSE, ref. 1) requires 9W, 10W, 11W, and 12W, 8H, and 10H canyon cells and rack pans be inspected, using a color camera/video to detect plutonium deposits and assess floor conditions by a minimum of two qualified personnel. The inspection requirements for 9W-12W cells are to confirm that any floor depression does not exceed 2” (depth) x 6” (diameter) and a large amount of plutonium nitrate (>70kg), which could be dissolved in water and cause a criticality, is not left in these cells. The inspection of the 9W-12W rack pans is to ensure than a large amount of plutonium nitrate (>200 kg) is not left in the rack pans. The requirements for 8H and 10H cells are that the inspections confirm that sump and any floor depressions/fissile deposits or accumulations do not exceed 20” depth x 35” diameter and there are no large plutonium nitrate/uranium deposits (>20” in depth), remaining on the cell floor. The rack pan inspection of 8H and 10H is to detect accumulation of plutonium nitrate/uranium deposits and assess the pan conditions. Only inspection of accessible areas is required; moving the equipment to look underneath is not required per the NCSE.

The NCSE also requires the most recent photographs and/or video tapes of the Hot and Warm Canyon Air Tunnel (CAT) Inspections be reviewed and compared with past records to identify any changes and assess the floor conditions. The review will ensure large quantities of plutonium nitrate (> 70 kg) are not left in the WCAT and depressions/geometrically unfavorable regions greater than 2” deep by 6” (diameter) in the WCAT sections 9-12 or greater than 20” deep by 35” (diameter) in the HCAT will be identified.

The purpose of this memorandum is to document the conditions that were found in the cells and air tunnels upon inspection and to demonstrate that these meet with the NCSE requirements.

3.0 Approach

Color cameras were installed on the cranes and color monitors installed in the crane control room. The cameras and monitors were tested using colored paper in the crane maintenance areas to ensure color images were observable in the crane control room. The sodium vapor lights installed on the cranes prevented good color resolution. In the canyon, the low light situation further degraded the ability to discern color, such that the images were more sepia in nature.

Addition of a white light source on one of the monorail hooks somewhat improved the color perception and definitely improved the detail and contrast for the inspection. The color cameras did not provide the crispness of detail that the black and white cameras provided.

A tool (depth gauge), developed to measure the depth and diameter of any puddles remaining in the cells, was constructed of a 2” ring of 5” SS pipe with a crosspiece on top made of 6” lengths of metal rod. This depth gauge was attached to a bail so that it could be lowered by the crane into the cell and be placed in the puddle. If the liquid in the puddle covered the 2” ring, then it was deeper than 2” and if the puddle extended beyond the crosspiece, then it was larger than 6” in diameter. All puddles observed were greater than 6” in diameter, but less than 2” deep.

4.0 Results

WSMS Criticality Safety Engineering and Closure Business Unit Engineering inspected the cells, rack pans, and viewed the video tapes of the Canyon Air Tunnels. No large deposits of plutonium or plutonium/uranium were observed in any of the cells. The floors of warm canyon cells 9W-12W were flooded with water, the sump jetted, and standing puddles were measured for depth and diameter; none of the puddles/depressions exceeded 2” in depth (except the sumps), though all were greater than 6” in diameter. No plutonium nitrate deposits exceeding 70 kg in the Warm Canyon Cells or WCAT or deposits exceeding 200 kg in the rack pan were noted. No depressions or deposits greater than 20” in depth, except the sumps, were observed in sections 8H and 10H cells, HCAT or the rack pan, nor was any deposit containing greater than 200 kg of plutonium nitrate/uranyl nitrate observed in the rack pan. No unusual or suspicious colors were observed with the color cameras and monitors. After filling the sumps with concrete, the cells and rack pans meet the requirements to ensure criticality safe deactivation of the F-Canyon.

Engineering and Criticality Safety review of the Hot and Warm Canyon Air Tunnel 2001 and 2003 videos did not reveal any significant or unusual changes between the years viewed. The walls of the air tunnels (particularly those on the process side) were corroded, the paint was peeled and peeling off, aggregate exposed and etched out, and sand deposited to the floor, especially in the sections where evaporators were operated. Though large portions of the floors in both tunnels were covered with sand, aggregate, and process solution residues and deposits, liquid could flow between sections, allowing for the formation of only shallow pools. In the WCAT, no depressions or dams that would allow liquid to pool to 2” deep or greater with a diameter of 6” or greater were noted. The HCAT did not have any areas of unfavorable geometry (depressions greater than 20” deep by greater than 35” in diameter). Dark, blackish deposits, most likely plutonium oxide mixed with the sand, were noted in sections 9-12W in the WCAT. It was determined from the visual inspection of the recent video and comparison to previous cell inspection videos and pictures that a large amount of plutonium nitrate (> 70 kg) that could be dissolved in water and cause a criticality was not left in the WCAT.

5.0 Discussion

5.1 Nuclear Criticality Safety Evaluation (NCSE)

The NCSE provides a technical basis and guidance for the safe deactivation of 221-F. Attaining those conditions set forth upon deactivation will ensure a criticality accident in F-Canyon is incredible. The scenarios concerning potential plutonium accumulations, potential liquid (water) sources to the canyon, the quantities of fissile material and conditions favorable and unfavorable for criticality are discussed in the NCSE. The primary concern is the possibility of a criticality due to moderation (of neutrons by water) of plutonium deposits, specifically soluble plutonium nitrate. Moderated plutonium nitrate is safe for an infinite slab geometry less than 2” deep (any diameter) or for an infinite cylinder geometry less than 6” diameter. Therefore, as long as the depth of any liquid that is potentially accumulated in the cell, rack pan, or CAT is less than 2” deep, any amount of plutonium is safe. The 2” limit was applied to the Warm Canyon cells and WCAT. Because depleted uranium was processed in the Hot Canyon with the plutonium, the relative enrichment of the material in the sumps was considered, resulting in 8H and 10H being the only cells of concern. Using an equivalent ^{235}U enrichment of 2.5 wt. %, the limits for infinite slab thickness and/or infinite cylinder geometry were determined to be a maximum of 20” deep or 35” diameter. Therefore, for Hot Canyon sections 8 and 10 and Warm Canyon sections 9-12, the sumps and areas of unfavorable geometry must be eliminated (by filling with concrete).

The maximum safe mass of plutonium nitrate was determined with consideration of the following: the geometry of the cell floor (sloped at 3/8” per foot), the rack pan (relatively flat) and the CAT floor (no physical barriers dividing sections, nearly flat with a slight slope toward a centrally located drain in each section), and the volume of liquid (water) to exceed 2” in depth for the section. The plutonium nitrate is modeled as a homogenous solution and, subsequently, as the thickness in the infinite slab model increases, the amount of plutonium nitrate to achieve a critical solution concentration decreases. The result of the modeling is that, for the Warm Canyon cell floor and WCAT floor, a minimum of 70 kg of plutonium nitrate or 200 kg, for the rack pan, would have to be uniformly dissolved in water for a criticality to be possible. Once the sump and geometrically unfavorable floor depressions are eliminated and because the depleted uranium poisoning of the plutonium is credited in Hot Canyon sections 8H and 10H cells, rack pan, and air tunnel, several hundred kilograms of plutonium nitrate/uranyl nitrate would be required for a criticality. Therefore, Sections 8H and 10H inspections will ensure there are no deposits of plutonium nitrate/uranyl nitrate exceeding 20” in depth remaining on the cell or HCAT floors or in the rack pan.

5.2 General Cell and Rack Pan Conditions

The Warm Canyon floors were generally in good condition, the finish smooth, not exhibiting much erosion and/or corrosion, especially on the cold (east) wall. The rack pans had some staining and some deposits, but the deposits were shallow as compared with a lampshade gasket. No depressions or dams from debris were noted in the Warm Canyon rack pan that would cause any pooling of water, specifically, there was not any evidence of geometrically unfavorable regions (greater than 2” deep). In every section, below at least one of the four rack pan drains, typically near the expansion loop table, the canyon wall showed significant corrosion and erosion. A gully, some more severe than others, had been eroded in the wall depositing concrete, sand, and aggregate on the cell floor. In some case, under the rack pan drain, the re-bar in the wall is exposed near the top of the wall. Fallen gaskets, dust covers, and dummy connectors are sprinkled across the floors and rack pans. There were some deposits in the rack pans. Typically, the tops of the tanks were reasonably clean, no significant accumulations or deposits. The area around the overflow pipe on each tank was inspected, and no evidence of fissile material accumulation was noted.

The Warm Canyon cell floors were flooded from each floor flush valve. One to two thousand pounds of water from the north floor flush was sprayed, each of the 4 spray nozzles and the flow path across the floor observed, the sump jetted, and flow from the cell into the sump observed. This process was repeated with the south floor flush system. The sumps in general, were in good physical shape. The sand/concrete deposits next to the west wall, under the rack pan drains, prohibited thorough flushing of the floor in some cells. However, after flooding the cell, the liquid usually drained quickly to the sump, leaving few puddles. After the liquid in the sumps was jetted, any standing water was observed and measured for depth and breadth.
Typically the northwest corner of the Warm Canyon cell, near the trunion guide and cell curb, showed a black deposit on the floor and on top of the curb, most likely due to material from the expansion joints. The NW corners of the cells, specifically the small area between the trunion guide and the curb, did not flush well.

The Hot Canyon (HC) cells, 8H and 10H, were in significantly worse shape than the Warm Canyon cells. Both HC cells were congested with equipment making it difficult to see the floor. The cold wall and floor were in relatively good shape, though chunks of concrete and debris from the cell covers and cell pedestals has fallen to the cell floor. The hot (east) wall was severely corroded and eroded under the rack pan drains with significant re-bar exposure, as was the hot (west) wall in the warm canyon. The cells and tops of the tanks were littered with gaskets, dummies, dust covers, and debris from the cell covers. The rack pans had yellow, crystallized uranium deposits. The area near the expansion loop tables were littered with gaskets. There were no deposits or depression observed that exceeded the 20” in depth limit imposed by the NCSE.

Damage to the wall underneath the rack pan drains was severe enough there were gaps in the concrete behind the plate covering the air tunnel exhaust register. As the concrete degradation progressed, the sand, cement, and aggregate, as well as liquid, would wash into the canyon air tunnel.

5.3 9W Specifics

Section 9W contains vessels 9.5, 9.6, 9.7, and 9.8. Vessel 9.5 received the 2BP stream from 2BP decanter 10.8. For about the last 15 years, it was used as the 2BP n-paraffin wash tank. Over its history, Tank 9.6 has been used to receive Pu drops from FB-Line, 1BP from 1st cycle and, for roughly the last 15 years, 2BP from 9.5. Tank 9.7 was used as an FB-Line waste receipt tank. And tank 9.8 was the 2BP tank for transferring to FB-line.

Overall, 9W was the cleanest and least damaged cell and rack pan. Some corrosion of the west wall, along with some sand and aggregate, was located under nozzles 100-60(9W), the 9.7 discharge jet, and roughly under nozzles 46-48(9W) [picture 9W-1]. Both corrosion paths seemed to have originated from the rack pan drain. Some deposits were observed in the NW corner next to the wall between the curb and the trunion guide and some stains from leaks were noted on the west wall appearing to originate near nozzles 43-44(9W). Some indications of leaks were observed on the wall below nozzle 40(9W) [picture 9W-3], a transfer route to FB-line; no deposit was noted on the floor. The top of tank 9.8 looked to have a smattering of a light colored crystalline deposit.

The rack pan was clean except for roughly a 2’x2’ area north of the expansion loop table under lanes H-J [picture 9W-2]. This area has some black staining and some light-colored deposits. Generally solutions transferred in the far lanes like H and J are waste solutions such as spent solvent washes, 1DW and sump solutions.

Floor flush spray coverage was good from each of the 8 nozzles. Drainage across the floor was good with the entire floor being flooded. The sump was then jetted and the water drained rapidly to the sump. Little standing water was observed after jetting 9W sump [pictures 9W-5 and -6]. However, the NW corner, where the trunion guide and curb are inches apart did not flush well. The sump receipt tank received 4 grams of plutonium from the 9W floor flush on 4/19/04.

No significant deposits/accumulations were noted in the cell or rack pan. No depressions or dammed area retaining water were observed in 9W. The sump was filled with concrete on May 25, 2004 [picture “filled sump” 9W].

5.4 10W Specifics

Section 10W contains vessels 10.5, 10.6M, and 10.8. Vessel 10.5 was used as the decanter for the 2BW solvent stream from 2nd Pu cycle 2B-Bank 10.6M prior to transferring the solvent to washer 12.8. Vessel 10.6M was the 2B-Bank type-A mixer-settler used for stripping and concentrating the Pu from the 2AP solvent stream into the 2BX/2BP aqueous stream. Vessel 10.8 was a modified tank decanter used to decant any entrained organic from the 2BP stream prior to transfer to vessel 9.5.

Most of the 10W cell floor was relatively deposit-free with the exception of two large, distinctive deposits of sand/concrete [pictures 10W-1, -2, and -3] and, possibly, plutonium on the floor in the northwest quadrant of the cell [picture 10W-4]. The deposits were located under nozzles 59(10W) and 48(10W) where solution drained down the walls from the rack pan drains. The concrete was deeply corroded and eroded, exposing sections of re-bar. There were noticeable stains on the wall and deposits near and around nozzles 47, 48, and 49(10W); these nozzles were used for 2BP transfers (up to 3 g Pu/liter). An unsuccessful attempt was made to sample the concrete deposits using a scooping device that H-Canyon uses to sample their floor deposits. The deposit appeared to be hardened and solid, though some of the aggregate on the top of the deposit was moveable.

A small amount of corrosion was noted on the floor under sample box drain (under nozzle 23(10W)). There was a scattering of the usual canyon debris: lampshade gaskets, dummied, dust covers, crane hooks, and concrete chunks.

Yellowish, white deposits, somewhat crystalline in appearance, were observed south of the expansion loop table [picture 10W-5]. The deposit(s) covered a triangular area approximately 6 feet down the east side of the rack pan by 8 feet south of the expansion loop table. The same type of deposit was noted on top of the west side of the table where routes that usually handled waste streams (sumps, washes and 2AW to waste) are located. It would seem the deposits are of the same origin. Close to the middle of the rack pan was a pail on its side [picture 10W-5]. A light colored stain/deposit was noted south of the pail near nozzle 68(10W), estimated to cover an area of about 18”x18”, and thought to be from leaks when making sump transfers. As noted earlier, deposits were noted around nozzles 48 and 49(10W), which were used for 2BP transfers. The deposits were estimated to be less than 2” deep and did not create regions of unfavorable geometry. They did not show evidence of containing significant quantities of plutonium nitrate (black solids) mixed in the solids matrix.

Floor flush spray coverage was good from each of the 8 nozzles. Drainage across the floor was good with the entire floor being flooded, except for the sand/concrete deposits against the west wall of modules 10.7 and 10.8. The top portion of the deposits remained dry. The dry area in module 10.7 was estimated to be 2’ x 8’ and, in 10.8, 2’x2’. The sump was then jetted and the water drained rapidly to the sump. A puddle of water was observed in the NW corner of the cell after jetting 10W sump. The depth gauge showed the depth did not exceed 2 inches [picture 10W-6]. As seen in 9W, the NW corner of 10W, where the trunion guide and curb are inches apart did not get flushed well [picture 10W-4]. Black deposits noted on the curb surface were most likely from the degradation of the mastic expansion joint filler. The sump receipt tank received 30 grams of plutonium from the 10W floor flush on 4/23/04.

Based on engineering judgment, the deposits/accumulations noted in the cell and rack pan were determined to contain much less than 70 kilograms of plutonium nitrate maximum per the NCSE. No depressions or dammed area retaining water greater than 2 inches deep were observed in 10W. The sump was filled with concrete on June 14, 2004 [picture “filled sump” 10W].

5.5 11W Specifics

Section 11W contains vessels 11.5M, 11.7, and 11.8. Vessel 11.5, a type A-modified mixer-settler, was the Second Plutonium Cycle 2A-bank. Plutonium solution (up to approximately 0.6 g/l) was fed to the 2A-bank from 2AF feed tank 11.8, and extracted into a solvent stream to be fed to the 2B-bank, 10.6M. Tank 11.7 was the 2AW decanter: the 2A-bank aqueous waste stream (2AW) drained from the bank to 11.7 to be decanted from entrained organic prior to transfer to waste evaporation. The 2nd Pu cycle feed tank was Tank 11.8; though the 2AF was usually in-specifications prior being transferred to 11.8, it could be chemically adjusted to meet specifications in 11.8.

The cell floor had more debris scattered across it in the form of concrete chunks and sand than the previous cells [pictures 11W-1, -3, and -4], probably because the solutions in this cell consisted of 4M nitric acid versus the less than 1M acid processed in 9W and 10W. It also had its share of gaskets, dust covers, and dummies. There were two (2) areas on the west wall under the rack pan drains that were corroded and eroded, each resulting in a concrete/sand deposit west of 11.7 and 11.8 [pictures 11W-2, -3, and -5]. Neither of these areas was as severe as that seen in 10W, e. g. no re-bar was exposed, the channeling was not as deep, and the deposits did not appear to be as extensive. Tank 11.7 looked to be dusty on top. Tank 11.8 was covered with grease and oil from the agitator lube line [pictures 11W-2].

The north flush system had good flow and coverage from spray nozzles on the east side of the cell and across the floor. However, next to the west wall of the cell, three areas did not flood with the flush water. They were the following areas: 1) an area measuring approximately 3' (on the west wall) by 7' (on the north curb) containing dark colored material (probably lube oil mixed with dirt and concrete) and concrete chunks, 2) an area measuring approximately 1' wide running along the west wall between the 11.8 and 11.7 trunion guides from what appears to be sediment due to the concrete degradation, and 3) a deposit from the wall corrosion (concrete, sand, aggregate) measuring about 2.5' out from the west wall by 3-4' along the west wall. The south floor flush coverage and flow was good in all parts of the cell. The sump receipt tank received 8.5 grams of plutonium from the 11W floor flush 4/27/04.

After the sump flush water was allowed to drain and was jetted from the sump, a small puddle remained north of the 11.7 trunion guide and west of tank 11.8. Its depth was less than 2" as measured by the depth gage [pictures 11W-6].

The 11W rack pan contained no significant deposits, though there was some of the same crystallization around high vertical nozzles associated with the sump jumpers. The rack pan contained the usual gasket debris.

There were no indications of large deposits of plutonium nitrate (greater than 70 kg.) in the cell or the rack pan. No depressions or dammed areas sustained puddles greater than 2" deep, other than the sump. The liquid sources have been isolated. The sump was filled with concrete on 6/28/04 [picture "filled sump" 11W].

5.6 12W Specifics

Section 12W contains tanks 12.5, 12.6, and solvent washer 12.8. A pump stand occupies module 12.7. Tank 12.6 received 0.3-1.0 g Pu/liter aqueous solution as 1BP from 1st cycle. The 1BP was transferred from tank 12.6 to tank 12.5 and the valence and acidity adjusted to Pu(IV) in 4M acid using 50% acid and 30% nitrite. The adjusted 1BP was transferred from tank 12.5 to tank 11.8 from where it was fed as 2AF to 2nd Pu cycle. Over the history of the cell, plutonium solutions from tank 9.6 (B-line solutions, 1BP, and 2BP) were transferred to tank 12.5 for adjustment to be fed or recycled to 2nd Pu cycle for additional decontamination and concentration. Tank 12.8 was the carbonate washer for the 2nd Pu cycle solvent 2BW. The solvent (2BW) from the cycle was transferred to washer 12.8 via tank 10.5. The solvent was contacted with sodium carbonate solutions (2-8 wt. %) to be washed of metal contaminates (Pu, and in later years, U) and degradation products (DBP) in the solvent. The solvent was transferred from Washer 12.8 to segregated solvent tank 905 in Outside Facilities (OF-F).

The cell floor in 12W had the most trash and debris of the four Warm Canyon cells and several areas of the walls were corroded [pictures 12W-1, -2, and -3]. This cell was the only one with the concrete defaced on the cold wall. It looked as though acid had been sprayed on the cold wall east of vessel 12.5, as the erosion started mid-wall and appeared wider at the top than the bottom. The walls under each of the rack pan drains exhibited corrosion and erosion, though no exposed re-bar was noted. The floor contained a scattered assortment of gaskets, dust covers, dummies, a hook, nuts, concrete chunks, etc. The added equipment litter is most likely due to equipment handling and storage in the pump storage rack in module 12.7. The floor also seemed dustier and grimier than the previous cells, possibly due to a combination of corrosion caused by the higher acidities of the solutions and chemical reactions during valence adjustment, and the organic washed in washer 12.8. Over the life of the cell, tank 12.5 has eructed and overflowed several times because of uncontrolled nitrite reactions.

The floor flush flow from both sets of nozzles was good. A fair volume of water flowed evenly across the floor, however, there were noticeable dry areas that the water seemed to channel around in the middle of the cell. There were not obvious deposits of material or channels in the concrete causing the water to leave dry areas. The flush water did not saturate all of the deposits of concrete debris deposited against the hot wall. One particular area of note was the build up of concrete from the walls and the extremely corroded trunion guide in module 12.5. However, after jetting the sump, only two areas in section 12W retained water. The standing water depth in both areas, one under nozzles 48-49 (west of 12.8) and the other, on the west side between tanks 12.5 and 12.6, did not exceed the 2 inch criteria as measured by the depth gage [pictures 12W-6]. The sump receipt tank received zero (0) grams of plutonium from the 12W floor flush 4/29/04.

In the rack pan near the expansion loop table, on the table, and several of the nozzles, evidence of white, crystalline deposits were noted. The material was most likely sodium carbonate, considering the location and the solutions processed on that side of the cell. No other build-ups were noted in the rack pan [pictures 12W-4 and -5]. The usual assortment of gaskets was observed.

There were no indications of large deposits of plutonium nitrate (greater than 70 kg.) in the cell or the rack pan. No depressions or dammed areas sustained puddles greater than 2” deep, other than the sump. The liquid sources have been isolated. The sump was filled with concrete on 6/22/04 [picture “filled sump” 12W].

5.7 8H Specifics

Bi-cylindrical (bi-cell) vessels 8.1 and 8.3 are in section 8H [pictures 8H-1 through -4]. Each bi-cell vessel is 12’ across by 19’ long by 15’ tall, holds approximately 18,000 gallons, and spans two modules within the cell. Tank 8.1 was used for special nuclear material (SNM) accountability. Material (targets, slugs, miscellaneous fuels) received in the 221-F Canyon was dissolved in an acid medium (1-10M nitric acid) in the dissolvers, transferred to tank 8.1, and sampled in order to determine the amount of SNM entering the canyon. From tank 8.1, the solution was transferred to the head end tanks for treatment and subsequent processing through solvent extraction. Bi-cell 8.3 was used as the High Activity Waste (HAW) feed tank. Waste streams were collected (up to 4M nitric acid), and if necessary, diluted with water prior to feeding to HAW continuous evaporator, 9.3E.

The tanks occupy so much of the cell; it was difficult to see the floor. Large chunks of concrete were observed all over the floor, on top of the tanks, and intermingled within the nozzles [pictures 8H-1, -2, -4, -5, and -6]. Sand, aggregate, and smaller, broken pieces of concrete also covered the floor [pictures 8H-8 and -12]. Dummy connectors, dust cover, gaskets, fallen rebar, and miscellaneous tools were observed [pictures 8H-8, -11, and -12]. The cell covers and some of the cell pedestals were damaged. The cold wall exhibited some signs of corrosion under nozzles 10 and 11 [picture 8H-6]. The hot wall was scored in four areas with deep furrows as it had been corroded and eroded as the concrete washed out from under the rack pan drains; deposits were observed on the cell floor due to the sand and aggregate [pictures 8H-7 through -12].

The rack pan was dirty with deposits and abandoned equipment (gaskets, piping, flex jumpers, dummy connectors, dust covers, etc) particularly near the expansion loop table [pictures 8H-13 through -18]. The deposits either looked like some kind of fine grained sand [pictures 8H-17 and -18] or crystallized, yellow uranium [pictures 8H-14 and -15]. Most of the rack pan was covered with a dark, dusty or maybe oily, stain [picture 8H-17]. Based on engineering judgment, it was concluded that the deposits did not exceed 200 kg of plutonium nitrate.

The floor did not appear to be in such a condition as to support an evenly distributed flush, however, there were no deposits greater than 20” in depth noted. Also, there were no depressions, other than the sump, that exceeded 20” in depth. Though some suspected uranium deposits were noted in the rack pan and on tops of tanks, no deposits estimated to exceed 200 kg of plutonium nitrate/uranium were observed with the color camera.

The 8H sump has not been filled with concrete at this time.

5.8 10H Specifics

Section 10H contains the following vessels: Tank 10.1 – High Activity Waste (HAW) concentrate hold tank [picture 10H-1], 10.2 – B-Line (special and B-line) Recovery receipt tank, 10.3 – B-Line (special and B-line) Recovery receipt tank [picture 10H-2], 10.4 – centrifuge feed tank [picture 10H-3], 10.1-1K, -2K, -3K - Primary Recovery Column (PRC) [picture 10H-1], 10.1-2 – PRC eluate (product) receipt tank, and 10.2-1 – PRC spent resin receipt tank. Tank 10.1 received solutions from the concentrated HAW bottoms from HAW continuous evaporator bottoms tank 9.3BT and the PRC. The solutions, approximately 4M acid, were transferred from tank 10.1 to either acid stripping evaporator 11.3E or to waste neutralization tank 12.1 or returned to HAW feed tank 8.3 for reprocessing. The PRC was used to recover plutonium and neptunium from the waste streams. The raffinate went to tank 10.1, the product rich eluate to tank 10.1-2, and the spent resin to tank 10.2-1, when the spent anion resin was changed. Tanks 10.2 and 10.3 were primarily used as receipt tanks for the plutonium solutions of varying isotopics from FB-line recovery and occasionally served as accountability tanks; solutions from FB-Line received in tanks 10.2/10.3 were transferred to tank 11.2 to blend with dissolver solution for first cycle feed to make weapons grade plutonium or enrich the first cycle feed. Tank 10.4 was the centrifuge feed tank. Dissolver solutions were received in tank 10.4 from strike tank 12.2 and fed to the 11.1C centrifuge to clarify the solution and remove silica.

The south end of the 10H cell is filled with tanks (10.1, 10.1-2, 10.2, 10.2-1, and the PRC) so that the floor was difficult to see [picture 10H-1]. The west side of the floor (cold wall) was littered with broken pieces of concrete, as well as pieces of equipment (dummies, gaskets, dust covers, etc.) [pictures 10H-2 and -3]. The east side of the cell floor (hot wall) was filled with chunks of concrete, aggregate, and sand along with pieces of equipment [pictures 10H-5 through -10]. The west wall (hot wall) showed severe signs of corrosion at the site of the rack pan drains, eating away enough concrete that the re-bar was exposed or had dislodged and dropped to the floor [pictures 10H-6 and -7]. Some concrete pieces were observed on the tops of the tanks as well as accumulations of sand from the concrete cell covers and dried process solutions of fissile material (darker components), uranium, and concentrated waste salts [pictures 10H-1 and -4]. Shallow deposits, mostly likely waste solution salts and sludge with trace fissile material, were caked and peeling on the top of HAW concentrate tank 10.1 like dried mud [picture 10H-4]. Tanks 10.2, 10.3, and 10.4 appeared to be covered with a gritty, sandy looking layer of material (most likely concrete dust from the cell covers) and a darker, oily looking area (lube oil and dust) was on top of tank 10.4 [picture 10H-2 and -3]. Based on engineering judgment, the accumulations of fissile material did not exceed 200 kg of plutonium nitrate nor exceed 20” in depth by 35” in diameter.

The 10H rack pan had been cleared of most of the jumpers. The pan was dirty in appearance with a dark, dusty looking coating, a couple of areas with processing deposits, and abandoned equipment (gaskets, piping, a contactor motor, dummy connectors, dust covers, etc) particularly near the expansion loop table [pictures 10H-11 through 15]. Some deposits looked like some a fine grained sand [pictures 10H-13 and -15], others had a yellow color [picture 10H-14]. The largest of the deposits was next to the expansion loop table, extending across the rack pan and intermingled with abandoned gaskets and the contactor motor. The conclusion of the inspection was the deposits did not exceed 200 kg of plutonium nitrate.

The floor condition would not support an evenly distributed flush; however, there were no deposits greater than 20” in depth noted. Also, there were no depressions, other than the sump, that exceeded 20” in depth. Though some suspected uranium deposits were noted in the rack pan and on tops of tanks, no deposits estimated to exceed 200 kg of plutonium nitrate/uranium were observed with the color camera.

The 10H sump has not been filled with concrete at this time.

5.9 Hot and Warm Gang Valve Corridor Canyon Air Tunnels

Engineering and Criticality reviewed the 2001 and 2003 video tapes of the Hot and Warm Canyon Air Tunnel inspections. The videos were compared to each other and did not reveal any significant or unusual changes between these years. Large areas of the floor in each tunnel were covered with sand, aggregate, or process solution related stains and deposits. The canyon-side walls of the air tunnels were corroded, the paint peeled off, aggregate exposed, rough in texture, and sand was deposited on the floor, especially under the air ducts and in the sections where evaporators were operated. Paint was peeling and flaking on the PVV encasement opposite the canyon side of the CAT, but little concrete degradation could be observed.

The depths of the deposits were determined using the following points of reference: the height of the drain expansion loop curb (~2.5”), the height of the horizontal run of the Gang Valve Corridor floor drain legs (2’11” from the floor), and the overall slope of the floor (sloped from the expansion joints to the drain, a 2” change in elevation). The whole section would have to fill with water to be 2” deep at the 3” drain and as the distance from the drain increased, the depth of the liquid decreased. The water would then overflow to the adjacent sections, as the drain expansion loop curb (5’x 5’) does not extend from wall to wall (10’ on warm side and 9’6” on the hot side). The deposits from the sand and aggregate do not obscure the flow path from section to section in the WCAT. In the HCAT, the sand from the corroded concrete covered the floor such that the expansion loop curbs were barely discernable from 9H south. From 10H north, the walls of the air tunnel were in much better condition and the expansion loop curbs were distinct with flow paths on the east side. Therefore, the depth of the liquid that could be accumulated in the air tunnels will not exceed 2” in depth by 6” in diameter in the WCAT or 20” in depth in the HCAT.

In 1965, a chronic leak on one of the 2BP routes resulted in 7-8 kg of plutonium deposited in the WCAT; it was subsequently removed [Plutonium in Section 9W WCAT Incident- 1965 picture 10079-001]. The photographs showed the plutonium as a dark deposit; the <u>Plutonium Handbook</u> (ref. 2) reported plutonium nitrate crystals coloration as black. Dark deposits, a mixture of sand and aggregate and, possibly, some plutonium oxide or plutonium nitrate crystals were observed in WCAT. Pictures from 2001 and 2003 WCAT inspections were compared to those from the 1965 inspections before and after the plutonium incident. Based on the 1965 pictures with the known quantity of plutonium in the WCAT, it was determined that a large amount of plutonium nitrate (>70 kg) that could be dissolved in water and cause a criticality was not left in the WCAT. Refer to the Warm Canyon Air Tunnel Pictures- 2001 Inspection pictures.

In the 2001 and 2003 videos, the air tunnels were dry, for the most part. In the 2001 WCAT video, sections 13W through 16W had signs of dampness or some standing water; in the 2003 video, sections 13W, 14W, and 16W were damp or wet in the center part of the section near where the GVC floor drains entered. None of the WCAT sections were flooded with water. In the HCAT 2001video, the air tunnel was dry, but in the 2003 video, 11H, 12H, 13H, and 15H had small puddles of water usually near the center of the section and section 14H was flooded. The water in 14H was less than 20" deep. The water appeared to be from the GVC floor drains, though some may have been due to process solution leaks draining through the air ducts.

6.0 Conclusion

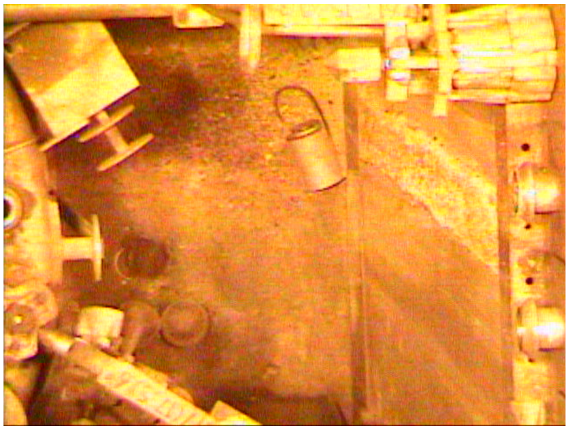
No significant deposits or accumulations of fissile material were revealed during the cell, rack pan, WCAT and HCAT inspections. No geometrically unfavorable regions either from depressions or created by debris exceeded the limits of 2" x 6" in 9W-12W or 20" x 35" in 8H or 10H, except the sumps. After filling the sumps and isolating the liquid sources, the cells, rack pans, and air tunnels meet the requirements for criticality safety as described in the NCSE. Sumps have been filled cells in 9W, 10W, 11W, and 12W. The hot canyon sumps, 8H and 10H, will be filled at a later date.

7.0 References

1. N-NCS-F-00103, Rev. 1, Nuclear Criticality Safety Evaluation: Safe Deactivation of F-Canyon (U), Washington Safety Management Solutions, Aiken, SC, June 9, 2004

2. O. J. Wick (ed.), Plutonium Handbook, A Guide to the Technology – Volumes 1 & 2, The American Nuclear Society, La Grange Park, Illinois, 1980

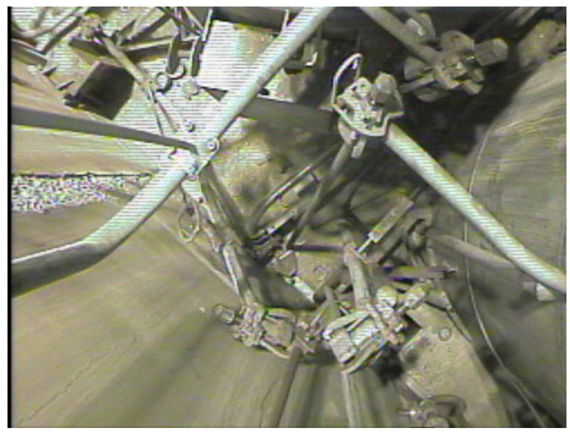
9W Snapshots



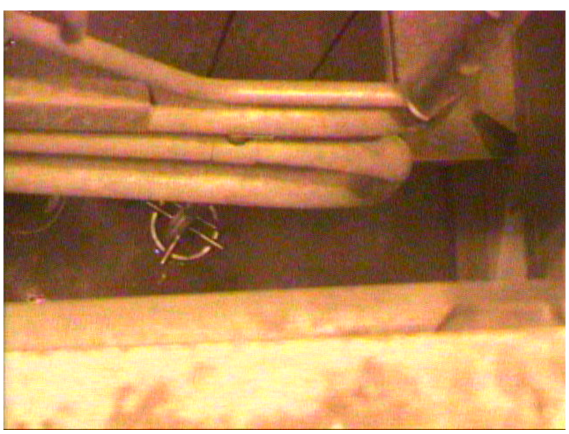
9W-1) Noz 60-100(9W) 9.7 jet

9W-2) 9W rack pan north of H-J lanes on rack table

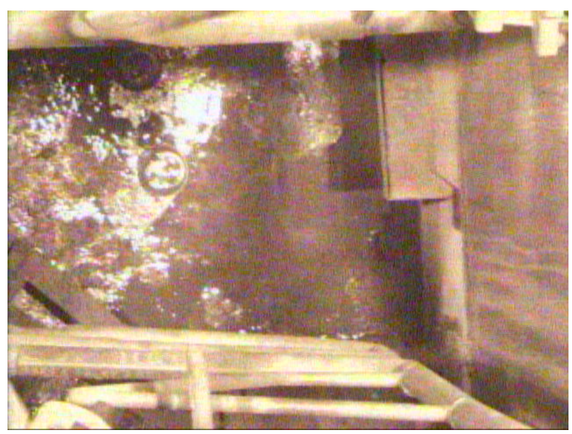
9W-3) 9W cell: South of north trunion guide under Noz 46-48 near tank 9.8



9W-4) 9W wall and floor next to 9.7, 9.6, and sump

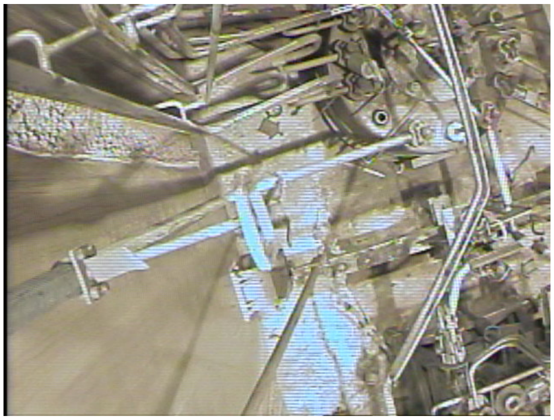


9W-5) Measuring tool sitting in puddle in northwest corner from north



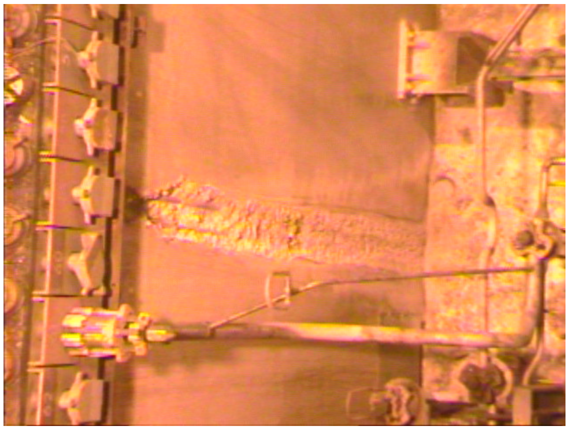
9W-6) puddle northwest corner, W of 9.8, under air exhaust

10W Snapshots

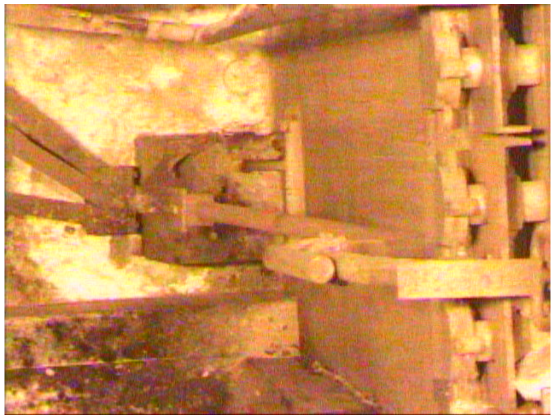


10W-1) West wall between vessels 10.8 and 10.6M

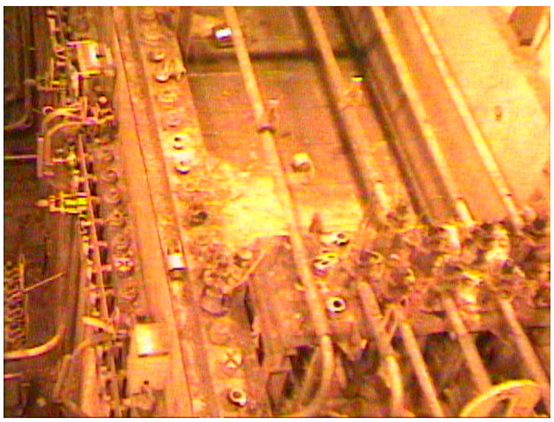
10W-2) 10W sump and 10.6M feed nozzles



10W-3) West wall corrosion under nozzle 60(10W) near 10.6M



10W-4) Nozzle 43-44(10W) trunion guide northwest corner of cell

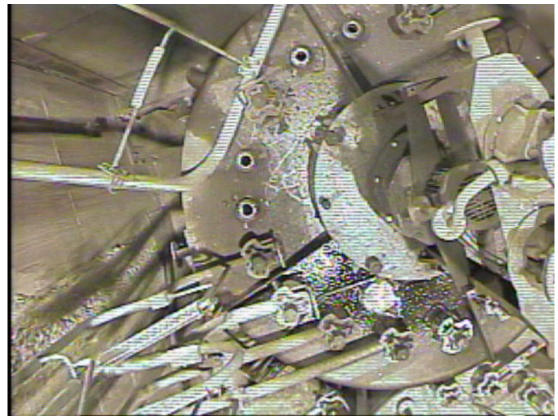


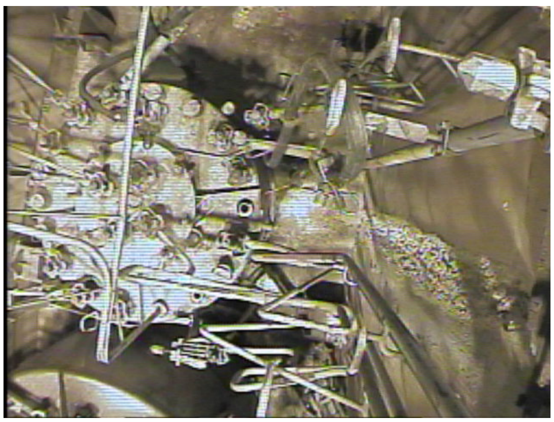
10W-5) 10W rack pan south of expansion table

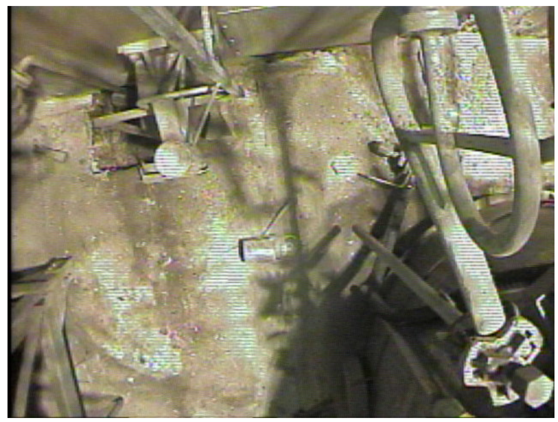
10W-6) Measuring tool in puddle on northwest corner

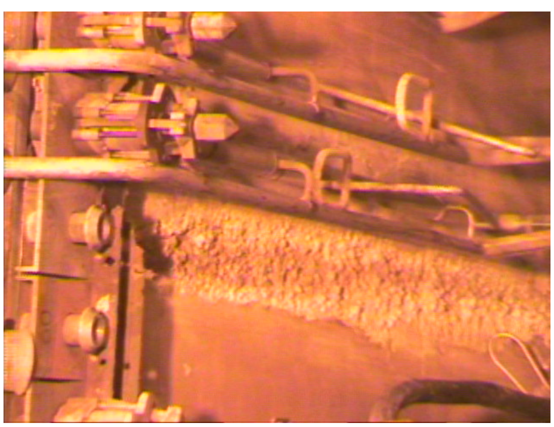
11W Snapshots

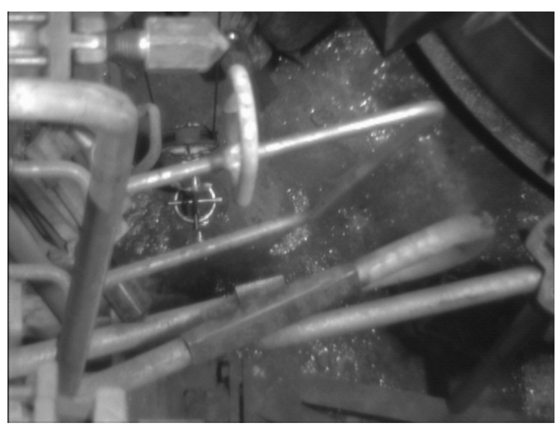

11W-1) Northwest corner by Tank 11.8


11W-2) Wall corrosion and lube oil on Tank 11.8

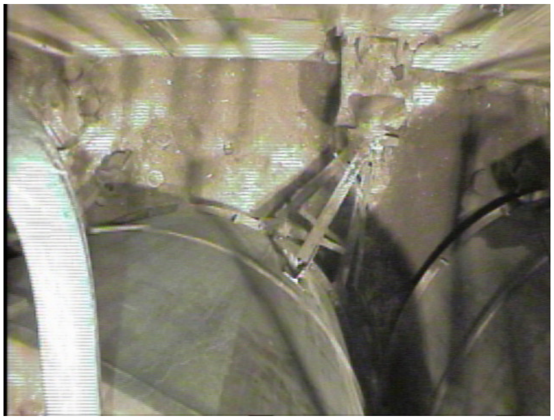

11W-3) 11.7 wall corrosion under nozzle 59(11W)


11W-4) 11W sump between Tank 11.7 overflow and 11.5M support frame

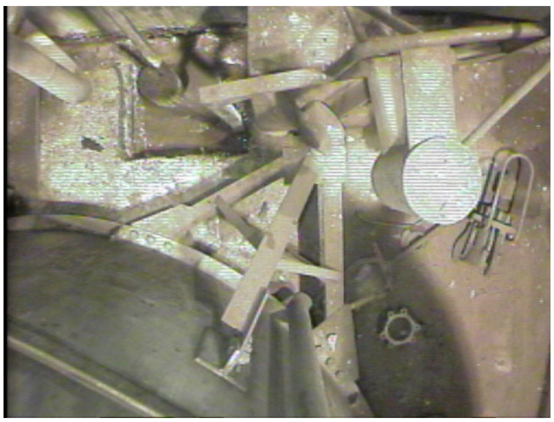

11W-5) Wall erosion under nozzle 59(11W)

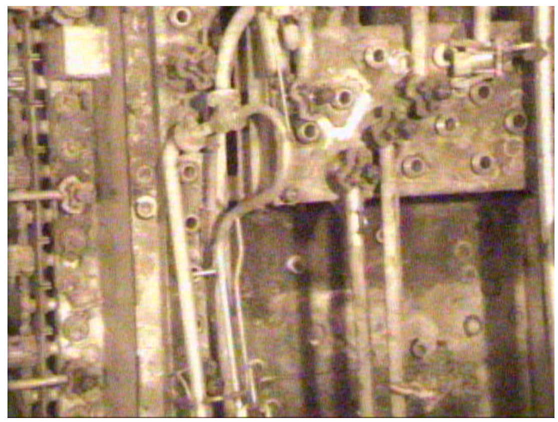

11W-6) Puddle west of Tank 11.7

12W Snapshots


12W-1) Wall and air register west of Tank 12.5


12W-2) Deposit and wall next to Tank 12.8

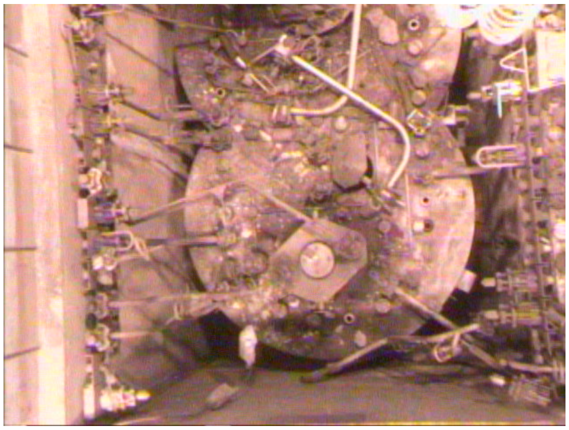

12W-3) 12W sump

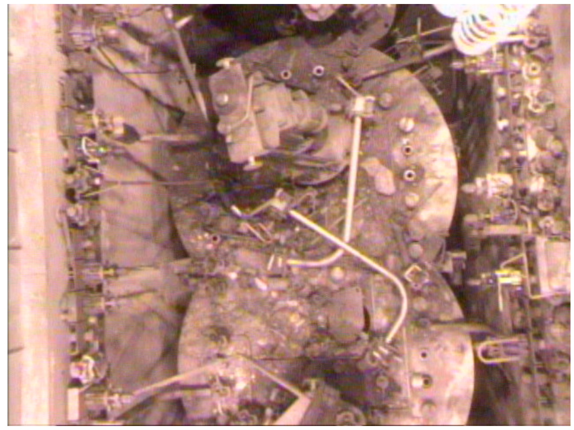

12W-4) 12W expansion loop table and rack pan

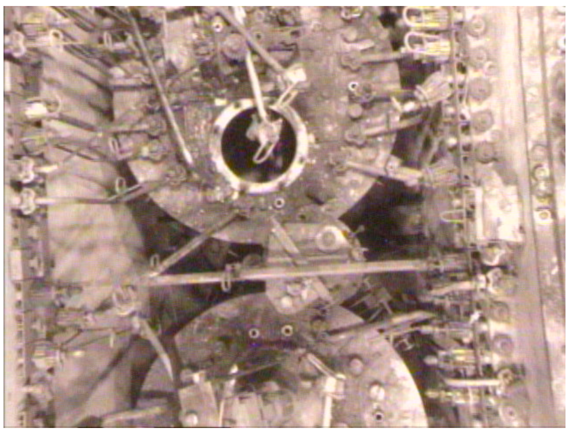

12W-5) Crystals in 12W rack pan

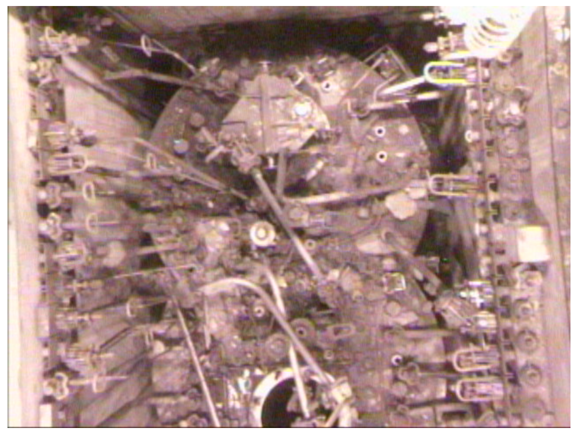

12W-6) Gauge resting in puddle

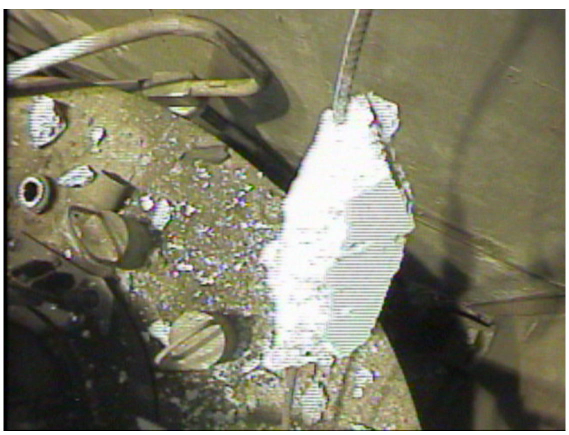
8H Snapshots (1 of 3)


8H-1) Tank 8.1, south end


8H-2) Tank 8.1

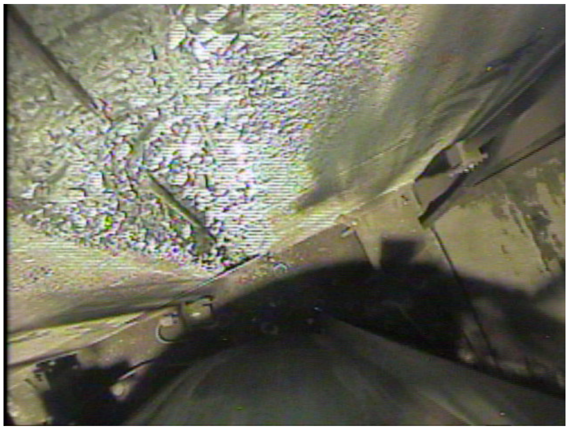

8H-3) Tanks 8.1 and 8.3 and stored agitator mid-cell

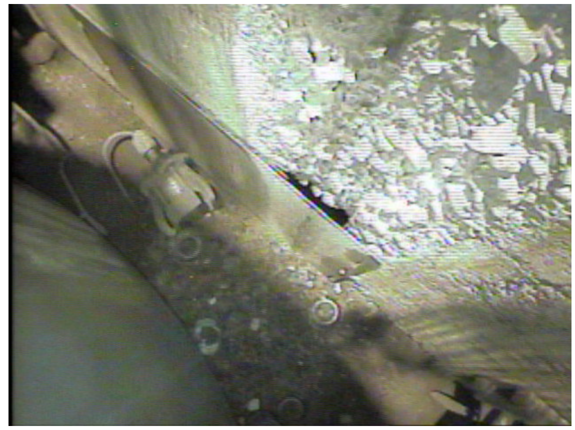

8H-4) Tank 8.3, north end

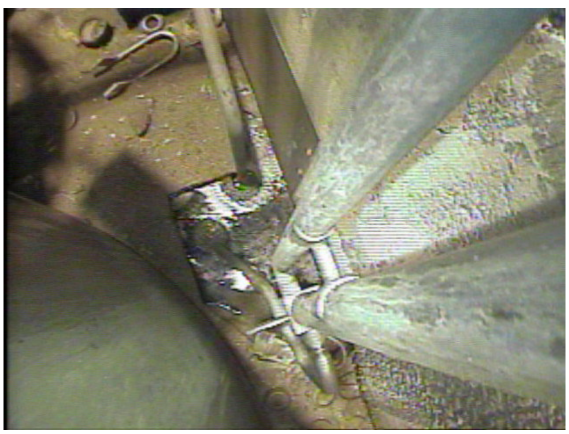

8H-5) Chunk of concrete on rebar over Tank 8.1


8H-6) Floor West of Tank 8.1 (cold wall) and module 8.2 trunion guide

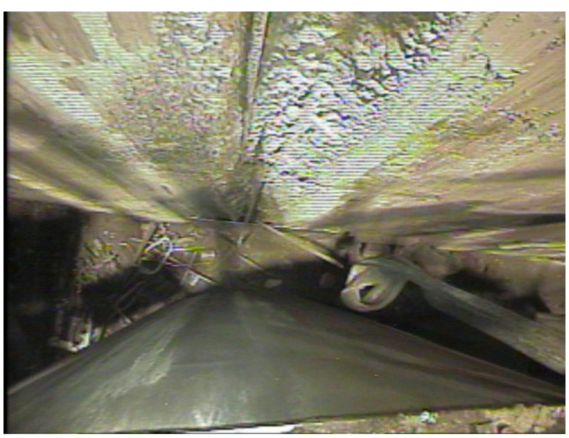
8H Snapshots (2 of 3)


8H-7) Corroded concrete under nozzle 80(8H) rack pan drain


8H-8) Corroded concrete under nozzle 80(8H) at air tunnel duct

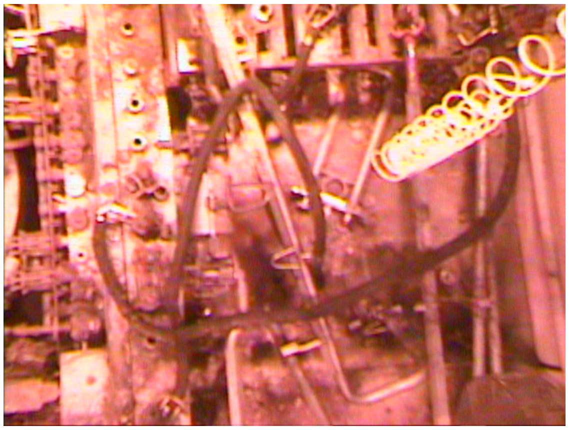

8H-9) 8H sump

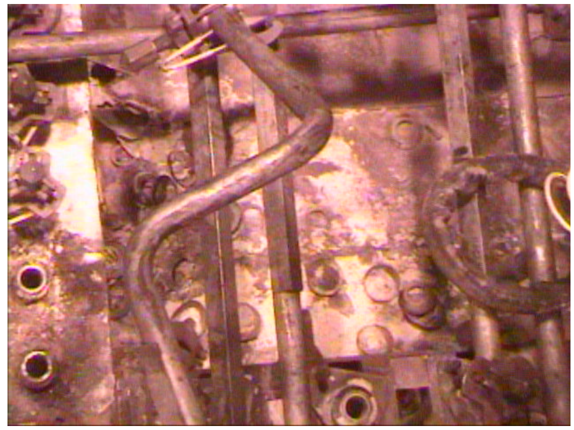

8H-10) Between 8.3 and wall under nozzle 59(8H) exposed rebar

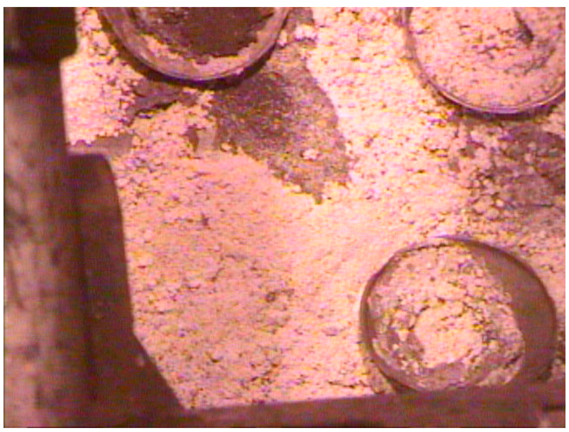

8H-11) East wall in 8.4 module under nozzle 48-49(8H)

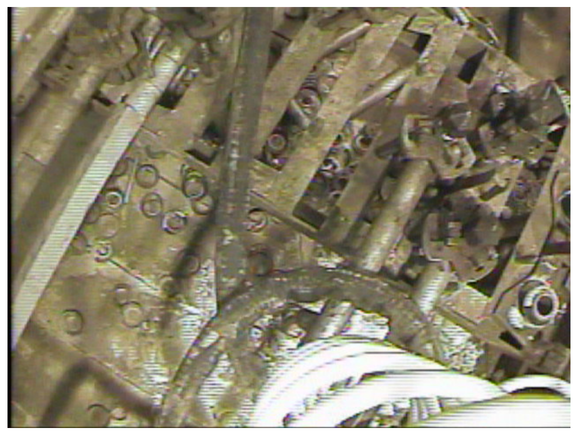

8H-12) Floor, dislodged re-bar, and air tunnel duct

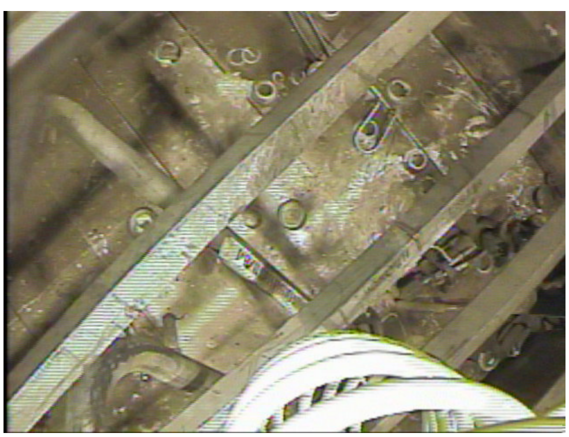
8H Snapshots (3of 3)

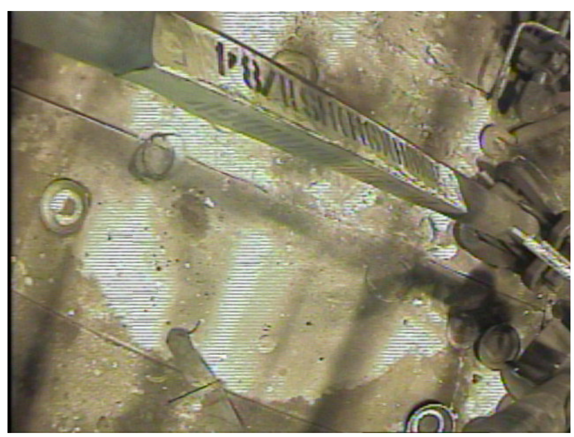

8H-13) 8H rack pan south of expansion loop table


8H-14) Close up of deposit area north of rack table

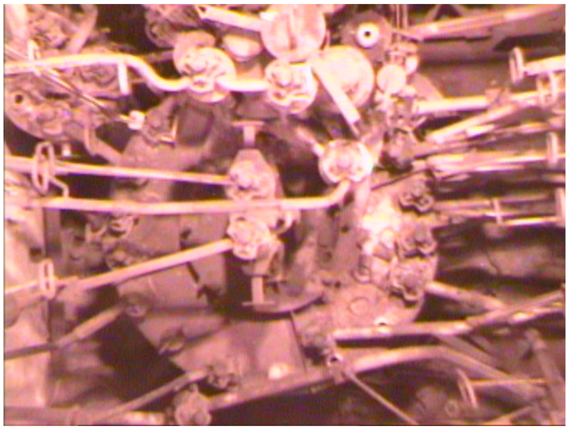

8H-15) Close up of deposit


8H-16) 8H rack pan north view of rack table

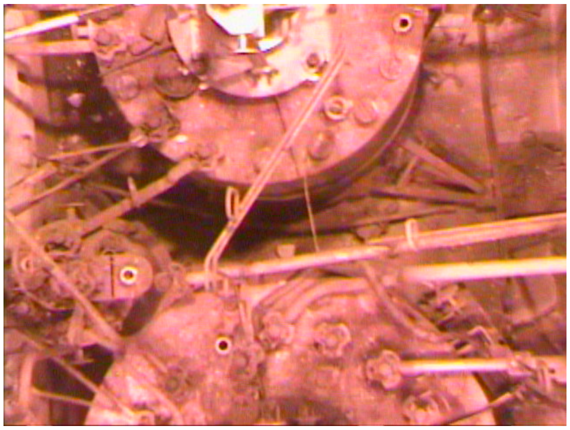

8H-17) Deposit in 8H rack pan


8H-18) Deposit in 8H rack pan

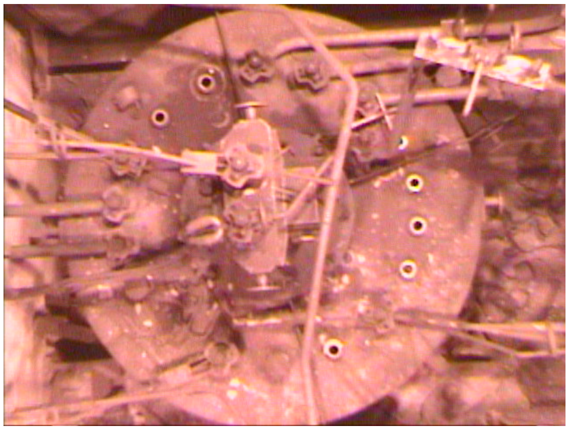
10H Snapshots (1 of 3)



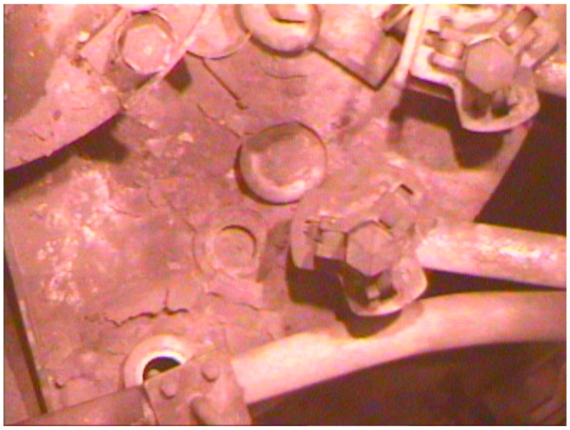
10H-1) Top of Tanks 10.1, 10.1-2 and PRC



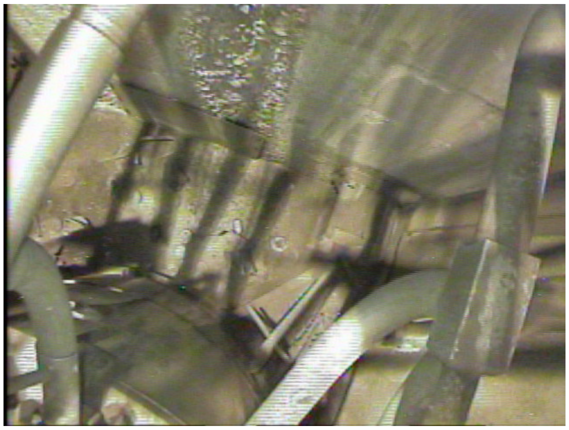
10H-2) Top of Tank 10.2-1 and between Tanks 10.2 and 10.3



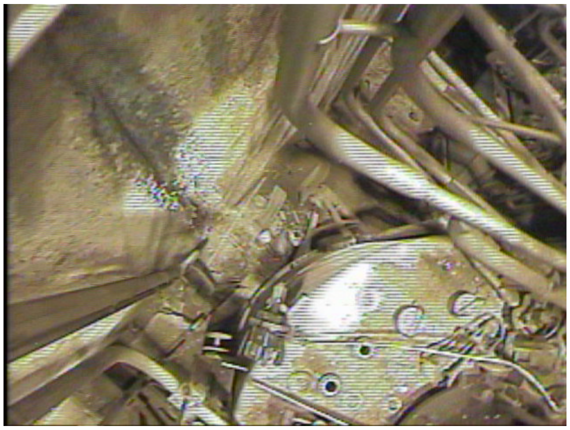
10H-3) Top of Tank 10.4



10H-4) Top of Tank 10.1 tank southeast corner



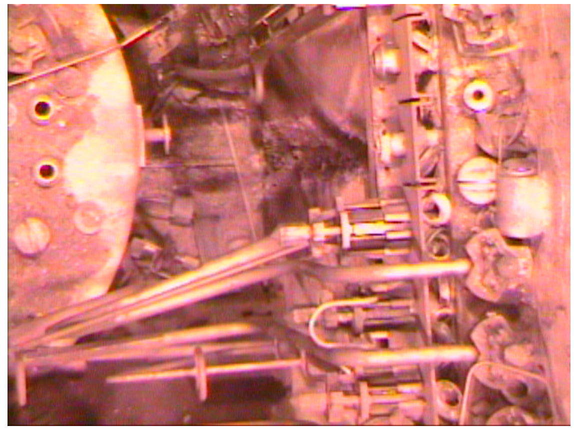
10H-5) Corrosion under nozzle 80(10H), east of Tank 10.1



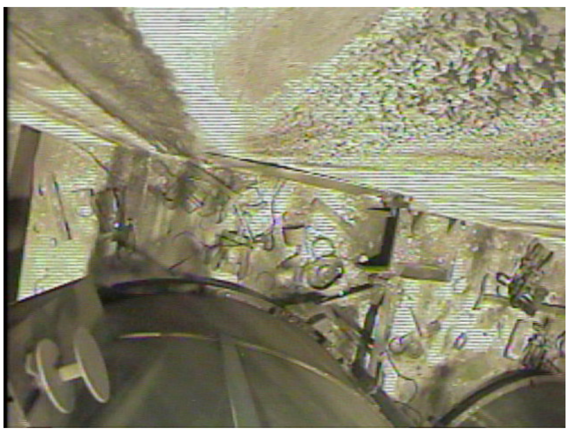
10H-6) Furrow under nozzle 70(10H), floor and top of Tank 10.2

10H Snapshots (2 of 3)

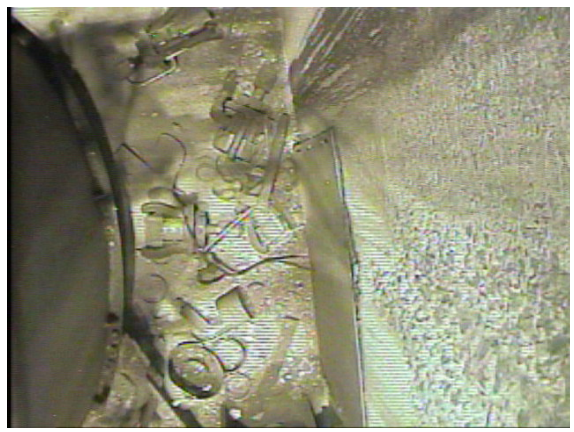
10H-7) Furrow under nozzle 70(10H), exposed and missing



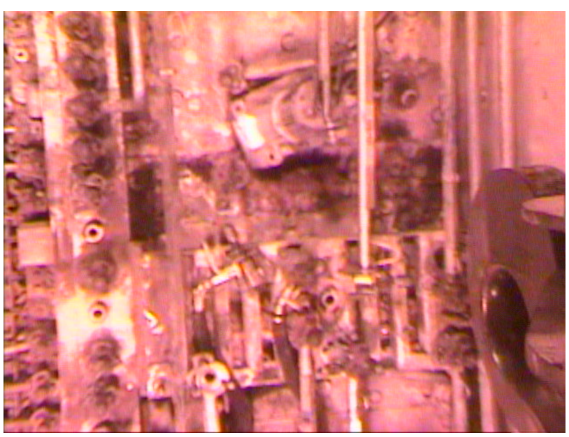
10H-8) Floor and wall east of Tank 10.2 under nozzle 71(10H)



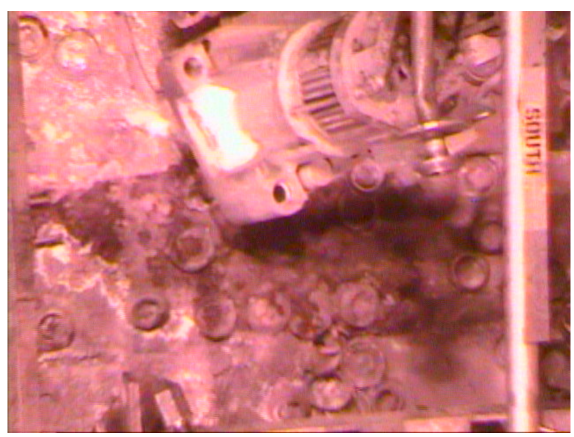
10H-9) Floor down between nozzle 47 and 49(10H) East of Tank 10.4



10H-10) Floor and air duct east of Tank 10.4

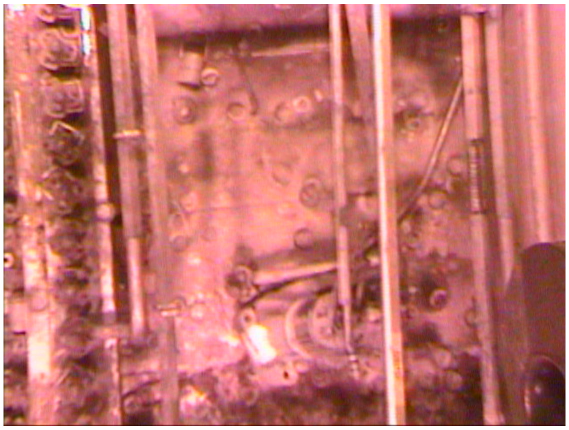


10H-11) Rack pan north of expansion loop table and stored contactor motor nozzle 78-69(10H)

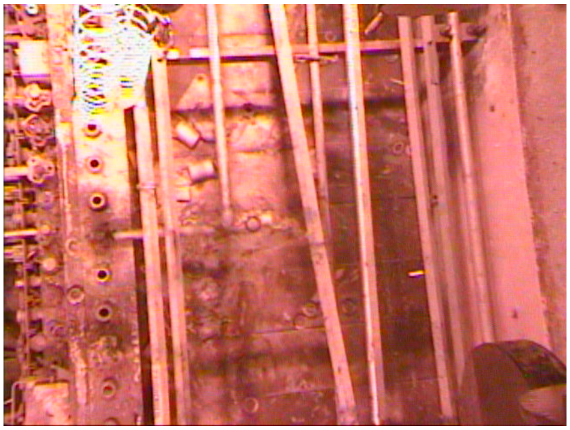


10H-12) Close up of stored contactor motor

10H Snapshots (3 of 3)



10H-13) 10H rack pan nozzle 65-72(10H)

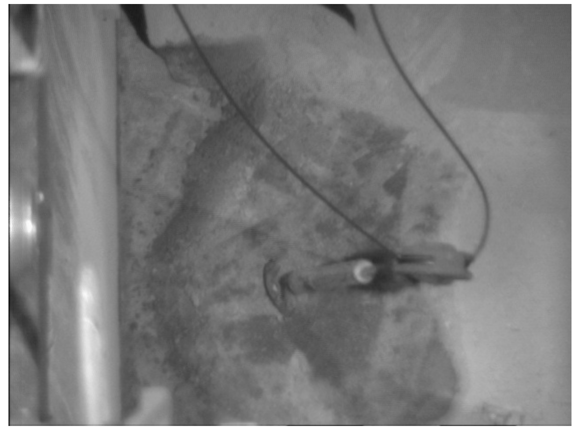


10H-14) 10H rack pan nozzles 62-55(10H)

10H-15) Stuff in the middle of the rack pan opposite nozzle 58(10H)

Filled Sumps Snapshots


9W Sump filled with concrete 5-24-04


10W Sump filled with concrete 6-14-04


11W Sump filled with concrete 6-28-04


12W Sump filled with concrete 6-22-04

Plutonium in Section 9W WCAT Incident- 1965

10079-001 Section 9W looking North toward module 9.8 at the plutonium deposit

10079-002 Section 9W looking South toward module 9.5

10079-003 Section 9W looking at center duct

10079-004 Section 9W looking South toward module 9.5

10079-005 Section 10W looking South toward modules 10.5 and 9.8 (Pu deposit)

10079-006 Section 10W looking north toward modules 10.8 and 11.5

Warm Canyon Air Tunnel Pictures- 2001 Inspection (1 of 3)


9W South and Center Air Duct


9W Center and North Air Ducts


9W North and Center Air Duct


10W South Air Duct


10W Center Air Duct


10W North Air Duct

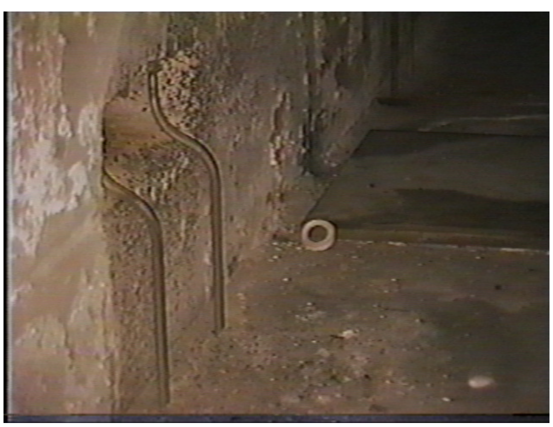
Warm Canyon Air Tunnel Pictures- 2001 Inspection (2 of 3)


11W Floor under South Air Duct


11W South Air Duct


11W Center and North Air Ducts

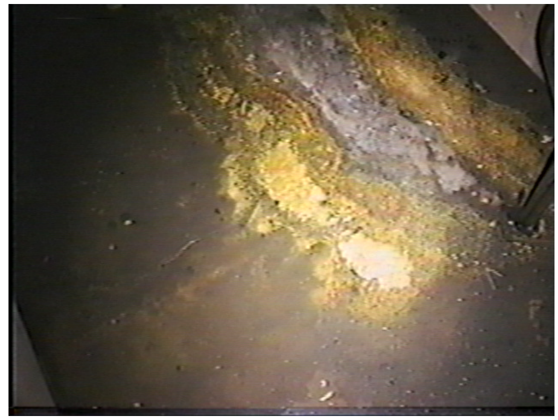

11W North Air Duct


12W South Air Duct


12W Center Air Duct

Warm Canyon Air Tunnel Pictures- 2001 Inspection (3 of 3)


12W North Air Duct


Near the 14W Center Air Duct


14W North and 15W South Air Ducts (looking north)


8W Center Air Duct


16W South Air Duct


16W North Air Duct -