WHC-SP-1147, Rev. 1

PUREX/UO_3 Facilities Deactivation Lessons Learned History

Prepared for the U.S. Department of Energy
Office of Environmental Restoration and
Waste Management

Westinghouse
Hanford Company Richland, Washington

Management and Operations Contractor for the
U.S. Department of Energy under Contract DE-AC06-87RL10930

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EXECUTIVE SUMMARY

In June 1996, the criticality alarm in the PUREX (plutonium-uranium extraction) facility at the Hanford Site in south-central Washington State was disconnected forever in a benchmark event (Figure 1). Except for being disconnected temporarily and upgraded during a plant shutdown that ran from 1972 to 1983, the alarm monitored the PUREX facility ever since the plant began practice runs with radioactive materials in December 1955. During many of those years the PUREX facility functioned as the largest plutonium separations plant in American history, processing much of the special defense material used to build the U.S. nuclear warhead stockpile (Figure 2). Disconnecting the alarm permanently in June 1996 signified that the hazards in the PUREX plant had been so removed and reduced that criticality was no longer a credible event. A U.S. Department of Energy (DOE - federal management agency that oversees the Hanford Site) spokesman summarized the situation this way. "To turn off the criticality alarm means an era really has come to an end."[1]

Turning off the PUREX criticality alarm also marked a salient point in a historic deactivation project, 1 year before its anticipated conclusion. The PUREX/UO_3 Deactivation Project began in October 1993 as a 5-year, $222.5-million project[a].[2] As a result of innovations implemented during 1994 and 1995, the project schedule was shortened by over a year, with concomitant savings. In 1994, the innovations included arranging to send contaminated nitric acid from the PUREX Plant to British Nuclear Fuels, Limited (BNFL) for reuse and sending metal solutions containing plutonium and uranium from PUREX to the Hanford Site tank farms. These two steps saved the project $36.9-million.[3] In 1995, reductions in overhead rate, work scope, and budget, along with curtailed capital equipment expenditures, reduced the cost another $25.6 million.[4] These savings were achieved by using activity-based cost estimating and applying technical schedule enhancements. In 1996, a series of changes brought about under the general concept of "reengineering" reduced the cost approximately another $15 million, and moved the completion date to May 1997.[5]

With the total savings projected at about $75 million, or 33.7 percent of the originally projected cost, understanding how the changes came about, what decisions were made, and why they were made becomes important.

At the same time sweeping changes in the cultural of the Hanford Site were taking place. These changes included shifting employee relations and work structures, introducing new philosophies and methods in maintaining safety and complying with regulations, using electronic technology to manage information, and, adopting new methods and bases for evaluating progress. Because these changes helped generate cost savings and were accompanied by and were an integral part of, sweeping "culture changes," shifts in employee relations and work structures, new methods and philosophies in the safety and regulatory aspects of the project, increased use of electronic information

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[a] Note: Deactivation of the UO_3 Plant was completed in February 1995, and this facility was turned over to the DOE's decontamination and decommissioning (D&D) organization. After that time, the name of the PUREX/UO_3 Deactivation Project was shortened to the PUREX Deactivation Project.

technology, and in methods and bases of evaluating progress, the story of the lessons learned during the PUREX Deactivation Project are worth recounting.

Foremost among the lessons is recognizing the benefits of "right to left" project planning. A deactivation project must start by identifying its end points, then make every task, budget, and organizational decision based on reaching those end points. Along with this key lesson is the knowledge that project planning and scheduling should be tied directly to costing, and the project status should be checked often (more often than needed to meet mandated reporting requirements) to reflect real-time work. People working on a successful project should never be guessing about its schedule or living with a paper schedule that does not represent the actual state of work.

Other salient lessons were learned in the PUREX/UO_3 Deactivation Project that support these guiding principles. They include recognizing the value of independent review, teamwork, and reengineering concepts; the need and value of cooperation between the DOE, its contractors, regulators, and stakeholders; and the essential nature of early and ongoing communication. Managing a successful project also requires being willing to take a fresh look at safety requirements and to apply them in a streamlined and sensible manner to deactivating facilities; draw on the enormous value of resident knowledge acquired by people over years and sometimes decades of working in old plants; and recognize the value of bringing in outside expertise for certain specialized tasks.This approach makes possible discovering the savings that can come when many creative options are pursued persistently and the wisdom of leaving some decisions to the future.

Because deactivation is an interim step in the life of a facility - not the beginning or the end - the team managing a deactivation project should make straightforward, cost-effective decisions based on the needs of the current situation, but should not try to foresee, force, or preclude decisions about decontamination and decommissioning (D&D) that deserve to be made by citizens of the future. The essential job of a deactivation project is to place a facility in a safe, stable, low-maintenance mode, for an interim period. Specific end points are identified to recognize and document this state. Keeping the limited objectives of the project in mind can guide decisions that reduce risks with minimal manipulation of physical materials, minimal waste generation, streamline regulations and safety requirements where possible, and separate the facility from ongoing entanglements with operating systems. Thus, the "parked car" state is achieved quickly and directly.

The PUREX Deactivation Lessons Learned History was first issued in January 1995. Since then, several key changes have occurred in the project, making it advisable to revise and update the document. This document is organized with the significant lessons learned captured at the end of each section, and then recounted in Section 11.0, "Lessons Consolidated." It is hoped and believed that the lessons learned on the PUREX Deactivation Project will have value to other facilities both inside and outside the DOE complex.[6]

Figure 1. News Conference Announcing the Turnoff of the PUREX Criticality Alarm, June 1996.

Figure 2. PUREX Plant and Ancillary Facilities, 1995.

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1.0 HISTORY AND BACKGROUND AT THE PUREX AND UO_3 FACILITIES

1.1 DEFENSE PRODUCTION HISTORY OF THE PUREX PLANT

The PUREX facility (202-A Building) was constructed by the Atomic Energy Commission (AEC - a predecessor agency to the DOE) from 1953 through 1955, and began full-scale processing of aluminum-clad, irradiated natural uranium (U) fuel elements in January 1956. It operated in support of the national plutonium (Pu) production efforts until September 1972. The dissolver equipment was changed beginning in 1963 to accommodate the processing of larger, zirconium-clad fuel elements with higher U-235 content. Throughout its early operating years, the PUREX Plant was modified to allow production increases, the segregation of neptunium-237 into a separate, continuous stream, the processing of fuel from various special test reactors throughout the nation, and other missions. In November 1983, after 11 years of upgrades, the PUREX Facility reopened to resume processing irradiated fuel elements for defense production (Figures 3 and 4). The PUREX Facility closed briefly in 1988 to correct a minor violation of safety standards. On December 7, 1988, the plant was shut down for nearly a year when steam pressures fell below the levels needed to support backup safety equipment.

1.2 STABILIZATION CAMPAIGN CONDUCTED WHILE LEGAL ISSUES DEBATED

On January 12, 1989, the Natural Resources Defense Council, writing on behalf of two additional interest groups (the Hanford Education Action League [HEAL] and the Nuclear Safety Campaign), notified the DOE of their intention to sue if PUREX operations were resumed without preparing a supplement to the 1983 Environmental Impact Statement (EIS).[7] Following several equipment repairs and improvements to waste handling systems, the PUREX Facility conducted a "stabilization campaign" to reduce its inventory of special nuclear materials and to place various internal systems into a stable configuration. This activity lasted from November 1989 through March 1990, and processed a total of 90.7 metric tons of irradiated uranium material that had been "stranded" in various forms and locations in the plant at the time of the abrupt shut down on December 7, 1988. Conducting the stabilization campaign placed the facility in a much safer mode than would have existed if the irradiated material had been left in its then-current state. The material processed in the stabilization campaign included 54.7 metric tons of irradiated uranium material already declad and dissolved in 5 tanks, as well as material in the 3 dissolver cells. It also included 36 metric tons of uranium in solutions containing plutonium that needed rework (i.e., plutonium that did not meet the specifications from previous processing) (Figures 5 and 6).[8]

At the end of the stabilization campaign, the PUREX Plant still contained large quantities of radioactive and hazardous materials. Major portions of the inventory included the following:

- Approximately 9 kilograms of plutonium in oxide form in N-Cell (the oxide conversion cell) and the Product Removal (PR) room

Figure 3. Inside the 1,000-foot Long PUREX Canyon During Shutdown, 1982.

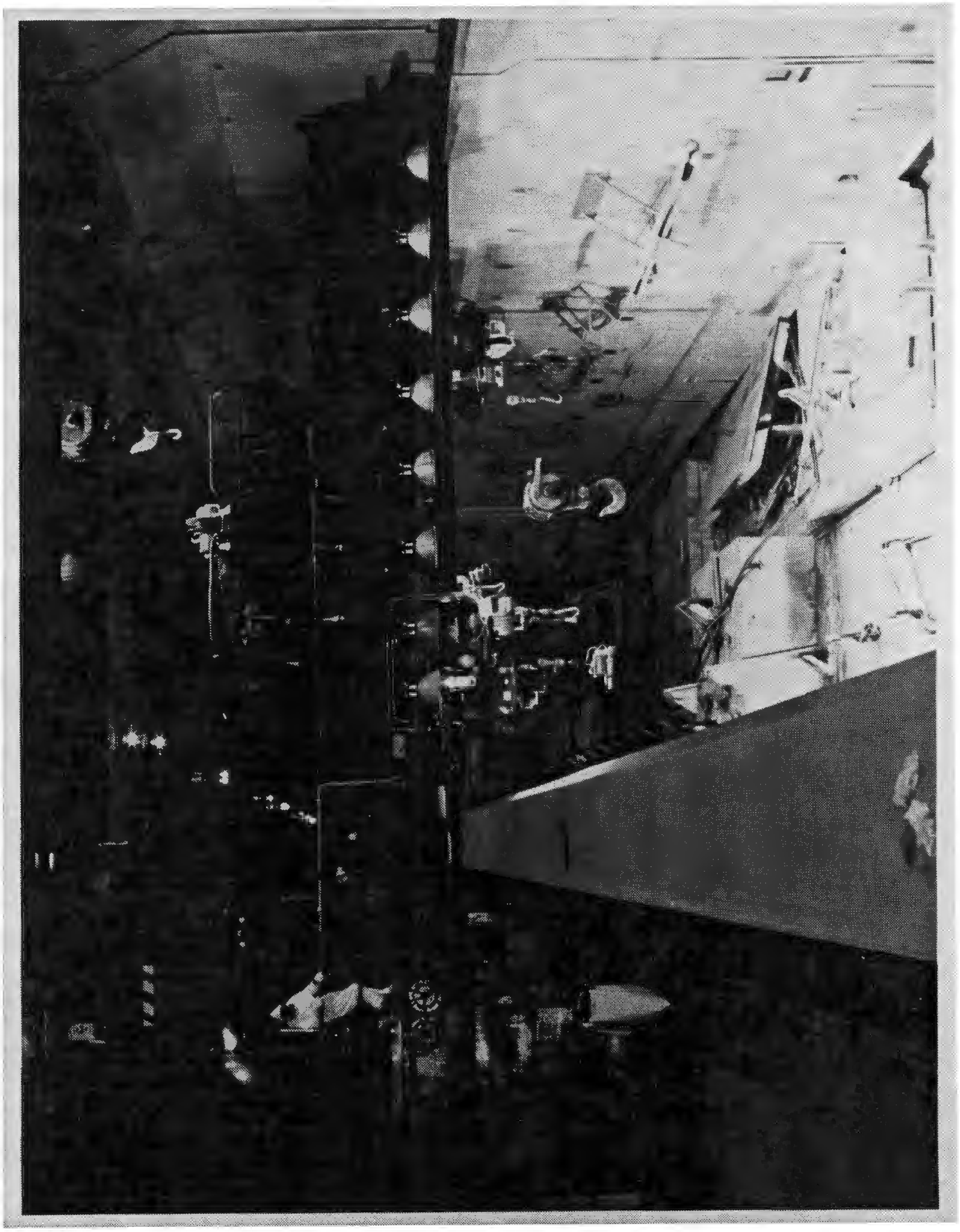


Figure 4. Inside the PUREX Control Room During Operations, 1984.

Figures 5 and 6. PUREX Workers Celebrate Completion of the Stabilization Run, March 1990.

- Approximately 9 kilograms of plutonium and 5.3 metric tons of uranium in recycled uranium nitrate solution in tanks D5 and E6
- Approximately 4,164 liters (1,100 gallon) of neptunium-bearing solution in tank J2
- Solids on the L-Cell floor containing an estimated 3.90 kilograms of plutonium
- Sludge on the E-Cell floor that covered approximately 1.1 to 1.4 cubit meters (40 to 48 cubit feet) that could contain up to 400 grams of plutonium
- 2.9 tons of aluminum-clad irradiated uranium fuel in the PUREX Slug Storage Basin
- 681,372 to 757,080 liters (180,000 to 200,000 gallons) of contaminated nitric acid (both recovered from the PUREX process and subsequently from the UO_3 Plant)
- 79,493 liters (21,000 gallons) of organic solvent [tri-butyl phosphate (TBP), 23 percent in a normal paraffin hydrocarbon (NPH), 77 percent diluent--TBP/NPH] in G and R Cells
- Approximately 50 zirconium-clad, irradiated fuel elements on the floor of dissolver Cells A, B, and C
- Silver reactors containing active ^{129}I in A-, B-, and C- Cells.

Lead, mercury, and other hazardous substances were located in various parts of the facility, and 907,200 to 1,088,640 kilograms (1,000-1,200 tons) of bulk, fresh chemicals also were present.[9]

1.3 PUREX STANDBY PERIOD AND FINAL SHUTDOWN ORDER

On July 12, 1990, President George Bush approved the Nuclear Weapons Stockpile Memorandum, which demonstrated that plutonium recovered in the PUREX Facility was not needed to support nuclear weapons requirements. In effect, this memorandum invalidated the basis for the 1983 PUREX EIS, which was that PUREX operations were to be resumed to process plutonium necessary for national defense. In light of these developments, Secretary of Energy James Watkins announced in October 1990 that the PUREX Plant would be placed in standby mode, and that an options study and an EIS would be prepared before restart of the facility. On December 22, 1992, a final shutdown (closure) order was issued by the DOE for the PUREX Plant.[10]

Although the PUREX Plant was not officially ordered to standby status until October 1990, transition-to-standby activities began as soon as the stabilization campaign was finished in March 1990. Thus, the actual standby period extended from March 1990 through December 1992.

Expensive and frequent surveillance and maintenance (S&M) checks of safety and operating systems, mandated in safety documentation and necessary to keep the plant in standby-ready condition, consumed most of the facility's time and budget. During 1990, tank integrity assessments, tank and vessel flushes, tank and other instrument calibrations, various stack filter change-outs, and flushes and drains of headers in the pipe and operating (P&O) gallery were performed. Some instrument calibrations for non-critical systems and repairs to non-essential equipment were postponed because facility managers did not know when or if the instruments and equipment would be used. The nitrogen oxide monitors on the main stack and the back-up facility were deactivated, as were exhausters in the P&O gallery. Efforts were made in a Radiation Zone Reduction Plan to move all regulated items into more central areas of the plant and surrounding area (Figure 7). This made more areas accessible without them needing radiological postings and monitoring. The PUREX Plant was visited by DOE Tiger Teams (internal fact-finding teams) in May and June of 1990.[11]

1.4 STANDBY ACTIONS AND GOALS AT PUREX

In early 1991, shortly after the standby order was issued officially, PUREX personnel began to define both overall and specific goals for the standby condition. General goals included minimizing utility and surveillance requirements, and curtailing gaseous and liquid effluent releases to levels as low as reasonably achievable (ALARA) (at or below permitted levels) while laying up essential plant systems. Ventilation flows were to be reduced as far as possible to maintain confinement in radiation contamination zones and health and comfort in occupied areas (Figure 8). Program objectives were maintaining compliance with all applicable regulations and policies, maintaining effluent systems in a safe, minimum-flow condition, satisfying *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) milestones, minimizing chemical inventories in the plant, minimizing solid and liquid waste generation, limiting equipment deterioration so that equipment would be available to support subsequent facility activities (either terminal cleanout or the resumption of fuel reprocessing), and executing all activities in a cost-effective manner.[12]

In January 1991, in response to a DOE, Richland Operations Office (RL) request for a Standby Plan that would look ahead 3 to 8 years awaiting final mission clarification, PUREX documented the actions that would be taken and conditions that would be maintained during Standby. These actions included keeping the dissolver heels in A-, B-, and C- Cells and the single-pass fuel in the storage pool covered with water, locking out the dissolver off-gas electric and steam heaters, and disconnecting air supplies to air-driven pumps in N-Cell. The plant also pledged not to receive any further irradiated fuel shipments, not to introduce any ammonia-bearing solutions into its systems, to maintain water coverings over the dissolver heels and the single-pass reactor fuel, to continue applicable operational safety requirements surveillances, and to maintain engineering and administrative controls designed to prevent criticalities.[13]

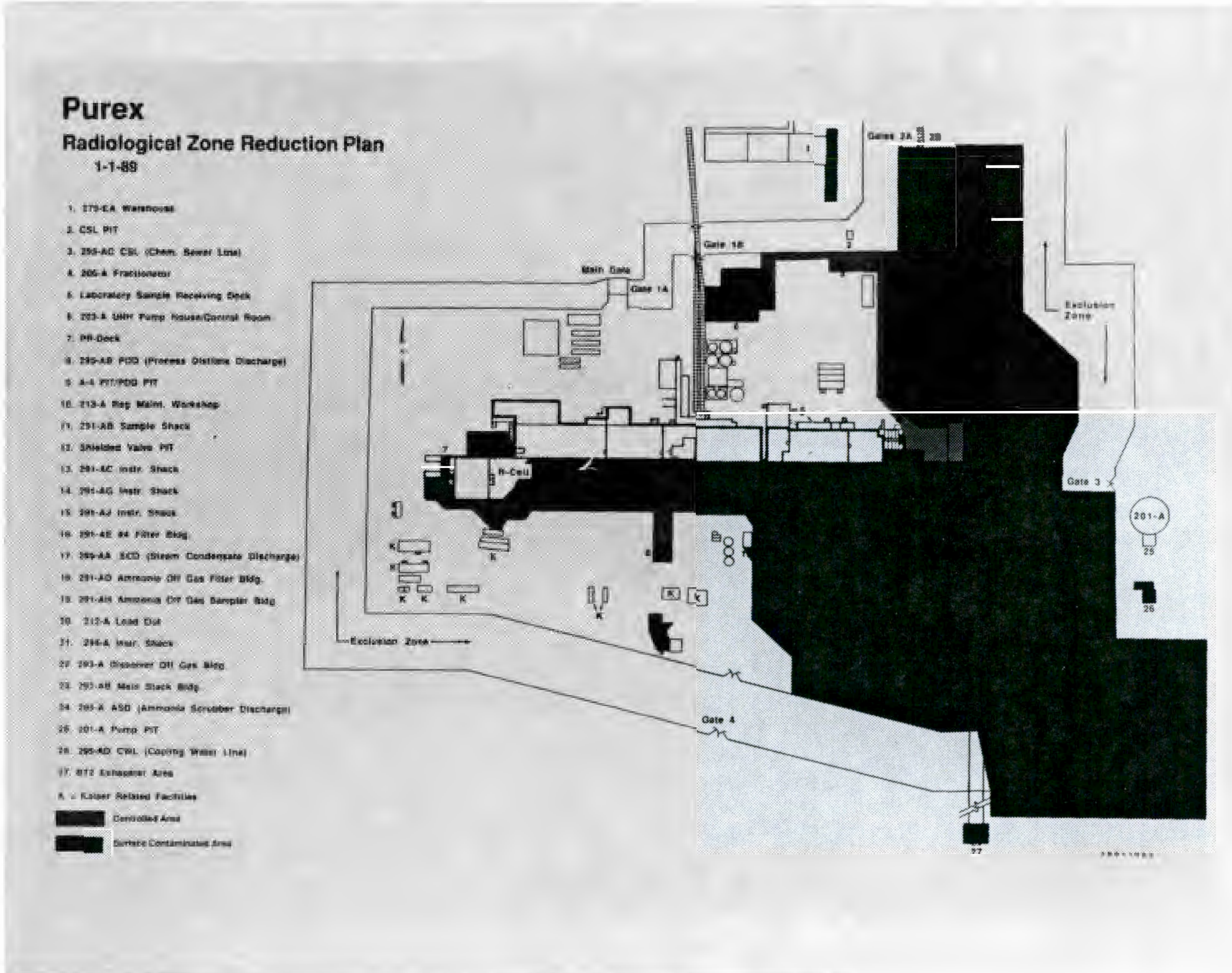
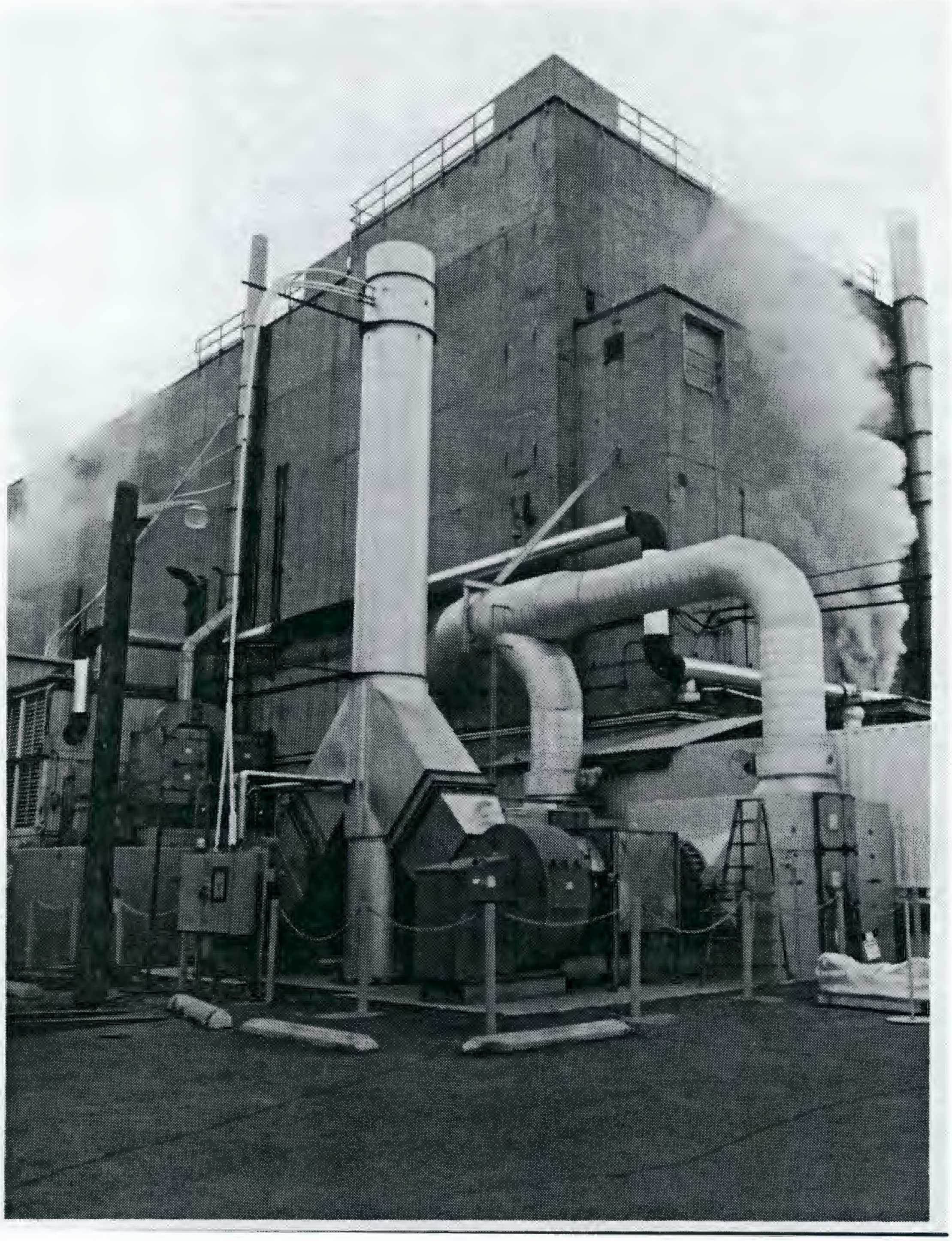


Figure 7. Radiation Zone Reduction Plan was one of the Earliest Steps Taken During the PUREX Standby Period.

Figure 8. Emissions from the PUREX White Room Fans and Exhaust Stacks were Reduced as Part of Standby Period Work.



Because the ultimate mission of the PUREX Plant was unknown in 1991, work was selected on a case-by-case basis to ensure future mission flexibility. Much of the day-to-day work of the facility continued to focus on preventive maintenance to electrical and other essential systems, filter changeouts, sampling various effluents and in-plant materials, tank and piping assessments and integrity verifications, transfer and consolidation of various solutions, and necessary repair work. As in 1990, many optional equipment upgrades and instrument calibrations at PUREX were deferred until the plant's future could be better defined. However, an in-cell closed-circuit television system was installed in the west canyon crane and new liquid beta-gamma monitors were installed for the PUREX chemical sewer.

Major cleanout work went forward in 1991 in N-Cell and the PR room. Plutonium oxide powder was removed from N-Cell glove boxes, dissolved in nitric acid, and transferred to tank E6. In March 1992, approximately 8,328 liters (2,200 gallon) of plutonium nitrate solution were transferred from tank E6 to tank D5 to make room for additional transfers into tank E6. (The plutonium nitrate solution that was accumulated in tanks D5 and E6 during this period would become the subject of major goals and regulatory attention in the PUREX Deactivation Project. See Sections 6.1 and 8.2.)

Other work accomplished in 1991 included terminating the PUREX steam condensate and cooling water heat exchange effluents, reducing the cold side service effluents in the P&O gallery to minimize corrosion during standby, and shutting down the carbon-14/tritium sampler on the main stack.[14]

1.5 SALE OF PUREX FRESH CHEMICALS DEMONSTRATES EARLY CREATIVITY

A major activity undertaken at PUREX in 1991 to sell bulk fresh chemicals being at the plant actually began some key deactivation work. In early 1991, PUREX had an inventory of 1,000 to 1,200 tons of fresh chemicals (about 80 percent in liquid form and 20 percent as dry solids) that had been shipped to the facility in anticipation of use in radiochemical processing. Plant personnel decided to try removing the chemicals in case the plant did not restart, and to avoid the safety implications and environmental concerns associated with long-term storage. They evaluated the possibility of disposing of these chemicals as waste, a quick but expensive choice. Because waste generators retain "cradle to grave responsibility" when generating a waste (under 40 CFR 262), costs would have included not only the initial disposal fees (estimated at $300,000 to $400,000), but potential later expenses if the landfill that accepted the chemicals ever leaked. Also, the General Services Administration procurement processes followed by the contractor that operated PUREX, Westinghouse Hanford Company (WHC), did not include a ready procedure to sell the chemicals back to the original vendors.

Therefore, PUREX personnel decided to sell these chemicals as excess on the open market, by placing notices in the *Commerce Business Daily*. Chemical brokers and distributors, local fertilizer companies, and another DOE site purchased or accepted most of the chemicals. The chemicals sold for only about 20 percent of the original market value, but all disposal and potential liability costs were saved by not declaring the chemicals as waste. Under U.S. Department of Transportation regulations (DOT 40 CFR), most of the chemicals had to be relabeled as hazardous materials, which caused some shipping delays. Still, shipments off the Hanford Site began in May 1992 and continued for about a year.[15] Following the same path of excessing useful materials and equipment that were no longer needed at PUREX, hydrogen peroxide and sodium hydroxide tanks, and other items were transferred to other projects on site in 1993 (Figure 9).

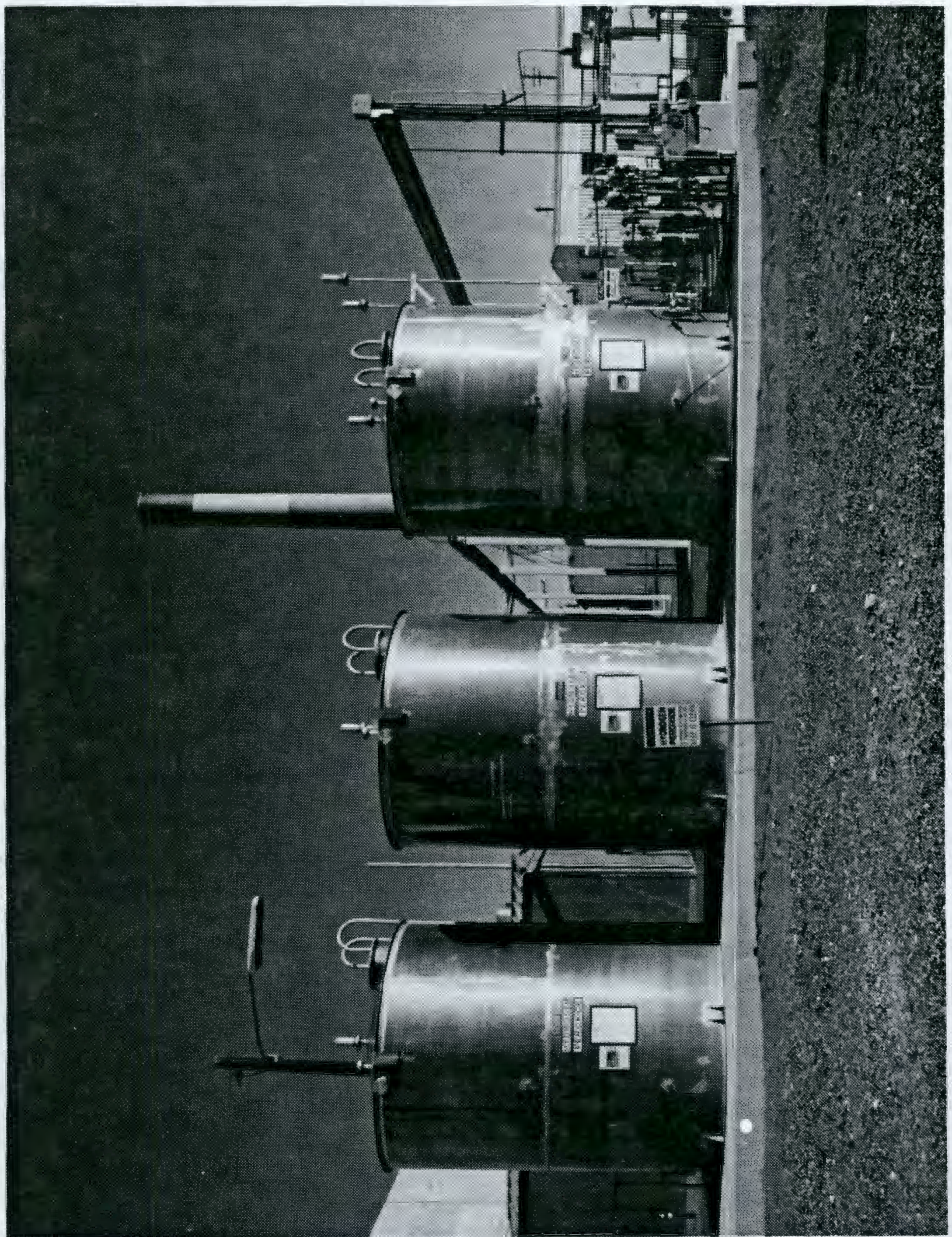
During 1992, work was again performed cautiously at PUREX because the mission continued to be uncertain. Cleanout continued at N-Cell, with loose plutonium oxide powder removed from crevices in the equipment, dried, and stored in the 2736-Z vaults at the Hanford Site's Plutonium Finishing Plant (PFP) for safe keeping. Also, about 4,164 liters(1,100 gallons) of neptunium-bearing solution were removed from tank J2 and discharged to the Hanford Site tank farms in January 1993 as high-level waste. The steam condensate stream overflow line was plugged, thus preventing any discharge to cribs 216-A-30 and 216-A-37-2 and allowing the shutdown of instrumentation that monitored the steam condensate stream. Other minor repairs were performed, and closed-loop chillers were installed on the main stack vacuum pumps to eliminate single-pass cooling water effluent. The main PUREX sanitary septic tile field failed and was taken out of service, and the sewage flow was successfully rerouted to a backup tile field. One of three cooling water liquid effluent streams was terminated, and the backup foam fire system at the main stack were deactivated along with the krypton and iodine monitoring systems. Other work included transferring liquids, flushing various tanks, draining of pipes and other lines, assessing tank and vessel integrity, and, of course, the required S&M checks.[16]

1.6 DEACTIVATION PLANNING BEGINS - NEW DEFINITIONS ARISE

In the early spring of 1992, DOE and WHC PUREX management conceived and embarked on a new, key activity that led directly into deactivation planning. In view of the end of the Cold War, the breakup of the former Soviet Union into 15 independent republics, the re-unification of Germany, and other obvious trends that reduced even further the national need for special nuclear materials, starting to plan an overall strategy to close down the PUREX and UO_3 Plants in an orderly, comprehensive manner seemed prudent. At that time, no officially defined, intermediate position between standby/shutdown and D&D for nuclear facilities existed, except for a commercial power reactor condition termed "SAFSTOR" by the Nuclear Regulatory Commission. When PUREX managers examined the SAFSTOR requirements, they realized that few of them applied to the PUREX and UO_3 Facilities. A whole new concept in planning and establishing requirements was needed.

DOE headquarters, RL, and PUREX WHC management decided that, because the entire concept of a "transition" or "deactivation" phase in a facility's life-cycle was new, independent experts should be brought in to evaluate the planning process itself. If PUREX/UO_3 planning could be formulated into a system, the knowledge gained could serve as a model for other aging, terminated facilities across the DOE complex. An independent technical review team (known as the Red Team because it was to serve as a red flag or bold indicator of a new pathway) was chartered by the DOE EM-60 organization on May 19, 1992. This team was overseen by a Technical Oversight Board of senior-level individuals with extensive experience in industry and the nuclear world. The Red Team's mission was defined to "perform a review of the planning,

Figure 9. Hydrogen Peroxide Tanks Before they were Removed from the PUREX Facility for use in Another Project, 1993.



technical basis, and issues related to the transition of the PUREX Plant status from standby to safe deactivation, with minimum surveillance." The Red Team also would "provide recommendations, methods, activities, criteria and potential changes to requirements that would be applicable at PUREX and other Department of Energy Facilities while personnel familiar with the plant operation are still available."

1.7 RED TEAM RECOMMENDS PROJECT APPROACH/STREAMLINED DOCUMENTATION

In October 1992, the Red Team issued its report. It concluded that the PUREX Plant had no technical barriers to a timely transition to safe deactivation, defined as a "D&D ready state" that could be maintained "for a decade or more." It found that institutional management and regulatory barriers existed, but that these factors could be surmounted by "a change in methods of doing business." Treating the deactivation as a project, rather than as another form of ongoing activity, could save one-third the time, one-seventh of the personnel effort, and one-sixth of the integrated cost of a "more conventional approach." Achieving the goal of a "low mortgage end-state," the report summarized, would take close and active cooperation among many organizations, including DOE at all levels, Washington State and other regulators, WHC, and numerous stakeholders.[17]

In terms of specific recommendations, the Red Team report offered seven crucial end point criteria in order of importance:

- Eliminate or stabilize environmental and safety risks
- Leave in place equipment, systems, and materials for which an end state is not yet defined
- Complete activities dependent on facility-specific process, operating, and facilities engineering expertise
- Complete activities dependent on existing, functional facility-specific equipment that will be inoperable following a decade-long deactivation period
- Configure the facility for and limit access to a quarterly assessment entry
- Establish and archive records and drawings
- Leave the facility in an orderly condition.[18]

The report also proposed that all of the regulatory and planning documents except required Environmental Assessments (EAs) be combined into one Transition Project Management Plan, and that "overly conservative, zero-risk interpretations should be avoided...Not all regulations and orders apply to the transition to deactivation, and not all activities are regulated." In terms of work planning, the report stated that "project tasks should be managed by work packages using a graded [commercial] approach to simplify the packages." The report observed, "planning is an inherent transition delay. To offset this the project management team...must immediately define activities that can proceed in parallel with deactivation transition planning." Integrated, resource-loaded schedules with logic ties and a highlighted critical path were identified as the most sensible way to map, direct, and track the project.

The question of safety documentation was addressed clearly by the Red Team. "Preparation of a new SAR [Safety Analysis Report] for transitioning PUREX is not considered necessary...Use of the existing PUREX SAR, with appropriate supplements, is an effective method to define and manage the safety envelope during transition to safe deactivation." The report also recommended close coordination between the management teams of WHC, RL, and DOE Headquarters (DOE-HQ) (the "troika" approach) to ensure the timely success of the project. It further made a simple and direct attempt to address each major technical, physical challenge in the PUREX/UO_3 deactivation with a brief statement of the scope of work to be accomplished. Such work included draining and flushing tanks and vessels, fixing surface contamination, mothballing certain equipment, disposing of fuel elements and contaminated solvents, burying solid waste, and many similar tasks.[19]

1.8 UO_3 PLANT HISTORY AND BACKGROUND

The Uranium Trioxide (UO_3) Facility was created in 1951 via modifications to the World War II-vintage 224-U Facility. In 1952, it began full-scale operations to convert liquid uranyl nitrate hexahydrate (UNH) to UO_3 powder through a calcination process. During 1954 and 1955, an addition known as the 224-UA Building was constructed to hold six continuous-action calciners and improve powder and waste handling facilities. Together, the 224-U and 224-UA Buildings operated as the UO_3 Plant until the 1972 shutdown of the PUREX Plant. UO_3 operations closely followed the chronology of the PUREX Facility, because PUREX provided the sole feed material for UO_3 operations after 1967.

Calcination activities in the UO_3 Plant resumed in 1984, shortly after the 1983 restart of the PUREX Plant. Since that time, the UO_3 Plant has conducted 17 operating campaigns because the small facility could calcine UNH at a much faster rate than the PUREX Facility could produce it while processing zirconium-clad fuel. The final UO_3 Facility closure order from the DOE came in December 1992, in tandem with the PUREX closure order. A last run was carried out at the UO_3 Plant from April through June 1993, to convert 757,080 liters(200,000 gallons) of remaining UNH to uranium trioxide powder. At the close of this campaign, as in past operations, the nitric acid recovered in the UO_3 calcination process was returned to the PUREX Plant.[20]

1.9 LESSONS LEARNED

Lesson No. 1. Finding an alternative use for a material is better than disposing of it as waste, even if the alternative use brings little or no monetary income. A designation as waste subjects a material to long-term regulatory control, and to the costs associated with disposal and regulatory surveillance and paperwork.

Lesson No. 2. Using creativity and forethought is possible even during periods when clear direction is lacking and when mission flexibility needs to be preserved. Even during such times, some steps can be taken to temporarily deactivate portions of a large facility and bring down costs. Those who know the plant most intimately are best equipped to brainstorm the specific ways to implement cost-saving steps.

Lesson No. 3. Involving an independent technical review team early in the process to review a major deactivation operation and make overview recommendations provides healthy and useful input. It allows those with experience in the commercial world those not directly tied to, or constrained by, the day-to-day concerns of facility operations and management to look at the operation. It also challenges the facility staff to think of the deactivation project differently. For conceiving broad concepts, the value of independent oversight is immeasurable.

Lesson No. 4. The advice of an independent review team such as the Red Team in attempting to scope and define specific work tasks and pathways within a large deactivation project is less helpful than the broad overview perspective brought by such a team. Washington State regulators, regional trustees and stakeholders, and the constraints imposed by the needs and requirements of other divisions on the Hanford Site actually shaped the PUREX Deactivation Project. As the project progressed, the ongoing advice of ITEs that stayed with the work in a follow-on capacity helped define specific activities.

Lesson No. 5. Forewarning facilities as early as possible as a shutdown status approaches allows the facility engineers and work planners to begin preparing for deactivation work in a timely and efficient manner. The time that elapsed during the PUREX Plant's Standby period actually created additional work for the deactivation project because some instruments and equipment deteriorated during that period. To prepare for the deactivation, significant work needed to be done to recalibrate and upgrade instruments and machinery.

2.0 REENGINEERING THE HANFORD SITE

2.1 THE REENGINEERING CONCEPT

The term "reengineering," was devised by business consultants James Champy and Michael Hammer in 1993. The process it represents was integrated into the PUREX Deactivation Project late in calendar 1995 and early in 1996. Savings generated by the reengineering process are estimated at $15 million over the remaining life of the project, and the schedule acceleration is placed at 4 months. However, reengineering was not adopted at PUREX until just over 2 full years into the deactivation project. Because much greater savings and schedule accelerations probably could have been realized had the concept been implemented sooner, reengineering overhauls currently are being implemented early in the deactivation of other major Hanford Site facilities. The reengineering concept and its application at the PUREX facility are believed provide key lessons learned.[21]

According to Champy and Hammer, reengineering means "starting over" in terms of an overall assessment of the processes, methods, bases, assumptions, and organization of a facility or a business. Reengineering cannot occur in small steps, but only dramatically: "It is an all-or-nothing proposition." It means reevaluating why facilities and businesses perform the steps and procedures that they do. It cannot mean simply trying to introduce greater efficiency or productivity into existing processes. Industrial Revolution concepts of division of labor, and breaking complex tasks down into small, specialized, repetitive steps to achieve efficiency are virtually reversed in reengineering. Instead, multiple tasks are combined into processes because the variety inherent in process-oriented work can motivate employees bored by repetition and can allow businesses or facilities to solve problems with flexibility, agility, and innovation. Likewise, the early Industrial Revolution concepts of creating a rule for every contingency and a hierarchical management structure are seen in reengineering as making businesses and facilities unresponsive to changes in customer needs and desired outcomes.[22]

Several characteristics are present in reengineered facilities and businesses. Chief among these is that several jobs are combined into one to foster greater worker responsibility, decision-making and "ownership" of the outcome. Further, steps in processes are performed in natural order, according to the dictates of the process, not according to the rules of separate organizations. Processes have multiple versions, so that flexibility and need can govern actions. Organizational boundaries are opened, so that work can be performed where, and by which persons, it makes the most sense. Checks and controls are reduced, external contact points are minimized, and a "case manager" or "team leader" provides a single point of contact with other organizations or customers. "Hybrid," decentralized operations are prevalent, and work units change from functional departments to process teams. People, once they are members of teams, feel empowered instead of controlled, and their motivation to "make a difference" and produce a good end product or end state rises. Criteria for performance evaluation and advancement can then measure results, not just activity. Organizational structures are flat and cooperative, instead of hierarchical and competitive. Managers become leaders, changing from a "command and control" to a mentoring and participatory style. Throughout the new structures created in reengineering, information is exchanged and tracked electronically, with accessibility by and to all employee groups. Thus, information cannot be used as a source of power that furthers hierarchy.[23]

2.2 TIMING AND NEED DRIVE DECISION TO REENGINEER HANFORD

At the Hanford Site, the time was just right in 1995 for the Champy philosophy of reengineering to address crucial needs. Business in the record high, fiscal year (FY) 1995 Hanford Site budget of nearly $2-billion had barely begun when the November 1994 election brought a dramatic shift toward a cost-conscious Congress. On December 19, 1994, President Bill Clinton's administration proposed stiff budget cuts, including cuts in DOE funds for nuclear waste management and cleanup.[24] The following March, researchers for the U.S. Senate Committee on Energy and Natural Resources produced a report entitled "Train Wreck Along the River of Money," criticizing DOE's cleanup programs as wasteful and unfocused.[25] The *Wall Street Journal* and other major media ran equally critical articles denouncing "what happens if pork gets into play," specifically condemning the uses of DOE dollars in the Hanford Site cleanup.[26] When the Site's principal operating contractor, Westinghouse Hanford Company (WHC), approached RL with the idea that reengineering could reduce costs and increase output, RL responded positively. Through the "change control" budgetary process, they allocated funds to WHC to proceed with reengineering.[27]

When WHC leaders looked at hard facts, they recognized the need for reengineering. In 1995, only 56.4 percent of the company's budget went to accomplish "core" objectives in the Hanford Site cleanup mission. Core work was defined as waste characterization, waste treatment and/or disposal, plant and facility maintenance, facility modification or building, and facility and waste surveillance. More money was being spent on the Site when it produced half of the nation's total supply of defense plutonium and operated several research facilities. Increasing amounts of the budget were being spent on indirectly funded overhead organizations by "taxing" the programs that are directed to accomplish specific cleanup tasks. Such organizations included planning, administration, support functions in regulatory compliance, personnel, communications, and other areas. Only one in 29 performance-based incentives (PBIs) that WHC had negotiated with DOE considered cost effectiveness as a specific performance criterion, although most PBIs focused on accelerated completion of work in the belief that accelerated completion would lead to cost savings. Another company incentive, the internal Challenge-170 Program, rewarded cost reduction, not cost effectiveness.[28]

Reengineering, WHC and RL leaders concurred, could help set priorities and streamline work in many areas, resulting in cost savings and also in a more motivated, involved, and efficient work force. The primary Site mission of "cleanup" was too vague to motivate many workers, and people were not personally involved in this concept. Without a clear sense of participation and stake, many workers did not perform at optimal levels. This sense of being disconnected existed even though many facilities had begun to organize as projects, with clear deactivation missions and goals. That only 28 percent of projects active at the Hanford Site since 1987 had been completed by 1995, while 55 percent had been canceled or abandoned, added to employee feelings of frustration. Paradoxically, in the safety and regulatory arenas, the level of control at Hanford in 1995 was more strict for deactivating facilities than it had been for facilities fully operating to produce special nuclear materials. In February 1995, DOE Assistant Secretary for Environmental Management Thomas Grumbly told Hanford managers to be bold in seeking changes. "Don't think we're just going to slide down the road to gradual change. Jump in, take the plunge...think out of the box."[29] Grumbly also called for savings through "productivity improvements."[30] The stage was set for reengineering.

Early in 1995, a Sitewide executive team of senior managers from DOE, WHC, and WHC's partner companies at the Hanford Site--Boeing Computer Services Richland (BCSR) and ICF Kaiser Hanford (ICF/KH)--was formed to define essential business practices and goals. At the center of a "business diamond" was "the work" of the Hanford Site. Surrounding that center were four focal areas: organizational structure, work culture, information technology, and management systems (including measurements and rewards). Based on opportunities for clear and dramatic improvement, the executive team identified three areas to target for change: facility operations, regulatory processes, and administration. Consequently, three teams were formed: the Plant Team, the Requirements Team, and the Administrative Team. The Plant Team concentrated on facility planning/scheduling, maintenance, safety, engineering, surveillance, and operations. The Requirements Team concentrated on challenging, streamlining, combining, reducing, and integrating various compliance, safety, and quality assurance functions. The Administrative Team focused on reducing "overhead" expenses such as those associated with procurement, communications, site services including road repairs, mail delivery, etc., and program management. The Plant Team, tackling facility operations, looked for an organization to become Hanford's first reengineered facility.[31]

2.3 PUREX FACILITY FIRST CHOICE FOR HANFORD SITE REENGINEERING

In 1995, the Hanford Site's PUREX facility, long a leader in the United States's Cold War efforts, once again led a national effort. In this case, the effort was to conduct the deactivation of a major DOE plant as a project. Structured with goals, schedules, and budgets similar to those for a construction project, the huge deactivation of PUREX already had set many precedents for innovation approaches to safety and regulatory issues, stakeholder involvement, and technical achievements.[32] As a leading-edge undertaking, the PUREX Deactivation Project was selected as a reengineering laboratory at the beginning of FY 1996. One primary reason for the selection was the enthusiasm and willingness to risk change displayed by the WHC PUREX Plant Director. A second key reason was the demonstrable success of the PUREX Deactivation Project. Site decision-makers reasoned that the premier demonstration facility was the right choice to start reengineering. Management believed that reengineering could enhance PUREX's existing strong performance (although many plant workers questioned why they should be "reengineered" when they already were doing a good job).[33]

The core principle guiding the reengineering of PUREX was that a holistic approach to the entire business system would be implemented. The PUREX management structure and work force organization were completely overhauled, work scope was reorganized, responsibilities and training were developed to support the emergent order and culture. While efforts had been made earlier to develop project end points, the end points now became the central driving guide to all project work (see Sections 4.3, 4.4, and 4.6).

Information technology was thoroughly integrated into the new approach, so that information could infuse streamlining, leveling, and empowerment throughout the new system. Likewise, the ways that safety planning and assessment, regulatory compliance, scheduling, and technical work were accomplished were adjusted. All work responsibilities were integrated into a team-based organization. The result was that the reengineered PUREX facility, in the final two years of its deactivation project, pioneered more change than was envisioned even as the first set of lessons learned was being written in late 1994.[34]

2.4 LESSONS LEARNED

Lesson No. 6. The reengineering concept in total, with all of its non-traditional business practices, can successfully bring down costs and streamline work at deactivating facilities. Generally, even though such facilities may have already reorganized from their operating configuration into a deactivation project, they can still benefit from thorough reengineering. Reengineering focuses people to specific, personal, achievable goals, thus tapping their maximum energies.

Lesson No. 7. The present timing for reengineering is nearly perfect. While Congress calls for budget cuts in DOE facilities that have no known future missions, environmental and other laws and imperatives require safe shutdown. Reengineering can make closing out old facilities cost effective. It also can help empower and better prepare the frightened work force that exists at many older DOE facilities, thus improving prospects for continued employment of these loyal employees.

Lesson No. 8. While reengineering can help virtually all large organizations, it should be introduced first, if possible, at facilities that are already doing well and that are staffed by enthusiastic, positive leaders and employees.

Lesson No. 9. When reengineering is undertaken, an organization, a facility, and/or a DOE Site must plunge into it holistically, and with support for change at all levels.

3.0 REENGINEERING THE PUREX PROJECT MANAGEMENT STRUCTURE

3.1 THE CASE FOR ACTION

At the PUREX facility, reengineering began by completely renovating the management and work force structures. The shortfalls of the old organizational structure of PUREX included jobs that were narrowly defined, requiring many "handoffs" to accomplish even simple tasks. Also, the divisions of responsibility meant that the organizations writing procedures and work packages were not the same ones responsible for the work results. Organizations could stop or slow work to meet their own internal requirements and priorities without being accountable for the effect of their actions on the entire deactivation project. Steps toward "projectization," or organizing resources into functional project units, began during 1994-95, and gave facility managers more control than they had when large and centralized support organizations existed. However, by late 1995, it was clear that "stovepipe" organizations, self-contained units within projects, still existed and served to block the development of true, overall process ownership. Also, in deactivation, where the real business is "going out of business," motivating workers to accomplish their business quickly and efficiently was difficult. The executive team felt that reengineering could break the internal organizational barriers, as well as the mental barriers, and provide workers with motivation based on ownership. Employees would know that their own performance on a team would be recognized and could serve as the basis for an excellent recommendation for the next available jobs.[35]

3.2 REENGINEERING BRINGS DRAMATIC RESULTS AT PUREX

In terms of sheer numbers, the results of reengineering the management and work force structure at PUREX were dramatic. In September 1995, the PUREX facility was organized by functional departments, and employed 26 managers, 6 team leaders, and a staff of 268. Major departments were Surveillance, Deactivation, Maintenance, Radiation Control, Administration, and Technical Training, where individual managers oversaw their own "pieces of the pie." Smaller departments presided over laboratory and special analyses, safety, and quality assurance. By February 1996, reengineering at PUREX had reduced the number of managers to 6, increased the number of team leaders to 10, and reduced the number of employees to 225. Seventeen of the staff reductions were attributed simply to the deactivation process and 26 (about 10 percent of the total staff) were attributed to reengineering. The span of management at PUREX increased from 11 to one before reengineering to 37.5 to one after reengineering.

The number of people signing each work package at PUREX fell from an average of 14 before reengineering to only 5 within 6 weeks after reengineering. (Note: strict comparisons are not possible in this area because the Job Control System [JCS]) was used in nearly all cases before reengineering, and an innovation known as the Job Hazards Analysis [JHA] was substituted in many cases as part of reengineering. Section 7.6 describes the JHA.). With reengineering, the amount of work at PUREX that required full work packages dropped from 70 percent to 5 percent[b]; the average amount of hours that workers spent performing or planning work each day rose dramatically; the need for corrective maintenance operations fell; and the ratio of review time to work time also dropped.

3.3 REENGINEERING PROCESS BEGINS WITH ASSESSMENT OF ESSENTIAL PUREX TASKS

Reengineering of PUREX began with an assessment to identify its culture, its bottlenecks, its power structure; "taking the facility's temperature," according to a Sitewide reengineering leader.[36] In October 1995, a "culture" survey was conducted to establish PUREX Plant workers' baseline perceptions of problems and strengths in the work environment before reengineering. Results of the survey identified seven areas where significant improvement could be made.

- Regulation and rigor in risk management were applied almost to the point of seeking "zero risk"
- Employees did not always perceive paths forward for themselves
- Paperwork was burdensome
- Systems sometimes fostered conflict between organizations even when people themselves cooperated
- Management was not seen as a primary enabler for removing barriers in the field
- Employees felt unable to tap resources when and where they were needed
- Employees had to face losing their friends, identity, and the sense of "family" when shutdown occurred.

These problems were seen to be fed by management systems, values, rules both modeled and expressed. The PUREX management committed to adopting a new set of values, rules, and expectations that would point toward the following new future states to replace the problem areas identified.

- Regulation would be streamlined, managed risk would be at the center of all work, and no rigorous efforts would be made to drive risk to zero
- Employees would understand their own paths forward
- Only paperwork that supported essential work needs would be processed

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[b] Part of the reductions in the size and number of work packages also can be attributed to a concurrent WHC effort to streamline Standards and Requirements Identification Documents (S/RIDS). See Section 7.5.

- Cooperation in and among multidiscipline teams would be standard operating procedure
- Management would be forward thinking and would empower front-line workers to make decisions
- Resources would be deployed for maximum effect, and clearly defined goals and objectives would drive the work
- All employees would take personal accountability for performance and would be recognized appropriately. Also, poor performance would have logical consequences.[37]

While the culture survey was being done, a "Reengineering Laboratory Team" (known as the Lab Team) was created to assess and restructure PUREX job roles and the personnel system. Nominations to the Lab Team could be made by any PUREX employee or member of the WHC management structure that oversaw PUREX, or by unions whose members worked at PUREX. Any PUREX employee could submit his or her own name as a volunteer. Nominations were studied and membership on the Lab Team was decided by representatives of CSC Index, Inc., the consulting firm of reengineering inventor James Champy, and by two Hanford Sitewide leaders of the reengineering effort. Final approval for Lab Team selections came from the PUREX Deactivation Project Director. The Lab Team, as it was constituted in the Autumn of 1995, had 11 members. The chairman was a safety engineer who had been involved in the Sitewide Plant Team. Other members included a DOE representative, a person from CSC Index, Inc., a PUREX engineer, a shift manager and one operations engineer, a scheduler, a nuclear operator, a pipefitter, a radiological control technician, and an electrician. Service on the Lab Team was deemed a full-time job, and all other work assignments were suspended for the members. The Lab Team's work took from September through November 1995 (Figures 10 and 11).

The Lab Team's first task was to validate the core processes (surveillance, maintenance, and facility modifications) for PUREX. The existing organization was considered a barrier between workers and accomplishing work.[38] Therefore, the next task was to dismantle the existing departments and job roles at the facility. To complete this step, the Lab Team had to define the PUREX work necessary to accomplish the goal of deactivation. As soon as they began to deliberate, the Lab Team realized that speaking in general terms about essential PUREX work was easy, but really defining how the facility should/could operate was difficult. The involvement of the people who had worked at PUREX the longest and knew the facility intimately became the most important. The end points (defined and published at PUREX by August 1995, see Section 4.6) again served as the real drivers and focal points to map essential work.

After deliberating, the Lab Team decided that the PUREX work processes were: surveillance, turnover/end point management, and five specific field activities still to be accomplished. The field activities were HVAC

Figures 10 and 11. PUREX Workers Hear About Reengineering Plans at Special Employee Meetings, 1995.

consolidation, glove box stabilization, utilities consolidation, canyon/galleries closeout, and ancillary structures/outside areas deactivation. A team was designated for each of these work activities. Three other teams were designated to support the seven core teams. These were a facility support team, a project support team, and a technical support team. Also, a project management team consisting of six managers and several activity leads (lead scheduler, regulatory compliance officer, safety compliance officer, project analyst, and other) was designated to lead the entire deactivation project. The Project Director position, as the lead for the entire deactivation project, was retained.[39]

Early in its work, the Lab Team was confronted with an "in-house rebellion." Later said to have occurred on "Black Monday," the rebellion occurred when a Lab Team member from the PUREX facility stood up and stated that the team was trying to "sell" or "shove" programs at the plant. Soon, complaints to Lab Team members and Employee Concerns (a grievance process) representatives increased. The emotional aspects of change, especially fear, had been underestimated. Communication and participation with and by all employees was increased. The Lab Team invited employees to attend their work sessions. However, even though they wanted more information, most employees could not bring themselves to go to the sessions. So, Lab Team members began posting times when they would visit various PUREX lunch rooms to have "brown-bag" sessions with workers. In familiar settings, and not feeling outnumbered, workers felt more free to question Lab Team members. Gradually, in casual conversations, many of the ideas that Lab Team members had tried to incorporate were accepted by PUREX employees[c].[40]

3.4 TEAMS/SKILLS MIX IDENTIFIED

Once the PUREX teams were designated as entities, the next task was identifying what skills mix each process team needed to be successful. At this point, the discussions turned to the heart of reengineering concepts, and focused on empowerment and on driving decision-making to the lowest levels. Knowing the PUREX facility and tasks as well as they did, and having a few members from outside PUREX to add perspective, the Lab Team had to become very realistic about what would work and what would not work in actual practice in a reengineered facility. It was most important that each team comprise the resources it would need to perform work processes from beginning to end. If any critical resources were missing, teams, and the entire reengineering experiment, could fail. Some areas of specialized expertise, such as regulatory and safety compliance, were assigned to individuals who would serve the entire PUREX Plant. These individuals were placed on the project management team where the other teams could call on them.[41] After much discussion, the initial teams were assembled. (See Appendices A and B.)

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[c] Other efforts in communication, and also special training programs, also facilitated the change process at PUREX. See Sections 3.5 and 3.6.

3.5 JOB APPLICATION AND SELECTION PROCESS

Once the job positions needed for each team were identified, the employees then working at the PUREX facility had to apply for the new positions. The old jobs would be abolished under the reengineered system. The WHC Human Resources (HR) Department, involved from the start, now added new "attributes" to traditional, technical job descriptions. Initiative, judgment, teamwork skills, leadership, decision-making ability, and customer focus were added to job description for positions where employees were not represented by unions. Even for bargaining unit positions where job descriptions stayed the same, people were told that their work scope would broaden to include helping to prepare work packages instead of simply executing them. Four additional job positions were created. Three of these were for coaches,"champions for change" who would meet with teams to resolve issues that developed with the novel work situations. The coach positions were announced as temporary, but now they will function through the end of the deactivation project. The fourth position was that of Configuration Control Specialist; a person to coordinate and map interactions so that the various teams' work did not get in each other's way, and to ensure control of essential plant systems.

WHC's HR involvement in reengineering the PUREX work force focused on four areas: selection, compensation, performance measurements, and redeployment of excess workers. An employee selection process was devised allowing employees an opportunity to look at a variety of jobs. Selections were made by committee rather than by a single assessor, and selection was based upon job-specific criteria developed by the Lab Team and selection committees. With the need for employees to be able to move between jobs (including moving to jobs that have lower grade levels under the existing system), salary administration was changed to pilot a "broad banding" system for the new positions. Employees were slotted into broad salary ranges, so that in no cases would people's individual salaries immediately change. Bands were listed simply as management, professional, and salaried non-exempt. Broad banding supported reengineering by allowing flexibility in awarding compensation based on individual skills and experience. It fit with the change to less hierarchical organizations, and it supported horizontal skills development and lateral job mobility. No changes were made to the labor agreement and/or bargaining unit salary programs.

While performance evaluations were left with managers in the PUREX reengineering effort, a computer-based program was made available for piloting. The program provided an option for peer assessment of team members, as well significant input by team leaders in rating the performance of team members against specific objectives. With the potential for employees to be made surplus by reengineering and by faster completion of work scope, a more formal worker redeployment process also was initiated.

In December 1995, the new job positions were posted at the PUREX facility, in a "People Center" newsletter established in the Spring of 1995 at PUREX and some ancillary locations. (For an explanation and discussion of the PUREX People Center, see Section 3.6.) Only then-current PUREX employees could apply for the new positions. Applicants had 2 weeks to respond and were asked to list their first, second, and third choices for placement on teams. Two more choices were allowed initially, but the number was cut to three for workability. Employees were encouraged to list not just jobs most closely fitting their current job, but additional jobs that might utilize skills not previously recognized used.

While the jobs were posted, three selection committees were brought together to review the applications and to pick people. A high-level selection committee chose people for the six management positions, a second committee chose the team leaders and coaches, and a third committee chose the team members. The interviewing and selection process took approximately 2 weeks. During the posting, application, and selection process, work slowed dramatically at PUREX. WHC now estimates that the PUREX facility spent 9,000 hours, and approximately $649 thousand in specific costs on this process. (Additional costs associated with temporary lost productivity are difficult to measure.)[42]

In December 1995, 71 percent of the exempt (management and professional) applicants at PUREX received their first choice job, 12 percent received their second choice, four percent received their third choice, and six percent received their fourth choice. Seven percent of exempt persons were placed in jobs outside of their requested choices. Fifteen percent of the salaried non-exempt applicants at PUREX received their first choice, 24 percent received their second choice, 7 percent received their third choice, and 15 percent received their fourth choice. Thirty-nine percent of salaried non-exempt persons were placed in positions outside of their requested choices. The WHC HR Department presented job placement opportunities for the 26 people not placed in any of the new PUREX positions, and all persons were placed (Figure 12).

3.6 THE PUREX PEOPLE CENTER ADDRESSES CHANGE

In January 1995, well before the PUREX work force reengineering effort began, a "People Center" was established at the facility to address the massive changes that were anticipated and in some ways feared in the PUREX Deactivation Project. PUREX employees already were facing two huge transitions that prompted the formation of the People Center. They knew, as employees of a deactivating facility, that they were "working themselves out of a job." The PUREX Plant was scheduled to close completely, and stand empty, subject only to periodic visits by monitoring personnel, in 1997. Every PUREX employee would have to find another job. Furthermore, in 1995 RL announced that, instead of renewing WHC's contract, it would recompete the contract with an entirely new format. The Project Hanford Management Contract (PHMC) would be awarded to a "management and integration" (M&I) contractor to interface between RL and a consortium of smaller companies that would perform specific work functions. Many (perhaps most) WHC employees would be acquired by smaller companies to perform specific and specialized functions. (As far as WHC employees knew in 1995, they might not be hired at all by the new companies, or they might be hired under conditions and expectations so different that long-term retention of even their new jobs could not be assured.[d])[43]

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[d] On June 19, 1996, RL announced that, "with the exception of management personnel as defined in the RFP (Request for Proposals), all other incumbent staff will be offered jobs somewhere in the new structure" at least until December 31, 1996. However, this information was not known nor factual in 1995.

Figure 12. A PUREX Team Moves Into a Co-location Setting, Early 1996.

Management realized that the magnitude and overlapping effects of the changes PUREX employees faced could make them leave their jobs early unless some positive steps were taken to address these changes. This would jeopardize the schedule and success of the Deactivation Project. Early in the project, knowing that jobs would diminish and end by the very nature of deactivation work, the PUREX organization began some team-building and people-focused activities. In late 1994, a task team was formed at PUREX to discuss the formation of a People Center, perhaps modeled on a center observed at Motorola Corporation. The task team consisted of an organizational development specialist, a communications specialist, and representatives of many PUREX job categories (management, exempt, salaried non-exempt, and bargaining unit). The group quickly honed in on key missions for the Center in communications and providing job placement information and services. The crucial difference between the People Center and traditional HR services would be that the Center would be available well before people were officially issued notices of impending termination. In its charter, the PUREX People Center stated its purpose as being "to provide job retention at the project by providing direct access to all Human Resources services; timely information about the project, site and external information; and by giving PUREX employees opportunities to help prepare themselves for employment at the completion of the project." Placement efforts for people whose work actually was ending at the PUREX facility aimed outward in a widening circle first on the Hanford Site, then in the Tri-Cities area, and then throughout the Pacific Northwest.

For the PUREX People Center to function optimally, the task team decided that it would have to be located at the PUREX facility, and would have to be staffed full time on a rotational basis so that employees could have access to it whenever they felt most anxious. The benefits of the People Center to the PUREX Deactivation Project were defined as enhancing project stability; giving employees access to accurate information about the Hanford Site, the Transition Projects Division of WHC (in which the PUREX facility was located organizationally), and PUREX forecasts; providing employees access to career pathing tools; sharing information to enable employees to make intelligent career decisions; allowing employees a place to talk and a person to talk to; providing confidential counseling; and quashing unfounded rumors. The Center offered HR Job Placement services (Internet connections and other computer links, voicemail services, points-of-contact lists from local agencies, forms, WHC procedures, union contacts and contracts, union seniority lists); PUREX staffing forecasts; assistance in writing resumes; books, audio tapes and video tapes on the interview process; bibliographies of resources from the local college and university; and contact with coordinators and specialists in Employee Concerns (a grievance program), organizational development, and communications.[44]

A People Center newsletter was started immediately, and was published on an intermittent but frequent basis (not less often than every 3 weeks). It was distributed to PUREX employees, WHC and DOE senior management, HR, the WHC Employee Concerns office, and the WHC Communications Department. Copies also were left in a prominent place in the PUREX badge house. The newsletter featured articles on Deactivation Project milestones, stress management, teaming, team members, change, reengineering principles and news, and also, to enhance the fun/partnership aspect, a slip for a prize drawing. The newsletter always included a graphic or a graph, in recognition of the fact that some people retain graphic information more easily than printed words.

Also in view of people's different learning styles, employee meetings were held monthly at PUREX so that people could hear the project news verbally and ask questions (Figures 13 and 14).

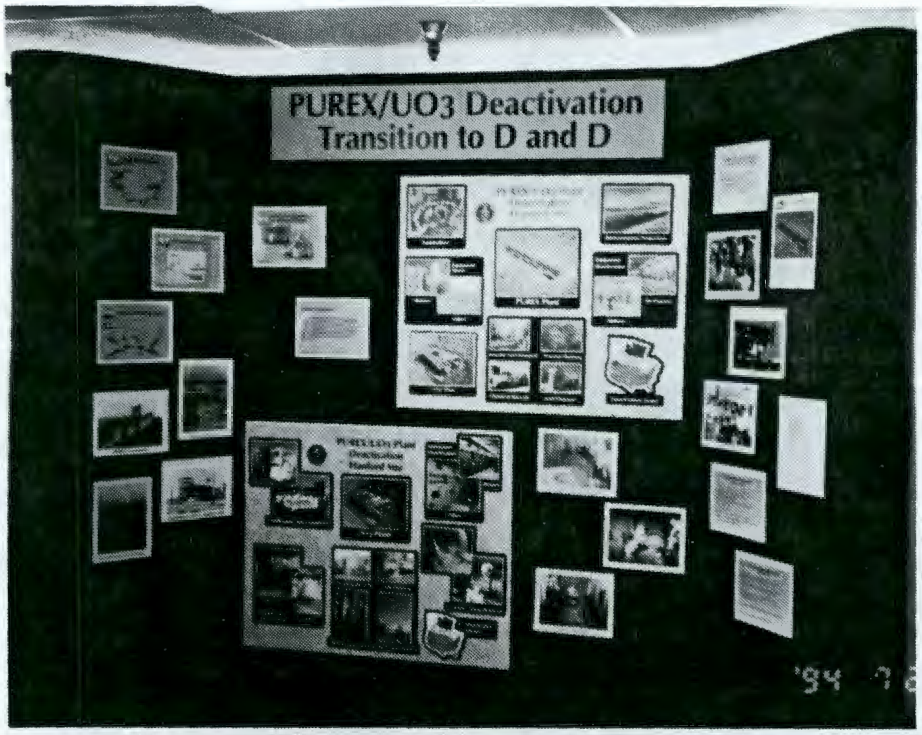
3.7 TRAINING PEOPLE FOR THE REENGINEERED WORK PLACE AT PUREX

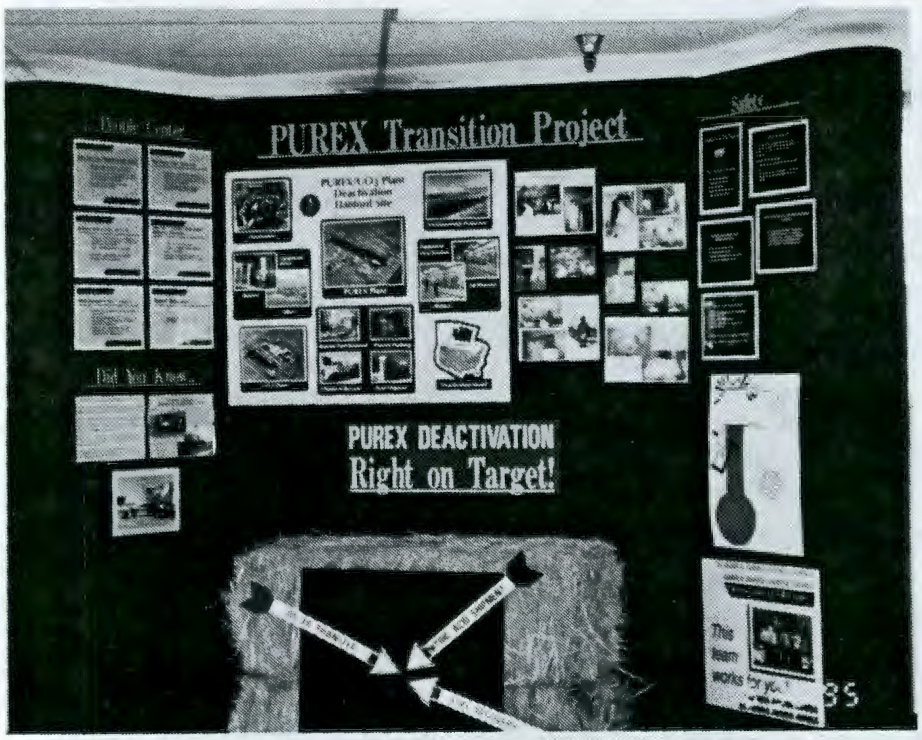
As reengineering implementation approached at the PUREX Plant, the team recognized that the effort would bog down and perhaps fail if people were not given ongoing training in how to function in new modes. A specialist in organizational development was hired full time in the Autumn of 1995. Training, based on vendor-supplied, commercial modules was developed in teaming skills, communication skills, leadership, and problem-solving. As soon as the PUREX work teams were formed in December 1995, each team began a 4-day training session. The module concept and length of training raised many complaints among PUREX workers. Workers chafed at the long length of the training when they felt they needed to be back at work accomplishing deactivation goals. They also perceived the training as moralistic, "motherhood-type" training on topics such as "how to get along. Also, the training was of the simplistic and mechanical "how to" variety, rather than of the "wide-angle" variety." The reengineering team soon realized that PUREX team members would not need this training until they were further along in the process of having to struggle with their first work endeavors as teams.

Soon, new training tools were substituted that focused on the basic roles and responsibilities of whole teams. A "Team Start-up Kit" module was used, that forced teams to look at their essential reasons for existing. Questions asked in the new module compelled teams to examine their basic purposes and ground rules, to define their customer(s), to identify what they actually did, and to ask why the overall organization could not exist without them. This kit helped to address many problems that can slow down new teams. It helped teams understand the team concept, establish operating guidelines, and conduct effective team meetings and training. Most importantly, the kit helped teams to understand and write a charter for themselves. At PUREX, charter-writing was delayed several months into the reengineering cycle. Plant leaders now realize that developing the charter earlier could have imprinted the teaming concept sooner. They also have learned that "basic" training should have come first, with specific training in "how to operate" as a team to follow in shorter, continuing periods (especially when requested by the teams).

Organizationally, the PUREX teams are following typical developmental curves leading through five distinct stages: start-up, state of confusion, leader-centered (dependent on the team leader for direction, motivation), tightly formed (integrated and loyal, though perhaps still sub-functional), and finally self-directed (capable of carrying out multiple tasks in a cooperative, coordinated manner). Ongoing training after the charter-writing stage, using a "Team Development Kit" is helping the teams work through these stages towards full maturity. It helps them to identify areas for development, measure effectiveness, and improve performance.[45]

Figure 13 and 14. Information Boards Established at PUREX to Keep Workers Informed. Extensive Communication with Employees Helped Reengineering Succeed.





Perhaps the most difficult aspect of training in the PUREX work force reengineering endeavor is addressing a "sea change in attitudes and values" regarding the definition of loyalty and the re-definition of workers from dependent to self-reliant. A 1994 article in the *Harvard Business Review* stated that the world of late 20th century and emerging 21st century change could only be weathered if American businesses entered a "new covenant" wherein employers and employees shared the responsibility for maintaining and enhancing employability inside and outside of existing organizations and companies. Employees, stated the article, could no longer entrust major career decisions to a parental organization. Such a situation made employees dependent and static. Employers could no longer regard employees as disloyal if they developed new skills and moved easily across functional boundaries.[46]

At the PUREX facility, a long history of secrecy and conservatism in following governmental directives made such new ideas difficult to internalize. Early in the deactivation project, PUREX leaders began to explore ways to encourage openness, boldness, and attitudes that bespoke personal independence in employees. However, the PUREX work force reengineering truly brought home and made real to workers the current DOE imperative to achieve "culture change." Many of the reengineering training sessions needed to focus on "career resilient" attitudes to replace the paternalistic patterns practiced over decades at the secret and isolated Hanford Site.[47]

3.8 RESULTS/ASSESSMENT OF PUREX WORK FORCE REENGINEERING

Thus far, the results of reengineering on the PUREX work force and its performance have been positive, and not just quantitatively (see Section 3.2). Greater efficiency in performing field work is obvious, as work teams are empowered to resolve problems encountered in the field and change work documents as appropriate. Reengineering has "legitimized" some processes that always existed unofficially at PUREX; ways around the system now are the system. Work teams follow work items from beginning to end, feeling and being responsible for a task until it is accomplished. Work teams schedule work within their own groups to support the overall project schedule. Teams approve their own procedures and work packages, and are responsible for all aspects of work performance and budgeting. RCTs write the Radiation Work permits for their teams. However, teams can draw on centers of expertise, such as estimators and safety officers, to augment existing plant capabilities. Teams are responsible for their own productivity and outcomes, and for evaluating their progress. Teams also are co-located, adding to a greater sense of involvement; job satisfaction and ownership are among the most notable differences among employees.

The issue of job security, always a worker concern in deactivation projects, is addressed by the assurance that personal and team excellence can more visibly show in a reengineered organization and can result in better future job prospects. Reengineering, according to HR personnel involved and watching the PUREX work force reengineer, actually allows a nonproductive person fewer places and ways to hide that lack of productivity. The new system brings many issues, especially performance, to light. In the old organization, personal commitment to the outcome of a job could be obscured. In the new work teams, an individual who is not performing, or is making excuses instead of acting to accomplish work, is more easily visible to other team members. Likewise, extreme egotism, which demands glory and subverts cooperation, may become more visible, even in workers who have seemed dedicated for many years. Corrective actions can be taken sooner and more directly.[48]

Managers and team leaders at PUREX likewise have experienced many positive changes. Managers in the old PUREX organization who became team leaders or individual contributors under reengineering undoubtedly were frustrated initially. However, as non-managers, they find that only a few of their functions (notably the right to allocate expenditures above certain levels and to take personnel actions) have been diminished. Managers and team leaders alike function more like mentors and "barrier-busters" than like traditional supervisors in the reengineered PUREX. Managers must let go of much of their accustomed decision-making role, because most work decisions are made by the teams. The sense of participation in a joint, mutually rewarding endeavor has increased among PUREX workers, team leaders, and managers.

One potential problem area of the reengineered PUREX work force mentioned by plant leaders thus far is that employees who used to devote much of their time to walk-in work, such as responding to investigative teams, writing special documents, leading facility tours, etc., are hard to fit into the new organization without diluting efforts toward core work. Therefore, the organization has to depend on specialists from outside the PUREX facility when special needs arise, then work to educate these people. Also, not every organizational problem has been solved by reengineering. Small refinements and issues, as all human endeavors, may arise and be resolved over time, and some issues will never be resolved.[49]

3.9 LESSONS LEARNED

Lesson No. 10. Reengineering breaks internal organizational barriers and motivates workers based on ownership and the knowledge that their own performance on teams will be recognized. The knowledge that the best performing teams may be the first to be hired or recommended for new positions offers a powerful incentive to people to work themselves out of their jobs.

Lesson No. 11. Organizational culture, fed by management systems, values, and rules both modeled and expressed, is often deeply entrenched and very conservative at older DOE Sites. (The same may be true of many older industries and Department of Defense sites.) This culture, which valued secrecy, loyalty, and a zero-risk mentality, must be recognized and the commitment to change underscored boldly at all levels of management, if reengineering is to succeed. Moves toward a self-directed work force must be encouraged by management, and must never be viewed as disloyal.

Lesson No. 12. Involving people who have worked at a facility or in an organization for a long time is essential if the true nature of the work and needs of the facility are to be understood. When newer, less intimately involved persons try to define essential work needs in a facility, they usually can achieve only general statements. For the detailed work analysis necessary to structure teams to succeed, long-time workers must be involved.

Lesson No. 13. When external teams arrive at a facility to begin reengineering, they must be careful not to "shove" ideas at the facility workers, and they must communicate and make themselves regularly accessible. Opportunities for workers to talk with external teams must be structured so that the workers are not intimidated. Team members should go individually to facility lunchrooms and other gathering spots, , announced and impromptu, and allow workers to ask questions. Announcing that the team has an open-door policy may not make employees comfortable enough to approach the team's door.

Lesson No. 14. If teams lack critical resources , they will not succeed. At the same time, it makes sense for specialists such as safety and regulatory experts to serve all teams equally, and not be assigned permanently to an individual team.

Lesson No. 15. Team leaders need skills in judgment, initiative, leadership, team-building, decision-making, and customer-focus, in addition to their technical skills. Also, individual workers can use the job re-application process to display personal skills that may have been unrecognized before.

Lesson No. 16. A reengineered, team environment offers fewer absolute opportunities to climb an organizational ladder. Therefore, salaries must be placed in "broad bands" to allow individuals to proceed at their own paces up a merit-based continuum.

Lesson No. 17. A facility such as the PUREX People Center benefits a deactivation project greatly because it opens up communication, quells rumors, and helps dispel discontent and fear by giving workers early and ongoing access to HR resources. The emotional reaction of fear of change is powerful. A People Center, *located in* the facility, and staffed full-time on a rotational basis, allows people to talk and seek resources and information when they feel the need.

Lesson No. 18. People working themselves out of a job should be given access to information about future jobs long before their own jobs end. Otherwise, fear of unemployment may drive them away from the deactivating facility before they can accomplish the deactivation work.

Lesson No. 19. Different people respond best to different forms of communication. Facilities should use all avenues of communication, including written, graphic, and verbal.

Lesson No. 20. A charter, stating basic purpose, identity, and reason for being should be written by each team soon after its formation. A charter sets the tone for the "new world" of the reengineered facility.

Lesson No. 21. Ongoing training, after a team begins to struggle with actual work problems, is important. Training in specific skills such as problem-solving, communication, etc. should not begin immediately after team formation. If such training is mandated too soon, much of what is offered is not appreciated and is even resisted by team members.

Lesson No. 22. Teams have five distinct stages of development: start-up, state of confusion, leader-centered, tightly formed, and self-directed. These stages must be recognized by management and organizational development personnel who facilitate the reengineering process. If these stages are not recognized as normal, facility leadership may think that reengineering has failed.

Lesson No. 23. Once a team is formed, it must be given cradle-to-grave responsibility for its work products. If control is taken away from the team, it may stop feeling responsible for the work and the reengineering experiment may fail.

Lesson No. 24. Teams must be physically co-located to bond and to feel jointly responsible for work.

Lesson No. 25. Reengineering brings nonproductivity and egotism to light. Hiding such patterns is impossible in a reengineered structure. Surprises may await managers and coworkers when some employees reveal these less than cooperative attributes.

Lesson No. 26. Reengineering is not a one-time activity; it is a way of thinking. Some problems will never be solved in a facility, and some may take long, slow, patient action to undercover and remedy. After reengineering, management and workers still need to be vigilant for ways to smooth and improve. Reengineering is a never-ending process.

Lesson No. 27. Teams should not be too large. A team of over 20 people will have trouble focusing their discussions and reaching closure on decisions.

Lesson No. 28. Not every job function or set of workers should be brought together in a team. Teams must have common goals to function. Workers in administrative support functions, facility support, and technical support, by the very nature of their tasks, will not share the same goals. These workers should continue to be managed as groups.

Lesson No. 29. All key reengineering decisions in a deactivation project must be driven by the project's end points. If the end points are not in place, teams may be organized in ways that are less than optimal, budgeting and scheduling will not be efficient, and the project will flounder.

4.0 PUREX WORK PLANNING/ENDPOINTS DEVELOPMENT AND DOCUMENTATION

4.1 FIRST STEPS IN DEACTIVATION WORK PLANNING

When the PUREX facility shutdown order was received in December 1992, plant managers began detailed planning for the actual physical steps that would be needed to bring the huge facility to a safe, low-cost, low-maintenance status. It must be recalled that facility deactivation work, pursued as a project, was a new field at that time, and DOE guidance manuals that are available today had not yet been written.[50] After receiving a generic set of D&D acceptance criteria in March 1993, PUREX personnel held a large workshop to discuss and define the major technical tasks. They divided the technical work into 20 major tasks:

- Chemical disposition
- Single-pass reactor fuel disposition
- Slug storage basin deactivation
- N-Reactor fuel disposition
- Zirconium heel stabilization
- Uranium/plutonium solution disposition (D5/E6)
- Canyon flushing
- In-plant waste concentration
- Contaminated solvent disposal (organic - TBP/NPH)
- Contaminated nitric acid disposition
- PR room cleanout
- N-Cell cleanout
- Q-Cell cleanout
- Sample gallery deactivation
- Laboratory deactivation
- P&O gallery and white room deactivation
- Utilities and service systems (water, steam, electrical, and fire suppression)
- Support and ancillary systems deactivation (293-A, 203-A, 211-A, 206-A, 205-A, 212-A, 294-A) and other ancillary buildings

- HVAC consolidation
- UO_3 Plant deactivation

Some technical tasks and subtasks were reorganized many times, but by July 1993, the list was finalized and has held through the end of the first official year of the PUREX/UO_3 Deactivation Project (FY 1994).[51]

Once the major technical tasks were defined, a lead engineer and a support engineering team were assigned to each task. For 2 months beginning in August 1993, personnel from the engineering, operations, maintenance, and program and project control organizations met nearly continually in the PUREX war room (a central conference room). They first defined the logic and sequence of each main task, along with the resources to continue routine and required S&M checks. In the summer of 1993, schedulers from the PUREX project control organization began producing draft schedules primarily based on the input and decisions of the meetings held in the war room. (See Section 5.0 for more detailed information on scheduling.)[52]

4.2 PROJECT MANAGEMENT PLAN

Early in FY 1993, work began on a *PUREX/UO_3 Deactivation Management Plan* (PMP). Prepared under the guidance of DOE Order 4700.1, *Project Management*, the PUREX plan was large. It attempted to encompass regulatory planning, safety strategy, scheduling and budgets, numerous technical plans, management and organizational structure, information and reporting requirements, safeguards and security plans, records management, a plan for managing critical skills and workforce redeployment, stakeholder involvement, an S&M plan, waste management, and provisions for quality assurance. When issued as a draft in September 1993, the document filled over 220 pages. After stakeholder and DOE review, the document became even longer.

The plan was issued in final form in August 1994. It was useful as a comprehensive record, but was unwieldy to review and revise, so it lost much of its flexibility and usefulness to the project. The plan also had other shortcomings. The work breakdown structure was not well defined nor structured for a true project. Because end point criteria, specific project end points, and S&M plans had not yet been developed, the plan could not be a true map of the project. It did not contain the same level of detail for S&M activities as for deactivation activities. Where deactivation activities were specified in detail, they sometimes changed over the life of the project. It also provided only limited detail for the technical baseline and for integration with other Site management systems. By the last year of the project, the plan had little value as a reference document.[53]

4.3 END POINT CRITERIA WORKSHOP

The process of developing end points in the PUREX/UO_3 Deactivation Process is described in detail because of the overriding value that end points have provided to the project. During late 1993 and early 1994, as the PUREX/UO_3 PMP was being drafted, DOE and independent technical experts (ITE) assigned to aid the project questioned work planning at its most basic level. The ITEs pointed out that without predetermined end point criteria, the deactivation project truly lacked a compass. How could planners decide whether or not a particular job was necessary and valid if they had not defined the desired or required end products of all the jobs? How could specific meaning be added to vague end point terms such as "safe," "ready for D&D," and "clean." These comments led to a PUREX management decision to perform an End Point Criteria Value Engineering (VE) Study[e] in February 1994.[54]

The End Point Criteria VE Study was conducted jointly by representatives of the contractor and RL D&D organizations, the RL deactivation organization, ITEs, and multiple components of the PUREX/UO_3 organization. The purpose of the study was to define D&D acceptance criteria for this particular project in a cooperative manner. The study emphasized that maximum safety improvements must be extracted from every deactivation dollar spent. The product of the study was not a set of joint D&D acceptance criteria at all. Instead, the key conclusion was that, with a long lag time between deactivation and eventual D&D, planners of the deactivation project could not know nor anticipate the methods, needs, and capabilities of future D&D endeavors. In other words, factors ranging from technology to public desires could change the character of 21st century D&D efforts into forms not even imaginable by today's planners. Therefore, the study concentrated on developing a methodology for making deactivation decisions, rather than on defining specific technical end points. The process itself was the product. Its highest value was that it could be applied in a flexible fashion to resolve the ITEs' concerns, as well as other concerns and issues that might develop along the way.

4.4 MATRIX-BASED APPROACH TO ESTABLISHING END POINTS

A matrix-based approach to establishing deactivation end points became the product of the study. A two-dimensional matrix was devised to be applied across systems and spaces in the PUREX and UO_3 Facilities. At the top of each page of the matrix, one structure or space (or a collection of similar structures and spaces) within the plants was identified. One axis of the matrix listed the top six goals to be considered in deciding which deactivation tasks to complete. These six goals were:

- Protect the deactivation and eventual D&D workers
- Protect the public and the environment
- Prepare the facilities to need only quarterly S&M (surveillance and maintenance) checks
- Comply with applicable regulations
- Consider D&D needs insofar as is possible in a general sense
- Keep commitments made to stakeholders.

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[e] Value Engineering is the name of a workshop with a specific format, used many times at WHC and other companies.

The other axis listed issues and hazards associated with each structure or space. Examples of such issues and hazards included the presence of the following:

- Fixed radioactive contamination
- Non-fixed radioactive contamination
- Mixed waste
- Low-level waste
- Transuranic waste
- Transuranic mixed-waste
- Non-regulated waste
- Hazardous materials
- Fissile materials
- Industrial Occupational Safety and Health Administration (OSHA) Washington Industrial Safety and Health Administration (WISHA) hazards
- Residual liquids
- Dose rates in the area
- Confined spaces
- Exterior penetrations that could allow animal or weather access;
- Fire hazards
- Active utilities
- Spare parts
- Whether or not the areas or structures in question were posted as radiation and/or asbestos zones
- The structural integrity of the facility
- The status of equipment in the facility.

Working across the matrix, each condition or hazard within the plants could be addressed in light of which actions could or should be taken to mitigate the hazard. The study report stated that the matrices identified in terms of concept and initial design during the VE Study needed to be refined and extended to more sophisticated levels.[55]

Once the End Point Criteria VE Study was completed, PUREX personnel convened in the war room to reexamine each planned deactivation action. Next, the PUREX engineering organization began examining the existing facility work plans and procedures and writing new ones where needed for deactivation actions. Where possible, existing work plans were used as a cost-savings measure. Revisions also began on the PUREX/UO_3 Deactivation Project Management Plan. At the same time, so many valuable concepts had emerged from the PUREX End Point VE Study that DOE Headquarters (HQ) contracted the writing of a Facility Deactivation End Points Handbook to serve as a guide for facilities across the nation.[56]

Even as deactivation work planning consumed much of the time and attention of PUREX personnel throughout 1993 and 1994, and as required S&M checks expended much of the remaining resources of the plant, some actual deactivation tasks moved ahead. Meeting together, engineers, supervisors, and nuclear process operators defined several deactivation tasks to be done as "best management practices" before specific end point criteria plans were finalized. The effort to define end points became more urgent as planners realized how crucial these criteria were to work and resource decisions.

4.5 END POINT PLANNING FIRST TESTED AT UO_3 PLANT

The first real test and application of end point planning came at the UO_3 Plant, where a series of precedent-setting steps were taken in 1994 that extended the concepts initially defined in the PUREX Deactivation End Point Value Engineering Study of February 1994. The seven key, generic objectives for facility deactivation projects remained the same. However, the following seven logic-based guiding principles were defined for the UO_3 deactivation.

- Every end point decision should be driven by, and clearly linked to, major program objectives and goals (those defined by PUREX in the Value Engineering Study).

- The end point condition of the deactivated facility should employ "defense-in-depth" as a fundamental safety approach. As applied at UO_3, there would be three layers of protection: elimination of hazards, effective facility containment, and facility monitoring and control.

- End point decisions should be linked integrally to decisions and constraints on resources and methods. Cost effectiveness was important.

- Successful end point development would require ownership (buy-in) by all affected organizations.

- Clear, measurable completion criteria would need to be established for work teams in the field.

- Because ultimate D&D methods, time frames, and end states could not be known, end point decisions should not be driven by D&D presumptions.[f]

- End point development should be an iterative process. While end points should be established early, they should retain some flexibility because they might have to be revised during the deactivation process.[57]

In the UO_3 Plant End Point Criteria document that was created in 1994, the primary deactivation tasks were defined as follows:

- Eliminate or reduce hazards (chemical and physical)
- Deal with radiation fields (eliminate, shield or isolate)
- Reduce contamination and prevent its spread
- Remove waste
- Isolate and contain residual, potentially hazardous materials or conditions
- Provide the capability to monitor and control the facility
- Refurbish or install any facility modifications necessary to support future work (S&M or D&D)
- Document and label legacy equipment and systems.

An internal classification system for spaces and systems within the facility then was applied. There were six cases or criteria, three concerning spaces and three concerning systems:

- Case 1 was internal spaces for which routine access was expected during the S&M period (post-deactivation, but pre-D&D)
- Case 2 was internal spaces for which routine access was not expected
- Case 3 was external spaces, including building envelopes
- Case 4 was systems and/or equipment that had to be kept operational (such as surveillance lights)
- Case 5 was systems and/or equipment that was to be mothballed for possible future use by D&D (such as freight elevators)
- Case 6 was systems and/or equipment that was to be abandoned in place.

[f] Note: End point criteria are those that apply to the finish points of a deactivation process. End state criteria are those that apply to the finish points of a D&D process.

Every place, system, and piece of equipment in the facility was to be assigned to one of these cases.[58]

The UO_3 deactivation project objectives, fundamental tasks, and the six cases were integrated in the first prototypical example of the extended end point matrix. Three levels of evaluation were performed:

- Level I activities applied to all the facility
- Level II activities applied to just one case (but to all spaces, systems or equipment within that case)
- Level III activities applied to just one object in the plant.

A matrix was created for each level. End points were determined for each level, based on what specific tasks would be necessary to achieve deactivation objectives. Each task was evaluated as it related to each objective, and was placed into one of four general categories.

- Category One tasks, because of the objective(s) they supported, needed to be given primary consideration or rank in setting the end points
- Category Two tasks, because of the objective(s) they supported, could be given secondary consideration. They were important but would not be the controlling factors in setting end points
- Category Three tasks were applicable to particular regulations, requirements, or stakeholder commitments
- Category Four tasks were not applicable to the direct support of any end point objective.

Every activity that could be done in deactivation was scored in at least one matrix (and sometimes in a matrix for each level), graded, and negotiated among representatives of the deactivation and D&D organizations. Finally, in this manner, agreement was reached as to which activities would be performed in the UO_3 Plant deactivation. The matrices and their agreed-on results were complied into the UO_3 End Point Criteria Tracking Document, a signature book that actually recorded completion of all 1,740 end points (signature by deactivation contractor personnel) and verification (signature by D&D contractor personnel).[59]

4.6 PUREX PLANT END POINTS DEVELOPMENT REFINES UO_3 APPROACH

As soon as the UO_3 Plant end points were fully written (although not all completed and signed off) in the Autumn of 1994, full-time work began in developing the PUREX end points. The same guiding principles and basic objectives applied at both facilities. PUREX end point development required the same primary tasks as had been performed for UO_3 end point development, following the sequence through classification of spaces and systems, applying the functional matrix, and establishing detailed end points for each space and system. However, difficulties emerged in applying the same methods at the huge PUREX facility. At the same time, lessons were being learned in implementing the end points at the UO_3 Plant. These events combined to bring about some key changes that improved the PUREX end points.[60]

One salient difficulty at PUREX concerned the facility's sheer size. At UO_3, all of the criteria assigned to each case had been applied to each applicable space and system, and became the end points for that space or system. When this process was applied at the PUREX Plant, and when specific named end points were added (such as the removal of plutonium residues from a given laboratory hood), the result was nearly 10,000 end points![61] Also, as the 1,740 UO_3 end points were being signed off at that plant, the team discovered that many of them were not applicable, and that simply using criteria as end points resulted in end points that were vague and subject to interpretation and argument. End points such as "remove fixed contamination from...(a certain space) using best management practices" had no real measurements attached to them, and the deactivation and D&D organizations sometimes could not agreed as to when they were completed. Also, every system and space did not need action for each criterion, so that some UO_3 had to be closed out by writing "N/A" (not applicable).

In February 1995, the same month that the UO_3 Plant transitioned to the D&D organization and the first set of nearly 10,000 PUREX end points was published, work began on revising the PUREX end points. The deactivation and D&D organizations both carefully evaluated each area, space and system in the PUREX Plant. If a given criterion did not apply, the end point was deleted at this nexus. Also, where criteria did apply and became end points, the end points themselves were tightened into quantifiable, measurable language. For example, "remove fixed contamination from...(a certain space..." became "remove fixed contamination from...(a certain space) such that contamination readings are no higher than XXX (a specific number). In this way, the PUREX end points, as finally determined by August 1995, stood at 2,525 and reflected exactly what needed to be done. Work plans then could be written to provide the specific "hows" of reaching each end point. Schedule rebaselining to fit the end points followed in the Autumn of 1995 (see Section 5.4). Unfortunately, at PUREX, post-deactivation S&M planning was not well developed when the end points were being written, so that the clarification that a clear S&M plan might have provided was not available.[62]

As a last step in the end point process, an independent contractor performed a hazards analysis to certify that the planned end state of the PUREX facility, once all of the end points were completed as agreed on by the deactivation and D&D organizations, would leave the facility in a safe, stable configuration. The hazards analysis used a graded approach in recognition of the complexity and inventory at risk in the PUREX facility, and assessed the likelihood and consequences of potential releases. When this study was completed in February 1996, it basically validated the PUREX end point plans, and the process of signing off all of the end point items moved forward.[63]

4.7 LESSONS LEARNED

Lesson No. 30. A short, high-level project plan prepared as a policy document would be a better tool for setting overall deactivation strategy than a deactivation project management plan. Subplans dealing with various issues such as regulatory compliance, safety strategy, stakeholder involvement, etc., then could be issued as supporting or ancillary documents. Then, each document could be revised and implemented more quickly without waiting for total consensus on all sectors of the project.

Lesson No. 31. A deactivation project management plan should focus primarily on the baseline, baseline control, reporting, management, and summary sections. The project control system is crucial and should be consistent with project management methods rather than with operating methods.

Lesson No. 32. End point criteria *must* be developed at the start of a deactivation project so that they can be available as tools to prioritize the work throughout the project. Much money, time, and effort will be saved if "right to left" thinking (end to beginning) is practiced. End point criteria should have been in place before PUREX schedules were developed and before other work planning went forward. End point criteria and end points must be set as a *first* priority in a deactivation project. They guide every aspect of the work, the budgeting, and the facility's organization.

Lesson No. 33. Because many years often pass, or can be expected to pass, between deactivation and ultimate D&D of major DOE facilities, the exact needs, methods, and end states of D&D in the 21st century cannot be anticipated. Therefore, developing a functional matrix-based approach to deciding which deactivation tasks add value to a project is better than establishing vague end point criteria. Such an approach must have joint participation and concurrence between the deactivation and D&D organizations.

Lesson No. 34. The sophisticated and interwoven objectives, fundamental tasks, levels, cases, and matrices developed in the PUREX and UO_3 Deactivation end point criteria compel all parties to take a justifiable, accountable look at why each task is done. Each task must have value to pass this test and to be approved and executed. This approach results in cost savings and enhanced safety for deactivation workers, because it eliminates some unnecessary tasks. Another advantage of this methodology is its inherent ability to build consensus between deactivation and D&D programs, and to avoid costly disagreements at the time of facility turnover and beyond.

Lesson No. 35. End point specifications should state what work must be done (in specific terms), but not how it should be done. The "how" aspect should be written into work plans that follow closely on the end points.

Lesson No. 36. End points should be specifically written such that visual verification is possible and can be agreed on easily by the deactivation and D&D organizations. If end points are not specific, agree ahead of time on the verification methods and standards. For example, visually verifying an end point that states "Resolve Serious Threats" or "Seal" is difficult. The criteria that constitute sufficient compliance need to be quantifiable, measurable, and agreed on ahead of time.

Lesson No. 37. "Not Applicable" can never close an end point. If an action is truly not applicable, it should not be an end point.

Lesson No. 38. Plans for post-deactivation S&M should be written before or along with end points, so that S&M activities can be factored into end point development.

Lesson No. 39. Negotiated agreements and/or special requirements resulting from regulatory drivers or stakeholder interests need to be known and factored into end point planning. If specific commitments have been made for the facility, or for or by the deactivation or D&D organizations, these need to be identified ahead of time.

5.0 SCHEDULING PROCESS AND PRODUCT

5.1 EARLY SCHEDULING DECISIONS

In early 1993, DOE made clear to the PUREX management that the project schedules should be a key component of the planning. The benefits of logical, integrated schedules were expected to more than surpass the costs and effort of producing them. By integrating tasks in a logical sequence, timed and resource-loaded to accurate completion dates, the huge deactivation project could proceed without repetitious effort, time lags or gaps, and thus save money. At PUREX, an early scheduling decision concerned whether the in-house Project Control organization or a specialized outside firm should perform the scheduling work. The first decision kept the work in house, but provided for additional training for the PUREX schedulers because they had never before performed tasks of the complexity and magnitude required by the Deactivation Project. It was reasoned that the dedication and commitment of the in-house staff to the old facility would outweigh the expertise of a specialized firm.

The "Quik-Net"[9] software scheduling program was chosen, primarily because Quik-Net equipment (software and compatible computers) already was in use at PUREX and many schedulers and engineers who would have input into the schedules were familiar with it. It was thought that several scheduling programs would or could function to establish the PUREX/UO_3 schedules, but that the procurement, training, and start-up times would impose unacceptable delays to the project. Because the PUREX/UO_3 deactivation would require a huge number of extremely complex schedules, the Quik-Net vendors conducted two types of special, project-specific training. They spent 90 days in full-time residence at the Hanford Site, working with the expanding PUREX Project Control scheduling staff. They also believed that one key to producing good schedules was to upgrade the level of understanding of scheduling needs among all of the personnel who would provide input to the schedules. To implement this belief, and to allow all PUREX personnel to "speak the same language" as the schedulers, the Quik-Net vendors conducted 2-day training sessions for the all personnel associated with the deactivation project.[64]

In early 1993, PUREX Project Control issued a call letter to all plant personnel responsible for Standby schedules. It was asked that open items on the old schedules be evaluated to determine if they were necessary to the deactivation project. Unnecessary items were removed via a formal schedule change request; useful items were retained but sometimes renamed or regrouped with other activities. At the same time, the Quik-Net vendors conducted a schedule review to identify crucial concepts that would allow the most useful deactivation schedules to be created. The primary recommendations from this review included the need to develop a high-level ("master") project framework and planning process, strengthen the resource management process, build flexibility for changes into the scheduling process, monitor progress in specific, identifiable ways, and transfer real leadership authority for schedules to the PUREX Project Control organization.[65]

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[9] "Quik-Net" is a trademark product of Project Software and Development Inc., of Cambridge, Massachusetts.

Scheduling for the PUREX/UO_3 deactivation tasks began in the spring of 1993 with four main project areas (then known as Level I Schedules) identified: criteria and plans, facility deactivation, UO_3 transition, and project management. A lead manager was assigned to each Level I area and asked to gather a team of engineers to name the Level II tasks within each area. (At that time, Level II schedules represented one more increment of detail beyond the large umbrella tasks identified in Level I schedules.) Creating the Level II schedules resulted in 2 major tasks in criteria and plans, 15 activities in facility deactivation, 8 activities in UO_3 transition, and 6 activities in project management being identified. Each Level II activity then was assigned a champion, who in turn assembled a larger team composed of engineers, craft supervisors, and nuclear process operators.

It was at that time that the marathon meetings in the PUREX war room began (see Section 4.1). The specific tasks necessary to accomplish each Level II task were written on small pieces of paper and discussed in detail by the persons who actually would write the work plans and perform the work. Then the specific tasks were rearranged in various sequences along the walls until consensus was achieved on the best pathway to accomplish each task. Thus, Level III, IV, and V schedules (representing greater increments of detail) were drafted (Figure 15).

5.2 OVERALL COORDINATION REQUIRED FOR DEACTIVATION PROJECT SCHEDULING

For the deactivation tasks, the next scheduling step was to identify the proper sequence for conducting various activities. PUREX personnel soon learned that in defining the sequencing step they encountered the real differences between facility operations work and project work. In routine operations, many jobs occur simultaneously, so work groups do not have to coordinate closely with one another. Also, operations personnel generally work in just one area or task. However, in a project environment, work must be performed in a logical sequence or the performance of one task will result in delays in another task. Also, work already performed in one task may have to be redone, if, for example, the work on another task recontaminates or reactivates an area already cleaned or closed in the first task. Also, in a project environment, personnel shift among various jobs so their time needs to be carefully and logically allocated.

Once the logic ties were identified, critical path jobs (high-priority jobs with long duration or first need in the project) were highlighted. Then all of the jobs were resource-loaded. Engineers and the people actually responsible for performing the tasks met to decide how many person-hours or days were needed to accomplish each task. For some tasks that depended on specialized, aged equipment (such as the PUREX cranes), a 40-percent contingency factor was added to the time allotments to allow for outages and equipment breakdowns. At this point, the PUREX Project Control schedulers placed all of the crucial information developed in the war room into their programs and produced draft schedules to be examined for overlaps, duplication, and other flaws.

Figure 15. Early Deactivation Project Schedules Being Developed in the PUREX War Room, 1994.

As part of the examination and checking process, the engineers responsible for each Level II task wrote a work breakdown structure (WBS) dictionary that named and described each task and listed the subtasks needed to accomplish it and any unknown factors that could affect the task. The WBS is a management technique for dividing a total program into manageable units of work. The WBS should provide the basic map for developing estimates, schedules, cost collection, and program reporting because it states what needs to be done. The WBS also should be the basis for developing a responsibility matrix to identify which organizations and subcontractors have prime and support responsibilities for each WBS element. At PUREX, although all the steps necessary to developing a WBS and a WBS dictionary were accomplished, they sometimes occurred in overlapping rather than sequential fashion. More outside scheduling and project control expertise could have helped streamline these steps. However, by the end of FY 1993, a set of 108 Level V schedules, fully integrated and resource-loaded, was issued as the baseline schedule of the PUREX/UO_3 deactivation project.[66]

5.3 1994 BASELINE REVISIONS

During FY 1994, the 1993 baseline schedules were revised in response to various technical and work changes imposed by regulatory requirements, stakeholder input, and new information received from preliminary characterizations of plant areas. Other factors contributing to the revision included steam outages and other equipment and system breakdowns. Throughout the year, the PUREX war room often was filled with discussions of how best to accomplish specific tasks in light of new developments. Two major innovative ideas in disposition options for the plutonium/uranium solution and for the contaminated nitric acid remaining in the plant resulted in a schedule compression of 10 months (see Sections 8.2 and 8.4). In combination with the reduced S&M costs associated with them, these new approaches saved $36.9 million for the overall deactivation project. At the end of FY 1994, the PUREX/UO_3 deactivation project still was guided by 108 Level V schedules, albeit revised from the 108 schedules used in FY 1993.[67]

5.4 REBASELINING, REENGINEERING BRING SCHEDULE REVISIONS: LEAD TO TEAMS OWNERSHIP

As an early milestone of FY 1995, the PUREX/UO_3 schedules converted from the Quik-Net program to a software product known as PX[h], because PX had become the Hanford Site standard and could integrate the financial data system (FDS) with schedules. In other words, when schedules delineated activities, the PX software could link these tasks integrally with their associated costs. Such a capability is a distinct advantage during rebaselining efforts, as it makes automatic the transfer of budgets with work tasks. In the PUREX Deactivation Project conversion to PX, difficulties were encountered because the PX software handled some data differently from the way Quik-Net had, especially in the area of sequencing. Because Quik-Net was not as sophisticated, it "ignored" (in effect) some logic ties in the schedules. PX searched for each logic tie. When it could not find some key ties that were

[h] PX is a trademark product of Project Software and Development Inc., of Cambridge, Massachusetts.

understood by everyone in the PUREX organization, but were not specifically programmed into the schedule, it showed the project schedule as having drastic variances and gaps. These problems were resolved during the Spring of 1995, and were folded into a periodic schedule rebaselining effort.[68]

In early Autumn 1995, reengineering began at the PUREX facility and resulted in the creation of work teams (see Sections 3.3, 3.4 and 3.5). Each team was assigned the existing schedules for its tasks, and became responsible for completing them. (The schedules had been assigned to cognizant engineers under the old system). An early effort for each team was to validate its schedules to make sure they reflected only those activities necessary to reach the PUREX end points (see Section 4.6). Only by such validation could the project define its remaining budget needs and determine whether resources were properly applied. The resource-loading in some schedules fit the new teams better in some cases than in others. All of the field teams rewrote their schedules in the Spring and Summer of 1996, buying ownership and participatory commitment to meeting those schedules. To help formulate its new schedules, the Utilities team wrote a detailed, eight-step process that its members follow in doing any generic task. Each step has several substeps to guide the team scheduler in allocating time. The eight steps are: scope the work; prepare the required paper work; schedule resources; procure and fabricate materials; prepare the job site, perform the work; stage waste for disposal and material excess; and close out. By using such internally devised tools, team commitment is strengthened and end points can be realistically set and met. In the final year of the PUREX Deactivation Project, teams have decided to update their schedules weekly, to reflect rapidly changing, real-time work.[69]

5.5 LESSONS LEARNED

Lesson No. 40. While the practice of generating fully developed, integrated, resource-loaded schedules is time-consuming, it saves money for a large project in the long run. The costs and efforts of producing the schedules are vastly surpassed by the cost savings that result from focusing the work and avoiding the work delays and duplication that would occur without such schedules.

Lesson No. 41. Organizations internal to old facilities and DOE sites often have strong emotional ties and commitments to these facilities. Also, the intimate familiarity of such persons with the facilities is invaluable in producing realistic estimates of how work must and will occur, given facility configurations and physical quirks. Such persons often need additional skill training in areas such as scheduling, but they are willing to learn new skills to stay with the facilities throughout deactivation. Their loyalty produces a strong work ethic and is valuable to the project. Keeping the operating employees with the deactivation project also provides these employees with enhanced skills that can provide them with better career opportunities after the deactivating facility closes.

Lesson No. 42. The specialized expertise of state-of-the-art firms using complex software definitely is needed in scheduling huge deactivation projects. Using schedules that are current, tied to costs, and readily adaptable to scope and budget changes and to rebaselining efforts is so crucial to project success that it must be directed by experts.

Lesson No. 43. Because S&M tasks consume much of a facility's budget during the early years of a deactivation project, detailed scheduling attention should be given to these tasks as well as to deactivation tasks. As requirements for S&M tasks decrease over the life of a deactivation project, this reduction of requirements must be reflected in the schedule.

Lesson No. 44. Schedules for large and complex deactivation projects need to be easy to change. They need to be "living" schedules because no person or collection of persons, however knowledgeable, can anticipate all of the various changes that will occur over the life of the project. Also, the schedule needs to recognize and incorporate the impacts of special tasks (such as responding to audits, providing special tours, etc.) that pull people away from their regular jobs.

Lesson No. 45. The software package chosen for a large deactivation project should be evaluated carefully before it is adopted. The sheer size and complexity of integrated, resource-loaded schedules that guide thousands of tasks demands software of huge capacity and flexibility. A change in software during a project can be very disruptive, even if the new software has technical advantages. Such changes should be made only if the technical advantages are overwhelming.

6.0 REGULATORY ISSUES

6.1 RESOURCE CONSERVATION AND RECOVERY ACT AND TRI-PARTY AGREEMENT ISSUES:

As soon as the PUREX/UO_3 shutdown order came in December 1992, the regulatory status of certain materials in the plants changed. As WHC pointed out in January 1993, during the facility operations period "materials containing special nuclear materials...[were] classified...as feed material to an ongoing production process. Therefore, the materials were not considered subject to regulation as a dangerous waste, as defined by *Washington Administrative Code* (WAC) 173-303. Since some of these materials are now intended for discard, the in-process materials are solid waste, and to the extent that nonradioactive components exhibit dangerous waste characteristics, those nonradioactive components are dangerous wastes...The units these materials are stored in are not covered in the PUREX interim status Part A Permit Application." In light of this new situation, RL requested an early meeting to review the PUREX situation with the Washington State Department of Ecology (Ecology), the agency that administers the *Resource Conservation and Recovery Act of 1976* (RCRA) as well as its own dangerous waste statutes.[70]

The RCRA issues centered around the fact that only 8 of more than 300 in the PUREX Plant were identified as systems in the PUREX treatment, storage, and/or disposal (TSD) unit in the Part A Permit Application for the plant at the time the shutdown order was issued. However, many more vessels contained in-process materials that could be reclassified as solid waste regulated under RCRA because of this order. Under WAC, an automatic 90-day "clock" (a temporary waste storage period under RCRA) began to tick for the PUREX Facility. At the end of that time, all vessels that were determined to hold dangerous waste would need to be permitted in a Part A Permit Application. However, WHC and RL noted and invoked an interpretation written into the *Federal Register* by the U.S. Environmental Protection Agency (EPA), a co-regulator with Ecology of the Hanford Site. This interpretation stated that process materials were excluded from being designated as waste for the first 90 days after facility operations ceased. Therefore, the PUREX Plant's 90-day clock under RCRA actually did not begin ticking until an initial 90 days had passed. PUREX had 180 days to develop a regulatory plan for the process materials and other solid materials.

Beginning in March 1993, WHC and RL met with Ecology and EPA, and solicited their help in effecting a proper shutdown of the PUREX and UO_3 Facilities. Waste minimization, cost-control, and compliance all were important goals. The contractor and federal management agency informed the regulators of the situation existing with the soon-to-be unpermitted tanks in the PUREX Plant, and asked for time and help in charting a pathway through such a new, large, and complex regulatory situation.

Because the PUREX Facility had received its shutdown order without warning, it could not anticipate the disposition of its hazardous materials or to prepare permitting documentation. In April 1993, RL, DOE-HQ, WHC, and Ecology held a week-long workshop to strategize and discuss the PUREX regulatory dilemmas imposed by the shutdown order. A day-long workshop also was held with PUREX work planners and engineers and WHC regulatory support personnel to help each group understand what types of information and help each would need from the other to resolve the complex PUREX regulatory situation. In July 1993, regular monthly video conferences to discuss these issues were initiated among RL, WHC, Ecology, EPA, and the Washington State Department of Health (DOH). In the summer of 1994, a series of unprecedented, face-to-face meetings was held at PUREX between WHC, DOE, and regulators. The cumulative outcome of all these meetings was to build trust and ownership and to obtain the assent of all the parties to work together to find solutions, rather than imposing penalties or engaging in other confrontational actions (Figure 16). Among the specific outcomes was the development of a Data Quality Objectives (DQO) document that set forth the requirements for flushing process vessels.[71]

In the meantime, a list of all the in-process chemicals remaining in the PUREX Plant was compiled all the process vessels and tanks in the facility were tabulated. (See Appendix 14.3.) For each vessel and tank, the location and capacity were identified, along with the part of the process in which they had been used, the current status and contents, the flush methodology, the sampling requirements, and when (if) they had been emptied. For example, in January 1993, PUREX tank J2, holding hazardous waste solutions bearing residues from previous neptunium 237 (Np-237) separation had been sent to Hanford underground waste storage tank 241-AZ-102, via PUREX transfer tank F18. In 1994, WHC and RL adopted the position that all but 41 of the PUREX vessels could be dispositioned without being permitted under RCRA. The materials in these tanks could be consolidated, sent or sold for reuse elsewhere, or flushed through underground piping to the Hanford Site's tank farms. Because the existing permit application included 8 of these vessels, DOE proposed including the additional 33 tanks in a revision of the RCRA Dangerous Waste Part A Permit Application. The regulators agreed to this position, and the tanks were so permitted.[72]

However, during the course of the deactivation project in 1995, four more tanks in the PUREX Plant were discovered to contain dangerous waste that had not been noted and permitted. Traditionally, a Notice of Intent (NOI) to amend the Part A permit and add the four additional tanks would have been required of DOE, and would have needed approval by Ecology. However, by the time the tanks were discovered, Ecology, DOE, and EPA were in the midst of discussions to revise the Tri-Party Agreement. They agreed to add language stating that for facilities "that have received a shut-down notice (facilities being transitioned)...system components (e.g., tanks and ancillary equipment) may be added to the Hanford Facility RCRA Dangerous Waste Part A permit without providing notification [to Ecology, local communities, and the public]...provided that these components have no further waste management mission prior to RCRA closure or deactivation." Thus, the four additional PUREX tanks were added to the Part A permit in a streamlined process.[73]

Figure 16. Washington State Police Inspect Truck that will Transport Contaminated Nitric Acid from the PUREX Facility.

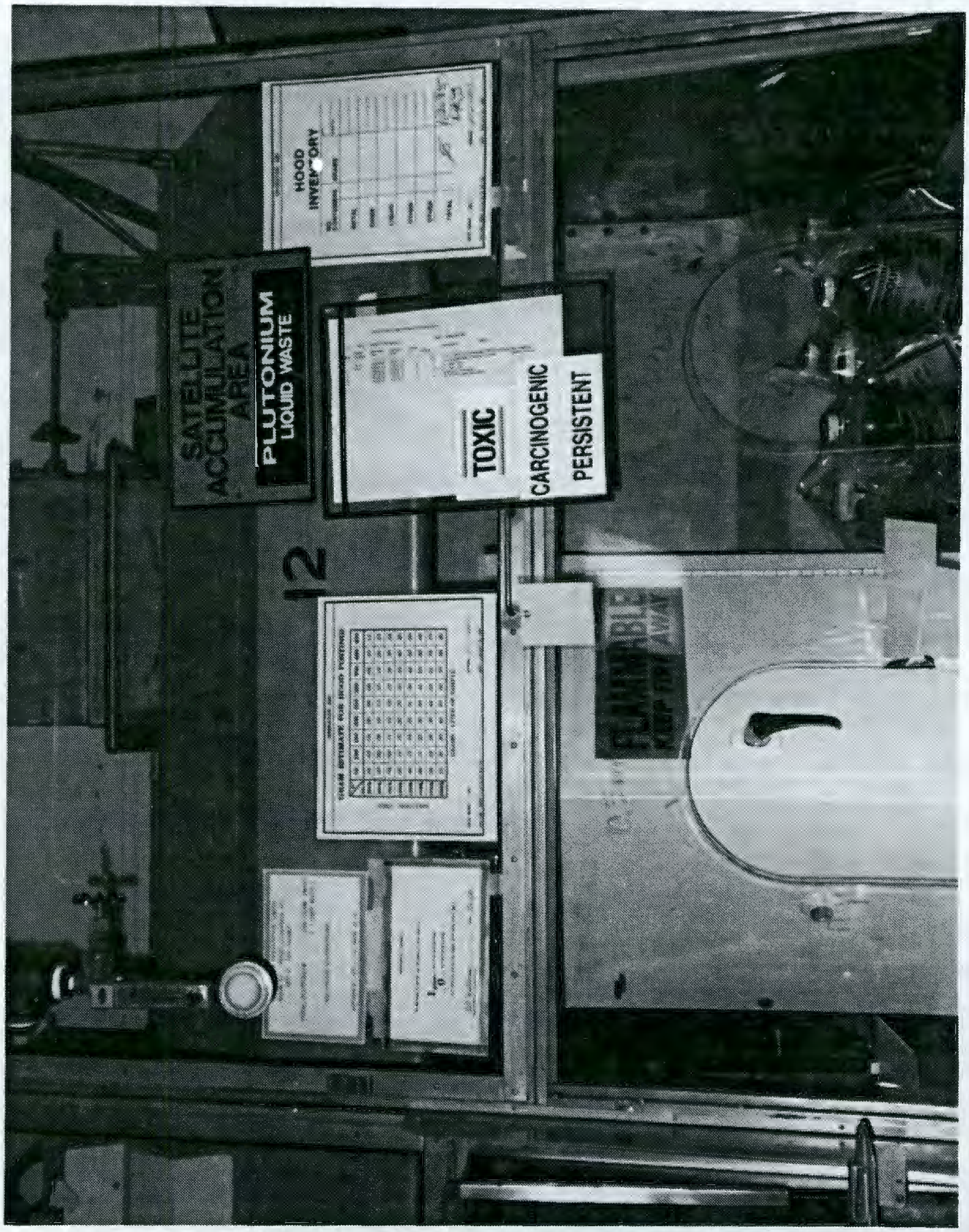
Another issue typically faced by transitioning facilities likewise was solved through cooperation between DOE and its regulators. DOE proposed carefully drawn, noncontiguous boundaries for the PUREX Building TSD unit for the revised Part A RCRA permit application. The boundaries included only the areas where dangerous waste actually was located, both in vessels and in areas and containers on the PUREX canyon deck where solid radioactive and mixed waste in the form of concrete debris, equipment pieces, and other materials were stored and staged. When Ecology approved these boundaries, it meant that waste storage boxes and other containers and areas on the PUREX deck could hold debris resulting from deactivation work and could stage solid wastes from other Hanford facilities awaiting final disposal. Areas within and near the PUREX facility that were included in the revised Part A Permit included Cells D through N, Q Cell, U Cell, Tanks P-4 and TK-40 outside, the crane area, hot pipe trench, slug (fuel element) storage basin, hot shop, west crane maintenance platform, and a shielding wall between the crane area and the canyon lobby (Figures 17 and 18).[74]

In January 1994, the Tri-Party Agreement was modified "to include the stabilization of facilities and 'transition' activities (those activities between the shutdown decision and the start of formal decontamination and decommissioning." That year, many of the key issues pending under RCRA and under other laws and regulations affecting the PUREX and UO_3 Plants were swept into Tri-Party Agreement milestone negotiations.[75] A specific variance discussed as part of the Tri-Party Agreement negotiations was requested by DOE for the 21,433 gallons of organic (TBP/NPH) solution and vessels at PUREX. DOE asserted that this substance did not constitute a waste as defined by RCRA. (See Section 8.5.) When the regulators concurred, this solution was shipped out of Tank 40 at the PUREX Plant to Diversified Scientific Services Incorporated in Tennessee.[76] The six shipments occurred between September 27, 1995, and June 12, 1996.[76]

Likewise, DOE contended that the approximately 187,000 gallons of contaminated nitric acid at PUREX was not a waste because an alternate process use had been found for the material in England. (See Section 8.4.) This position was accepted by Ecology and EPA, and the PUREX nitric acid was shipped to the BNFL facility at Sellafield, England, in 50 shipments, with completion in early November 1995.[77] Another variance request concerned listed wastes in the PUREX Plant. In past practice, the PUREX laboratory had removed small liquid samples from the process and conducted solvent extraction operations on the samples for analyses. The leftover materials were returned to the process solutions. Solvents from the products that had been removed technically constituted listed waste. However, DOE proposed to Ecology in 1994 that "de minimus additions of PUREX laboratory solvents to the PUREX process do not necessarily make the PUREX system a hazardous waste management system." As a part of the Tri-Party Agreement decisions, settlements were reached concerning the various hazardous materials in the PUREX Plant, and the laboratory solutions did not need to be specifically permitted as dangerous waste.[78]

Figure 17. A Washington Department of Health Inspector Verifies a Sampler Installation at PUREX, 1993.

Figure 18. Permitted Waste Accumulation Area in the PUREX Facility, 1995.



An additional key issue negotiated for the PUREX Deactivation Project as a part of the Tri-Party Agreement was whether a RCRA Part B Permit Application or a facility closure plan would constitute the final documentation for the hazardous and dangerous components of the PUREX Plant. As the outcome of such negotiations, the PUREX Storage Tunnels (two enclosures, one 500 feet long and one 1,500 feet long, accessed by rail track and holding contaminated equipment and other solid waste forms) were administratively separated from the PUREX Plant, and deemed to need different documentation. The PUREX Tunnels, as waste storage units, required a Part B (final) Permit to continue functioning as an operating TSD facility. As such, the PUREX Tunnels can receive and store waste from other Hanford Site facilities. The tunnels may continue to receive waste until they undergo final closure and their wasteis dispositioned. In late July 1996, Revision 3 of this Part B Permit was sent to the regulators, as required in Tri-Party Agreement Milestone M-80-02, in conjunction with a preclosure work plan for the PUREX Plant. This final Part B Permit for the PUREX Tunnels will be incorporated into the modified Hanford Facilities RCRA Permit.[79]

The PUREX facility itself was placed in a special "transitioning TSD" category created in revisions to Chapter 8 of the Tri-Party Agreement. It would continue to store waste simply by virtue of its existence as a facility containing hazardous components, but it would not "operate" as a TSD. Three phases of RCRA documentation were called out for such transitioning facilities, because of the expected long lag time between deactivation and final D&D. In the "Transition Phase," a project management plan, an end point criteria document, and a preclosure work plan were required. In the S&M Phase, an S&M plan was required. Lastly, in the "Disposition Phase," a final D&D phase that could occur decades after Transition, another project management plan would be required, along with a facility disposition end state criteria document and a RCRA closure plan for the TSD units within the facility. In compliance with Milestones M-80-02 and M-80-02-T02, the PUREX Deactivation End Point Criteria document was written in 1995, and the PUREX S&M Plan was completed in 1996. All Tri-Party Agreement signatories became involved in approving these documents.[80]

Other specific technical activities in the PUREX Deactivation Project also became Tri-Party Agreement milestones in revisions finalized during 1995-96. Once these activities were incorporated into the Tri-Party Agreement, Ecology was designated as the "lead regulator" to track compliance, and EPA became less involved in monitoring the PUREX Deactivation Project. Removal of spent fuel rods from the PUREX Plant (see Section 8.3) became milestone M-80-00-T05, and was completed when the spent fuel was transferred to the K-West Basins at the Hanford Site on October 12, 1995. Deactivation of the PUREX R-Cell became milestone M-80-01, and was completed in early 1995. Removal of process waste solution from PUREX tanks D5 and E6 became milestone M-80-03, and was completed in 1995 (see Section 8.2). Deactivation of the PUREX Sample Gallery, including but not limited to flushing headers and high radiation samplers, decontaminating or stabilizing hoods containing significant quantities of SNM, and decontaminating, stabilizing, and/or removing hood ductwork became milestone M-80-00-T07. It was completed in July 1996.[81]

Deactivation of the U-Cell fractionator, including but not limited to removing recovered nitric acid, flushing vessels, and sealing U-Cell cover blocks became milestone M-80-04, due for completion in April 1997. Deactivation of the 211-A Aqueous Make-Up (AMU) area, including but not limited to removing the chemical inventory and flushing or emptying tanks and supply headers to the PUREX canyon, became milestone M-80-05. It was completed in July 1996. Deactivation of the 203-A Uranium Storage and Pumping Station, including but not limited to emptying and flushing tank systems, and decontaminating and stabilizing contaminated surfaces as necessary, became milestone M-80-07, which is due for completion in April 1998. Completion of canyon and vessel flushing, isolation and blanking of canyon piping became milestone M-80-06, completed in July 1996. Lastly, the designation and documentation of all hazardous/dangerous substances in the PUREX Plant at the conclusion of the transition phase became milestone M-80-08, due for completion in July 1998. Of course, because the PUREX facility is being deactivated on an accelerated schedule (see Sections 2.1 and 3.2), all of the these milestones will be achieved in 1997.[82]

6.2 AIR PERMITTING ISSUES

In the area of air permitting for the PUREX/UO_3 deactivation project, the approval of DOH, Ecology, and EPA was needed to conduct deactivation activities. DOH had the authority to regulate radioactive air emissions, while Ecology was responsible for regulating nonradioactive air emissions (nitrogen oxides--nitrogen oxide and toxic air pollutants). EPA had the authority to regulate both radioactive and nitrogen oxide emissions, but not toxic air pollutants. WHC and RL believed that deactivation activities would generate emissions at a much lower level than emissions during years of past normal operations, as represented by the last two full years of normal PUREX and UO_3 operations. WHC and RL proposed to demonstrate the lower emissions to the regulators with clear figures, hoping that full new permit applications would not be necessary. Such a strategy would save time and money. Several "emissions comparison documents" were submitted to the state regulators in early 1994, and accepted by them later in the spring and summer (Figure 19).[83]

However, permit applications for radioactive air emissions generated for certain "non-routine" activities were required by WDOH and EPA. These activities required air permitting because they were outside the normal or routine activities performed by PUREX.

Three such permits for activities that would potentially generate radioactive air emissions, were written in 1995 and 1996. The first permit application was for the transfer or return of spent fuel in PUREX to 105-KW Basin. The return of spent fuel to the fuel storage basins was not considered routine. The permit application was approved by WDOH (7/11/95) and EPA (8/14/95).

Figure 19. Monitoring PUREX Stack Emissions, 1994.

The second permit application allowed up to two million curies of radioactive waste from Hanford's 324 Chemical Engineering Building to be transferred into PUREX Storage Tunnel 2. The addition of the 324 Building waste was the first non-PUREX generated waste to be considered for storage in the PUREX tunnels. Several negotiating sessions were required with EPA and WDOH because the PUREX Storage Tunnel 2 stack was a minor stack and the addition of the 324 Building Waste had the potential to require re-classifying it as a major stack. Finally, both agencies agreed to allow RL to prove that the stack should remain a minor stack and the permit application was approved with conditions by WDOH (12/04/95) and EPA (12/06/95). The PUREX facility must comply with the following final permit approval conditions received from the WDOH.

- The material must be transported to the PUREX Plant in U.S. Department of Transportation (DOT)-compliant (or DOT-equivalent) sealed casks or containers.

- The material can be staged in the PUREX Plant until transferred into PUREX Storage Tunnel 2. This staging technically represents a modification to the PUREX Plant, which has been reducing its inventory. However, because the storage is temporary, no additional NOC will be required, because the PUREX Plant main stack is already a National Emission Standards for Hazardous Air Pollutants (NESHAPS) stack.

- Beginning with the receipt of the WDOH approval, the tunnel exhauster and existing stack sampler must operate continuously before placement of the waste in PUREX Storage Tunnel 2 to establish a current baseline. This has been completed. Continuous operation started on December 13, 1995.

- Nondestructive analysis (NDA) of the high-efficiency particulate air (HEPA) filter on the tunnel exhauster must be completed before placement of the waste in the tunnel, as a baseline for determining filter loading after the project is completed. This has been completed. The detection limit must be low enough to determine changes on the filter loading that would indicate a need to upgrade the stack later if required. The NDA must be representative of the entire filter surface. Because the NDA is suitable only for gamma-emitting radioisotopes, a demonstration must be made that beta- and alpha- emitters are conservatively addressed so that WDOH can verify, and agree with, the results. If there is little or no confidence in the source term, the NDA may not be suitable.

- The tunnel exhauster and sampler must be operated continuously for a minimum of 6 months after placement of waste is completed. There is no basis for the September 1996 date given in letter 96-PCA-058. No Tri-Party Agreement milestones are associated with that date.

- A new NDA on the HEPA filter must be performed at the end of the 6-month period, with the same conditions outlined for the initial NDA.

- Stack sample analyses must include total alpha and beta analysis, and quarterly composites of alpha spectrometry, strontium-90, and a gamma scan.

- All data must be retrievable and auditable.

EPA approved the transfer for a period of 1 year with the following conditions.

- The NDA of the HEPA filter on the tunnel exhauster will be completed before placement of the additional waste. The lower limit of detection in the nano-curie range should be sufficiently sensitive for the intended purpose. This has been completed.

- The tunnel exhauster and existing sample train will be operated continuously for 6 months after placement of the waste. At that time a second NDA will be performed on the HEPA filter and compared to the previous analysis.

- Stack sample analysis will include monthly total alpha and beta analysis. Two quarterly composites will be analyzed by alpha spectrometry, strontium-90, and high-resolution gamma spectrometry.

- The results of sampling will be reported within 2 months of the conclusion of the mandatory 6 months of operation of the exhauster and sample train. These results also will be modeled as offsite dose.

On March 11, 1996 PUREX placed two railcars of waste material (contaminated PUREX equipment) into PUREX Storage Tunnel 2. Conversations with WDOH revealed that placing the two railcars into the PUREX Storage Tunnels was jeopardizing the following approval condition.

- Beginning with the receipt of the WDOH approval, the tunnel exhauster and existing stack sampler must operate continuously before placement of the waste in PUREX Storage Tunnel to establish a current baseline.

When EPA and DOH approved the permit application for the 324 Building waste, they were not aware that additional PUREX waste material would be placed in Tunnel 2. Conversations with EPA on the placement of the two additional PUREX railcars revealed that submitting a request for a determination of modification or new construction was a possible solution. On March 11, 1996, RL prepared correspondence to EPA and WDOH requesting such a determination. On March 27, 1996, EPA responded that the addition of the two railcars did not constitute a modification. On March 29, 1996, WDOH responded that the addition of the two railcars did not significantly affect the potential to emit for the tunnel, given the uncertainty associated with the original baseline.

Finally, in the Spring of 1996, a third permit application for DOH and EPA, was prepared for four rail cars used to transport varied liquid waste. For concurrence purposes, waste from Hanford's 325 Radiochemistry Building was described as a sealed source in the third permit application. It should be noted that the 325 Building waste was considered to be a sealed source and concurrence was obtained from WDOH at the May Routine Technical Meeting (5/14/96). , DOE requested that WDOH and EPA approve the permit application with the same approval conditions as the 324 Building waste approval conditions. EPA and WDOH approved the permit application on May 28, 1996, and June 7, 1996, respectively. However, WDOH notified DOE that any additional materials placed into PUREX Tunnel 2 would require an upgrade of stack 216-A-10 to a "major" stack for compliance with NESHAPS. Earlier in 1995, changes were written into the WAC, requiring that NOCs be filed for DOH approval as soon as decommissioning or transitioning begins at state facilities generating radioactive air emissions.[84]

In the case of nitrogen oxide emissions in the PUREX Deactivation Project, Ecology did not approve of the levels of nitrogen oxide that were to be generated by an initial PUREX proposal to conduct in-plant sugar denitration (destruction) of approximately 700,000 liters(187,000 gallons) of contaminated nitric acid. However, the issue was dropped when PUREX technical personnel developed an alternative strategy for dispositioning this nitric acid (see Section 8.4). Another PUREX initiative in 1994 challenged the sampling frequency of all of the facility's 11 exhaust stacks. From discussions with regulators and technical evaluations, all but two of the stacks were reclassified as "minor" under NESHAPS (40 CFR 61) regulations, thus reducing the frequency of required monitoring and saving costs.[85]

6.3 NATIONAL ENVIRONMENTAL POLICY ACT (NEPA) ISSUES

Jointly, WHC and RL worked to achieve compliance with the requirements of the *National Environmental Policy Act of 1969* (NEPA) in as cost-effective and efficient manner as possible. A creative solution was needed that encompassed both compliance and time- and cost-saving measures. The PUREX and UO_3 Facilities had an existing EIS for operations, and management realized that the preparation of a new EIS for deactivation could be a lengthy activity and consume a sizeable share of the project's budget.[86]

Together with WHC regulatory support personnel, PUREX management proposed the formation of a NEPA screening panel that would compare each deactivation activity with activities already documented and analyzed in the existing EIS for plant operations. The screening was performed in the autumn of 1993 by a panel composed of personnel from PUREX, WHC regulatory support, and RL. The panel initially indicated that all proposed deactivation activities except two could be performed under existing Hanford sitewide categorical exclusions (CXs), a simple form of NEPA documentation, or under three, separate new CXs that would need to be written for the deactivation. At the time, three new CXs were expected to be needed to document consolidation of the PUREX heating, ventilation, and air conditioning (HVAC), contaminated nitric acid offsite, and shipment of the PUREX TBP as a waste to an offsite incinerator.

The NEPA screening panel also initially indicated that, in addition to the three new CXs, the PUREX deactivation project would need to prepare EAs, a medium level of documentation, for two activities: Phase III cleanout (i.e., glovebox removal) of the N-Cell, and shipment of irradiated fuel to wet storage in the Hanford Site's K-Basins.[87] During 1994-96, the original NEPA strategy changed. PUREX facility management changed its plans for N-Cell deactivation, making the cleanout less extensive (see Section 8.1). With this decision, the screening panel determined that an EA would not be required. In September 1994, DOE-HQ decided that CX for shipping the contaminated nitric acid offsite would be insufficient, and provided direction to prepare an EA for this action. This EA was finalized in February 1995. In the meanwhile, the CXs for the shipment of the TBP/NPH organic mixture, and for the consolidation modifications to the PUREX HVAC systems were finalized in late 1994. The EA for the transfer of the PUREX Spent Fuel to the K-West Basins was finalized in July 1995.[88]

In late 1995, DOE and WHC decided to prepare another CX that would provide NEPA documentation for several transition activities that would be undertaken both by the PUREX Plant and by other deactivating Hanford Site facilities. This CX, finalized in early 1996, provided for the "deactivation, deenergization, or isolation of unneeded plant systems and stabilization in Hanford facilities, all areas, Hanford Site." Undertaken as part of WHC's Regulatory Integration and Process Improvement PBI, this CX provided NEPA "coverage" for a wide range of activities that included decontamination of areas (wash downs, wipings, flushings, and vacuum blasting of surfaces); stabilization of surfaces via painting, sealing, or the application of fixatives; draining or emptying of vessels and piping; flushing of vessels and piping; plugging, capping or blanking ductwork, piping and vessel nozzles; stabilization, consolidation, or removal of outside contaminated areas adjacent to facilities; decontamination, stabilization, or removal of glove boxes and fume hoods; the removal, reuse, or recycle of nonhazardous and hazardous materials; the removal and transport of hazardous and radioactive waste to appropriate storage locations or burial grounds; the removal of fencing and paved parking lots adjacent to facilities; the sealing of facility penetrations and the repair of roofing; excavation to isolate piping to and from facilities; testing, sampling, and monitoring in and around deactivated facilities; winterization of equipment and facilities for freeze protection; minimization or elimination of plant operating systems (such as electrical and utility equipment); and the installation of electrical, monitoring, and utility services to facilities to maintain, if appropriate, essential system operations.[89]

6.4 NATIONAL HISTORIC PRESERVATION ACT COMPLIANCE

Early in the PUREX Deactivation Project, a Cultural Resources Review was conducted as required under the *National Historic Preservation Act (NHPA) of 1966* (NHPA). It was determined that none of the actions planned in the PUREX/UO_3 deactivation were invasive or intrusive enough to activate the need to prepare facility documentation under NHPA. Later, in 1996, plans to document briefly the history of the PUREX canyon building (202-A), the PUREX Dissolver Off-Gas Building (293-A), the PUREX Exhaust Air Filter Building (294-A), and the PUREX Badge House (2701-AB--a replacement Badge House built in the 1980s) were formulated in an agreement between RL, the Washington State Historic Preservation Office (SHPO) and the National Advisory Council on Historic Preservation (Advisory Council). In the same agreement, plans were made to document the history of one of the PUREX Tank Farms (241-AW).[90]

6.5 CLEAN WATER ACT COMPLIANCE

Compliance with clean water regulations in the PUREX Deactivation Project was not difficult or complicated because no discharges to the Columbia River occurred. Discharges to groundwater beneath the Hanford Site already were addressed in early, sitewide Tri-Party Agreement negotiations. In accordance with Tri-Party Agreement milestone M-17-00, 19 major untreated Site discharges to the ground ceased by June 1995, and 14 other major untreated discharges will cease by October 1997. Accordingly, in June 1995 when the Hanford Site 200 Areas Treated Effluence Disposal Facility (TEDF) was completed, the PUREX facility connected its existing low-level waste water discharges to it. The PUREX chemical sewer will continue to feed into the TEDF for treatment until complete plant shutdown occurs in May 1997. After that time, no effluents will drain from the PUREX Plant.[91]

6.6 UO_3 PLANT REGULATORY COMPLIANCE

The regulatory compliance situation for the UO_3 Plant deactivation was considerably simpler than for the larger and more complex PUREX Facility. No RCRA permits were required at the UO_3 Plant, because no waste was treated or stored there for over 90 days. The facility did have some less-than-90-day-storage pads and satellite accumulation areas for which RCRA permits were not needed. RL determined, with concurrence of the regulators, that all NEPA documentation requirements for the UO_3 deactivation already were fulfilled under existing Hanford sitewide CXs. Under 1995 amendments to the Tri-Party Agreement, DOE's state and federal (EPA) regulators did have approval authority over the UO3 Plant End Point Criteria Document and the UO3 Plant S&M Plan (milestones M-80-00-T01 and M-80-00-T02). Contaminated discharges to the ground and groundwater were eliminated in decontamination actions taken as part of the UO_3 deactivation (see Section 9.0).[92]

6.7 LESSONS LEARNED

Lesson No. 46. Every effort should be made for facilities to continually coordinate their status and potential regulatory situations to DOE-HQ, to avoid sudden or unexpected shutdown orders. Better planning and communications between the DOE and its contractors should be instituted, so that facility preparations for the consolidation and disposition of hazardous materials can begin before formal closure orders arrive. The PUREX Facility was in possession of a number of substances for which there were no RCRA permits after the operational/standby status of the facility changed. Likewise, NEPA documentation might/could have been prepared as part of the deactivation decision, and in support of that decision.

Lesson No. 47. It is essential to involve and inform regulators early in any regulatory process or negotiation. A cooperative spirit is established by such actions, and joint efforts then can be directed at solutions rather than confrontational or penalty-based actions. The regulatory dilemmas inherent in the PUREX deactivation project were unique and the first of a kind. Early and open communication with regulators was crucial to finding acceptable solutions to these dilemmas.

Lesson No. 48. Regulatory issues and needs must be communicated by contractor and DOE experts to all of the managers, engineers, and work planners at a facility. Just as understanding the methods and needs of the scheduling professionals by the plant operating personnel contributed to better schedules, likewise understanding of regulatory requirements by facility operators will (and did at PUREX) help ensure that regulatory mistakes and violations are avoided.

Lesson No. 49. For facilities in states that have negotiated special agreements with state and federal regulators (such as the Hanford Site's Tri-Party Agreement), such agreements can serve to break regulatory impasses that might be encountered under RCRA and other statutes. Because the Hanford Site Tri-Party Agreement has legal precedence over some other environmental laws, it can be a useful tool in negotiating creative solutions in response to unique needs. One example of such a prototypical solution might be the provision written into the Tri-Party Agreement that transitioning facilities do not need to prepare NOIs before modifying their RCRA Part A permits when additional hazardous waste units are discovered during the course of deactivation.

Lesson No. 50. Emissions comparison documents, while initially useful, will not stand in lieu of full new permit applications for deactivation actions that generate radioactive air emissions. Radioactive air emissions are a subject of such intense public concern that, at least in Washington State, the WAC has been tightened to require full NOCs for deactivation activities that generate such emissions.

Lesson No. 51. The NEPA screening approach taken in the PUREX and UO_3 Facility deactivations is an extremely helpful and precedent-setting activity. Because an operational EIS existed, it was possible to comply with NEPA requirements without preparing a new EIS for deactivation. This action saved enormous amounts of time and money, and in particular should be highlighted and used at other facilities that are undergoing deactivation and that possess existing EIS documentation. In cases where deactivating facilities do not have operational EISs, other existing documentation at the facilities (such as Accelerated Hazards Reduction program documentation, etc.) should be examined to see if it can serve a similar function.

Lesson No. 52. The idea of designing a noncontiguous boundary for those portions of deactivating facilities that are RCRA TSDs, then writing the Part A permit specifically to those boundaries, is creative and cost-effective, in that it forces monitoring and oversight only for the truly affected portions of large facilities. It is also important to carefully distinguish between facilities that will function as long-term TSDs (such as the PUREX Tunnels), and those that will serve as interim TSDs (such as the PUREX Building), and to permit each type of TSD differently.

Lesson No. 53. Categorizing process substances that have alternative uses or possible alternative definitions as materials other than waste is beneficial and cost effective. At PUREX, examples such as the disposition of the slightly contaminated nitric acid, the organic TBP/NPH solution, and the laboratory sample solutions, demonstrate clearly the life-cycle savings that can be realized from not having to permit and monitor unnecessary substances as waste.

Lesson No. 54. The evolution of three types of documentation to serve various time periods in the life cycle of transitioning TSDs is beneficial in that it leaves room for modification of long-term plans whenever D&D occurs. It would not be useful for today's decision-makers to try to write the final closure plan for the PUREX facility, not knowing the technology or the public preferences and values of the future.

Lesson No. 55. As in the case of the various PUREX stacks, it is important for deactivating facilities to scrutinize their diminishing emissions, effluents, etc. to identify when they may fall below regulatory criteria and allow lesser levels of monitoring and documentation. The result is cost and time savings.

Lesson No. 56. The CX that was prepared for "deactivation, de-energization, or isolation of unneeded plant systems and stabilization in Hanford facilities" is an example of a very valuable concept. That is the concept of writing broad and inclusive, Sitewide or complex-wide regulatory documentation whenever possible to avoid creating documentation for every small or repetitive action. Cost and time savings again result.

7.0 SAFETY DOCUMENTATION AND INNOVATIONS

7.1 EXISTING OPERATIONAL AND STANDBY SAFETY DOCUMENTATION

When the shutdown order came for the PUREX and UO_3 Facilities in December 1992, each facility had an existing final safety analysis report (FSAR). The PUREX Plant's operations safety requirements (OSR), the safety boundaries, safety conditions, and other control features, were contained in Chapter 11 of the facility FSAR. PUREX also possessed a long list of preexisting hazards control documents and criticality prevention specifications, along with a process control manual (PCM), with Addendum, that mandated which routine S&M checks were required at the facility. During the Standby period, a revised version of the PUREX FSAR was written, along with an operating specifications document, to cover expected activities that had not been documented and analyzed from a safety perspective during operations. However, this revision had not yet been approved by DOE-HQ. A separate document, known as the "Split Report," also was created at PUREX as the result of a screening process in which each OSR was examined for its applicability to the operating mode and/or standby conditions. The Split Report represented an effort to reduce the number of OSRs, but still maintain an adequate safety boundary for ongoing actions. This report examined each OSR's applicability to installed instrumentation, to key process variables, and to any structure, system, or component that functioned to actuate or to mitigate accidents or transients. All OSRs that were found to apply to any of these situations or this equipment, were retained as being applicable during Standby.[93]

The analysis contained in the Split Report, as well as other safety analyses carried out by PUREX personnel, defined 10 limiting conditions of operation that would apply to limit the PUREX Plant's operations during Standby. As long as the activities described in the following limiting conditions of operation were prohibited, the plant could safely carry out certain standby activities not fully anticipated or described in existing safety documentation.

- Fuel receipt and handling were prohibited.
- The dissolver off-gas system would be deactivated.
- Charging operations were prohibited.
- The ammonium fluoride/ammonium nitrate (AFAN) line to the dissolvers would be isolated to prevent accidental additions. (AFAN is a unique mix of chemicals used to dissolve N Reactor fuel through what was known as the "Zirflex" process.)
- The organic streams from G- and R-Cells to the solvent extraction vessels would be isolated.
- The pumps and agitators servicing the TK-G5 and TK-R7 would be deactivated and the coil inlets isolated.
- The sugar header would be isolated to prevent the addition of sugar to any canyon vessel (to prevent sugar denitration activities).

- The inlets to canyon tank coils that discharged to the cooling water low-level effluent stream and the chemical sewer low-level effluent stream would be isolated.

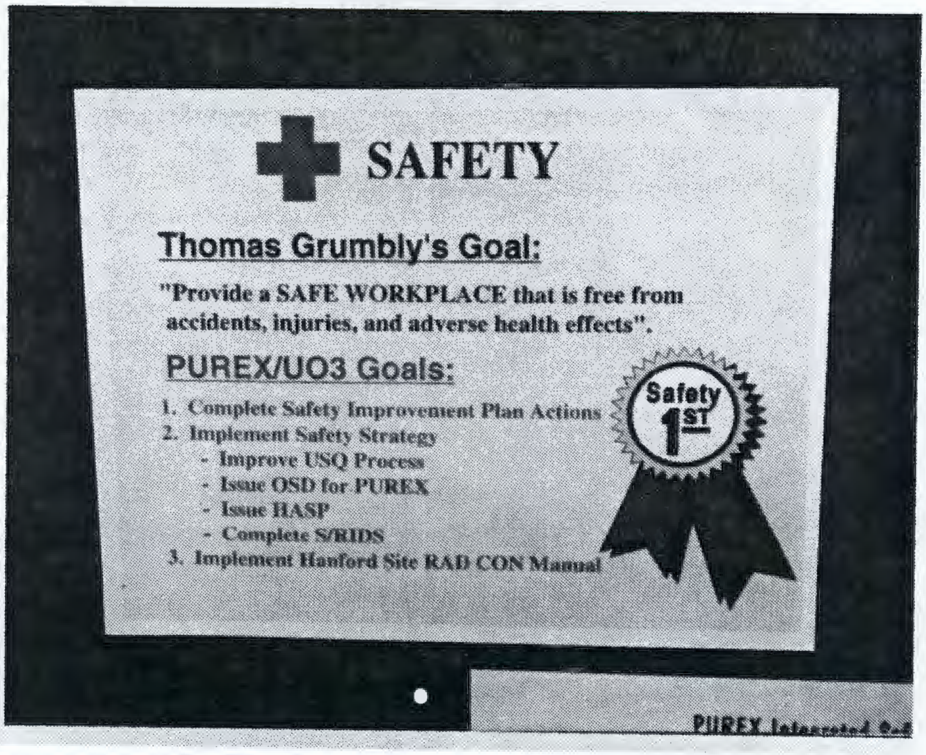
Also, a preliminary hazards analysis for Standby was performed at PUREX, and Standby operating specifications were approved for issue.[94] At this point, in December 1992, the final closure order was issued.

7.2 DEACTIVATION ORDER SPARKS "CROSSWALK" ACTIVITIES

In early 1993, a series of small workshops was held with personnel from WHC, RL, and a consulting firm with expertise in safety. The purpose of these workshops was to discuss how to address safety concerns about deactivation activities, while remaining true to the Independent Technical Review Team's 1992 advice not to write an entirely new FSAR for deactivation. In April and June of 1993, larger workshops were held that also included stakeholders and regulators. At these workshops an idea known as the "crosswalk" was presented and amplified by PUREX personnel. The crosswalk concept consisted of a series of comparison activities (somewhat similar to the NEPA screening concept described in Section 6.3). All of the activities expected during the PUREX deactivation project would be compared with existing safety documentation, and also screened using guidance and forms found in DOE Order 5480.23. The existing PUREX safety documents to be used would be the last approved revision of the FSAR (Rev. 5), the PCM Addendum 1 (latest revision), the Split Report, and another applicability document created during the Standby period. The existing unreviewed safety question (USQ) process explained in DOE Order 5480.21 would be used to prepare a screening form and examine each deactivation task. Tasks identified as non-USQ (those falling within existing safety envelopes) would be closed. A safety evaluation would be prepared for every task falling outside of previously analyzed safety criteria.[95]

In the crosswalk strategy, any deactivation actions that were not covered in existing documentation would be addressed by revising the PCM to add "mode applicability statements," compiling an interim safety basis document for shutdown activities, and writing a preliminary hazards classification document for deactivation. However, DOE-HQ expressed strong concerns that, in the crosswalk strategy as defined, worker safety and health issues were not receiving as much attention as they would under OSHA standards. It was suggested that PUREX conduct a scoping review of WHC occupational safety and health manuals, evaluate the applicability of existing manuals and safety and health programs to the PUREX/UO_3 deactivation project, develop and modify existing programs as necessary to cover all deactivation tasks, and then implement these programs (Figures 20 and 21).[96]

Figure 20 and 21. Safety, Including Employee Awareness and Good Housekeeping were Always an Important Part of the PUREX/UO_3 Deactivation Project.



7.3 SAFETY BASES FOR EARLY DEACTIVATION ACTIVITIES

Throughout the remainder of 1993 and into early 1994, discussions went forward between PUREX WHC and DOE personnel regarding various proposals for developing adequate safety documentation for the huge deactivation project without writing an entirely new FSAR. In January 1994, PUREX issued a technical information document that allowed some early deactivation actions to go forward. In March, RL issued a letter authorizing deactivation activities to go forward at PUREX using the safety analyses and requirements in the following documentation:

- The existing version of Chapter 11 of the PUREX FSAR
- All of the associated and existing safety bases documentation
- The non-radiological risk acceptance guidelines contained in the (revised) WHC *Safety Analysis Manual*
- The (revised) PUREX/UO_3 Plant Administration Manual (for the identification and resolution of unreviewed safety questions).

Because the RL letter did not include the operations-based PCM, it paved the way for the elimination of that document.[97] Both DOE and the contractor realized that the new PUREX S/RID that would soon be produced in response to recommendation 90-2 of the Defense Nuclear Facilities Safety Board (DNFSB) also would have to be incorporated into the safety authorization basis for deactivation activities. (Or, if the S/RID was not so linked, a path to waive it would have to be defined with DOE concurrence). An upgraded worker safety and health program plan also would need to be developed.[98]

7.4 GRADED HEALTH AND SAFETY PLAN DOCUMENT BECOMES CORNERSTONE

As a "best management practice" in early 1994, PUREX decided to create a health and safety plan even though one was not required in the *Code of Federal Regulations* because PUREX was not (and still is not) defined as an uncontrolled hazardous waste site. To begin, PUREX commissioned a subcontractor to write a hazards baseline document for the facility. A hazards training class was developed for deactivation workers. These activities were supported by the development of a unique preliminary hazards screening/assessment (PHSA) form/process. The process used a two-part screening form to evaluate the relative hazards for each task and to determine the appropriate level of analysis to assess the task. The matrix-based form was based partially on a checklist found in a 1992 hazards evaluation procedures study conducted by the American Institute of Chemical Engineers. The PHSA form was initiated to achieve the following:

- Increase attention to worker safety issues during the PUREX deactivation project
- To serve as a graded formal approach to determine activities with potential to affect the safety authorization basis and to analyze them

- To involve the workers in the worker safety development and evaluation processes

- To communicate potential hazards to deactivation workers

- To integrate the S/RID into the work authorization process in a graded manner.

The form was to be used to screen each work plan for all levels of potential safety issues as it was written.[99]

The safety requirements and analyses written into the PUREX deactivation PHSA process were more strict than those in general use at DOE non-reactor facilities. This conservative approach was endorsed by DOE-HQ, "in view of the absence of approved...DOE guidelines over the credible spectrum of potential accidents." The PUREX PHSA form analyzed each job on the basis of five initial criteria.

- Its complexity and size

- The type of process (physical, electronic, mechanical, computer, biological, or human)

- The type of operation (fixed facility, transportation, permanent, temporary, continuous, semi-batch, or batch)

- The nature of the hazard (toxicity, reactivity, flammability, radioactivity, explosivity, criticality, or other)

- The event or scenario of concern (loss-of-function event, single failure, multiple failure, procedure, process upset, software, hardware, human, or simple loss of containment).

The form then probed the perceived risks and experiences of workers who would be involved with the job. Finally, it asked a series of questions about the nature of job, the physical hazards, what could go wrong, how much damage would be done in worst case scenarios, and whether or not further analysis should be done.[100]

Under the PUREX PHSA process, a team of experienced safety analysts and the preparer of each work plan participated in each job screening. A graded approach was applied.

- If a job was deemed to be so simple that it did not require any formal analysis (Case III), it could be performed under existing WHC procedures.

- If a job was judged to be of medium complexity, with more than minimal accident potential (Case II), a job safety analysis (JSA) was performed by a team to identify hazards and the controls necessary to prevent or mitigate those hazards.

- If a job was deemed so hazardous as to require a formal analysis (Case I), a team would perform a hazards and operability analysis or use other, more detailed analysis techniques, recommend and incorporate job controls into the work plan, and conduct a USQ determination.

Additional actions taken included modifying the PUREX procedures in regard to USQs to strengthen the PHSA form for use with existing safety documentation. PUREX also issued a revised version of its deactivation operating specifications, which replaced the PCM Addendum 1.[101]

In late FY 1994, the PUREX safety documentation strategy, a creative blend of existing safety documentation with new consideration of deactivation tasks, achieved DOE-HQ concurrence. Especially in the areas of worker safety, health, and participation, areas about which DOE is increasingly concerned, the PUREX Health and Safety Plan's graded approach was so successful that its designer became instrumental in developing a new EM/EH handbook for the safety documentation and integration of all DOE facilities.[102]

7.5 PUREX S/RID COMPLETED

In early 1996 the PUREX S/RID was completed. It incorporated all previous standards and requirements into the following 17 functional areas.

- Management Systems
- Configuration Management
- Emergency Management
- Engineering Program
- Maintenance
- Fire Protection
- Waste Management
- Occupational Safety & Health
- Decontamination & Decommissioning
- Quality Assurance
- Training and Qualification
- Safeguards & Security
- Operations
- Radiation Protection
- Packaging & Transportation
- Nuclear Safety
- Environmental Protection

The new PUREX S/RID also consolidated requirements that were mentioned in several documents into one statement of each requirement, which reduced the overall number of requirements by approximately 200.[103]

7.6 REENGINEERING DEVELOPS EMPLOYEE JOB HAZARDS ANALYSIS

Even as the S/RID activity was approaching its conclusion, the WHC Reengineering Plant Team identified the need for more streamlining. The safety basis for facility operations at the Hanford Site, the Plant Team found, was "outdated and conservative, causing over-interpretation." No integrated risk management strategy was implemented Sitewide, and, most importantly, workers were not integrally involved in making decisions about their own safety.[104]

Specifically in response to the reengineering mandates to place serious responsibility with work teams and to use information technology in a way that is accessible and user friendly for everyday application, the Qualitative Job Hazards Analysis was developed at the PUREX facility. In practice, the majority of the PHSA (Part I) was converted into a computerized Job Hazards Analysis (JHA). This on-line job assessment tool was implemented during January 1996, just after the PUREX work teams were formed. It was converted to a "numerical scoring system" during the Spring of 1996. It now is used by every PUREX team to screen and score jobs. The JHA does not replace the JCS system, but it does allow many jobs to proceed with minimal, team-based approvals. Determinations of when additional analysis and/or approvals are needed for work to proceed are based on the Conduct of Work section of WHC-CM-3-5, the *Document Control and Records Management Manual*. Only jobs hazardous enough to be rated as "Case I" under the older PHSA need the involvement of safety professionals outside of PUREX. The PUREX S/RID is linked as a list of references to the JHA, and soon the S/RID will become part of the PUREX safety basis authorization by becoming a reference in the PUREX FSAR. Thus, a complete tie-in of safety basis authorizations for deactivation activities will be achieved.[105]

Graded in every aspect, the PUREX JHA first instructs workers to complete the appropriate sections of the form if any of the following conditions apply.

- The planned activity is not covered under an existing RWP (Radiation Work Permit)
- Hazards and hazard controls have not been previously identified in standard operating procedures (SOP) or existing JHA
- The planned activity will change existing equipment;
- "Lock and Tag" other than personal locking devices will be required
- The work is on safety or safety-significant systems
- Detailed work instructions are required to complete the activity
- Permits are required to complete the activity
- Special waste handling instructions will be required to complete the activity.

These criteria immediately screen out some jobs that are extremely simple and innocuous, and/or jobs that have existing safety analysis and documentation. Such jobs are freed of unnecessary or redundant documentation.

Next, the JHA follows the same path as the PHSA (formerly completed by technical safety support personnel) in asking about the complexity of the job, the type of process, the type of operation, events of concern, length of worker experience, relevance of experience, accident exposure, perceived risks, and severity of consequences. Then, a series of follow-on questions are asked about the exact requirements of the job. The presence of any of the following exposure factors raises the hazards score of a job.

- Radiological work
- Welding/cutting/burning/hot work
- Hazardous waste operation
- Lead handling or abatement
- Confined space entry
- Noise area or noise producing
- Dust producing

- Chemical use involvement
- Temperature extreme
- Tank/line/vessel opening or breaching
- Surface removal (sand or abrasive blasting, grinding)
- Painting
- Asbestos abatement/handling
- Special metals or carcinogenic materials
- Contaminated soil excavation/disruption
- Other exposure hazards.

Worker safety concerns are then incorporated. The presence of any of the following exposure factors raises the hazards score of a job.

- Fall hazards of over 6 feet
- Energy sources
- Temporary electrical arrangements
- Electrical hazards
- Deenergization of equipment
- Fire/explosion
- Walking/working surfaces
- Excavation
- Demolition
- Roof work
- Pinch points
- Remote work
- Mechanized equipment
- Hand tools
- Power tools
- Hoisting and rigging.

Environmental and nuclear safety concerns are then incorporated, and the JHA actually ranks each job. A numerical score at or above 13 of a possible point score of 28 means that the job requires further safety analysis. This graded approach ensures that jobs with more significant safety hazards receive serious professional attention, while simpler jobs can proceed without time-consuming and expensive layers of unnecessary analysis.

7.7 LESSONS LEARNED

Lesson No. 57. Existing safety documentation from facility operational periods should and can be used in creative and careful ways to begin deactivation project safety documentation. Revisions, comparisons, "crosswalks," and other types of screening procedures can be used to determine which deactivation actions may be covered in existing documentation and which actions need supplementary coverage. Such comparison efforts, performed by those who know the facility well, are more cost effective and time efficient than preparing all new safety documentation for facility shutdowns.

Lesson No. 58. Workshops and other joint working efforts that bring together the principals interested in safety documentation (DOE, the operating contractor, and ITEs and other consultants) are important early in a deactivation project for brainstorming and establishing the major cornerstones of consensus about the safety documentation.

Lesson No. 59. Worker health and safety, always a DOE and contractor concern, has been elevated in recent years to even more important status. Often, worker safety and health aspects of older facility safety documentation will prove to be the area where such documentation falls short of modern standards. Incorporating worker safety and health considerations that are comparable to or exceed the levels demanded by OSHA into newer revisions or supplements of safety documentation is extremely important.

Lesson No. 60. Worker involvement (including the use of job screening devices that are operated by worker teams at their own personal computer work stations) and a graded approach to the levels of safety analysis required for various deactivation tasks are the two most important keys to making the safety analysis process useful, efficient, and satisfactory to all concerned. The graded approach is cost effective in that it does not demand a high level of analysis for simple jobs already covered in established procedures. Worker involvement is also cost effective in that it provides a higher level of assurance that workers are participating willingly and without hesitation in the jobs that are required for facility deactivation.

8.0 TECHNICAL ISSUES

This chapter does not describe every technical activity in the PUREX deactivation project. It covers only the major technical activities believed to yield lessons of larger or precedent-setting importance. Technical activities not discussed encompass instrument deactivation, fire protection system deactivation, liquid effluents system deactivation, utilities deactivation, surveillance and monitoring planning, P&O gallery and white room deactivation, in-plant waste concentration (E-F11), dissolver heels stabilization, and 211-A stabilization. Discussion of these issues can be found in the *PUREX/UO_3 Deactivation Project Management Plan.*[106] The following technical activities are discussed because they have followed unique pathways.

8.1 N-CELL, PR ROOM, Q-CELL, AND SAMPLE GALLERY DEACTIVATION

N-Cell processing equipment was added to the PUREX Plant in 1978, to provide the capability to convert plutonium nitrate solution (the original PUREX product) to plutonium oxide powder. Although oxide conversion traditionally had been done at the PFP, it was believed that it would be safer to transport plutonium from PUREX (in the Hanford Site's 200 East Area) to the plutonium storage vaults (in the 200 West Area, PFP Complex) in oxide form. The cell contains 6 full-size glove boxes [typically 3.7 meters (12 feet) tall and 2.7 to 4 meters (9 to 13 feet) long], two extra-large glove boxes built together as a free-standing unit [7.6 meters (25 feet) tall and 11 meters (36 feet) long], as well as four small glove boxes for powder loadout, canning, bagging, and maintenance.

During operations, each of the extra-large glove boxes contained a calciner, a first stage titanium calciner and a second stage stainless steel calciner that operated in series. The second stage calciner discharged plutonium oxide powder into a vibrating screen assembly known as a scalper. The powder loadout glove box contained a small muffle furnace.[107]

Once the decision was made to close the PUREX Facility in 1992, removing as much plutonium and plutonium-contaminated equipment as possible from N-Cell became important. A boundary estimate of the plutonium inventory conducted in 1993 found between 900 and 13,000 grams of plutonium in the cell, with the best estimate found to be about 3,000 grams. Such amounts helped to place the PUREX Plant into a "high-hazard classification" as defined in the preliminary hazards analysis. Reducing this amount was necessary to attain many other deactivation goals: shutting off the criticality alarm in N-Cell, lowering the probability of a contamination spread after the building ventilation was reduced (in later deactivation steps), and keeping the radiation exposure to workers ALARA. It was known that the experienced crew of PUREX nuclear operators available to the deactivation project could perform N-Cell cleanout more efficiently than could future D&D workers who would not be familiar with the plant, and that the decay of ^{241}Pu to ^{241}Am in the intervening years actually would increase future radiation exposures.[108]

An early draft plan called for removing the 12 N-Cell glove boxes. This would ensure that N-Cell was left in a state in which S&M personnel could safely work without the spread of alpha contamination. However, PUREX personnel decided by mid-1993 that such equipment removal was D&D work and could not be justified as part of deactivation work. Also, an EA would likely have been needed for the activity. The cost of the work itself, as well as the costs of preparing the EA (with concomitant time additions to the project), led to the decision to stabilize the glove boxes in place. It was decided to reduce plutonium contamination within the glove boxes to a level that would ensure that D&D personnel could later remove the glove boxes without the risk of criticality and with minimal risk of significant contamination spread.

The next plan for N-Cell cleanout included three phases. Phase I, which began in the Spring of 1993, consisted of removing small equipment from the glove boxes. ("Small" was defined as anything that could fit through a bagout port, including tubing, valves, pumps, and other items.) Phase I also included installing new gloves on many glove ports that had been sealed temporarily during Standby, and refurbishing the cell's Segmented Gamma Scanning Assay System (SGSAS). The SGSAS monitoring instrumentation assayed the material being removed from the glove boxes to document the amount of plutonium being placed in each transuranic waste drum.[109] Phase I of the N Cell deactivation was completed by March 1996.

Phase II was to consist of cutting up and removing some large equipment (such as the calciners) from the glove boxes. As it turned out, very little of the large equipment was cut up and removed.

Phase III included wiping down and painting the interior of the glove boxes with an acrylic latex contamination fixant (Figures 22 and 23). Next, metallic "pie pans" were placed over the glove ports, then the glove ports were wrapped with a polyolefin "shrink-wrap" material and finally that material was heated to activate a tar-like adhesive it contained (Figure 24). Also, miscellaneous storage cabinets were removed from the N-Cell loadout room. These activities were completed ahead of schedule in June 1996.

A milestone project is under way that will consolidate the entire ventilation system that served N-Cell, Q-Cell, and the PR room. In this project, many of the filters will be removed, and the glove boxes will be vented to the canyon. These activities are part of the larger PUREX HVAC consolidation project (see Section 8.10.)[110]

The PR room at the PUREX Plant was used during operations to sample plutonium nitrate solution from the process, then transfer it either to M-Cell storage tanks for processing in N-Cell or into product cans for shipment to the PFP. The PR room also functioned to receive rework solution from N-Cell and L-Cell for transfer back into the PUREX process. Major upgrades in 1981 included replacing glove box panels with noncombustible materials and redesigning the L9 agitator shaft seal. The PR room contains four glove boxes, which held receiver tanks, vacuum jets and condensers, a scale hoist, liquid seal pot, piping, pumps, valves, and other hardware. During the Standby period, PR room tanks and glove boxes were flushed with nitric acid to reduce the plutonium inventory. The flush solution was stored in tank E6, and the nitric acid transfer lines to the PR room were blanked in the P&O gallery.[111]

Figure 22. Nuclear Operator Removes Residual Plutonium Contamination from Equipment Inside N Cell Glove Box, as Part of Deactivation, Early 1996.

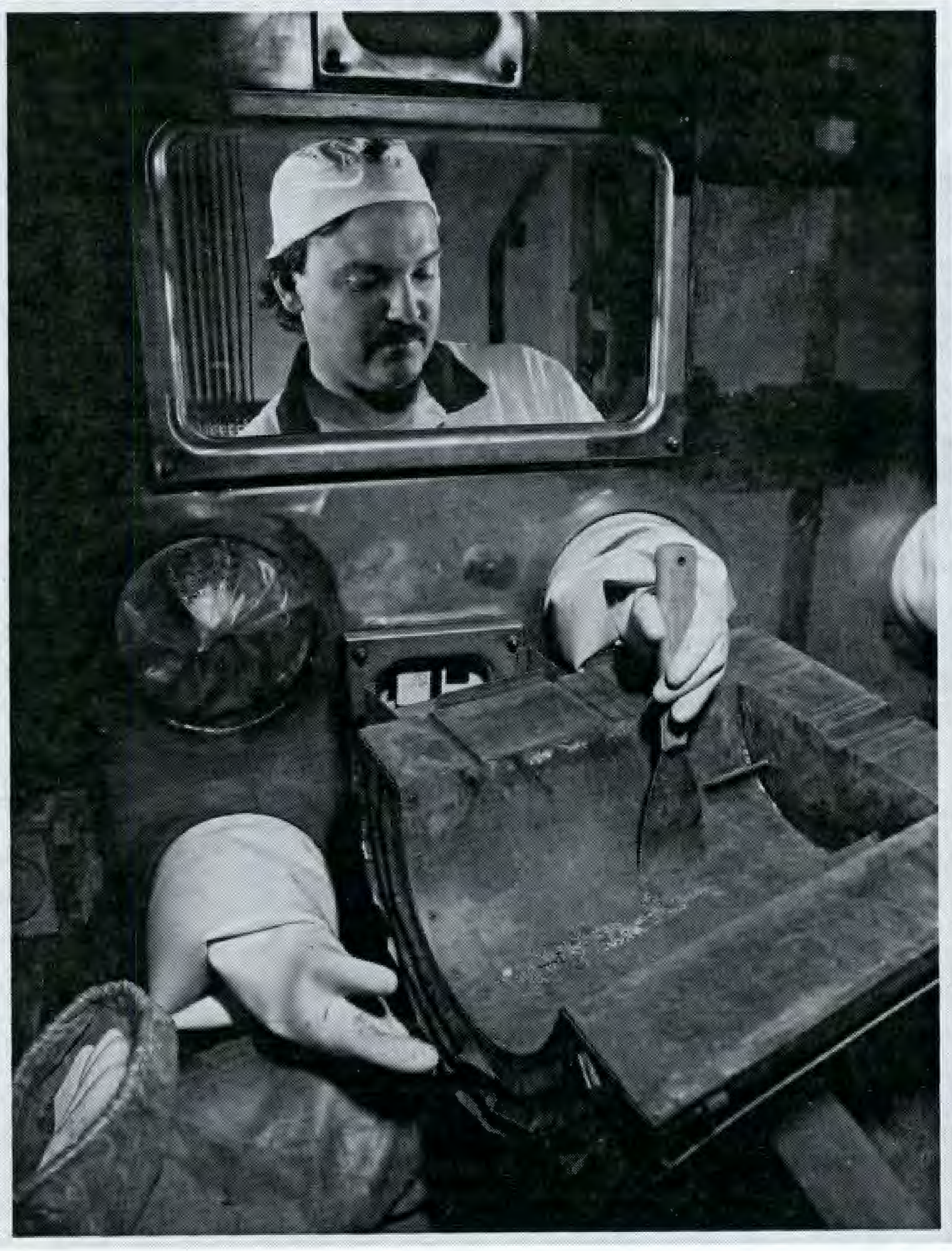


Figure 23. Waste is Packaged out of PUREX N Cell, as Part of Deactivation, 1996.

Figure 24. N Cell Equipment is Sealed Shut After Cleanout, PUREX, 1996.

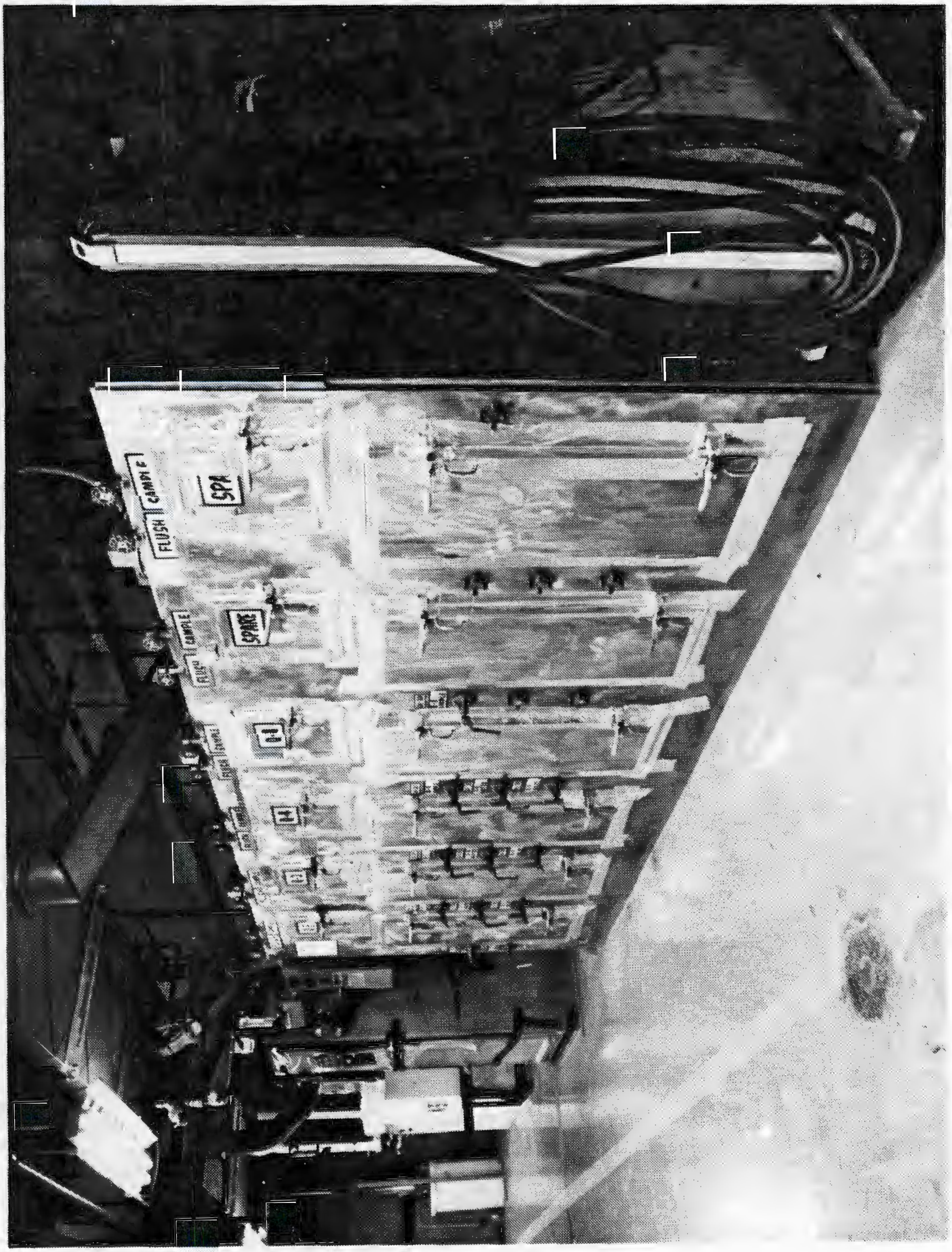
The deactivation plan for the PR room basically followed the same sequence as that for N-Cell, and took place after most of the N-Cell deactivation was completed. Residual solution heels were removed from the PR room tanks, small equipment was removed from the glove boxes, then the glove box interiors were wiped and sprayed with fixant. Lastly, glove box exterior penetrations and ports were sealed, and miscellaneous equipment used during the deactivation work was removed. The removal and sealing work was completed in June 1996, ahead of schedule. The ventilation system is being consolidated, and the glove box ventilation is being rerouted as part of the PUREX HVAC consolidation milestone.[112]

Q-Cell in the PUREX Plant was used from 1958 through 1972 to perform the final steps in purifying ^{237}Np from the process stream. Neptunium was separated and concentrated in the J-Cell package, then transferred to Q-Cell for concentration and purification, and finally loaded into bottles as neptunium nitrate for shipment to other facilities. After the decision was made in the early 1980s not to restart Q-Cell, the transfer line from the J-Cell package was blanked, the vessels and glove boxes were flushed, and the steam and water headers to Q-Cell were disconnected during the Standby period. At that time, the total inventory of fissile materials in Q Cell was inventoried and placed at less than 450 grams. This amount allowed the Q Cell criticality alarm to be disconnected. The equipment remaining in Q-Cell after that time included the concentrator, an ion-exchange column, feed tanks, and a sump tank located inside a hot cell, and valves, pumps, and other small equipment pieces located inside the maintenance glove box.[113]

Again, the deactivation plan for Q-Cell followed the pattern for N-Cell and the PR room. Residual solution heels in Q-Cell tanks were sampled. It was necessary to remove contaminated residual solutions from the Q-Cell aqueous make-up tanks and the hot cell tanks. Some glove box equipment was removed, the interiors of the glove boxes were wiped and sprayed with contamination fixant, and the outer penetrations and ports on the maintenance, loadout, and hot cell vault glove boxes were sealed ahead of schedule, by June 1996 (Figure 25). Currently, ventilation ducts are being blanked and the filters removed, and the glove box ventilation is being rerouted as part of the PUREX HVAC consolidation milestone.[114]

The Sample Gallery in the PUREX Plant is a long corridor that runs parallel to the main canyon on the second floor of the 202-A (PUREX) Building. During operations, it provided access to the canyon tanks for sampling purposes. Three types of sample stations were built, with varying amounts of shielding to accommodate sample solutions containing different levels of radioactivity. Air jets were used to circulate solutions from process vessels, through sample cups enclosed in housings in sample stations, and then back to the point of removal from the process. Other miscellaneous activities and equipment that were housed in the Sample Gallery included a manipulator maintenance shop, a low-level waste compactor, cold chemical make-up tanks for N-Cell, two neutralization systems, and a shielded pipe chase containing chemical headers. Sampler hoods were exhausted through two stacks (296-A-6 on the east end and 296-A-7 on the west end) via a sampler exhaust duct that runs the length of the Sample Gallery. Recurring leaks of contaminated condensate over the years indicate a buildup of radioactivity in the hoods and duct.[115]

Figure 25. Q Cell Samplers Sealed Shut After Deactivation, PUREX Plant, 1994.



Deactivation of the Sample Gallery consisted of removing debris from samplers, then sealing the sampler hoods and valve pits. Silicon rubber sealants were used on the cracks around the hood doors, and larger openings were covered with rigid plastic sheets. Polyurethane foam sealants were used to seal valve pit cover blocks, and valve extension handles. Sample Gallery deactivation was completed in July 1996, as part of the PUREX Residence Out milestone, a large campaign to empty the 202-A Building of personnel, furniture, supplies, and other fixtures necessary to support everyday occupancy.[116]

8.1.1 LESSONS LEARNED

Lesson No. 61. New techniques in contamination fixation and sealing can be used to reduce the possibility of contamination migration so that full removal and burial of contaminated equipment and duct work is not necessary during deactivation. NDA results and facility conditions should be carefully weighed. In some cases, physical glove box and duct removal may be the best and safest choice.

8.2 METAL SOLUTION DISPOSITION (D5/E6)

Because the PUREX Facility was in "Standby pending restart" until late 1992, approximately 8,101 liters(2,140 gallons) of recycled product UNH solution were routed into tank E6. This substance was needed to meet criticality specifications for receipt of plutonium-bearing solutions generated during stabilization and cleanout activities conducted at the plant. From 1990 to 1993, the plutonium oxide powder from N-Cell was dissolved in nitric acid and transferred as plutonium nitrate solution into head-end tank E6 (via temporary storage tank L-11). Tank E6 also received plutonium-bearing solutions generated from flushing solvent extraction vessels during Standby. In March 1992, about 8,328 liters(2,200 gallons) of the solution blend in tank E6, containing an estimated 3,760 grams of plutonium, was transferred into tank D5 to make room in tank E6 for additional transfers from tank L-11. By early 1994, the solutions in both tanks E6 and D5 contained approximately 9 kilograms of plutonium and 5 metric tons of uranium.[117]

With the December 1992 shutdown order, the PUREX Plant was prohibited from any processing activities. Furthermore, solvent extraction vessels already had been partially flushed of residual actinides; canyon process streams had been partially isolated from input and output streams; aqueous make-up tanks were flushed, drained, and disconnected; and many instruments and procedures associated with canyon activities had been deactivated or allowed to lapse. In many cases, operator training to support in-canyon activities associated with the plutonium/uranium solutions had expired. Therefore, a crucial question became how best to dispose of the plutonium/uranium solution material in tanks D5 and E6. Several options were considered, including multibatch separation of the uranium and plutonium, using various partitioning flowsheets and mechanisms. However, the integrity of several PUREX tanks and vessels would have to be verified if these options were adopted, N-Cell would have to be kept operational for converting the recovered plutonium portion to plutonium oxide, and some of the required activities were outside the bounds of the existing PUREX FSAR.[118]

Another disposal option involved co-precipitation of the solids from the supernate portion of the solutions. The liquid portions [about 26,498 liters(7,000 gallons)] would be transferred to the Hanford Site's tank farms, and the solids would be added with absorbent material (vermiculite) into 208-liters(55-gallons) drums for storage as transuranic waste. It was estimated that 150 to 300 such drums would be generated. For a time in 1993, the co-precipitation option was preferred. However, further analysis showed that, for this option, risk levels were in the "medium" range in the areas of worker and environmental protection and regulatory concerns were associated with the vessels needed for the co-precipitation operation, waste minimization, and life-cycle cost. Also, this option presented serious implementation time and schedule impacts, because new equipment would need to be designed, procured, built, installed, tested, and reviewed.

In late 1993, another option, that of direct transfers of the neutralized D5/E6 materials to the Hanford Site's tank farms, was selected. The transfer option was found to involve "low" risks in many of the same areas where the co-precipitation option had involved "medium" risks. An added main benefit of this decision concerned the overall cost reduction associated with early completion of the PUREX deactivation project. Early in the transfer planning, it was thought that this material would be diluted with flush solutions that resulted from other canyon deactivation activities and that had been concentrated in the PUREX F-11 concentrator. Approximately 50 batch transfers, totalling 757,080 liters(200,000 gallons), were thought to be needed. Criticality limits within the D5/E6 material and within the waste tanks were studied carefully. Because the PUREX material contained uranium and cadmium (both of which enhance criticality safety), a criticality safety analysis in early 1995 allowed the amount of fissile material per batch from PUREX to be increased to 500 grams per batch. At that point, the D5/E6 material was mixed with limited amounts of canyon flush material and transferred to the tank farms in only 30 transfers totalling 80,000 gallons. The transfers were completed in April 1995.[119]

8.2.1 LESSONS LEARNED

Lesson No. 62. Any unnecessary manipulations, separations, conversions, or handling of plutonium and uranium-bearing solutions should be avoided. The age of the process vessels (at least in the PUREX Plant, and also at many other DOE facilities) activates the need for renewed regulatory involvement if any further or different uses are made of this equipment. Also, worker and environmental risk increases every time additional processes are performed on plutonium and uranium materials.

Lesson No. 63. The cost savings associated with timely deactivation of large facilities such as the PUREX plant are so overwhelming and important that optional activities that involve keeping plant systems active must be declined. The PUREX facility is so complex and its internal systems so intertwined that the need to perform any activities associated with plutonium/uranium solutions meant that nearly all of the plant's systems would have to remain active. This would have slowed the overall deactivation project, and the imperative need and desire of the DOE to proceed with deactivation would not have been realized.

Lesson No. 64. The use of well-established, simple technologies that could be readily implemented contributed to the successful disposition of the D5/E6 material. Existing procedures and specifications also were used, so that only minor piping changes within the PUREX facility were required. As a result of "keeping it simple," significant cost savings were achieved and the activity was completed safely and ahead of schedule.

8.3 SINGLE-PASS REACTOR FUEL AND N-REACTOR FUEL DISPOSITION

At the time of the PUREX shutdown order, the plant still contained 2.9 metric tons of aluminum-clad, single-pass reactor fuel stored underwater in the facility slug storage basin. This fuel had been in storage in the basin since 1972, and consisted of 779 pieces packaged into four baskets. The PUREX dissolver cells also contained approximately 40 N-Reactor fuel elements (0.5 metric tons total), that had been inadvertently dropped on the floor during charging operations 12 or more years ago. Remote inspections of the fuel and samples of the water from the storage basin showed that the single-pass reactor fuel was somewhat corroded, and that the N-Reactor fuel had deteriorated significantly.

Several alternatives existed for the disposition of the fuel. One option, that of leaving the fuel inside the PUREX canyon, had to be ruled out immediately as the D&D organization absolutely would not accept the building for turnover if it contained spent fuel. Another option that was prohibited specifically by the DOE shutdown order was that of processing the fuel through PUREX. Likewise, the alternative of transferring the PUREX spent fuel to an offsite storage facility was deemed to be nearly impossible because of stakeholder and regulatory concerns about the shipment of unprocessed nuclear fuel. One potentially viable option was to transfer the single-pass fuel to other storage facilities on the Hanford Site. However, of the available facilities, the Fuels and Materials Examination Facility and the Washington Public Power Supply System reactor would have needed extensive, expensive, and time-consuming modifications. The only other available facility was the T-Plant pool cell, and T-Plant officials were trying to rid themselves of their spent fuel inventory to reduce the hazard classification of that structure. Another possible choice was to install a fuel conversion process in the PUREX Plant and convert the fuel to an acceptable dry storage mode. However, selecting, permitting, and installing a stabilization process would have taken several years. By 1993, the preferred option for WHC and DOE officials was to transfer the PUREX spent fuel to wet storage in the K-Basins of the Hanford Site. These basins already stored 2,200 metric tons of other spent nuclear fuel, and were funded on a path forward to stabilizing and moving this fuel to a new storage facility to be built and permitted on site.[120]

The fuel transfer activities were reviewed to evaluate to determine what documentation would be required. An environmental assessment was prepared to determine the impacts of the fuel loading, transfer, and unloading on the environment. This document was issued and a Finding of No Significant Impact was approved by the DOE in July 1995. At the same time, an air permit was prepared for the K West Basins to support the fuel unloading activities. This permit was approved by DOE, Ecology, and WDOH, also in late Summer 1995. The development of both of these documents required a cooperative effort by the Hanford Site Spent Nuclear Fuel Project, and PUREX and Regulatory Support groups. Late in the process it was decided that because fuel transfers had not taken place in some time, readiness reviews would be required at both PUREX and K Basins. These reviews were accomplished and all necessary concerns were addressed.[121]

The recovery of the fuel dropped on the PUREX dissolver cell floors presented a unique challenge. This fuel had been dropped many years ago and needed to be recovered and packaged into canisters for the shipment to the K-Basins. This process had never been accomplished in the PUREX facility (nor was it required before) and all new tools and equipment were required. The engineering and operations groups combined to develop the new tools to recover and package the fuel. First, computer mock-ups were created to test the equipment designs in simulated PUREX settings. All designs were kept simple to reduce possible failures and to aid construction. State-of-the-art designs, which might have allowed more intricate maneuverability of equipment and more compact packing of the fuel, were rejected in favor of sturdy, simple equipment. Because the equipment would be used only once, it was designed and built using procedures that allowed a great deal of hands-on testing and evaluation. The equipment was tested (and later modified) using "dummy" (non-radioactive) materials before it was placed into the PUREX process canyon. Also, every part of the PUREX dissolver cells and all pertinent work locations were videotaped and studied to help in the equipment design and work planning.[122]

The recovery of the fuel started with removal of the dissolver equipment to expose the fuel elements. The fuel recovery equipment then was used to grasp each element, wash it, and load the element into canisters. Each day's work was videotaped and studied to improve the procedure for the next day's work. The loaded canisters were stored in a rack on the canyon deck. The preparation of the aluminum-clad fuel required that an overpack basket be removed and the fuel baskets be placed into new lifting buckets. Only one single basket of fuel in the PUREX basin had been placed into an overpack bucket. This bucket was designed for charging the dissolvers and would not fit into the shipping container. This overpack was removed by lifting the bucket to the top of the water level and using an impact wrench to remove the retaining bolts. The overpack was then lowered and the bucket was removed and placed into a new overpack as were the other three buckets (not previously overpacked). The new overpack was used both as a precaution to ensure that the fuel remained covered with water and to provide a new lifting container. Before the fuel transfer, the buckets were moved onto the canyon deck and flushed with water to remove as much corrosion material as possible.[123]

The K Basins prepared an area for unloading the canistered fuel. The equipment needed to seal the canisters after receipt was constructed and installed in the basins. Additions tools needed to unload the aluminum-clad fuel were also fabricated and installed. Both the aluminum-clad fuel and recovered dissolver fuel canisters were loaded into irradiated fuel cask cars. These cask cars had been prepared for this shipment by the removal and replacement of the shielding water. The lids to the cars were closed and sealed with tape (an added precaution required by the regulatory agencies to prevent sloshing water from exiting the cars). The cars were surveyed and shipped to K Basins where they were opened and the fuel was loaded into one segment of the K West Basin. These operations were completed in October 1995 (Figure 26). Although communication was excellent between the Spent Nuclear Fuel Project and PUREX, the procedures had not been cross-reviewed. This omission led to confusion about the security sealing of the cars and caused some delay. However, the basketed fuel was removed and loaded into canisters at the K Basins. A problem arose when the very fine corrosion material remaining on the fuel rose from the baskets and obscured the camera. This problem was overcome using experienced operators who worked without the video to collect the elements and load the canisters.[124]

8.3.1 LESSONS LEARNED

Lesson No. 65. Video taping the PUREX dissolver cells where the fuel was lying, and video taping all pertinent locations was very helpful in planning the fuel recovery and transfer activities. Taping also helped to assign recovered fuel Nuclear Material values, to document of canister loading, account for all fuel elements, and provide an ongoing method to review and learn from previous days' activities. All work with sensitive materials such as spent fuel elements (and other items with accountability requirements) should be taped without editing and at the highest tape speeds, to provide the best opportunities for learning and improving the activities.

Lesson No. 66. Planning and surveying every step of the way when dealing with an activity involving radiological contamination outside of plant radiation zones leads to time savings in the end. Such activities have high visibility, and involve many regulations and stipulations. Making sure all of the surveys and preparations are done before starting the main activity will prevent any expensive work stoppages during the activity. At PUREX, the identification of allowable contamination levels on the cask cars almost stopped the fuel transfer at the last minute.

Lesson No. 67. The EA process can be very time consuming. To expedite matters, processes that already are covered in existing documents should be identified, and the existing documentation included in the beginning. Early contact should be made with the EA review team to discuss and agree on what will be included. Also, the review team itself should be carefully chosen to include the people directly involved with the activity. They have expert knowledge and this knowledge should be tapped. The review team should not be expanded to include anyone other than those who are essential or the process may become unwieldy.

Lesson No. 68. Alternatives for the disposition of spent fuel are severely limited by considerations of the time and money it takes to satisfy regulatory requirements, safety considerations, and stakeholder concerns. The requirements to permit the movement of even small amounts of spent fuel away from the DOE site of origin are very significant and perhaps not even achievable in today's climate. Therefore, spent fuel remaining at the end of processing activities should be dealt with on site, and should be grouped with other existing spent fuel if it exists.

Figure 26. Transfer of Spent Fuel from PUREX to the 105-K West Basin, Hanford Site, 1995.

Lesson No. 69. Operating personnel should be kept involved with every step of the design, to improve the ease of use with new equipment. Also, problems with the design can be identified early using the plant experience. Such problems may not necessarily be recognized even by a knowledgeable engineering staff. For example, by allowing the crane operator at PUREX to design his tools with minimal support by engineering, the tools were constructed quickly and accurately for use in the specific task.

Lesson No. 70. Design of equipment should be kept simple and rugged to ensure consistent operation and to avoid potential equipment failures. Such equipment may not be state of the art, and may not be able to perform intricate maneuvers, but the performance tradeoff in remaining operable and cost effective is worthwhile. Also, keep the design classification for new equipment to as low a level as possible, to allow for timely inspections and drawing development.

Lesson No. 71. Provision should always be made for cross-review of procedures when more than one organization is involved in an activity.

Lesson No. 72. When an activity (such as fuel transfer) is a high priority action for one project but not for another, understandings and agreements need to be reached at high management levels as to which priority level will apply.

Lesson No. 73. Computer simulation of equipment is very helpful to engineers and operators in both evaluating use inside remote areas (such as the PUREX canyon) and in visualizing and planning activities.

Lesson No. 74. To the extent possible, keep the time period between planning, documenting, and carrying out an activity as short as possible. When time elapses, documentation changes may be required, personnel assigned to the activity may change, and readiness reviews may become more extensive. Such changes add time to the overall activity schedule. At PUREX, some of the personnel familiar with fuel transfers were lost during the initial years after the Standby runs. When the time came for the final fuel transfers in 1995, some of the personnel in key positions had never done this activity before, so more extensive readiness reviews were needed.

8.4 NITRIC ACID DISPOSITION

Once the PUREX/UO_3 Facilities received their final closure orders and the UO_3 stabilization run (see Section 9.0) was complete, the plants were left with approximately 681,372 to 757,080 liters(180,000 to 200,000 gallons) of slightly contaminated (low specific activity) nitric acid. The original plan in 1993 was to dispose of this material via sugar denitration in the PUREX Plant. Sugar denitration had been a standard practice at the facility since 1963, but it produced a strong nitrogen oxide off-gas that would have posed a significant regulatory hurdle. Also, the amounts present at PUREX would have taken over 1 year to process, thereby prolonging the overall deactivation project. In early FY 1994, an alternative disposition plan was developed to sell the nitric acid as a process chemical to a fuel reprocessing facility owned by BNFL at Sellafield, England.[125]

Because the transfer of a process chemical to a foreign reprocessing facility would involve non-proliferation concerns, DOE stipulated that the UO_3

product that would be generated by BNFL would not be placed on the commercial uranium market. The next concern was the safe transportation of the material, and the development of adequate NEPA documentation (with attendant public involvement) to ensure such safety. A memorandum of understanding was written between WHC and DOE, and a transportation plan was developed to ensure the implementation of all required safety procedures. In the summer of 1994, an export license for the shipment was sought by the DOE from the Nuclear Regulatory Commission, and a final contract was under negotiation between BNFL and the DOE. In August however, strong concerns about non-proliferation and the costs and procedures of the transfer were expressed by the environmental group Greenpeace and by some members of the DOE-HQ staff.[126]

In September, Secretary of Energy Hazel O'Leary authorized the shipment to proceed pending the preparation of an EA (with attendant public involvement), the receipt of an export license, and the approval of a transportation plan. At nearly the same time, concurrence was achieved with Washington State regulators that the nitric acid was not a waste, because it would be used as a beneficial process chemical and would not be abandoned or stored. The export license was granted in November, and the EA was completed in February 1995. A Finding of No Significant Impact was approved in May 1995. Shipments began almost immediately, and were completed 25 weeks later, in November 1995 (Figures 27, 28, and 29).[127]

8.4.1 LESSONS LEARNED

Lesson No. 75. Finding an alternate use for a slightly contaminated process chemical, with an interested buyer or consumer, is better than having the material declared a waste. The same lesson was learned, and for the same reasons, in connection with uncontaminated fresh chemicals that were sold from the PUREX Plant during the Standby period.

Lesson No. 76. Public involvement, conducted with an honest and open attempt to communicate and find mutually satisfying solutions, can be the key to resolving seemingly intransigent issues. Also, Public involvement uncovers true majority public sentiments, and prevents a vocal minority from inaccurately presenting "public" sentiments. (See Section 10.0)

Figure 27. Shipping Container Used to Transport Contaminated Nitric Acid from the PUREX Facility to England, 1995.

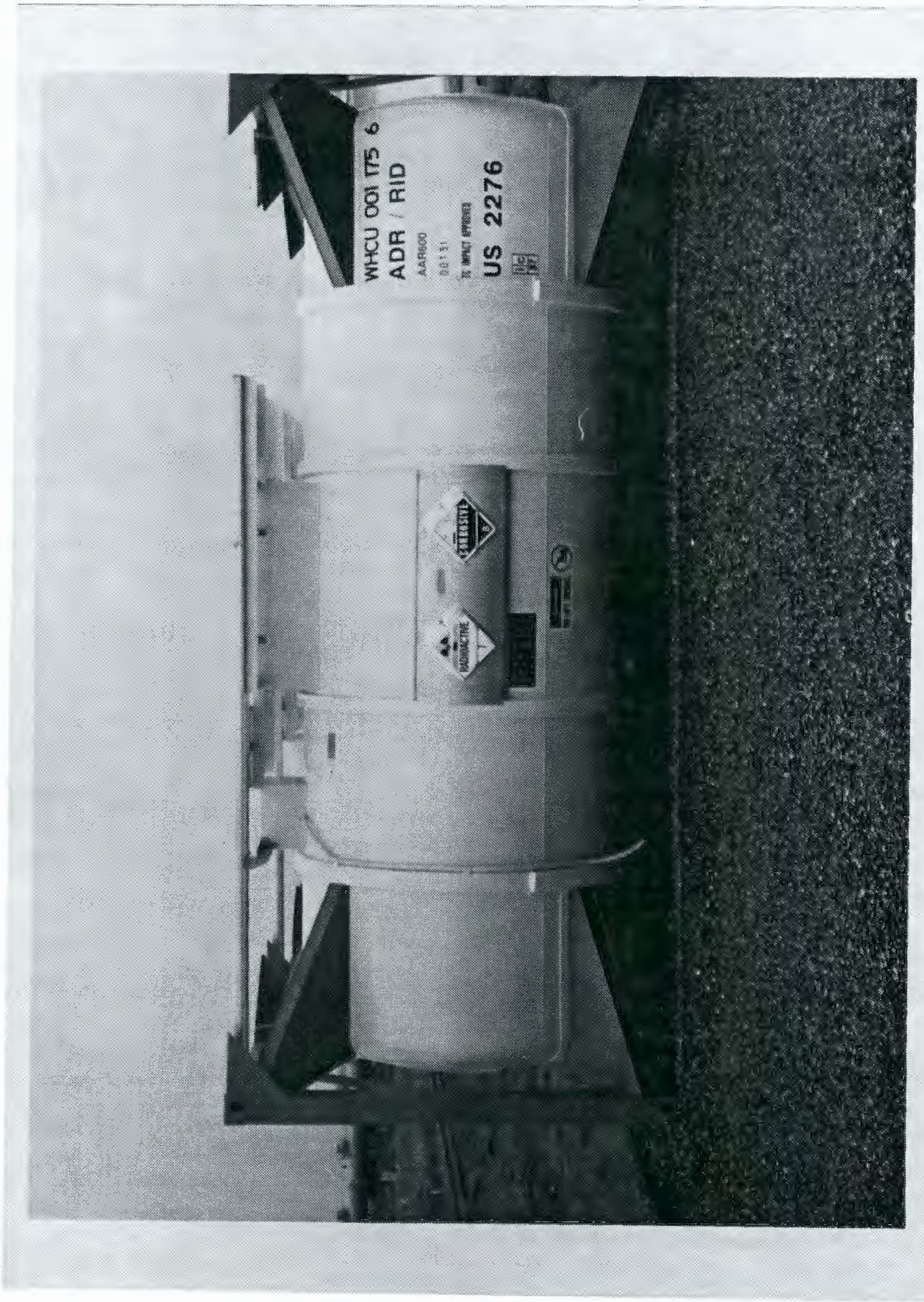


Figure 28. Final Nitric Acid Shipment from PUREX is Readied, November 1995.

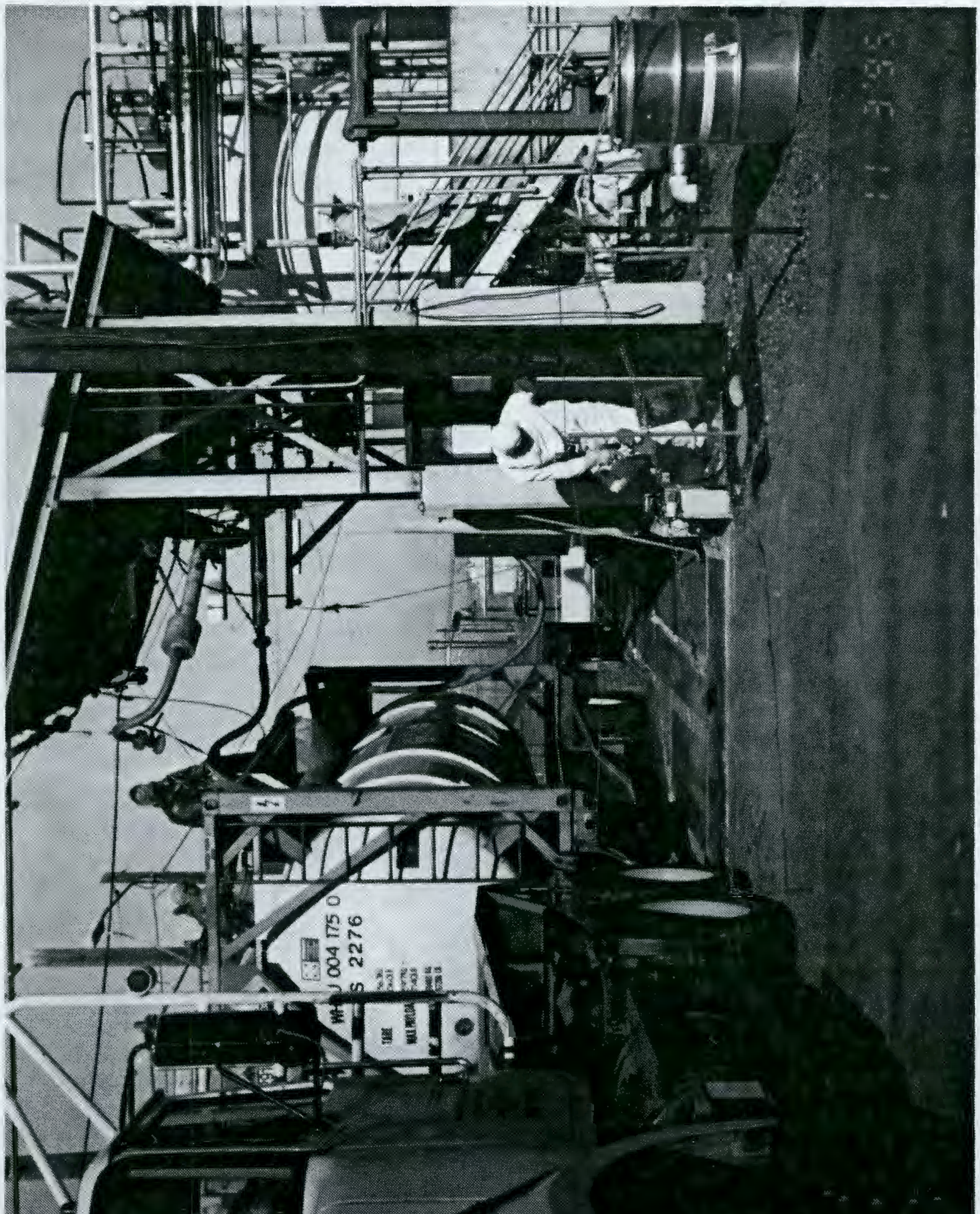
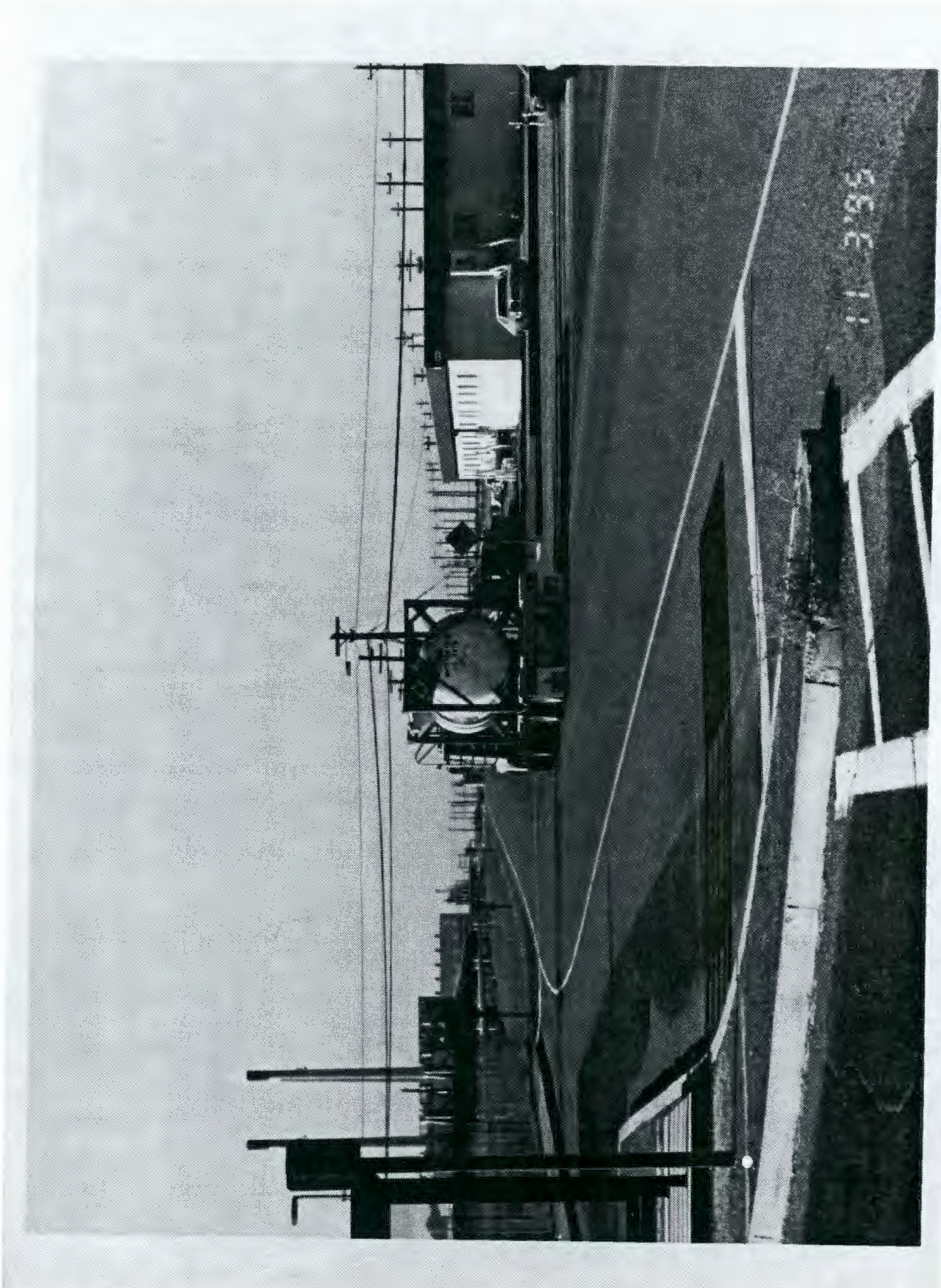


Figure 29. Final Nitric Acid Shipment Leaves the PUREX Facility, November 1995.



8.5 ORGANIC DISPOSITION

When the shutdown order came for the PUREX plant, the facility was left with approximately 79,493 liters(21,000 gallons) of slightly contaminated organic solvent, a mixture of tri-butyl phosphate (TBP) and normal paraffin hydrocarbon (NPH). It was located in tanks G5 and R7 within the PUREX canyon, but was moved outside the plant into tank 40 in 1993, to allow the deactivation of certain in-plant fire system components. Among several potential disposal methods, two were identified as the most viable from the perspectives of safety, waste minimization, and environmental hazard control. Thermal destruction in a licensed commercial incinerator was one preferred option, but this choice would have cost approximately $1.5 million because of the scarcity of incinerators able to accommodate mixed waste. The alternative pursued most avidly by WHC and RL was to transfer the solvent to the New Waste Calcining Facility at the Idaho National Engineering Laboratory for use as a fuel. Discussions to effect this transfer were initiated in the Spring of 1993 among all the interested parties: RL, DOE/ID, WHC, Westinghouse Idaho Nuclear Company, Inc., and state officials and regulators of both Washington and Idaho. The material was to be shipped as a hazardous waste. Approvals were obtained from nearly all parties, and a shipping date was set in September 1993. However, Idaho state officials, having taken strong positions in the recent past against receiving nuclear waste from other states and having had to compromise and accept unwanted spent nuclear fuel from decommissioned naval vessels earlier in 1993, decided that they could not accept the PUREX solvent as a waste.[128]

A series of negotiations followed in 1994, wherein DOE officials attempted to demonstrate that the PUREX organic solvent was not a waste because of its intended beneficial use as a product in the New Waste Calcining Facility. Furthermore, the 1993 CX prepared on the shipment of the solvent had identified it as a Low-Specific-Activity material, one of the least restrictive transport categories. However, Idaho officials were unconvinced, and the issue became entangled in a larger dispute between Idaho's Governor Cecil Andrus and the U.S. Navy over shipments of naval nuclear waste to Idaho. An alternative destination for the PUREX organic solution was found at Diversified Scientific Services Incorporated (DSSI) in Tennessee. DSSI planned to burn the material in a co-generation facility to create electricity. The solution was shipped as waste, to DSSI in six shipments between September 1995 and June 1996 (Figures 30 and 31).[129]

8.5.1 LESSONS LEARNED

Lesson No. 77. Some obstacles to movement of nuclear process materials and to other types of deactivation alternatives cannot be controlled or overcome by plant and DOE personnel. The historical/political climate toward nuclear materials is such that even the most preferred alternatives (from the technical perspective) sometimes cannot be implemented in every locality.

Lesson No. 78. Persistence and patience can find a destination and a cooperative customer when pursued over time. Many avenues should be explored.

Figure 30. Inspection of Equipment Used to Transport Organic Solution from PUREX Facility to Diversified Scientific Services Incorporated, in Tennessee, 1995.

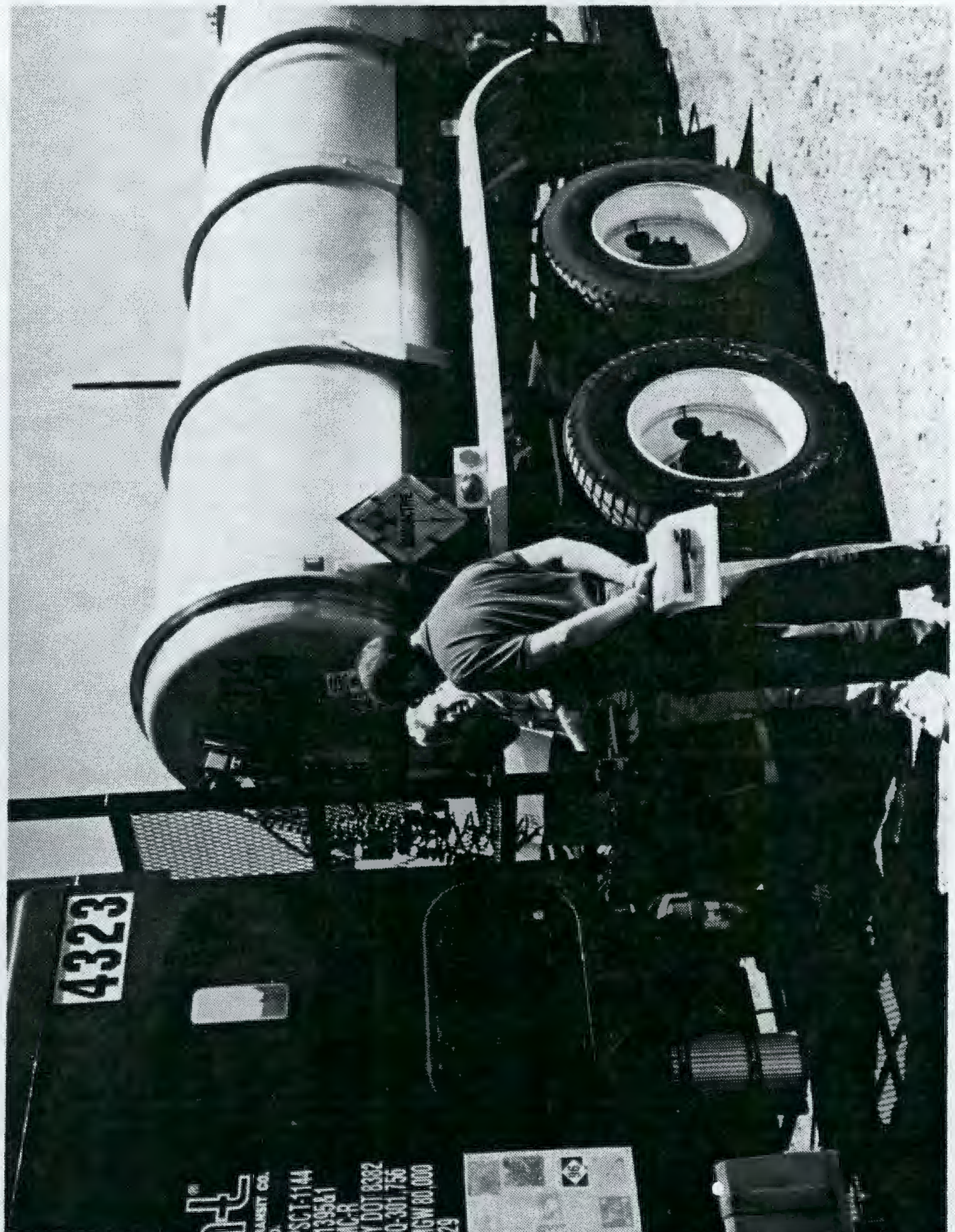
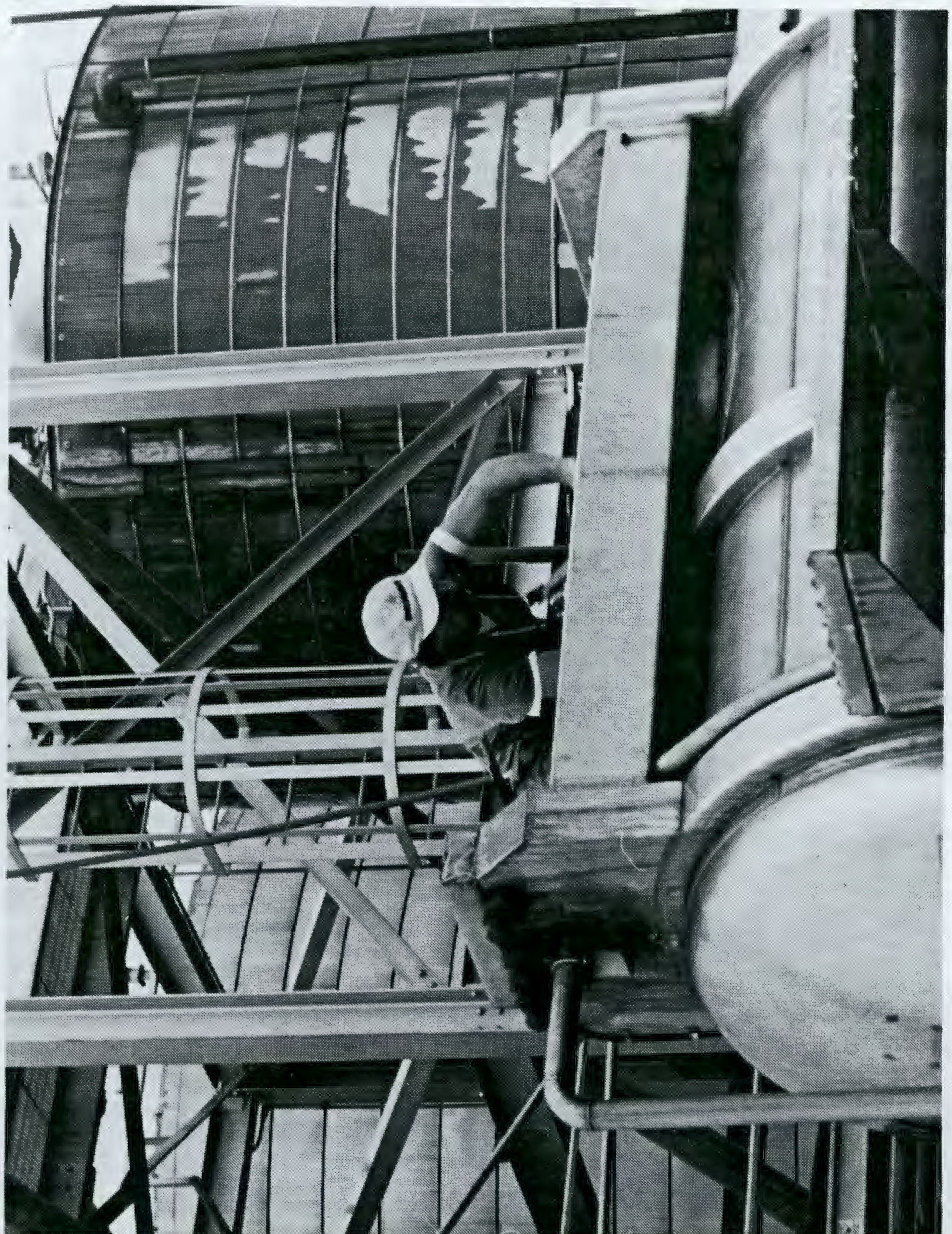


Figure 31. Operator Prepares Tank for Loading and Shipment of Organic Solution from PUREX Facility, 1995.



8.6 LABORATORY DEACTIVATION

The PUREX laboratory was/is an integral part of the facility in that it was constructed to be completely contained within the facility. When PUREX was built, this connection was seen as an advantage because it offered better radiological protection superior than could be achieved when transferring sample solutions outside the plant. However, such a connection appeared in a different light when it came time for the PUREX Plant to shut down. For a time in 1993, consideration was given to keeping the PUREX laboratory open to perform waste characterization and other work valuable to the Hanford Site. However, even though laboratory shortages were a subject of concern to the DOE, the continuing function of the PUREX laboratory after plant deactivation could not be justified. Whole new support systems (i.e., electrical, water, HVAC, etc.) would have to be constructed, or else overall plant utilities would have to be maintained. The overall goal of driving S&M costs to the absolute minimum also could not be reached. Therefore, the decision was made to close the PUREX laboratory toward the end of the deactivation project after maintaining it to sample canyon flush materials and other substances generated by the project itself.[130]

The actual steps in the deactivation of the PUREX analytical laboratory closely followed the pattern established in the cleanout of N-Cell, the PR room, Q-Cell, and the Sample Gallery. Small equipment within glove boxes and open-faced hoods was removed, but the structures themselves remain. Contamination fixants were sprayed and painted inside and around the glove boxes and hoods (Figures 32 and 33). As part of the overall PUREX HVAC consolidation project, the exhaust plenum at the rear of each laboratory hood, the exhaust lateral between hoods and the overhead exhaust header, and the exhaust lateral itself will be filled with polyurethane foam to prevent contamination migration. At this time, the vacuum header lateral lines have been injected with epoxy resin, utilities have been disconnected, piping and drains have been blanked, and filters have been removed. Sink drains have been filled with grout. All laboratory deactivation work except for the HVAC portions was completed in mid-1996. The HVAC tasks will be completed in 1997.[131]

8.6.1 LESSONS LEARNED

Lesson No. 79. The lessons learned in the deactivation of the PUREX analytical laboratory closely follow those learned in connection with N-Cell, the PR room, Q-Cell, and the Sample Gallery. Individual systems within large facilities cannot be kept open without the undue expense of maintaining at least portions of larger systems. There is an optimum time to deactivate a support facility and to move the needed services to other facilities. Also, modern contamination fixant techniques allow glove boxes and other large equipment pieces to be left inside facilities, while still controlling contamination.

Figure 32. Nuclear Operators Deactivate PUREX Laboratory Hoods, 1995.

Figure 33. Foam is Spread Inside PUREX Laboratory Hood in Final Deactivation Step, 1996.

8.7 L-CELL CLEANOUT

L-Cell at the PUREX Facility housed the third (final) plutonium concentration step (Figure 34). As such, it became highly contaminated over the years. During the standby and early deactivation periods, remote television cameras operated by the PUREX crane detected solids and sludge material on the floor of L-Cell. Learning about the nature, extent,and source of this contaminated material was essential to characterization efforts. In the spring of 1994, a team of PUREX personnel comprising health physics technicians, engineers, managers, safety experts, and nuclear process operators began meeting to plan a human entry into L-Cell to obtain better characterization information. They carefully mapped a route through the cell that would be followed by the entering personnel who would take video footage and obtain floor residue samples. Then they made the crucial decision that, to best follow the ALARA radiation exposure guidelines, the entry would be made by just one person. Next, "dry run" dress and undress procedures, as well as a practice route through an uncontaminated area, were rehearsed. When the L-Cell entry was made on May 4, 1994, it went smoothly and two hours of valuable video footage, as well as many important samples, were obtained (Figure 35).[132]

Two solid matrix accumulations were found under tanks L2 and L8, and subsequent assay determined an overall cell floor estimate of between 3,718 to 6,168 grams of plutonium. Criticality analyses of the form, amount, and configuration of the plutonium in L-Cell showed that material was not conducive to a criticality event. Therefore, it was decided in the deactivation project to leave the cell in its current condition. Removing the plutonium, it was believed, would not appreciably reduce the risk to the public, the environment, onsite workers, or future D&D workers. Furthermore, it was estimated that such removal would extend the deactivation schedule by 6 months and increase project costs by approximately $15 million.[133]

8.7.1 LESSONS LEARNED

Lesson No. 80. Careful planning, involving many knowledgeable plant people, as well as practice dry runs, are key elements in achieving smooth, efficient, and low-exposure results when work is required in high-radiation areas.

8.8 CANYON/VESSEL FLUSHING

Following the completion of the PUREX stabilization campaign in 1990, the operating process was shut down in accordance with routine procedures. These procedures involved vessel integrity tests that filled process vessels with water and then emptied them. Essentially a flushing activity, these actions removed much of the SNM and fission product waste from the process piping and equipment. Subsequent activities performed in preparation for potential restart of the plant, including tank calibration and tank integrity assessments, provided additional water flushes of most of the canyon equipment. Therefore, it was decided in the PUREX Deactivation Project to limit further internal flushing of the canyon equipment to that required to ensure that any residual heels did not exhibit dangerous waste characteristics

Figure 34. PUREX L Cell Equipment During Operations, 1971.

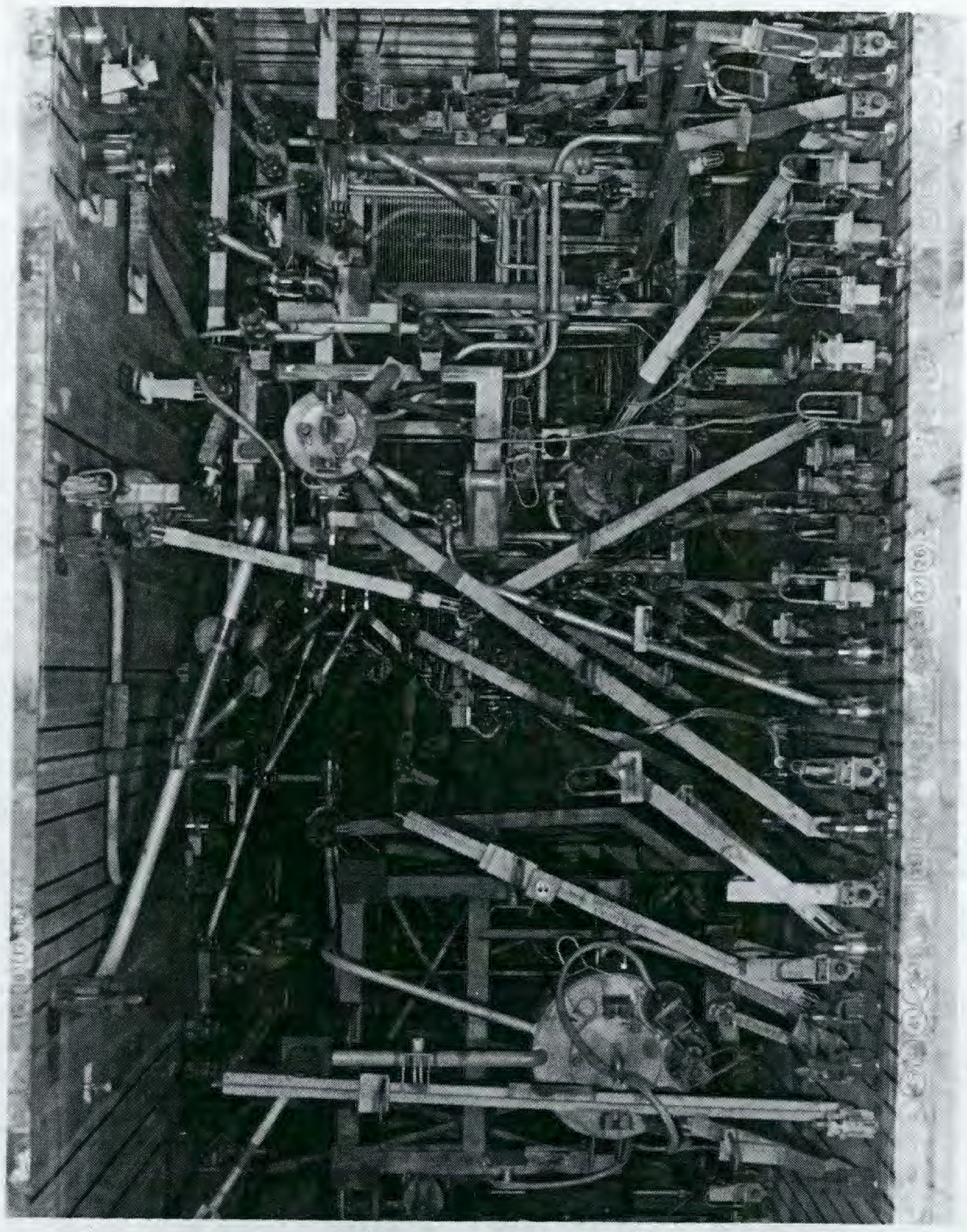


Figure 35. PUREX Workers Prepare for L Cell Characterization Entry, 1994.

(pH between 2 and 12.5), and to remove any suspected high potential "pockets" of SNM or fission products. The decision to flush only to these levels and criteria was based on waste minimization considerations, and on the belief that future D&D decisions should and would determine the necessary levels of "cleanliness" of the process vessels.

At the start of deactivation planning, several alternatives for flushing the canyon equipment were available. The first alternative was to transfer all solutions in the canyon vessels to the Hanford Site's tank farms, and to document the holdup of SNM or hazardous constituents within each vessel. Regulations governing the Hanford Site require that all hazardous material from vessels in a TSD unit or system be removed from the unit before turnover to D&D. Therefore the option of leaving holdup material was eliminated. The second alternative was to conduct chemical and water flushes of the process equipment for the removal of SNM and hazardous material. Because of the large volume of waste water that would be produced, this alternative was also eliminated.

The best available method selected to flush the canyon equipment was to transfer all remaining solutions in the PUREX canyon vessels to the tank farms, then conduct a cascading heel flush of the process equipment using raw water. This method of flushing not only eliminated hazardous constituents remaining in the tank heels, but also minimized waste water volume transferred to tank farms (Figure 36). In addition to minimizing the use of raw water, excess water from the PUREX Slug Storage Basin and steam condensate were used to flush specific canyon vessels.

A total of 74 PUREX canyon vessels were flushed, including vessels named as part of the TSD system. These vessels and associated systems were flushed (cascaded) to ensure that dangerous waste constituents were removed from the corresponding piping and tanks. Significant waste volume minimization was achieved through this approach. To support the cascading of flush solution through the individual systems of canyon vessels, canyon routes were installed or reconfigured.

Flush solutions were cascaded from one vessel in a system to the next with samples obtained at a predetermined point (See Appendix E for an example chart from K Cell). Each system was flushed until the sample of the rinsate in the vessel heel no longer exhibited dangerous waste characteristics. Once the process sample exhibited no dangerous waste characteristics, a RCRA protocol sample was collected. This sample was the final factor needed to designate the solution as non-dangerous waste.

Strict compliance with federal regulation required analysis for every constituent listed by the Environmental Protection Agency in 40 CFR Part 261. In lieu of sampling and analyzing for each of these constituents, the DQO process was employed to determine an appropriate degree of analysis. The DQO process involved discussions among personnel from DOE, WHC, and Ecology, and yielded an agreement to sample for only 20 analytes. The basis for the agreement consisted of past RCRA sample results from PUREX waste and past process knowledge. Although the review of past sample analyses indicated that corrosivity (pH), cadmium (Cd), and chromium (Cr) were the only constituents of concern, it was agreed that the additional analyses would be performed to ensure that no dangerous waste characteristics remain in the canyon vessels.[134]

Figure 36. Cascade flushing of K Cell is Monitored in the PUREX Control Room, 1994.

Approximately 500,000 gallons of waste water were transferred to the Hanford Site's tank farms on completion of canyon vessel flushing in April 1996. A total waste volume of 1.5 million gallons was projected and allotted for PUREX deactivation activities before the canyon vessel flushing project began. Recycling waste water from other sources to be used as flush water for the canyon vessels, contributed to very successful waste minimization. In addition, the cascading method of flushing vessels allowed significant waste minimization by adding water to one vessel and cascading it through the system of vessels. The cascaded approach resulted in significant cost savings and waste volume reductions.[135]

8.8.1 LESSONS LEARNED

Lesson No. 81. Establishing effective, early and ongoing communication between facility and regulatory personnel is essential. Regulatory support and communication was an essential factor in determining the extent of flushing at PUREX, the sample analysis required, and the methods of flushing. Although interaction with regulators often costs time, ultimately it results in completion of the project safely and ahead of schedule.

Lesson No. 82. Looking for ways to combine activities is important, especially with reference to waste minimization considerations. The combination of recycling waste water from other sources and utilizing the cascaded flushes method to flush the canyon vessels at PUREX reduced the anticipated waste volume by 50 percent. It also resulted in significant cost savings by completing the canyon vessel flushing project ahead of schedule.

8.9 PUREX TUNNELS 1 AND 2 (218-E-14) (218-E-15)

Two solid waste storage tunnels are associated with the PUREX facility. The tunnels extend southward from the main railroad tunnel that serves the PUREX plant on the east end. Tunnel Number 1 was built when the PUREX facility was constructed, and Tunnel Number 2 was built in 1964 to store high-dose-rate mixed waste from the PUREX plant and from other sources on the Hanford Site (Figure 37). Each storage tunnel is isolated from the main plant railroad tunnel by a water-fillable shielding door. No electrical utilities, water lines, drains, fire detection or suppression systems, radiation monitoring, or communication systems are provided inside the PUREX Storage Tunnels.

Construction of Tunnel Number 1 was completed in 1956 and consists of three areas: the water-fillable door, the storage area, and the vent shaft. The water-fillable door is located at the north end of Tunnel Number 1 and separates the storage tunnel from the main PUREX railroad tunnel. The door is 7.5 meters high, 6.6 meters wide, and 2.1 meters thick, and is constructed of 1.3-centimeter-thick steel plate. The door is hollow so that it can be filled with water to act as a radiation shield when in the down (closed) position. The Tunnel Number 1 water-fillable door will be drained as part of PUREX Deactivation Project.

Figure 37. PUREX Storage Tunnel #1 Under Construction in, 1954.

The storage area of the tunnel extends southward from the water-fillable door. Inside dimensions of Tunnel Number 1 are 109.1 meters long, 6.7 meters high, and 5.9 meters wide. Ceiling and walls are 35.6 centimeters thick and are constructed of 30.5- by 35.6-centimeter, creosote pressure treated, Douglas fir timbers arranged side by side. The first 30.5 meters of the east wall are constructed of 0.9-meter-thick reinforced concrete. A 40.8-kilogram mineral surface roofing material was used to cover the exterior surface of the timbers before placement of 2.4 meters of earth fill. The earth cover serves as protection from the elements and as radiation shielding. The timbers that form the wall rest on reinforced concrete footings 0.9 meter wide by 0.3 meter thick. The floor consists of a railroad track laid on a gravel bed. The space between the ties is filled to top of tie with gravel ballast. The tracks are on a 1.0-percent downward slope to the south to ensure that the rail cars remain in their storage position. A rail car bumper is located 2.4 meters from the south end of the track to act as a stop. The capacity of the storage area is eight, 12.8-meter-long rail cars.

Between 1962 to 1980, nine pipe risers were installed through the roof of Tunnel Number 1. Seven of the nine risers were used for wood sampling of the tunnel ceiling timbers. The other two were used to obtain air samples and temperature data about the internal environment of the tunnel. Currently, all risers are capped. A vent shaft is located at the south end of Tunnel Number 1. The shaft is approximately 1.5 meters in cross section and is constructed of reinforced concrete. The vent stack extends approximately 0.3 meter above grade and was capped with a single-stage HEPA filter, a 283-cubic-meter per minute exhaust fan, and a 6.1-meter-tall exhaust stack.

Over the years, material selected for storage in the tunnels was loaded onto rail cars modified to serve as both transport and storage platforms. A remote-controlled battery-powered locomotive or a locomotive and a string of spacer cars was used to position the rail car in the storage tunnel. The cars were placed in storage positions numbered sequentially, commencing with position number 1 that abuts the rail stop bumper at the south end of each tunnel. Position number 2 is the location of the rail car that abuts the rail car in position 1 and the sequence continues.

In June 1960, the first two rail cars were loaded with a single, approximately 12.5-meter-long failed separation column and placed in Tunnel Number 1. Between June 1960 and January 1965, six more rail cars were placed in Tunnel Number 1, filling the tunnel. After the last car was placed in the northernmost storage position (Position 8), the water-fillable door was closed, filled with water, and deactivated electrically. After Tunnel Number 1 was filled to capacity, it was sealed. Sealing activities included deenergizing the ventilation system and blanking the ventilation system upstream of the air filters to prevent interaction of the tunnel air with external air.

Construction of Tunnel Number 2 was started and completed in 1964. Like Tunnel Number 1, Tunnel Number 2 consists of three functional areas: the water-fillable door, the storage area, and the vent shaft. Construction of Storage Tunnel Number 2 differs as follows.

- A combination of steel and reinforced concrete was used instead of wood timbers to construct the storage area.

- Tunnel Number 2 is longer, with five times the storage capacity of Tunnel Number 1.

- The floor of Tunnel Number 2, outboard of the railroad ties, slopes upward to a height of approximately 1.8 meters above the railroad bed. The floor in Tunnel Number 1 remains flat all the way out to the side walls.

- The railroad tunnel approach to Tunnel Number 2 angles eastward then angles southward to parallel Tunnel Number 1. The approach to Tunnel Number 1 is a straight extension southward from the PUREX plant. Centerline to centerline is approximately 18.3 meters.

The vent shaft, located at the south end of Tunnel Number 2, is approximately 1.5 meters by 1.5 meters in cross-section and is constructed of reinforced concrete. The vent shaft extends approximately 0.3 meter above grade and is capped with an exhaust system consisting of a single-stage, HEPA filter, a 153-cubic-meter-per-minute exhaust fan, and a 6.1-meter-tall exhaust stack. The ventilation system is currently active; however, the exhaust fan has been dampened down to provide only about 100 cubic meters per minute of exhaust flow.

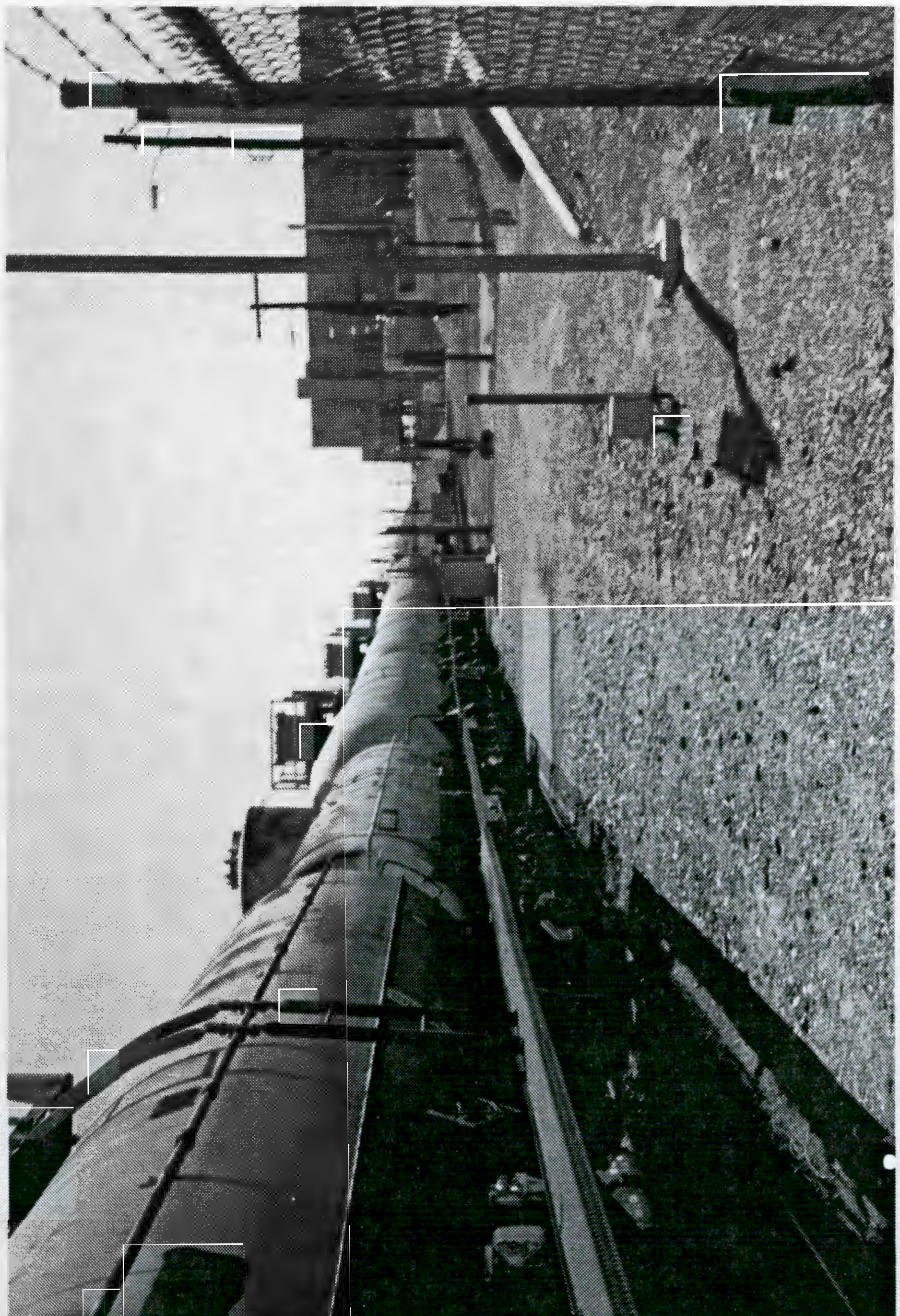
The first rail car was placed in storage in Tunnel Number 2 in December 1967. As of June 19, 1996, 28 rail cars had been placed in Storage Tunnel 2.[136]

In the PUREX Deactivation Project, Hanford Site officials and regulators decided to separate the tunnels administratively from the PUREX facility. The rail cars and stored waste material will remain in the storage tunnels until retrieval is required. Separate permitting requirements and agreements now apply to the tunnels. (See Sections 6.1 and 6.2.)

During the PUREX Deactivation project, some plant waste and some waste from elsewhere on the Hanford Site were added to Tunnel Number 2. Rail cars in positions 24 and 25 contain waste that originated in B-Cell in Hanford's 324 building. The waste was packaged in stainless steel canisters and shipped to PUREX in a steel shipping cask mounted on a railroad flat car (Figure 38). The first nine shipments were completed April 1, 1996, and staged in G-Cell in the PUREX canyon. Eight more shipments were completed June 8, 1996. The waste canisters were loaded into reinforced concrete burial boxes in two separate operations. The first box was placed into Storage Tunnel Number 2 on April 26, 1996, and the second box was placed into Storage Tunnel Number 2 on June 12, 1996. The two boxes sit on separate railroad flat cars. Also, during the PUREX Deactivation Project, three, empty 75,800-liter (20,000-gallon) stainless steel rail-tank cars with high dose rates resulting from internal contamination were placed in positions 26, 27, and 28 of Storage Tunnel Number 2 (Figure 39). These rail cars were purchased in 1966 and were used for contaminated liquid waste transfers on the Hanford Site between N-Reactor, the 340 facility, FFTF, T-Plant, and the tank farms. Rail cars in positions 1 through 23 contain failed equipment from the PUREX Facility.

Figure 38. 324 Building Waste is Moved into PUREX Storage Tunnel #2, 1996.

Figure 39. Final Three Permitted Rail Cars of Waste (Closest to Plant) are Moved into PUREX Storage Tunnel #2, Summer 1996.



When significant decay of the radioactive fission products contaminating the equipment has occurred, the equipment may be retrieved for final disposal. While each rail car is retrievable, the rail cars can be removed only in reverse order (i.e., last in, first out) because they are stored in a single, dead-end railroad track. Therefore, decay of the most recent waste, having some of the highest activity, must occur before older waste can be retrieved. For these reasons, final disposition of the PUREX tunnels will be treated in entirely different projects and circumstances from the PUREX Deactivation Project. Meanwhile, the Deactivation Project has committed to 56 end points for the tunnels, including surveying and posting of radiological conditions, documenting the location of remaining dangerous waste, installing physical barriers to prevent unauthorized entry, isolating and removing the tunnel effluent release points (296-A-9 and 296-A-10), and draining water from the tunnel doors.[137]

8.9.1. LESSONS LEARNED

Lesson No. 83. When ancillary facilities such as the PUREX Tunnels clearly have different missions and vastly different anticipated operating life spans, they should be separated administratively and treated differently in terms of regulatory and physical planning.

8.10 PUREX HVAC CONSOLIDATION

During normal operations and throughout most of the deactivation years, the 202-A Building was served by four separate ventilation systems designed to keep normal work areas free of airborne radioactive contamination. The systems operated by maintaining differential pressure (DP) to ensure airflows from zones containing no contamination into zones of progressively greater radioactive contamination potential. Air was taken from the environment, passed through roughing filters and spray washers, heated if required, and supplied to the zone to be ventilated. Air was removed from the area at a constant rate, passed through HEPA filters, and exhausted to the atmosphere. The supply was modulated to maintain the correct DP within the zone.

Ventilation System 1 served the canyon and the process cells, the area with the greatest potential for radioactive contamination. Ventilation air supplied to the main canyon area was drawn into the cells from the top. From the cells, air was drawn through small ports into the air tunnel, then through deep bed fiberglass filters 1 and 2 and the 291-A stack filters, and was exhausted through the stack by electric fans. The exhaust was monitored and sampled for radionuclides content.

Deep bed filters 1 and 2 were designed to remove 99 percent of the radioactive particles from the exhaust ventilation air, and tests in the 1990s showed efficiencies greater that 99.93 percent. The filters were 85 feet long by 52 feet wide and 13 feet deep. In these filters, the air flowed sequentially through two glass filters. The first unit or pre-filter consisted of a 7-foot deep bed of "free packed" 115 K glass fiber for filter 1 and 5 separate layers packed with different densities of glass-fiber for filter 2. The second unit, known as the cleanup filter, consisted of

132 American Air Filter[i], "Deep-Bed" filter units, each of which was packed with 0.5 inch of AA fiberglass (1.2 lb/ft^3 density) and 0.5 inch of B fiberglass (1.4 lb/ft^3 density), each with a total area of 50 feet squared. The design pressure drop was 2.0 inch water gauge (WG) at superficial velocities of 50 feet/minutes through the prefilters and 20 feet/minutes through the clean up filters. There was a bypass channel and provisions for the air duct to direct the air through either or both filter units. The air flowed downward through the prefilter bed in filter 1 and upward in the prefilter of filter 2. Air flow was upward through the cleanup filters in both glass-fiber filter units.

The 291-A stack filters, or #4 filter building, was designed to remove 99.95 percent of the radioactive particles from the exhaust ventilation air (Figure 40). The unit consisted of a filter building containing 10 filter assemblies arranged in parallel. The filter building is 114 feet long by 42 feet wide by 17 feet high. An inlet and outlet plenum were installed underground to provide air routing to the facility. The filter assemblies were installed across the two plenums. The filter assemblies consist of two banks (stages) of 12 HEPA filters arranged in a three-filter wide by four-filter high configuration. Each filter assembly was rated for 12,000 ft^3/min air flow at 1 inch. WG differential pressure drop. Each filter assembly could be valved out at the inlet and at the outlet. Each filter assembly was provided with instrumentation to monitor the filter bank deferential pressure, the first stage front face radiation level. The filter assembly flow rate was displayed on an instrument panel located in the facility supply blower room. Additional instrumentation indicated plenum differential pressure and air lock-to-filter room differential pressure. The facility was equipped with a supply fan that was exhausted through a single-stage HEPA filter assembly to the outlet plenum.

Air from the 202-A building had to pass through Deep Bed filters 1 and 2 in parallel. All air then passed through the 291-A stack or 4 filters before being released to the environment through the main stack.

Ventilation System 2 serviced the areas of the building that had a potential for contamination, and that were routinely occupied or entered by the work force. Air was supplied to the Sample Gallery, the regulated shop, N-Cell, Q-Cell, R-Cell, U-Cell, the PR room, and the canyon lobby. There were six exhaust fans for these areas. Eleven distinct HEPA filter units refined the effluent air before release. Exhaust was continuously sampled and monitored for radionuclide content.

Ventilation System 3 serviced the P&O Gallery, storage gallery, AMU areas, and the shop and office areas, all of which had the lowest potential for becoming contaminated. A portion of the P&O gallery was ventilated through the East Crane Maintenance Platform (ECMP) and into the main canyon. The west end of the P&O Gallery was known as the White Room and had a potential for contamination from suck-back and line rupture. A separate ventilation system filtered the air from this area. This exhaust was continuously sampled and monitored for radionuclide content.

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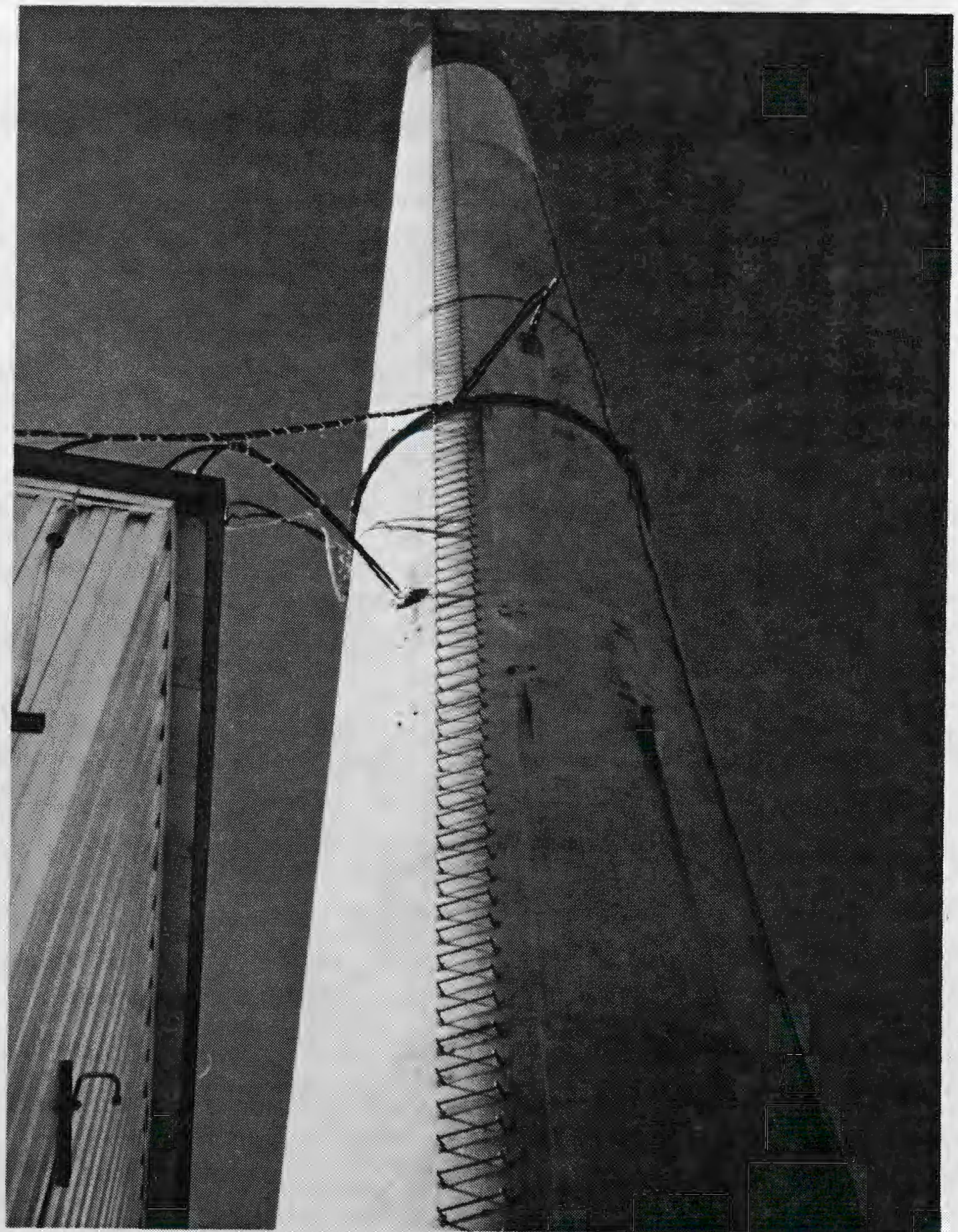
[i] American Air Filters are a trademark product of the SnyderGeneral Corp. of Dallas, TX.

Figure 40. Main PUREX Stack (291-A), 1987. All Air Emissions will be Consolidated to this Stack in the PUREX HVAC Deactivation.



Ventilation System 4 serviced the PUREX Plant laboratory and was largely independent of the systems in the rest of the 202-A Building. This regulated area included the decontamination room, laboratory rooms, and the sample storage room. Exhaust air was discharged from the laboratory hoods and rooms through two local stacks. Two exhaust fans were provided. Exhaust air was monitored and sampled before discharge.[138]

After the decision to close the PUREX facility was announced, the most important HVAC deactivation issue was whether to attempt a static containment of the plant's contamination or to provide a low-level ventilation system. After numerous discussions it was determined that a low flow rate ventilation system would provide the greatest margin of safety. The 202-A Building was not designed as a containment structure, but relied on differential pressure zones to control the radionuclide content. The building contains numerous openings, pass-throughs, pipe chases, and expansion joints. To provide more than a temporary seal would represent significant investment of manpower and resources. Early in predeactivation planning, the Red Team recommended a low-flow ventilation system.[139]

The chief HVAC deactivation task then became simplifying the existing ventilation system. It was determined that the work could be done by opening ducts at key locations in the plant and allowing the air to flow from "clean" areas to areas with more potential for contamination. By using the rooms, hallways, and stairways essentially as ducting (or in place of ducting) the friction losses of the system would be greatly reduced, allowing a reduction of operating equipment. Areas with no potential or extremely small potential of contamination could simply remain stagnant.

Plans were formulated to reduce the four separate ventilation systems to one cascaded flow scheme. The 11 effluent points of the PUREX plant would be reduced to the one main exhaust stack. The number of miscellaneous artificial air movers would be greatly reduced. Of the 177 fans at PUREX, only the three main exhaust fans would continue to function. Of the 89 air filters, only two main exhaust filters would remain in service. The total air flow through the plant would be reduced from about 85,000 cubic feet minute to about 30,000 cubic feet minute. Engineering studies were performed to estimate the system feasibility and performance.[140]

Engineering documentation was prepared for these modifications, and a series of reviews were performed to validate the design. A value engineering review was performed to explore different options for the cascaded system. WHC nuclear safety groups approved the engineering documentation, and also performed a hazardous operations review and a safety analysis, checking potential failure modes and estimating theoretical releases. A study was performed to determine if the supply air to the plant after shut-down should be heated. Options for ventilating the PUREX railroad tunnel were explored and reviewed by DOE. A private engineering firm evaluated the potential of building air in-leakage under normal and high-wind conditions, with and without ventilation. Because the 202-A Building is so large and the HVAC issues so crucial, other reviews were performed by other consultants as an overview of the whole PUREX utilities system (HVAC, electrical, and controls). Finally, facility walk-downs and job-scoping exercises were performed by the crafts, for each task to be performed, to ensure that the deactivation HVAC modifications were constructable and that they used workers efficiently.[141]

After identifying the required modifications to the systems, the tasks were divided into three groups: 1) Preswitchover, 2) Switchover, and 3) Shutdown. All of the HVAC modification activities were scheduled to take place toward the end of the deactivation project, after the completion of other key activities had cleared the 202-A Building of nearly all other workers. Preswitchover activities included tasks that could be performed without a major impact on the existing plant ventilation. These task included opening ducts at key locations, closing off the ventilation to U-Cell and R-Cell, and staging and preparing for major tasks to be performed later in the project. Preswitchover activities were completed in September 1996.

The Switchover activities will modify and reconfigure the overall PUREX ventilation system to a cascade-flow system. Some flow paths will be diverted or created; others will be blanked. Each level inside the building will have the flows rerouted, balanced, and stabilized to match the new flow scheme. Tasks in this effort include modifying air handlers, blanking N-Cell exhaust, and removing ducting elbows in the Hot Shop. Switchover activities are scheduled to be completed in May 1997.

Shutdown tasks will adjust the final configuration of the system. Flows within the building will be reduced, the final main HEPA filters will be configured, stacks will be capped and documentation will be completed. The end of project date is May 28, 1997.

8.10.1 LESSONS LEARNED

Lesson No. 84. Existing ventilation systems can be modified in many ways, and many devices are available to help regulate them. At PUREX, as with the fuel removal equipment and procedures, the simplest methods were chosen because they were felt to be the most dependable. Systems that will require the least amount of maintenance are the best for long-term use in large facilities.

Lesson No. 85. In planning large deactivation activities, discern which outside resources have the necessary expertise and experience to validate the designs and obtain their help in reviewing plans. Make sure that the most expert reviews are conducted as early in the process as possible.

9.0 UO_3 DEACTIVATION

From April to June 1993, a stabilization run was conducted at the UO_3 Plant to convert 757,080 liters(200,000 gallons) of UNH liquid to UO_3 powder. At the same time, deactivation planning was under way. The initial deactivation plan, completed in July 1993, enunciated the following objectives for the UO_3 project: reduce the level of support needed to maintain and monitor the plant in a safe shutdown condition, define and meet D&D acceptance criteria, terminate effluents, shut off electrical power at the main transformer, remove PCB-contaminated transformer oil, connect to a new power source, disconnect steam and water lines outside the building, and shut down all active ventilation so that personnel would enter the facility only quarterly for periodic maintenance.[142]

The initial deactivation plan proposed a three-phase project. Phase I was to include the removal of residual process materials; the cleanout, flushing, and deactivation of most process instrumentation and equipment (including the calciners themselves); the stabilization and pump out of plant liquid systems; the isolation of unnecessary steam and water lines; and the removal of most spare parts, furniture, tools, and other equipment and supplies. Phase II was to include the decontamination and/or covering of outside surface contamination areas so that storm water processing no longer would be needed. This work would eliminate the ongoing generation of liquid effluents that might need treatment and would obviate the need for most S&M checks at the facility. Then, the remaining equipment that processed storm water was to be deactivated. Phase III was to encompass "all remaining activities that must be completed before the facility is turned over to the Surplus Facilities Program, now the Environmental Restoration Contractor (ERC). The work of Phase III was to encompass deactivating and isolating all remaining utilities, deactivating the HVAC and fire protection systems, sealing building penetrations, dealing with a problematic roof, stabilizing the 211-U chemical storage tanks associated with the UO_3 Plant, cleanout of the 272-U Shop Building, shipping of stored UO_3 powder to the Oak Ridge Site (Figure 41), and removing any last flammable or hazardous materials and miscellaneous items.[143]

As the UO_3 deactivation project went forward, however, opportunities for consolidating work were seen so that some work was performed in a sequence other than that originally planned. Also, Phases II and III of the deactivation project were combined. Shortly after the stabilization run was completed, 4 tons of depleted UO_3 powder stored in drums were shipped to the Oak Ridge Site. At the same time, transfers of recovered nitric acid to PUREX began. Approximately 378,540 liters(100,000 gallons) of this substance were sent to PUREX in 33 tank truck shipments. While these transfers were taking place, UO_3 Plant liquid systems were being flushed. The goal was to flush until the pH of the flush solution was between the regulatory threshold limits of 2.0 and 12.5. The plant liquid systems included the UNH receiving and concentration systems (tanks C-1, X-1, X-2, X-30, concentrators ED-2, ED-6, and ED-7, along with all associated pumps and piping), the nitric acid and wet scrubber system (TA-3 acid tower, tank C-6 acid cooler, storage tanks C-3 and C-4, the wet scrubbers, and all associated pumps and piping), and miscellaneous tanks and equipment (tanks X-38, X-19, X-20, and associated pumps and piping, the plant's two UNH trucks, and three nitric acid tank cars). The tanks of the 211-U chemical storage tanks that were associated with the UO_3 Plant also were flushed and stabilized.

Figure 41. T-hoppers Holding Uranium Trioxide Powder, Outside the UO_3 Plant, 1984.

As soon as the flushings were complete, about 37,854 liters (10,000 gallons) of flush solutions measuring more than 1 molar nitric acid were shipped to PUREX, along with small amounts of UNH concentrated from tank flushes. The UNH tank truck heels then were removed at PUREX, and the nitric acid tank car heels were sent to PUREX for removal in late 1994. Further steps taken in Phase I of the UO_3 Plant cleanout included removing the tops of the calciners and vacuuming out the UO_3 powder. Also, powder was removed from the powder handling system and bag filters, the U-2 exhaust system was disconnected, and the UO_3 Facility instruments were deactivated. Phase I of the deactivation project was completed in early March 1994, two weeks ahead of the RL milestone date of March 16.[144]

One of the crucial UO_3 Deactivation Phase II projects was to discontinue discharges of low-level contaminated effluents to the 216-U-17 crib and the 216-U-14 ditch. Almost all such effluents resulted from the runoff of storm water over contaminated roofs, piping, and other outdoor surfaces at the facility. In the system that had been used since the mid-1980s, such storm water was collected in sumps and tank enclosures at the back of the 224-U Building (sumps 203-U and 203-UX), and in sumps located in a concrete pad between the 224-U, 224-UA, and 272-U Buildings. The sumps drained to a collection tank (C-7) and then were sent to tank C-2 for concentration. Condensate from the off-gases was collected and stored in tank X-37 until ready for disposal. The tank C-2 condensate was neutralized with potassium hydroxide and a small amount of phosphoric acid (for pH stabilization) in tank C-5, and then sent to the 216-U-17 crib. Some uncontaminated storm water, along with the discharged cooling water resulting from Tank C-2 operations, drained to the 216-U-14 ditch via the 207-U basins. From the 207-U basins, this material was sent to the 216-U-14 ditch for ground percolation.

When the UO_3 deactivation project began, UO_3 Plant work planners did not know whether they would place protective coverings over the contaminated outdoor surfaces, reroof the facility, or decontaminate the surfaces. To evaluate the decontamination option, they had to negotiate acceptable levels of contamination reduction with the Hanford Site's regulators. A new approach was devised in meetings between the contractor and DOE representatives and regulatory agencies. They agreed that if outside surfaces could be decontaminated to the point that not more than 5 to 50 grams of uranium per year would enter the 207-U basins via runoff from the UO_3 Plant, reroofing and protective outside coverings would not be needed. The 207-U basins had been lined with high-density polyethylene in December 1992 and could be used to evaporate relatively clean runoff. Independent DOH sampling of ambient air at a location 100 yards from these basins would verify compliance with the requirements. To implement the agreement, decontamination was undertaken at UO_3 with water, scrub brushes, and a mobile pressure sprayer attached to a HEPA filter. No chemical decontaminating agents were used. Then, the sump collection system at the facility was diverted to the 207-U basins (not tanks C-7, C-2, and C-5), and the lines between the 207-U basins and the 216-U-14 ditch were blanked. The tie-ins were completed on September 22, 1994, beating an RL milestone date.[145]

Further work done in the UO_3 Plant deactivation project in FY 1994 included stabilizing the asbestos in rooms housing old calciner pots and the old powder handling tower, cleaning out both the "hot" (radioactive) and cold portions of the 272-U shop, applying a new roof coating to the 272-U shop and the 224-U facility, disconnecting remaining utilities and power sources to the

UO_3 Plant buildings, and installing an independent power source for the new surveillance lights for 224-UA (Figure 42). A great deal of time also was spent removing small objects, furniture, contaminated tools, and other miscellaneous materials from the facility, and documenting the plant's legacy equipment for turnover to the D&D program.[146]

In defining its end point criteria, the UO_3 Plant took a series of precedent-setting steps that extended the concepts initially defined in the PUREX Deactivation End Point VE Study of February 1994 (see Section 4.2). In fact, the UO_3 Plant deactivation end point planning became the Hanford Site's first real test and application of the new methodology (see Section 4.4). Once the deactivation and D&D organizations agreed on which activities would be performed in the UO_3 Plant deactivation, each matrix and its agreed result was compiled into the UO_3 End Point Criteria Document, a signature book. The 1,740 end points (signature by deactivation contractor personnel) and verification (signature by D&D contractor personnel) were completed in January 1995. Only one issue remained--disposing of some very old depleted UO_3 powder (about 0.2 percent uranium-235) and some enriched (about 0.9 percent uranium-235) powder from the 1993 UO_3 stabilization campaign. The depleted material was stored in steel drums and the enriched material was stored in containers called T-hoppers in the 2714-U Building in the UO_3 Plant complex. The depleted powder was buried in its containers as low-level waste in early 1996, and the enriched powder (along with 14 more drums from BNFL) will later be moved to another storage location. In the meanwhile, in a special ceremony in February 1995, the UO_3 facility was turned over to the D&D organization (Figure 43).[147]

After the turnover, one additional UO_3 issue emerged to provide a lesson for the PUREX Plant. During the winter of 1995-96, the Hanford Site experienced severe freezing weather and some freeze damage occurred in piping at the UO_3 Plant. When the weather moderated, puddles of water from the damaged pipes melted into the plant. As it happened, the pipes in question could not be drained via gravity, or in some cases, could not be accessed at all without dismantling other large sections of pipe. When the DNFSB (an inspector agency of Congress) was informed about the leaks, it expressed concern not for the UO_3 Plant, where contamination levels are low, but for similar occurrences that might happen in the future at the more highly contaminated PUREX Plant. As a result, PUREX pipes were inspected for locations that might not be subject to gravity drain. A commercial vendor "hot tap" product (used to connect into pipes while they are pressurized) was used to drain certain PUREX pipes without dismantling them. Use of this equipment was very cost effective, in that it was used in 11 places to drain small amounts of liquid without having to dismantle large pipes. The resultant savings amounted to approximately two work days per tap.

Figure 42. Worker Cleaning Calciner as Part of UO_3 Plant Deactivation, 1994.

Figure 43. Officials Gather to Transfer UO_3 Plant from the DOE's Deactivation Organization to the D&D Organization (Thomas Grumbly holds key).

9.1 LESSONS LEARNED

Lesson No. 86. At UO_3, the final flushes of the process vessels were included as part of the activities of the stabilization run. Because these flushes were considered part of operations, no RCRA permits were needed for the flush material and the RCRA 90-day clock for the UO_3 Facility did not start ticking until the final flushes were completed. By that time, almost all hazardous materials that might have been considered waste under a different timing structure had been removed from the plant. Other facilities should consider writing vessel and equipment flushes and other ancillary activities into their stabilization run plans.

Lesson No. 87. Issues such as which groups will perform deactivation work tasks must be worked out globally at the start of a project. For example, the issue of which tasks constitute plant "modifications" can have legal (Davis-Bacon Act) and labor ramifications, and can slow or stop a deactivation project.

Lesson No. 88. The disposition of small equipment, tools, furniture, and other miscellaneous supplies and items might be viewed as a private business opportunity as facilities deactivate across the DOE complex. The amount of time spent on such disposition was disproportionately large, in the view of facility management, and these activities had to compete with other deactivation tasks for the time of facility personnel. If such activities were privatized, more productive uses might be found for some of the equipment and waste burials might be minimized.

Lesson No. 89. When a facility is in the final stages of deactivation, high priorities are assigned to final close-out items. However, other organizations and facilities are not in the rush mode, and may not assign as high a priority to their interfaces and correspondence, sign-offs, etc. as the deactivating facility that is facing final deadlines. Leaving time for other organizations to work at their usual pace or on their usual cycles is important.

Lesson No. 90. Many final deactivation end points mandate posting signs at various places around facilities. Make a "signs map" ahead of time, make sure that all signs are physically prepared, and accounted for on the map, well before the deadlines.

Lesson No. 91. The hot-tap method of sealing inaccessible pipes, or pipes configured so that they cannot be drained by gravity, is a cost-effective way to ensure that contamination will not migrate out of such pipes over time in deactivated facilities. Deactivating facilities should be inspected for such piping situations and hot-tap drained before deactivation is complete.

10.0 STAKEHOLDER INVOLVEMENT

The PUREX/UO_3 deactivation project recognized very early that stakeholder involvement would be crucial to its success. Following DOE guidelines, the public involvement strategy was to involve DOE and contractor personnel (with employees viewed as key stakeholders), legislated authority structures such as state and federal regulators, the Defense Nuclear Facilities Safety Board, public advocates, advisory groups, Indian nations, and public opinion. Any group affected by, or able to affect, the PUREX/UO_3 deactivation project was considered a stakeholder. A key goal of the stakeholder involvement plan was to include stakeholders from early in the concept stage throughout the implementation phases.

The purpose of stakeholder involvement activities was first to establish a common information base from which interested parties could learn about the PUREX and UO_3 plants, including their history and past missions, current status, condition, and needs. Next, the project recognized, stakeholders needed to be informed about key decision points and alternatives, including constraints, costs, and timetables. In turn, stakeholders needed to be given a chance to define their values and provide feedback about how the project and its alternatives would affect those values. The facilitation of information transfer, back and forth between stakeholders and project managers, was deemed to be essential. Also, providing progress reports was considered important.[148]

To begin their own public involvement learning process, PUREX/UO_3 deactivation managers and work planners attended a workshop in April 1993. At the same time, a historical report on the facilities was begun. For this document, more than 300 formerly classified documents on plant operations were declassified and incorporated. A smaller brochure on the facilities and their major deactivation issues also was written and distributed through the public mailing lists associated with the Tri-Party Agreement. In the winter of 1993-94, a 4-page fact sheet on the project was prepared and distributed to more than 1,000 stakeholders. At the same time, the original draft Project Management Plan was mailed to a shorter list of interest groups involved with the Hanford Advisory Board (HAB), a regional consortium organized by RL to provide input to key Hanford Site decisions. This mailing was followed up by phone calls by PUREX/UO_3 managers to HAB members to solicit comments, and the comments that were received back were incorporated into the final PMP that was issued in August 1994.

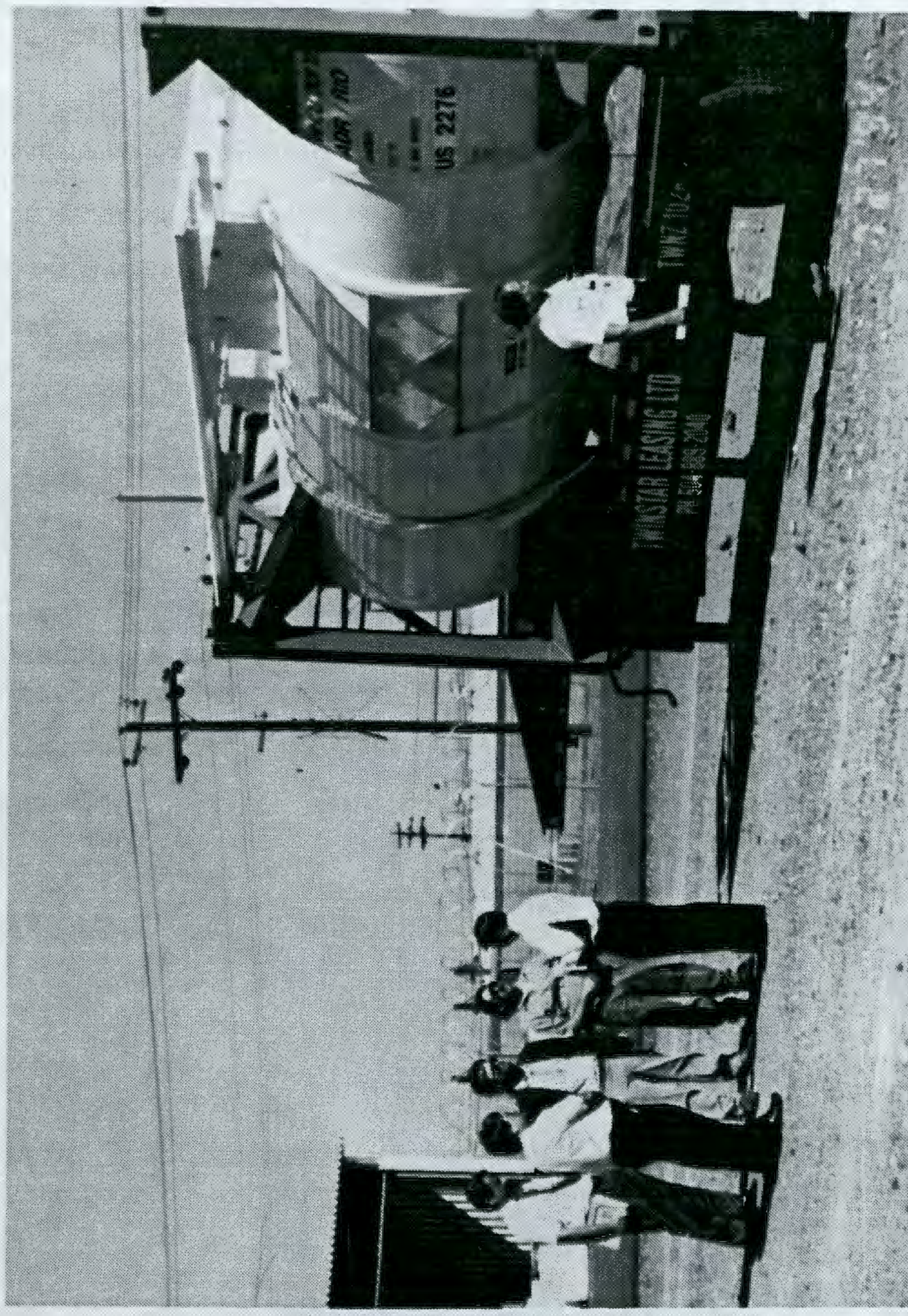
In December 1993, Ecology took the initiative to host a meeting with PUREX personnel and other interested parties to discuss deactivation issues. A series of PUREX facility tours was conducted for members of the new HAB in January and February of 1994. After the HAB began its regular monthly meetings, PUREX managers worked through the designated HAB staff personnel to maintain open communication and to supply any documentation or presentations that the HAB requested. In May 1994, PUREX/UO_3 managers traveled to Seattle to present information and answer questions about the deactivation project at a premeeting of the HAB. PUREX management participated in another similar meeting held in Richland in October.

Beginning in March 1994, other face-to-face meetings took place between PUREX/UO_3 personnel and interested stakeholders when managers traveled to the offices of the Confederated Tribes of the Umatilla Indian Reservation (CTUIR). CTUIR representatives in turn visited the PUREX Plant in July and September. In July, they met with a small group of PUREX personnel to explain their stake in the Hanford Site and to enunciate how their values could be affected by deactivation activities. They also inspected the shipping containers that would be used to transport contaminated nitric acid to BNFL. On the September visit, the CTUIR Hanford Site Projects manager was the featured speaker at a PUREX/UO_3 All-Employee meeting and praised facility tribal involvement as "a model for the rest of the Hanford Site...They have bent over backwards to incorporate our concerns into their transportation plans" (Figures 44 and 45). In July, PUREX personnel traveled to Pendleton, Oregon to meet with the Transport Committee of the Oregon Hanford Waste Board. Several subsequent meetings were held with this group, as well as meetings with, and presentations to, a myriad of other groups throughout the remainder of the deactivation project. Among these groups were audiences at annual Waste Management, Environmental Remediation, Spectrum, and other conferences and the Hanford Natural Resources Trustee Council.[149]

Near the end of FY 1994, PUREX personnel began their most extensive public involvement activity, planning a far-flung series of public mailings and meetings with interested groups in states and Indian reservations across the nation, along the shipping route that would be followed by the contaminated nitric acid on its way to England. Secretary of Energy O'Leary decreed that September that she would authorize the shipments, totalling approximately 726,000 liters (205,000 gallons), if certain conditions were must to satisfy expressed public concerns. (See Section 8.4.) The EA on the shipment was the primary vehicle for public comment, but PUREX officials went further and drew up a map of the entire route. They contacted every state and local government along the route, as well as the Umatilla Indian reservation, , offering to come present facts on the shipment plans. Because the 50 separate shipments would travel nearly 4,000 overland miles in the United States and pass through 12 states, obtaining the cooperation and buy-in of everyone along the way was considered essential. PUREX personnel held public meetings in the three cities under consideration as the ports of departure (Baltimore, Maryland; Newark, New Jersey; and Portsmouth, Virginia). The draft EA was sent to more than 200 states, Indian nations and individuals, and more than 50 requests for clarification or more information were received. Approval of the EA and transportation plan allowed the shipments to take place from May through November 1995. During the period of shipments, weekly conference calls were held between DOE and emergency response and public health organizations in every corridor state to report progress and discuss any questions or concerns.[150]

Figure 44. J. R. Wilkinson, Hanford Programs Manager for the Confederated Tribes of the Umatilla Indian Reservation, speaks at PUREX All-Employee Meeting, 1994.

Figure 45. Representatives of the Confederated Tribes of the Umatilla Indian Reservation Inspect Nitric Acid Transport Container at PUREX Facility, 1994.



10.1 LESSONS LEARNED

Lesson No. 92. Public and tribal involvement is essential to the success of major deactivation projects. Such involvement should be started early, and should include initial efforts to assemble and distribute informational documents that allow non-technical people to understand the history, operations and condition of large, complex facilities. The provision of such documents can save plant personnel enormous time that might otherwise have to be spent answering repetitive questions. Communication also can prevent a domino-effect of misunderstandings about the deactivation, based on basic misunderstandings of plant functions, layout, history, chemical and radiological inventory, and many other topics. Plant tours are important to help stakeholders understand the scope of the physical plant, the deactivation project, and the work being performed.

Lesson No. 93. Once the common information base is established (the first phase of public involvement), the public involvement process should become a dialogue. Two-way, iterative communication is essential. Plant personnel must truly listen to the values, motivations, and concerns of stakeholders, and must be willing to change their ideas based on the input of others. The era of unilateral federal decisions clearly is over, and leadership in the new era means flexibility and trust. Compromises can be reached, and the value of obtaining the buy-in of regional stakeholders can ensure the long-term success of deactivation projects and other DOE missions.

Lesson No. 94. Communication with facility employees (a key stakeholder group) is essential, especially considering that employees of a successful deactivation project literally work themselves out of their jobs. They must be kept apprised of project goals and their roles in achieving these goals, and they must be given guidance on how and where their skills can be applied in new, future positions.

Lesson No. 95. Stakeholder involvement includes many external review groups that have an interest in various aspects of a complex, prototypical facility such as the PUREX Plant. During 1993 and 1994, the PUREX Facility was subject to a spent fuel vulnerability assessment, a chemical vulnerability assessment, and a plutonium vulnerability assessment and reviews by the Defense Nuclear Facility Safety Board, the General Accounting Office, and DOE-HQ special safety teams. It also experienced a vast increase in requests for tours and media information associated with its being a deactivation project model. Supporting all these requests for information must be factored into deactivation project costs and personnel needs. However, one innovative cost-saving method adopted at PUREX and available to other plants is to prepare video tours and information packages that can be duplicated and used many times.

Lesson No. 96. Communication and dialogue take many forms. Some groups, such as some Native Americans, prefer verbal communication to written. Flexibility and variety and format must be used to reach all stakeholders.

Lesson No. 97. The biggest potential physical hazards in a deactivation project may not attract the most public comment and interest. At PUREX, the shipment of irradiated fuel rods to the K West basins generated vastly less public interest that the nitric acid shipment to England, yet the radionuclide inventory and hazardous nature of the spent fuel was much greater. The public will tell the facility managers what its interests are, and managers must listen and heed the public's perceptions.

11.0 LESSONS CONSOLIDATED

Lesson No. 1. Finding an alternate use for a material is better than disposing of it as waste, even if the alternative use brings little or no monetary income. Designating a material as waste means long-term regulatory control and generates costs associated with disposal and regulatory surveillance and paperwork.

Lesson No. 2. Creativity and forethought can be employed even during periods when clear direction is lacking and mission flexibility needs to be preserved. Even during such times, some steps can be taken to temporarily deactivate portions of a large facility and bring down costs. Those who know the plant most intimately can best brainstorm the specific ways to implement cost-saving steps.

Lesson No. 3. The early involvement of an independent technical team to review a major deactivation operation and make overview recommendations allows the operation to be viewed by those with experience in the commercial world, and by those not directly tied to, nor constrained by, the day-to-day concerns of facility operations and management. It also provides a challenge to the facility staff to think of the deactivation project in different terms. In terms of broad concepts, the value of independent oversight is immeasurable.

Lesson No. 4. The advice of an independent review team such as the Red Team in attempting to scope and define specific work tasks and pathways within a large deactivation project is less helpful than the broad overview perspective brought by such a team. Washington State regulators, regional trustees and stakeholders, and the constraints imposed by the needs and requirements of other divisions on the Hanford Site actually shaped the PUREX Deactivation Project. As the project progressed, the ongoing advice of ITEs that stayed with the work in a follow-on capacity was helpful in defining specific activities.

Lesson No. 5. The time that elapsed during the PUREX Plant's Standby period created additional work because some instruments and equipment deteriorated during that period. To prepare for the deactivation, significant work was needed to recalibrate and upgrade instruments and machinery. As much forewarning as possible should be given to facilities as a shutdown status approaches. Such warning would allow the facility engineers and work planners to begin preparing for deactivation work in a timely and efficient manner.

Lesson No. 6. The reengineering concept, with all of its non-traditional business practices, can be a very successful tool in bringing down costs and streamlining work at deactivating facilities. Generally, even though such facilities may have already reorganized from their operating configuration into a deactivation project, they can still benefit from a thorough reengineering overhaul. Reengineering focuses people to specific, personal, achievable goals, thus tapping their maximum energies.

Lesson No. 7. The present historical timing for reengineering is nearly perfect. While Congress calls for budget cuts in DOE facilities with no known future missions, environmental and other laws and imperatives require safe shutdown. Reengineering can bring cost-effective close-out to old facilities.

It can also help empower and better prepare the frightened work force at many older DOE facilities, thus improving reemployability of these loyal employees.

Lesson No. 8. While reengineering can help virtually all large organizations, it should be introduced first at facilities that are already doing well and that are staffed by enthusiastic, positive leaders and employees.

Lesson No. 9. When reengineering is undertaken, an organization, a facility, and/or a DOE Site must plunge into it completely and support change at all levels.

Lesson No. 10. Reengineering breaks internal organizational barriers and motivates workers based on ownership and the knowledge that their own performance on teams will be recognized. The knowledge that the best performing teams may be the first to be hired or recommended for new positions offers a powerful incentive to people to "work themselves out of their jobs."

Lesson No. 11. Organizational culture, fed by management systems, values, and rules both modeled and expressed, is often very entrenched and very conservative at older DOE Sites. (The same may be true of many older industries and Department of Defense [DOD] Sites.) That culture, which valued secrecy, loyalty, and a zero-risk mentality, must be recognized, with the commitment to change underscored boldly at all levels of management, if reengineering is to succeed. Moves towards an independent self-directed work force must be encouraged by management, and must never be viewed as disloyal.

Lesson No. 12. The involvement of people who have worked at a facility or in an organization for a long time is essential if the true nature and needs of facility work is to be understood. Newer, less intimately involved persons trying to define essential work needs in a facility usually can provide only an overview. For the detailed work analysis necessary to structure teams to succeed, long-time workers must be involved.

Lesson No. 13. When external teams arrive at a facility to begin the reengineering process, they must be careful not to "shove" ideas at the facility. They must communicate and make themselves accessible on a regular basis. Opportunities for workers to talk with external teams must not be intimidating. Team members should visit facility lunchrooms and other gathering spots individually for both announced and impromptu sessions, and allow workers to ask questions. Simply announcing an "open door policy" for an external team may be too unapproachable a setting for employees.

Lesson No. 14. If teams lack critical resources, they will not succeed. At the same time, specialists such as safety and regulatory experts who serve all teams in a facility-wide mode should not be assigned permanently to individual teams.

Lesson No. 15. Team leaders need skills in judgment, initiative, leadership, team-building, decision-making ability and customer-focus, in addition to their existing technical skills. Also, individual workers can use the job re-application process to display personal skills that may have been unrecognized before.

Lesson No. 16. A reengineered, team environment offers fewer absolute opportunities to climb an organizational ladder. Therefore, salaries must be placed in "broad bands" to allow individuals to proceed at their own paces up a merit-based continuum.

Lesson No. 17. A facility such as the PUREX People Center benefits a deactivation project greatly because it opens up communication, quells rumors, and helps dispel discontent and fear by giving workers early and ongoing access to HR resources. The emotional reaction of fear of change is powerful. A People Center, *located in* the facility, and staffed full-time on a rotational basis, allows people to talk and seek resources and information when they feel the need.

Lesson No. 18. People working themselves out of a job should be given access to information about future jobs long before their own jobs end. Otherwise, fear of unemployment may drive them away from the deactivating facility before they can accomplish the deactivation work.

Lesson No. 19. Different people respond best to different forms of communication. Facilities should use all avenues of communication, including written, graphic, and verbal.

Lesson No. 20. A charter, stating basic purpose, identity, and reason for being should be written by each team soon after its formation. A charter sets the tone for the "new world" of the reengineered facility.

Lesson No. 21. Ongoing training, after a team begins to struggle with actual work problems, is important. Training in specific skills such as problem-solving, communication, etc. should not begin immediately after team formation. If such training is mandated too soon, much of what is offered is not appreciated and is even resisted by team members.

Lesson No. 22. Teams have five distinct stages of development: start-up, state of confusion, leader-centered, tightly formed, and self-directed. These stages must be recognized by management and organizational development personnel who facilitate the reengineering process. If these stages are not recognized as normal, facility leadership may think that reengineering has failed.

Lesson No. 23. Once a team is formed, it must be given cradle-to-grave responsibility for its work products. If control is taken away from the team, it may stop feeling responsible for the work and the reengineering experiment may fail.

Lesson No. 24. Teams must be physically co-located to bond and to feel jointly responsible for work.

Lesson No. 25. Reengineering brings nonproductivity and egotism to light. Hiding such patterns is impossible in a reengineered structure. Surprises may await managers and coworkers when some employees reveal these less than cooperative attributes.

Lesson No. 26. Reengineering is not a one-time activity; it is a way of thinking. Some problems will never be solved in a facility, and some may take long, slow, patient action to undercover and remedy. After reengineering, management and workers still need to be vigilant for ways to smooth and improve. Reengineering is a never-ending process.

Lesson No. 27. Teams should not be too large. A team of over 20 people will have trouble focusing their discussions and reaching closure on decisions.

Lesson No. 28. Not every job function or set of workers should be brought together in a team. Teams must have common goals to function. Workers in administrative support functions, facility support, and technical support, by the very nature of their tasks, will not share the same goals. These workers should continue to be managed as groups.

Lesson No. 29. All key reengineering decisions in a deactivation project must be driven by the project's end points. If the end points are not in place, teams may be organized in ways that are less than optimal, budgeting and scheduling will not be efficient, and the project will flounder.

Lesson No. 30. A short, high-level project plan prepared as a policy document would be a better tool for setting overall deactivation strategy than a deactivation project management plan. Subplans dealing with various issues such as regulatory compliance, safety strategy, stakeholder involvement, etc., then could be issued as supporting or ancillary documents. Then, each document could be revised and implemented more quickly without waiting for total consensus on all sectors of the project.

Lesson No. 31. A deactivation project management plan should focus primarily on the baseline, baseline control, reporting, management, and summary sections. The project control system is crucial and should be consistent with project management methods rather than with operating methods.

Lesson No. 32. End point criteria *must* be developed at the start of a deactivation project so that they can be available as tools to prioritize the work throughout the project. Much money, time, and effort will be saved if "right to left" thinking (end to beginning) is practiced. End point criteria should have been in place before PUREX schedules were developed and before other work planning went forward. End point criteria and end points must be set as a *first* priority in a deactivation project. They guide every aspect of the work, the budgeting, and the facility's organization.

Lesson No. 33. Because many years often pass, or can be expected to pass, between deactivation and ultimate D&D of major DOE facilities, the exact needs, methods, and end states of D&D in the 21st century cannot be anticipated. Therefore, developing a functional matrix-based approach to deciding which deactivation tasks add value to a project is better than establishing vague end point criteria. Such an approach must have joint participation and concurrence between the deactivation and D&D organizations.

Lesson No. 34. The sophisticated and interwoven objectives, fundamental tasks, levels, cases, and matrices developed in the PUREX and UO_3 Deactivation end point criteria compel all parties to take a justifiable, accountable look at why each task is done. Each task must have value to pass this test and to be approved and executed. This approach results in cost savings and enhanced safety for deactivation workers, because it eliminates some unnecessary tasks. Another advantage of this methodology is its inherent ability to build consensus between deactivation and D&D programs, and to avoid costly disagreements at the time of facility turnover and beyond.

Lesson No. 35. End point specifications should state what work must be done (in specific terms), but not how it should be done. The "how" aspect should be written into work plans that follow closely on the end points.

Lesson No. 36. End points should be specifically written such that visual verification is possible and can be agreed on easily by the deactivation and D&D organizations. If end points are not specific, agree ahead of time on the verification methods and standards. For example, visually verifying an end point that states "Resolve Serious Threats" or "Seal" is difficult. The criteria that constitute sufficient compliance need to be quantifiable, measurable, and agreed on ahead of time.

Lesson No. 37. "Not Applicable" can never close an end point. If an action is truly not applicable, it should not be an end point.

Lesson No. 38. Plans for post-deactivation S&M should be written before or along with end points, so that S&M activities can be factored into end point development.

Lesson No. 39. Negotiated agreements and/or special requirements resulting from regulatory drivers or stakeholder interests need to be known and factored into end point planning. If specific commitments have been made for the facility, or for or by the deactivation or D&D organizations, these need to be identified ahead of time.

Lesson No. 40. While the practice of generating fully developed, integrated, resource-loaded schedules is time-consuming, it saves money for a large project in the long run. The costs and efforts of producing the schedules are vastly surpassed by the cost savings that result from focusing the work and avoiding the work delays and duplication that would occur without such schedules.

Lesson No. 41. Organizations internal to old facilities and DOE sites often have strong emotional ties and commitments to these facilities. Also, the intimate familiarity of such persons with the facilities is invaluable in producing realistic estimates of how work must and will occur, given facility configurations and physical quirks. Such persons often need additional skill training in areas such as scheduling, but they are willing to learn new skills to stay with the facilities throughout deactivation. Their loyalty produces a strong work ethic and is valuable to the project. Keeping the operating employees with the deactivation project also provides these employees with enhanced skills that can provide them with better career opportunities after the deactivating facility closes.

Lesson No. 42. The specialized expertise of state-of-the-art firms using complex software definitely is needed in scheduling huge deactivation projects. Using schedules that are current, tied to costs, and readily adaptable to scope and budget changes and to rebaselining efforts is so crucial to project success that it must be directed by experts.

Lesson No. 43. Because S&M tasks consume much of a facility's budget during the early years of a deactivation project, detailed scheduling attention should be given to these tasks as well as to deactivation tasks. As requirements for S&M tasks decrease over the life of a deactivation project, this reduction of requirements must be reflected in the schedule.

Lesson No. 44. Schedules for large and complex deactivation projects need to be easy to change. They need to be "living" schedules because no person or collection of persons, however knowledgeable, can anticipate all of the various changes that will occur over the life of the project. Also, the schedule needs to recognize and incorporate the impacts of special tasks (such as responding to audits, providing special tours, etc.) that pull people away from their regular jobs.

Lesson No. 45. The software package chosen for a large deactivation project should be evaluated carefully before it is adopted. The sheer size and complexity of integrated, resource-loaded schedules that guide thousands of tasks demands software of huge capacity and flexibility. A change in software during a project can be very disruptive, even if the new software has technical advantages. Such changes should be made only if the technical advantages are overwhelming.

Lesson No. 46. Every effort should be made for facilities to continually coordinate their status and potential regulatory situations to DOE-HQ, to avoid sudden or unexpected shutdown orders. Better planning and communications between the DOE and its contractors should be instituted, so that facility preparations for the consolidation and disposition of hazardous materials can begin before formal closure orders arrive. The PUREX Facility was in possession of a number of substances for which there were no RCRA permits after the operational/standby status of the facility changed. Likewise, NEPA documentation might/could have been prepared as part of the deactivation decision, and in support of that decision.

Lesson No. 47. It is essential to involve and inform regulators early in any regulatory process or negotiation. A cooperative spirit is established by such actions, and joint efforts then can be directed at solutions rather than confrontational or penalty-based actions. The regulatory dilemmas inherent in the PUREX deactivation project were unique and the first of a kind. Early and open communication with regulators was crucial to finding acceptable solutions to these dilemmas.

Lesson No. 48. Regulatory issues and needs must be communicated by contractor and DOE experts to all of the managers, engineers, and work planners at a facility. Just as understanding the methods and needs of the scheduling professionals by the plant operating personnel contributed to better schedules, likewise understanding of regulatory requirements by facility operators will (and did at PUREX) help ensure that regulatory mistakes and violations are avoided.

Lesson No. 49. For facilities in states that have negotiated special agreements with state and federal regulators (such as the Hanford Site's Tri-Party Agreement), such agreements can serve to break regulatory impasses that might be encountered under RCRA and other statutes. Because the Hanford Site Tri-Party Agreement has legal precedence over some other environmental laws, it can be a useful tool in negotiating creative solutions in response to unique needs. One example of such a prototypical solution might be the provision written into the Tri-Party Agreement that transitioning facilities do not need to prepare NOIs before modifying their RCRA Part A permits when additional hazardous waste units are discovered during the course of deactivation.

Lesson No. 50. Emissions comparison documents, while initially useful, will not stand in lieu of full new permit applications for deactivation actions that generate radioactive air emissions. Radioactive air emissions are a subject of such intense public concern that, at least in Washington State, the WAC has been tightened to require full NOCs for deactivation activities that generate such emissions.

Lesson No. 51. The NEPA screening approach taken in the PUREX and UO_3 Facility deactivations is an extremely helpful and precedent-setting activity. Because an operational EIS existed, it was possible to comply with NEPA requirements without preparing a new EIS for deactivation. This action saved enormous amounts of time and money, and in particular should be highlighted and used at other facilities that are undergoing deactivation and that possess existing EIS documentation. In cases where deactivating facilities do not have operational EISs, other existing documentation at the facilities (such as Accelerated Hazards Reduction program documentation, etc.) should be examined to see if it can serve a similar function.

Lesson No. 52. The idea of designing a noncontiguous boundary for those portions of deactivating facilities that are RCRA TSDs, then writing the Part A permit specifically to those boundaries, is creative and cost-effective, in that it forces monitoring and oversight only for the truly affected portions of large facilities. It is also important to carefully distinguish between facilities that will function as long-term TSDs (such as the PUREX Tunnels), and those that will serve as interim TSDs (such as the PUREX Building), and to permit each type of TSD differently.

Lesson No. 53. Categorizing process substances that have alternative uses or possible alternative definitions as materials other than waste is beneficial and cost effective. At PUREX, examples such as the disposition of the slightly contaminated nitric acid, the organic TBP/NPH solution, and the laboratory sample solutions, demonstrate clearly the life-cycle savings that can be realized from not having to permit and monitor unnecessary substances as waste.

Lesson No. 54. The evolution of three types of documentation to serve various time periods in the life cycle of transitioning TSDs is beneficial in that it leaves room for modification of long-term plans whenever D&D occurs. It would not be useful for today's decision-makers to try to write the final closure plan for the PUREX facility, not knowing the technology or the public preferences and values of the future.

Lesson No. 55. As in the case of the various PUREX stacks, it is important for deactivating facilities to scrutinize their diminishing emissions, effluents, etc. to identify when they may fall below regulatory criteria and allow lesser levels of monitoring and documentation. The result is cost and time savings.

Lesson No. 56. The CX that was prepared for "deactivation, de-energization, or isolation of unneeded plant systems and stabilization in Hanford facilities" is an example of a very valuable concept. That is the concept of writing broad and inclusive, Sitewide or complex-wide regulatory documentation whenever possible to avoid creating documentation for every small or repetitive action. Cost and time savings again result.

Lesson No. 57. Existing safety documentation from facility operational periods should and can be used in creative and careful ways to begin deactivation project safety documentation. Revisions, comparisons, "crosswalks," and other types of screening procedures can be used to determine which deactivation actions may be covered in existing documentation and which actions need supplementary coverage. Such comparison efforts, performed by those who know the facility well, are more cost effective and time efficient than preparing all new safety documentation for facility shutdowns.

Lesson No. 58. Workshops and other joint working efforts that bring together the principals interested in safety documentation (DOE, the operating contractor, and ITEs and other consultants) are important early in a deactivation project for brainstorming and establishing the major cornerstones of consensus about the safety documentation.

Lesson No. 59. Worker health and safety, always a DOE and contractor concern, has been elevated in recent years to even more important status. Often, worker safety and health aspects of older facility safety documentation will prove to be the area where such documentation falls short of modern standards. Incorporating worker safety and health considerations that are comparable to or exceed the levels demanded by OSHA into newer revisions or supplements of safety documentation is extremely important.

Lesson No. 60. Worker involvement (including the use of job screening devices that are operated by worker teams at their own personal computer work stations) and a graded approach to the levels of safety analysis required for various deactivation tasks are the two most important keys to making the safety analysis process useful, efficient, and satisfactory to all concerned. The graded approach is cost effective in that it does not demand a high level of analysis for simple jobs already covered in established procedures. Worker involvement is also cost effective in that it provides a higher level of assurance that workers are participating willingly and without hesitation in the jobs that are required for facility deactivation.

Lesson No. 61. New techniques in contamination fixation and sealing can be used to reduce the possibility of contamination migration so that full removal and burial of contaminated equipment and duct work is not necessary during deactivation. NDA results and facility conditions should be carefully weighed. In some cases, physical glove box and duct removal may be the best and safest choice.

Lesson No. 62. Any unnecessary manipulations, separations, conversions, or handling of plutonium and uranium-bearing solutions should be avoided. The age of the process vessels (at least in the PUREX Plant, and also at many other DOE facilities) activates the need for renewed regulatory involvement if any further or different uses are made of this equipment. Also, worker and environmental risk increases every time additional processes are performed on plutonium and uranium materials.

Lesson No. 63. The cost savings associated with timely deactivation of large facilities such as the PUREX plant are so overwhelming and important that optional activities that involve keeping plant systems active must be declined. The PUREX facility is so complex and its internal systems so intertwined that the need to perform any activities associated with plutonium/uranium solutions meant that nearly all of the plant's systems would have to remain active. This would have slowed the overall deactivation project, and the imperative need and desire of the DOE to proceed with deactivation would not have been realized.

Lesson No. 64. The use of well-established, simple technologies that could be readily implemented contributed to the successful disposition of the D5/E6 material. Existing procedures and specifications also were used, so that only minor piping changes within the PUREX facility were required. As a result of "keeping it simple," significant cost savings were achieved and the activity was completed safely and ahead of schedule.

Lesson No. 65. Video taping the PUREX dissolver cells where the fuel was lying, and video taping all pertinent locations was very helpful in planning the fuel recovery and transfer activities. Taping also helped to assign recovered fuel Nuclear Material values, to document of canister loading, account for all fuel elements, and provide an ongoing method to review and learn from previous days' activities. All work with sensitive materials such as spent fuel elements (and other items with accountability requirements) should be taped without editing and at the highest tape speeds, to provide the best opportunities for learning and improving the activities.

Lesson No. 66. Planning and surveying every step of the way when dealing with an activity involving radiological contamination outside of plant radiation zones leads to time savings in the end. Such activities have high visibility, and involve many regulations and stipulations. Making sure all of the surveys and preparations are done before starting the main activity will prevent any expensive work stoppages during the activity. At PUREX, the identification of allowable contamination levels on the cask cars almost stopped the fuel transfer at the last minute.

Lesson No. 67. The EA process can be very time consuming. To expedite matters, processes that already are covered in existing documents should be identified, and the existing documentation included in the beginning. Early contact should be made with the EA review team to discuss and agree on what will be included. Also, the review team itself should be carefully chosen to include the people directly involved with the activity. They have expert knowledge and this knowledge should be tapped. The review team should not be expanded to include anyone other than those who are essential or the process may become unwieldy.

Lesson No. 68. Alternatives for the disposition of spent fuel are severely limited by considerations of the time and money it takes to satisfy regulatory requirements, safety considerations, and stakeholder concerns. The requirements to permit the movement of even small amounts of spent fuel away from the DOE site of origin are very significant and perhaps not even achievable in today's climate. Therefore, spent fuel remaining at the end of processing activities should be dealt with on site, and should be grouped with other existing spent fuel if it exists.

Lesson No. 69. Operating personnel should be kept involved with every step of the design, to improve the ease of use with new equipment. Also, problems with the design can be identified early using the plant experience. Such problems may not necessarily be recognized even by a knowledgeable engineering staff. For example, by allowing the crane operator at PUREX to design his tools with minimal support by engineering, the tools were constructed quickly and accurately for use in the specific task.

Lesson No. 70. Design of equipment should be kept simple and rugged to ensure consistent operation and to avoid potential equipment failures. Such equipment may not be state of the art, and may not be able to perform intricate maneuvers, but the performance tradeoff in remaining operable and cost effective is worthwhile. Also, keep the design classification for new equipment to as low a level as possible, to allow for timely inspections and drawing development.

Lesson No. 71. Provision should always be made for cross-review of procedures when more than one organization is involved in an activity.

Lesson No. 72. When an activity (such as fuel transfer) is a high priority action for one project but not for another, understandings and agreements need to be reached at high management levels as to which priority level will apply.

Lesson No. 73. Computer simulation of equipment is very helpful to engineers and operators in both evaluating use inside remote areas (such as the PUREX canyon) and in visualizing and planning activities.

Lesson No. 74. To the extent possible, keep the time period between planning, documenting, and carrying out an activity as short as possible. When time elapses, documentation changes may be required, personnel assigned to the activity may change, and readiness reviews may become more extensive. Such changes add time to the overall activity schedule. At PUREX, some of the personnel familiar with fuel transfers were lost during the initial years after the Standby runs. When the time came for the final fuel transfers in 1995, some of the personnel in key positions had never done this activity before, so more extensive readiness reviews were needed.

Lesson No. 75. Finding an alternate use for a slightly contaminated process chemical, with an interested buyer or consumer, is better than having the material declared a waste. The same lesson was learned, and for the same reasons, in connection with uncontaminated fresh chemicals that were sold from the PUREX Plant during the Standby period.

Lesson No. 76. Public involvement, conducted with an honest and open attempt to communicate and find mutually satisfying solutions, can be the key to resolving seemingly intransigent issues. Also, Public involvement uncovers true majority public sentiments, and prevents a vocal minority from inaccurately presenting "public" sentiments. (See Section 10.0)

Lesson No. 77. Some obstacles to movement of nuclear process materials, and to other types of deactivation alternatives cannot be controlled or overcome by plant and DOE personnel. The historical/political climate toward nuclear materials is such that even the most preferred alternatives (from the technical perspective) sometimes cannot be implemented in every locality.

Lesson No. 78. Persistence and patience can find a destination and a cooperative customer when pursued over time. Many avenues should be explored.

Lesson No. 79. The lessons learned in the deactivation of the PUREX analytical laboratory closely follow those learned in connection with N-Cell, the PR room, Q-Cell, and the Sample Gallery. Individual systems within large facilities cannot be kept open without the undue expense of maintaining at least portions of larger systems. There is an optimum time to deactivate a support facility and to move the needed services to other facilities. Also, modern contamination fixant techniques allow glove boxes and other large equipment pieces to be left inside facilities, while still controlling contamination.

Lesson No. 80. Careful planning, involving many knowledgeable plant people, as well as practice dry runs, are key elements in achieving smooth, efficient, and low exposure results when work is required in high radiation areas.

Lesson No. 81. Establishing effective, early and ongoing communication between facility and regulatory personnel is essential. Regulatory support and communication was an essential factor in determining the extent of flushing at PUREX, the sample analysis required, and the methods of flushing. Although interaction with regulators often costs time, ultimately it results in completion of the project safely and ahead of schedule.

Lesson No. 82. Looking for ways to combine activities is important, especially with reference to waste minimization considerations. The combination of recycling waste water from other sources and utilizing the cascaded flushes method to flush the canyon vessels at PUREX reduced the anticipated waste volume by 50 percent. It also resulted in significant cost savings by completing the canyon vessel flushing project ahead of schedule.

Lesson No. 83: When ancillary facilities such as the PUREX Tunnels clearly have different missions and vastly different anticipated operating life spans, they should be separated administratively and treated differently in terms of regulatory and physical planning.

Lesson No. 84. Existing ventilation systems can be modified in many ways, and many devices are available to help regulate them. At PUREX, as with the fuel removal equipment and procedures, the simplest methods were chosen because they were felt to be the most dependable. Systems that will require the least amount of maintenance are the best for long-term use in large facilities.

Lesson No. 85. In planning large deactivation activities, discern which outside resources have the necessary expertise and experience to validate the designs and obtain their help in reviewing plans. Make sure that the most expert reviews are conducted as early in the process as possible.

Lesson No. 86. At UO_3, the final flushes of the process vessels were included as part of the activities of the stabilization run. Because these flushes were considered part of operations, no RCRA permits were needed for the flush material and the RCRA 90-day clock for the UO_3 Facility did not start ticking until the final flushes were completed. By that time, almost all hazardous materials that might have been considered waste under a different timing structure had been removed from the plant. Other facilities should consider writing vessel and equipment flushes and other ancillary activities into their stabilization run plans.

Lesson No. 87. Issues such as which groups will perform deactivation work tasks must be worked out globally at the start of a project. For example, the issue of which tasks constitute plant "modifications" can have legal (Davis-Bacon Act) and labor ramifications, and can slow or stop a deactivation project.

Lesson No. 88. The disposition of small equipment, tools, furniture, and other miscellaneous supplies and items might be viewed as a private business opportunity as facilities deactivate across the DOE complex. The amount of time spent on such disposition was disproportionately large, in the view of facility management, and these activities had to compete with other deactivation tasks for the time of facility personnel. If such activities were privatized, more productive uses might be found for some of the equipment and waste burials might be minimized.

Lesson No. 89. When a facility is in the final stages of deactivation, high priorities are assigned to final close-out items. However, other organizations and facilities are not in the rush mode, and may not assign as high a priority to their interfaces and correspondence, sign-offs, etc. as the deactivating facility that is facing final deadlines. Leaving time for other organizations to work at their usual pace or on their usual cycles is important.

Lesson No. 90. Many final deactivation end points mandate posting signs at various places around facilities. Make a "signs map" ahead of time, make sure that all signs are physically prepared, and accounted for on the map, well before the deadlines.

Lesson No. 91. The hot tap method of sealing inaccessible pipes, or pipes configured so that they cannot be drained by gravity, is a cost effective way to ensure that contamination will not migrate out of such pipes over time in deactivated facilities. Deactivating facilities should be inspected for such piping situations and hot tap drained before deactivation is complete.

Lesson No. 92. Public and tribal involvement is essential to the success of major deactivation projects. Such involvement should be started early, and should include initial efforts to assemble and distribute informational documents that allow non-technical people to understand the history, operations and condition of large, complex facilities. The provision of such documents can save plant personnel enormous time that might otherwise have to be spent answering repetitive questions. Communication also can prevent a domino-effect of misunderstandings about the deactivation, based on basic misunderstandings of plant functions, layout, history, chemical and radiological inventory, and many other topics. Plant tours are important to help stakeholders understand the scope of the physical plant, the deactivation project, and the work being performed.

Lesson No. 93. Once the common information base is established (the first phase of public involvement), the public involvement process should become a dialogue. Two-way, iterative communication is essential. Plant personnel must truly listen to the values, motivations, and concerns of stakeholders, and must be willing to change their ideas based on the input of others. The era of unilateral federal decisions clearly is over, and leadership in the new era means flexibility and trust. Compromises can be reached, and the value of obtaining the buy-in of regional stakeholders can ensure the long-term success of deactivation projects and other DOE missions.

Lesson No. 94. Communication with facility employees (a key stakeholder group) is essential, especially considering that employees of a successful deactivation project literally work themselves out of their jobs. They must be kept apprised of project goals and their roles in achieving these goals, and they must be given guidance on how and where their skills can be applied in new, future positions.

Lesson No. 95. Stakeholder involvement includes many external review groups that have an interest in various aspects of a complex, prototypical facility such as the PUREX Plant. During 1993 and 1994, the PUREX Facility was subject to a spent fuel vulnerability assessment, a chemical vulnerability assessment, and a plutonium vulnerability assessment and reviews by the Defense Nuclear Facility Safety Board, the General Accounting Office, and DOE-HQ special safety teams. It also experienced a vast increase in requests for tours and media information associated with its being a deactivation project model. Supporting all these requests for information must be factored into deactivation project costs and personnel needs. However, one innovative cost-saving method adopted at PUREX and available to other plants is to prepare video tours and information packages that can be duplicated and used many times.

Lesson No. 96. Communication and dialogue take many forms. Some groups, such as some Native Americans, prefer verbal communication to written. Flexibility and variety and format must be used to reach all stakeholders.

Lesson No. 97. The biggest potential physical hazards in a deactivation project may not attract the most public comment and interest. At PUREX, the shipment of irradiated fuel rods to the K West basins generated vastly less public interest that the nitric acid shipment to England, yet the radionuclide inventory and hazardous nature of the spent fuel was much greater. The public will tell the facility managers what its interests are, and managers must listen and heed the public's perceptions.

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13.2 ORAL HISTORY INTERVIEWS

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APPENDIX A

PUREX ORGANIZATIONAL CHARTS BEFORE AND AFTER REENGINEERING

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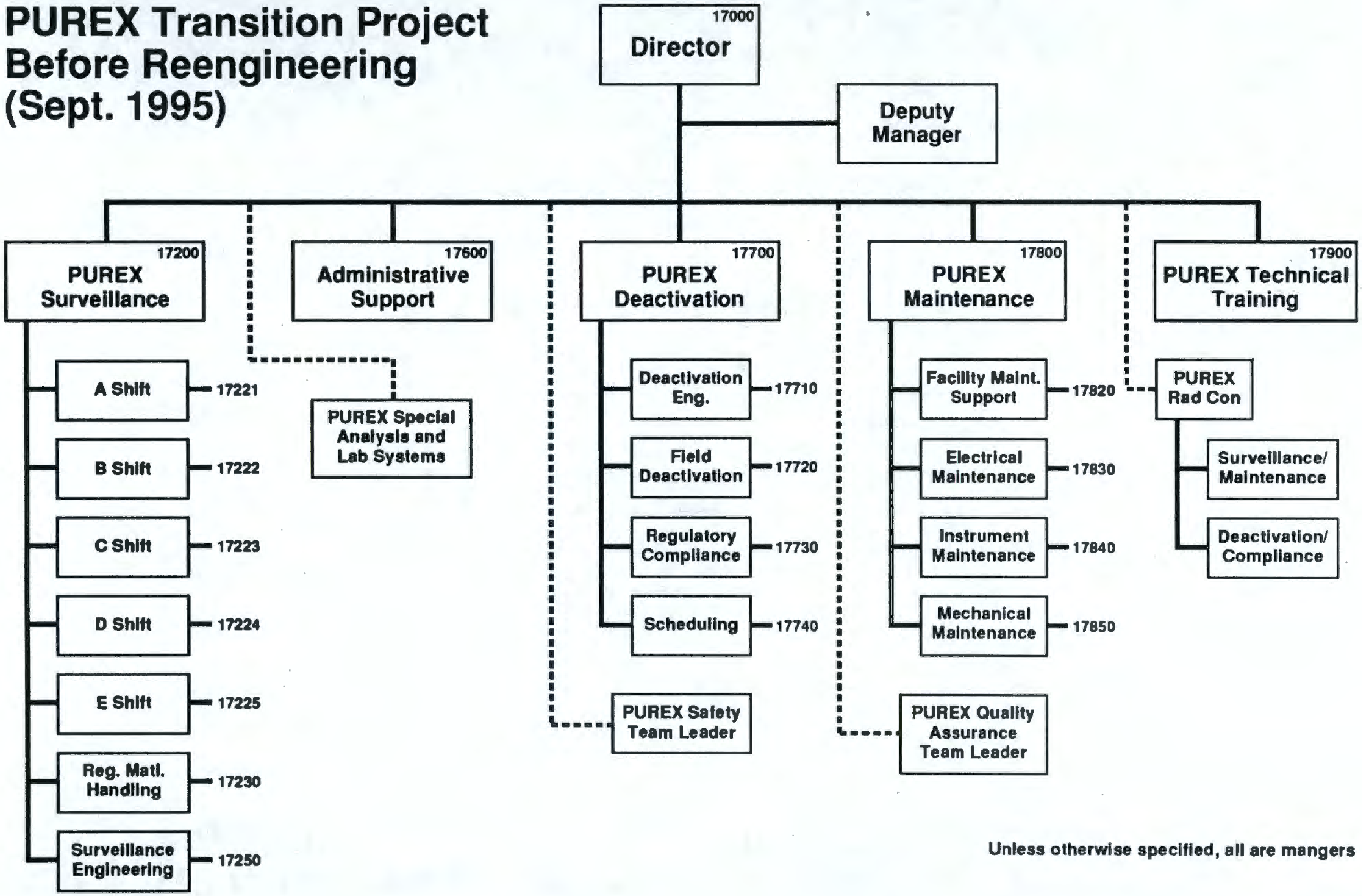
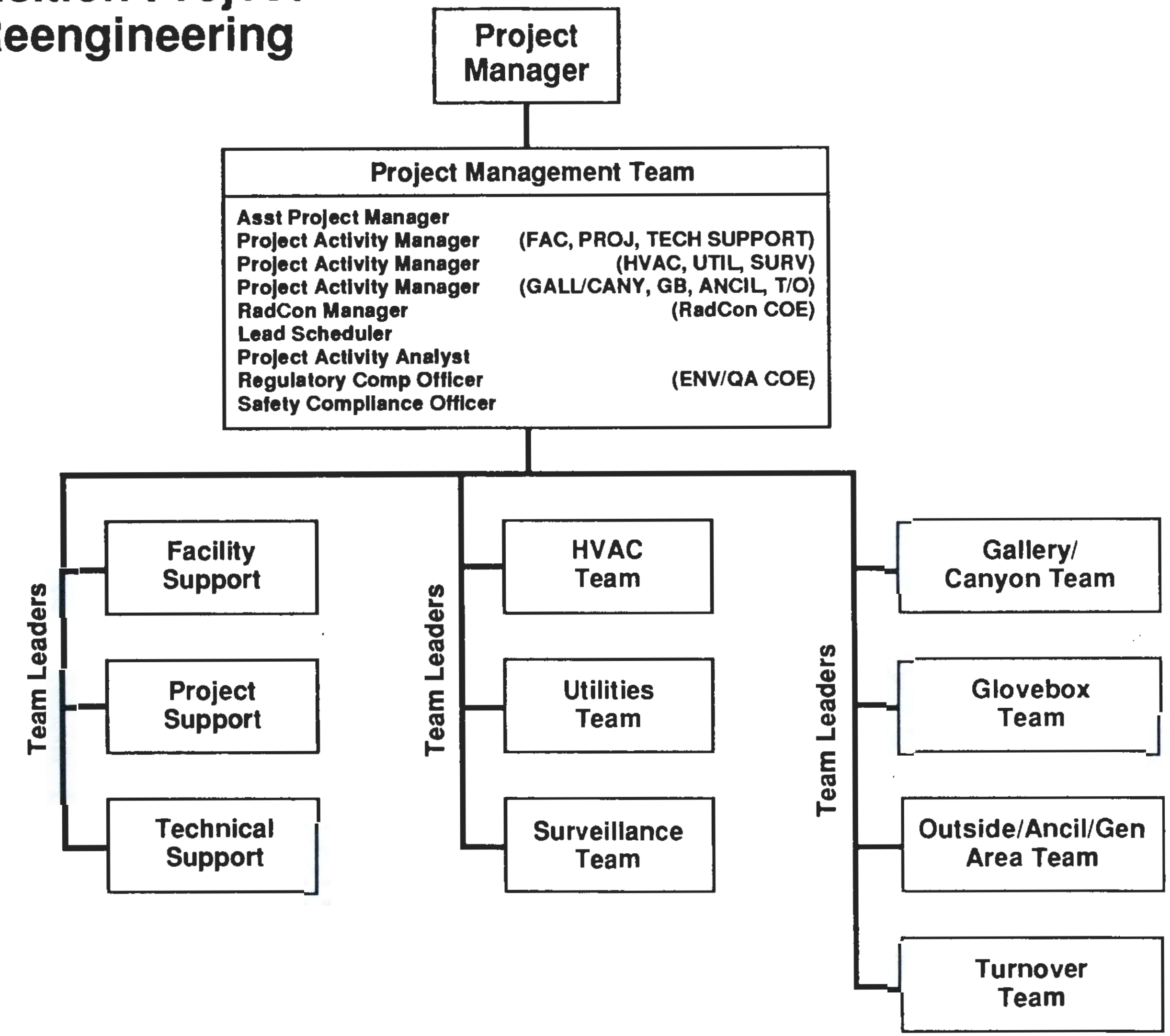
PUREX Transition Project Before Reengineering (Sept. 1995)



PUREX Transition Project 1700 After Reengineering May 1996



APPENDIX B

INITIAL PUREX TEAMS CREATED IN DECEMBER 1996

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Surveillance Team

- Team Leader
- Clerk (shared)
- Power Operator (3)
- RCT (4)
- Nuclear Process Operator (NPO) (8)
- Configuration Control Specialist
- Process Engineer (2)
- Plant Engineer

Turnover/Endpoints Management Team

- Team Leader
- Plant Engineer (2)
- Records Specialist (2)
- Engineer

Heating, Ventilation, and Air Conditioning Team

- Team Leader
- Planner
- Process Engineer
- Electrical Engineer
- Electrician
- Millwright (2)
- RCT (3)
- Power Operator
- Clerk (shared)
- Mechanical Engineer (3)
- Plant Engineer
- Instrument Technician
- Pipefitter
- Rigger (2)
- NPO (2)
- Scheduler

Glove Box Stabilization Team

- Team Leader
- NPO (5)
- RCT

Utilities Consolidation Team

- Team Leader
- Secretary
- Electrician (5)
- Power Operator (2)
- NPO (2)
- Environmental Engineer
- Engineering Technician
- Scheduler
- Task Manager
- Clerk (shared)
- Pipefitter
- Millwright (2)
- RCT (3)
- Electrical Engineer (3)
- Mechanical Engineer
- Plant Engineer (2)
- Planner
- Instrument Technician (2)

Canyon/Galleries Team

- Team Leader
- Plant Engineer (2)
- RCT (4)
- Crane Operator
- Electrician (2)
- Planner
- Process Engineer (2)
- NPO (6)
- Pipefitter

Ancillary Structures/Outside Areas

- Team Leader
- NPO (8)
- Scheduler
- Pipefitter (2)
- Clerk
- RCT (5)
- Process Engineer

Facility Support

- Team Leader
- Secretary
- Plant Engineer (3)
- Records Specialist
- Light Duty Truck Driver (2)
- Instrument Technician (4)
- Material Coordinator (3)
- Hazardous Materials Specialist (2)
- Plant Engineer-Resource Broker (2)
- Clerk
- RCT (7)
- Scheduler
- Insulator (2)
- Painter (3)
- Tool Crib Attendant
- NPO Chief Steward

Project Support Team

- Team Leader
- Secretary
- Administration Specialist (3)
- Project Control Analyst (2)
- Scheduler
- Administration Specialist/Employee Concerns
- Records Clerk (2)
- Engineering Writer
- Trainer (2)
- Plant Engineer (2)

Technical Support Team

- Team leader
- Quality Engineer
- Engineering Technician
- Principal Engineer (2)
- Radiation Control Expert (3)
- Engineer
- Planner
- Engineer, Regulatory Compliance (2)
- Secretary
- Quality Technician
- Project Specialist
- Plant Engineer
- Scientist
- Industrial Hygienist

Project Management Team

- PUREX Deactivation Director
- Project Activity Manager (3)
- Radiation Control Manager
- Assistant Project Manager/Team Leader
- Project Activity/Accounting Analyst
- Regulatory Compliance Officer
- Safety Compliance Officer
- Lead Scheduler
- Coach (3)
- Secretary (3)

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APPENDIX C

TABLE OF PROCESS VESSELS AND CHEMICALS IN THE PUREX PLANT, COMPILED FOR REGULATORY STREAMLINING SUBMITTAL

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PUREX PLANT VESSEL TABLE

VESSEL ID	LOCATION	CAPACITY (LITERS)
TK-D5	D Cell	19,851
TK-E5	E Cell	19,873
TK-E6	E Cell	19,813
TK-F3	F Cell	19,964
TK-F4	F Cell	19,593
T-F5	F Cell	1,132
E-F11	F Cell	9,804
TK-F15	F Cell	19,419
TK-F16	F Cell	19,870
TK-F18	F Cell	19,798
TK-G1	G Cell	18,662
TK-G2	G Cell	7,064
T-G2	G Cell	8,248
TK-G5	G Cell	55,403
TK-G7	G Cell	50,827
TK-G8	G Cell	19,881
TK-H1	H Cell	19,593
T-H2	H Cell	7,003
E-H4	H Cell	10,137
TK-J1	J Cell	19,926
TK-J3	J Cell	19,911
T-J6	J Cell	6,057
T-J7	J Cell	6,730
TK-J21	J Cell	1,162
T-J22	J Cell	568
T-J23	J Cell	393
TK-K1	K Cell	19,828
T-K2	K Cell	5,194
T-K3	K Cell	6,507
TK-K6	K Cell	19,593
T-L2	L Cell	447
TK-L3	L Cell	488
T-L4	L Cell	139
TK-M2	M Cell	6,852
TK-Q21	Q Cell*	81
TK-Q22	Q Cell*	968
TK-R1	R Cell	18,121
TK-R2	R Cell	6,746
T-R2	R Cell	8,282
TK-R7	R Cell	35,174
TK-U3	U Cell	31,124
TK-U4	U Cell	31,184
TK-P4	203-A	402,930
TK-40	211-A	247,360
TK-156	AMU	1,533
Total Capacity		1,263,233.00

* Q Cell is located in the storage gallery (refer to the PUREX Plant cross section figure, page 12 of 21).

For conversion, apply the following:
liters to gallons - multiply liters by 0.26417

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APPENDIX D

PUREX AND UO_3 M-80 TRI-PARTY AGREEMENT MILESTONES

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M-80-00	Complete PUREX and UO_3 Plant Facility Transition Phase and Initiate the Surveillance and Maintenance Phase
M-80-00-T01	Issue U.S. Department of Energy-Approved End Point Criteria for the UO_3 Plant
M-80-00-T02	Complete All UO_3 Plant Transition Activities and Initiate Surveillance and Maintenance Phase
M-80-00-T03	Submit Options and Recommendations for Final Management of Tank 40 Organic material to the U.S. Environmental Protection Agency and/or the Washington State Department of Ecology in Accordance with Their Respective Authorities
M-80-00-T04	Complete Removal of Concentrated (Recovered) 203-A Nitric Acid at PUREX
M-80-00-T05	Complete Implementation of Selected Alternative for Management of Spent Fuel from PUREX
M-80-00-T06	Complete Deactivation of the PUREX Plant 211-A Area
M-80-00-T07	Complete Deactivation of the PUREX Plant Sample Gallery
M-80-01	Complete Deactivation of PUREX Plant R-Cell
M-80-02	Submit the End Point Criteria and Surveillance and Maintenance Plan in Support of the PUREX Preclosure Work Plan
M-80-02-T01	Submit PUREX End Point Criteria for Transition of PUREX
M-80-02-T02	Submit PUREX Surveillance and Maintenance Plan
M-80-03	Remove Process Waste Solutions from Tanks D5 and E6
M-80-04	Complete Deactivation of the PUREX Plant U-Cell/Fractionator
M-80-05	Complete Deactivation of the PUREX Plant Aqueous Makeup Area
M-80-06	Complete Deactivation of the PUREX Plant Canyon
M-80-07	Complete Deactivation of the PUREX Plant 203-A Area
M-80-08	Document Hazardous Substances/Dangerous Wastes Remaining Within the PUREX Plant

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APPENDIX E

JOB HAZARDS ANALYSIS FORM

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PHSA Rank: 0

Qualitative Job Analysis

10-Sep-96

JHA ID: 2A-9609-102 **Work Request ID:**
Work Title:
Facility/Area **Walk-Through Conducted:** ☐
Description:

Other Activities:

Involvement

Industrial Safety	☐	**Fire Protection**	☐	**RadCon**	☐	**Quality Assurance**	☐
Industrial Hygien	☐	**Environmental**	☐	**Nuclear Safety**	☐	**Criticality Safety Rep**	☐

Determination

■ If the current activity is fully covered by an RWP check this box. Fully covered means that the RWP must cover all types of activities included in this planned activity (such as breaching lines,tanks,etc.

■ If the work activity is being performed per an approved (active) procedure, check this box.

■ If the activity does not involve equipment replacement/repair or if the repair is like for like, check this box.

■ If the safe completion of this work activity will not require a Caution or a Danger tag, then check this box.

■ Review the current Safety Equipment List (SEL), if the work activity does not involve any equipment identified on the SEL, then check the box.

■ If the safe completion of this activity does not require a permit, such as a Confined Space Permit, etc, then check this box.

■ If all instructions for waste generation, handling and disposal related to materials involved in this work activity are approved, then check this box.

PHSA

TYPE OF PROCESS	TYPE OF OPERATION	EVENT OF CONCERN/SCENARIO
☐ Chemical	☐ Fixed Facility	☐ Single failure
☐ Electrical	☐ Transportation	☐ Loss of function
☐ Physical	☐ Permanent	☐ Procedure
☐ Electronic	☐ Temporary	☐ Multiple failure
☐ Mechanical	☐ Continuous	☐ Process upset
☐ Computer	☐ Semi-Batch	☐ Software
☐ Biological	☐ Batch	☐ Hardware
☐ Human		☐ Simple loss of containment
		☐ Human event

Complexity/Size	Probability of an Accident	Previous Accidents
Team Experience	Severity of Consequences	Work Performed with...

☐ **Length - With similar proces** ☐ **Significant Changes Involved**

1

PHSA Rank: 0

Qualitative Job Analysis

10-Sep-96

ENVIRONMENTAL

AIR:
- ☐ New activity
- ☐ New source
- ☐ Modification
- ☐ Involves open burning or training fires

MISCELLANEOUS:
- ☐ Involves disposal of inert waste at a non-approved disposal site
- ☐ Includes construction of a solid waste facility
- ☐ Installs, removes, or modifies an underground storage tank
- ☐ Includes demolition, cleanup and/or renovation involving asbestos

DANGEROUS WASTE:
- ☐ Includes treatment, storage, and/or disposal of dangerous waste
- ☐ Generates or manages contaminated equipme

WATER:
- ☐ Involves a new or existing liquid discharge to the ground or river
- ☐ Modify an existing, approved wastewater treatment system
- ☐ Modify an existing drinking water system
- ☐ Requires work over, in, or adjacent to a surface water body
- ☐ Installation or modification of a septic system

WORKER SAFTEY

- ☐ Fall hazards over 6ft.
- ☐ Energy sources
- ☐ Temporary Electrical
- ☐ Electrical hazards
- ☐ De-energize equipment
- ☐ Fire or explosion
- ☐ Walking or working surfaces
- ☐ Excavation
- ☐ Demolition
- ☐ Roof work
- ☐ Pinch points
- ☐ Remote work
- ☐ Mechanized equipment
- ☐ Hand tools
- ☐ Pneumatic tools
- ☐ Electrical tools
- ☐ Hoisting or rigging or critical lift

NUCLEAR

- ☐ Work involving or impacting Criticality Alarm
- ☐ Plant location
- ☐ Fissionable materials in excess of 15g
- ☐ Criticality Prevention Specifications (CPS) or posting
- ☐ OSD/OSR limits
- ☐ Activity to be performed on OSD/OSR System
- ☐ Equipment on SEL
- ☐ System interacts with Safety Equipment
- ☐ > 500 gallons of hazardous materials
- ☐ More than one chemical involved
- ☐ Involves new chemicals or processes
- ☐ Radionuclide content
- ☐ ORR or Radionuclide non-routine or new activity
- ☐ Involves Radionuclide quantities exceeding 0.3 of the HC 3 levels

EXPOSURE

- ☐ Welding or cutting or burning or hot work
- ☐ Hazardous Waste operation
- ☐ Lead handling or abatement
- ☐ Confined space entry
- ☐ Noise or noise producing
- ☐ Contaminated soil or evacuation or disruption
- ☐ Temperature extreme
- ☐ Tank or line or vessel opening or breach
- ☐ Painting
- ☐ Asbestos handling or abatement
- ☐ Chemical/HazMat use/involveme
- ☐ Mercury work
- ☐ Berylium work
- ☐ Carcinogen work
- ☐ Dust Producing

Radiological work

Other exposure hazards:

2

PHSA Rank: 0 **Qualitative Job Analysis** *10-Sep-96*

Comments:

PERSONS COMPLETING JHA: **Team:**

Name	**Organization**	**CWO**

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APPENDIX F

FLUSH K CELL CHART

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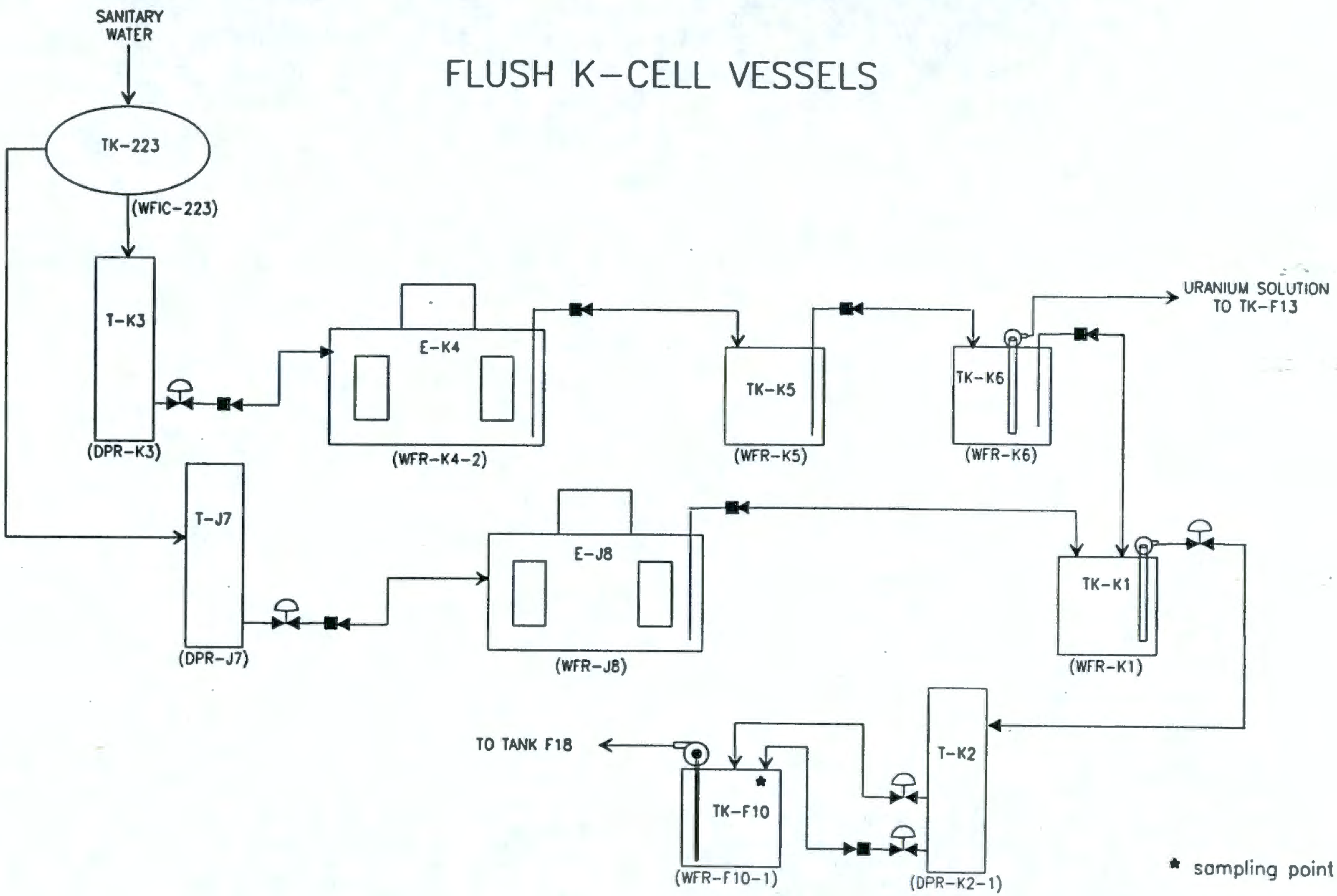
FLUSH K-CELL VESSELS



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APPENDIX G

DRAWING OF SIMPLIFIED PUREX EXISTING HVAC FLOW AND PROJECTED CONSOLIDATED FLOW

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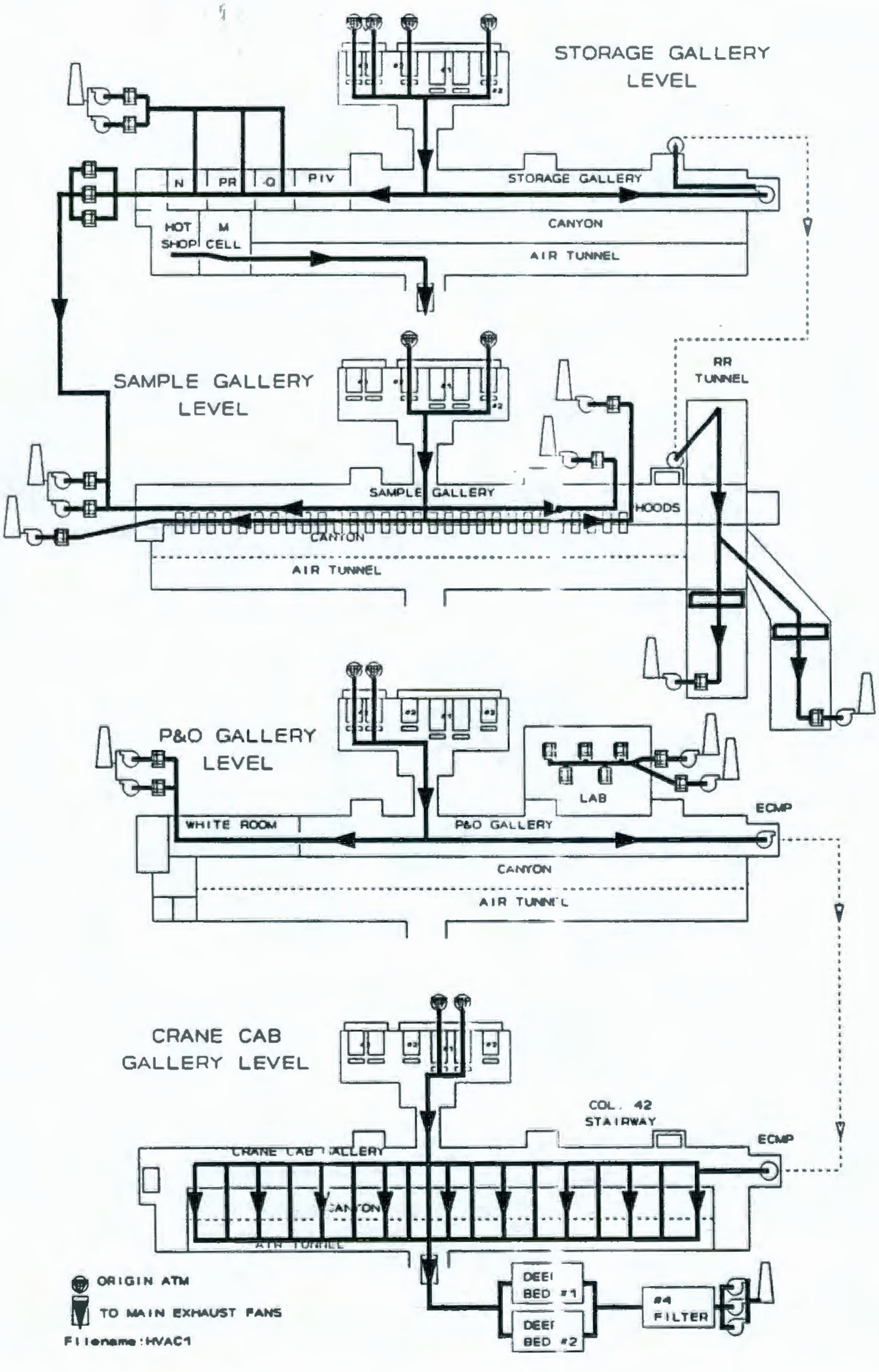

Figure 2. SIMPLIFIED EXISTING PUREX FLOW SCHEMATIC

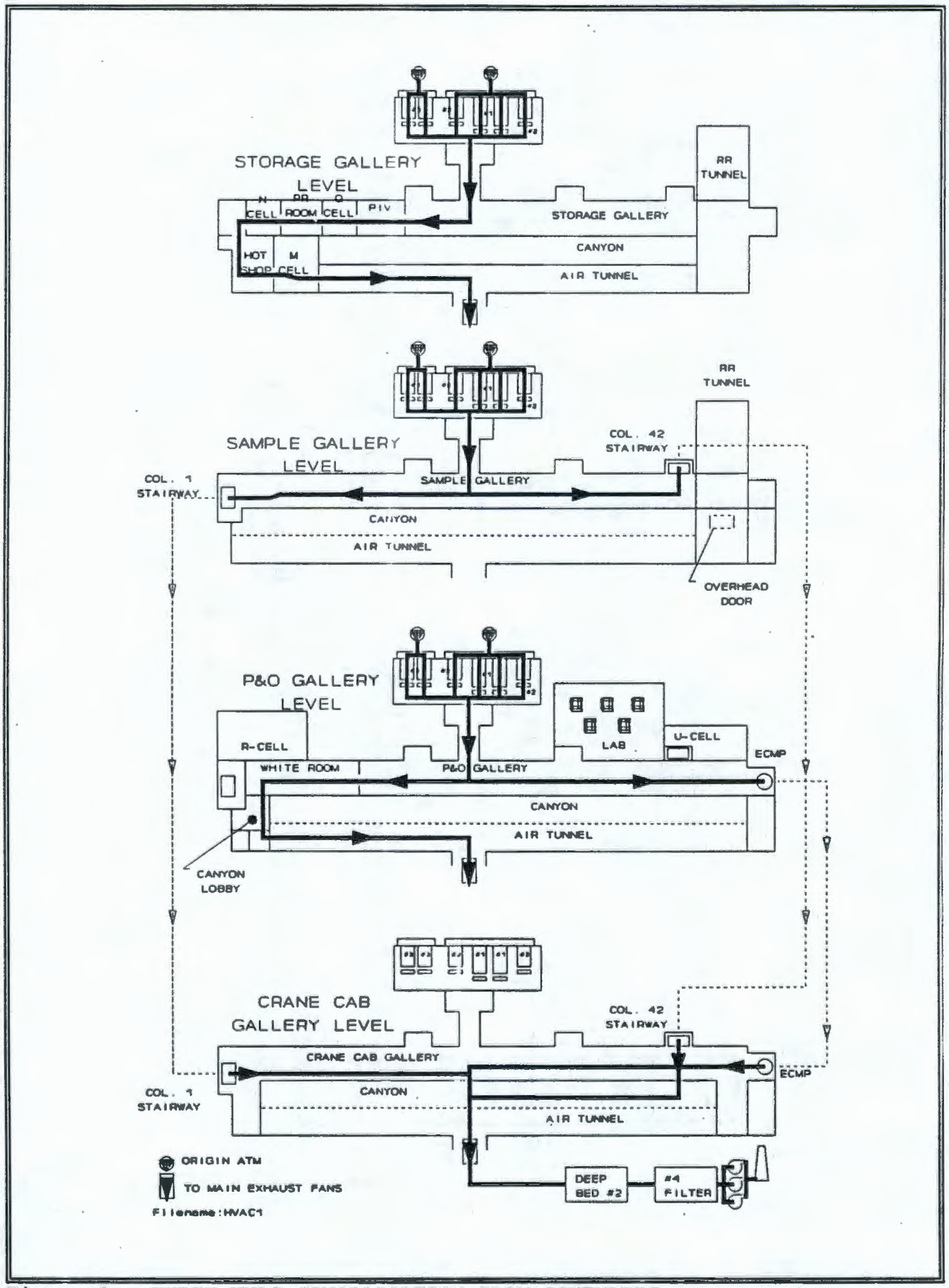

Figure 3. PUREX HVAC CONSOLIDATION FLOW SCHEMATIC

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