DECONTAMINATION OF THE PRODUCT PURIFICATION CELL-SOUTH AT THE WEST VALLEY DEMONSTRATION PROJECT

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ABSTRACT

The West Valley Demonstration Project (WVDP) is decontaminating cells in the only commercial nuclear fuel reprocessing plant to have operated in the United States. One of the cells that has undergone decontamination, the Product Purification Cell-South (PPC-S), presented multiple challenges that were directly related to the previous function and physical structure of the cell: high levels of alpha contamination and restrictive work space. Challenges related to in-cell contamination involved:

X Physical demands on workers wearing extensive Personnel Protective Equipment (PPE);

X Criticality concerns;

X Sampling needs;

X Maintaining radiological controls during decontamination operations.

Challenges related to working in a restrictive work space involved:

X Establishing and maintaining a functional point of access and egress for people, tools, and support equipment;

X Maintaining safe working conditions within the silo-like dimensions of the cell; and

X Safely staging waste during decontamination operations.

This paper discusses the approach taken by the WVDP to meet these challenges and successfully place the PPC-S into a safe, more stable configuration by the end of decontamination operations. Experience gained and lessons learned from decontaminating the PPC-S can be applied at other U.S. Department of Energy (DOE) sites involved in decontaminating cells that present similar challenges.

INTRODUCTION AND BACKGROUND

The Process Plant at the West Valley Demonstration Project (WVDP) is the only commercial spent nuclear fuel reprocessing plant to have operated in the United States. Reprocessing operations conducted in the plant during its period of operation involved the use of a system that was designed to separate usable uranium (U) and plutonium (Pu) from spent nuclear fuel, purify the resulting product, and package it for reuse. System operations were conducted through an interconnected series of shielded cells from 1966 until 1972, when spent fuel reprocessing ended at the West Valley site. The Product Purification Cell (PPC) is the shielded cell that was used to complete the purification and concentration of U and Pu product streams produced during this period of operation.

The interior of the PPC measures 6.4 m (21-ft) wide by 5 m (16-ft) long by 17 m (57-ft) high. Approximately 1.5m (5-ft) from the cell's south wall, an internal shield wall 0.3 m (1-ft) thick subdivides this space into two sections: the smaller south section of the cell where residual fission products were removed from U and Pu product streams and final Pu product was prepared for packaging and shipment, and the larger north section of the cell where final U product was prepared for packaging and shipment.

While extensive decontamination of the north side of the cell was conducted during the mid 1980's, the south section of the cell, the PPC-S, remained essentially as it was configured at the end of spent fuel reprocessing operations, containing vessels, tanks, valves, piping, structural supports, and miscellaneous debris that had accumulated inside the cell. (See Fig.1.) Decontamination of the PPC-S was undertaken to significantly reduce the level of radiological hazard and risk associated with the continued presence of these contaminated materials inside the cell.

Development of the approach used to decontaminate the PPC-S was initiated by preparing a preliminary view or "picture" of the cell, and using this picture to:

- Confirm current physical and radiological conditions inside the PPC-S;
- Prepare detailed work scope activities by evaluating current in-cell conditions; and
- Guide decontamination operations through an ongoing analysis of in-cell conditions during the performance of decontamination work.

The process of preparing to decontaminate the PPC-S is described here, followed by a discussion of decontamination operations, and a summary of activities conducted during PPC-S decontamination.

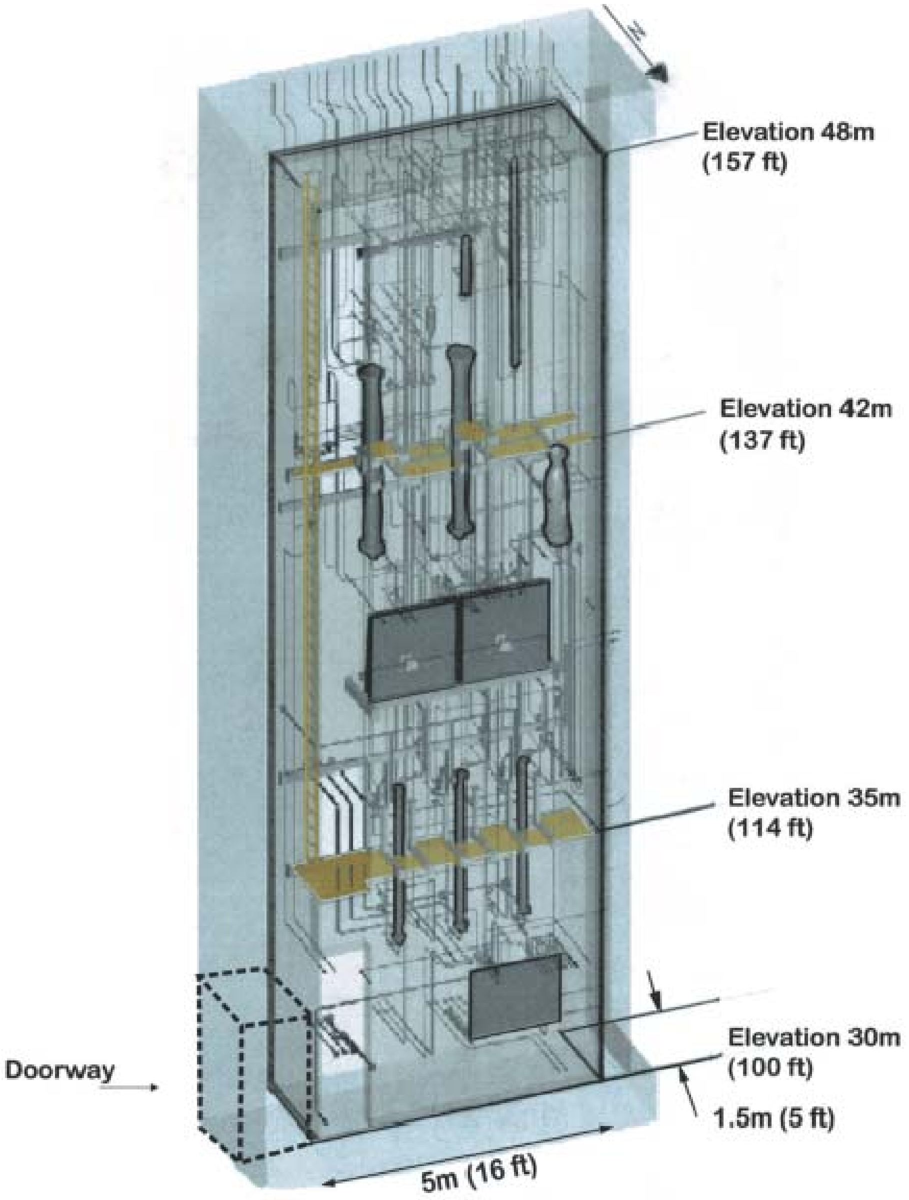

Fig. 1 Layout diagram of PPC-S before decontamination

DECONTAMINATION APPROACH

The approach taken to prepare for decontaminating the PPC-S involved conducting a series of evaluations to identify in-cell conditions, determine how to conduct entries, and create conditions needed to make an initial entry into the cell safely. This process began by assembling documentation about the cell, such as drawings and plant operating records, and using this documentation to establish the location and function of equipment, piping, and support structures. As the configuration and condition of the cell was being established through drawing review, plans were developed to confirm current in-cell conditions by conducting a preliminary visual (video) inspection. Arrangements also were made to prepare a three-dimensional computer model of the cell for use in the development of detailed work plans.

Points used to conduct the video inspection were selected based on the ability to examine interior surfaces and collect radiological data representative of current dose rates and gross contamination levels inside the cell. After penetrations were prepared at upper, mid, and lower elevations of the cell, they were used to introduce video cameras into the cell, examine interior surfaces, and create videotape records for later use in locating specific lines of process and utility piping. Following inspection, the penetrations were used again to take probe readings and gather smear samples needed to ascertain current radiological conditions.

By inspecting the interior of the cell with video cameras, it was possible to verify its configuration, confirm the overall integrity of support structures, and identify the type of debris that remained on the cell floor. By gathering radiological data during the inspection process, it was possible to determine the protection factor needed to work in the PPC-S, establish the level of PPE to be worn, set training requirements, and begin training as technical evaluations of the cell were being completed. Collectively, information developed through review, inspection and sampling activities supported the selection of alternatives for entering and exiting the cell, managing the flow of materials (including tooling, support equipment and waste containers), and preparing for initial entry. It also supported the development of a detailed safety analysis that assessed hazards specific to conducting an initial entry, and working at each level of the cell's four story structure.

Results showing levels of alpha contamination to be in excess of 50 million disintegrations per minute (DPM) at points where smear samples were gathered during the inspection process were particularly critical to guiding the development of specific radiological and safety controls, and creating conditions needed to conduct decontamination work safely. Given the high level of alpha contamination confirmed to be present on in-cell surfaces, the ability to protect workers and prevent the spread of contamination was of paramount concern as various techniques and methods for conducting work were being considered. The range of techniques and methods developed to provide a safe working environment and maintain safe working conditions during the performance of decontamination operations are described as follows.

Preparing the Working Environment

Built as a shielded area within a cell, the PPC-S was designed to allow for restricted access only when repairs were needed to keep in-cell equipment operational. (Refer to Fig.1.) To prepare for making an initial and then routine entries into the cell, it was therefore necessary to evaluate where a point of access/egress could be located, develop detailed plans for establishing this point, and then determine how to manage movement inside the cell once access/egress was provided.

Selection of the point to be used for conducting in-cell entries was based on the ability to create an opening large enough to support the flow of materials into and out of the cell (including large contaminated vessels and tanks) and to install containment areas around this point with sufficient space to support material handling and transfer operations. After assessing several options for establishing an optimal point of access/egress, plans were developed to situate the main point of access/egress at floor level at a point along the cell's east shield wall. Located in a concrete block room immediately adjacent to the east side of the PPC-S in an area once occupied by a glovebox, this point was selected because of its proximity to existing airlocks, points-of-entry, and a functional load out area. Additionally, putting the point of access/egress at this location it made it possible to create a doorway, containment area, and material flowpath capable of supporting the removal, packaging, staging, and transfer of major equipment items from the cell to a load out area at ground level.

Following selection of an optimal point of access/egress, detailed designs were developed to install two containment tents (each with an interior vinyl wall to provide additional containment) between the existing points of entry into the general area surrounding the east wall of the PPC-S and the point where access/egress was to be established. A detailed design also was developed to install a new doorway at the point of access/egress (indicated in Fig.1) by creating an opening approximately 1.01 m (40 inches) wide by 3.04 m (120 inches) high in the cell's 0.91-meter (3-foot) concrete shield wall.

As these plans were being prepared, ventilation flowpaths into and out of the PPC-S were assessed, giving special attention to ventilation system interfaces to avoid causing adverse impacts to ventilation system operation as modifications to help control airborne radioactivity were being made. The first of these modifications involved relocating an existing exhaust port and ventilation duct from the east end of the cell's north wall to the west end of the north wall. This modification was made so that clean air would be drawn from the containment area outside of the doorway, past work crews, to the new exhaust port instead of being immediately exhausted from the cell near the new doorway, creating a "dead air zone" both at the west end of the cell and at its upper levels.

The next modification made involved increasing airflow through the cell to affect a corresponding increase in the number of air changes inside the cell. This was accomplished by using existing penetrations at the south end of the cell to make a tie-in between the cell and the plant's intake ventilation exhaust plenum.

Additional mechanisms for increasing negative airflow were provided by connecting a portable section of flex-duct to the sleeve of the newly relocated ventilation duct to make it possible to bring the duct to specific in-cell locations as activities (like cutting) were being carried out, and by making portable HEPA vacuums available as a means of providing extra localized ventilation when needed. Supplemental measures taken to reduce the potential for spreading alpha contamination during initial entry into the PPC-S involved applying strippable (fixative) coatings to in-cell surfaces through the same set of penetrations used to conduct inspection and sampling activities.

Protective Measures and Controls Used to Maintain Safe Working Conditions

The level of radiological control provided through containment design, ventilation modification, and the use of fixatives was integral to establishing safe working conditions for initially entering and working in the PPC-S. Radiological protection provided through the level of PPE selected, limiting conditions set for conducting in-cell work, and air sampling methods used to monitor in-cell conditions helped to ensure worker protection within the working environment being prepared.

Radiation protection consistent with DOE requirements for occupational radiation protection (10 CFR Part 835) is established for work conducted at the WVDP through the site's radiological controls manual and its implementing procedures, including those used to develop contamination controls, estimate airborne radioactivity concentrations, and conduct air sampling and monitoring. (1) These procedures, in combination with data developed through preliminary sampling and hazards and safety analyses, were used to select an assigned protection factor (APF) for the type of respirator to be used and PPE to be worn during PPC-S decontamination.

Based on levels of gross alpha contamination confirmed during preliminary sampling (i.e., 50 million dpm) and the derived air concentration (DAC) limit for gross alpha activity observed at the site (2E-12 ΦCi/ml), a supplied air respirator with an AFP of 1000 was selected for use during PPC-S decontamination. To ensure this level of protection, the decision was made to use this type of respirator in combination with a multi-layered suit-up referred to as "Bubblesuit." This suit-up, which consists of an inner layer of anti-contamination clothing (including cloth coveralls, shoe covers, gloves, a cap and booties), an air-fed cooling vest, additional shoe coverings, a cloth hood cover, supplied air hood (worn over the supplied air respirator) and an outer layer of vinyl coveralls, was chosen because it provides additional respiratory protection via the air-fed breathing zone between the supplied air respirator and supplied air hood. As worn during entry, the full suit-up included a two-way radio (i.e., earpiece and transmitter) used to maintain communication with personnel outside of the cell, and a breathing zone air sampler (BZAS) attached between the respirator and supplied air hood that was used to take samples in the air-fed breathing zone created between the respirator and hood.

The ability to safely conduct decontamination work in the PPC-S while wearing this level of PPE depended both on the training given to work crews and the techniques used to access upper levels of the cell. After considering several alternative methods for working at upper elevations, including using scaffolding and various types of "scissor" lifts, a mast climbing work platform (or mast climber) was selected as the means for carrying out work at higher elevations.

The type of mast climber chosen is a compact, single-mast, single-platform unit specifically designed for use in narrow, restricted spaces. The length and width of the unit can be adjusted to fit the work area where it is used. The mast (which comes in sections) can be loaded, assembled, anchored, or disassembled from the work platform and easily adjusted to suit the working level once installed in a work area. Platform height can be set to any level using the unit's control system. These features, combined with the ability to customize the unit, made it possible to use the unit's platform as a moveable, in-cell floor capable of being raised or lowered as needed to conduct work. This in turn made it possible for work crews to conserve energy and maintain focus as they proceeded to work at higher elevations while wearing Bubblesuits.

After customizing the mast climber for use in the PPC-S, the unit was set up in a site facility with a ceiling height similar to that in the PPC-S (i.e., 48 m or 57-ft). Here the unit was used to train work crews in assembly, inspection, and operating techniques specific to the mast climber. Training held in this setting helped work crews to become proficient in assembly techniques while they became familiar with how to use the mast climber at higher elevations.

Once work crews completed training in basic assembly and operating techniques, advanced training sessions were held in a near-to-scale mock-up of the cell to give work crews experience assembling the mast climber in sequence inside the cell, beginning with moving the main section of the unit through the cell doorway, orienting it inside the cell, assembling the remaining sections of the platform and mast, and learning how to secure sections of the mast to the cell wall. A view of mast climber, including the fully assembled unit and scale mock-up used during training is shown in Fig. 2.

Like mast climber training, other training sessions held to prepare crews for conducting decontamination work involved the use of a scale mock-up. This helped crew members to practice techniques specific to entering and working in the cell (such as putting on a Bubblesuit within a containment area, or conducting an emergency rescue), as they learned how to work together under conditions similar to those they would experience during decontamination work.

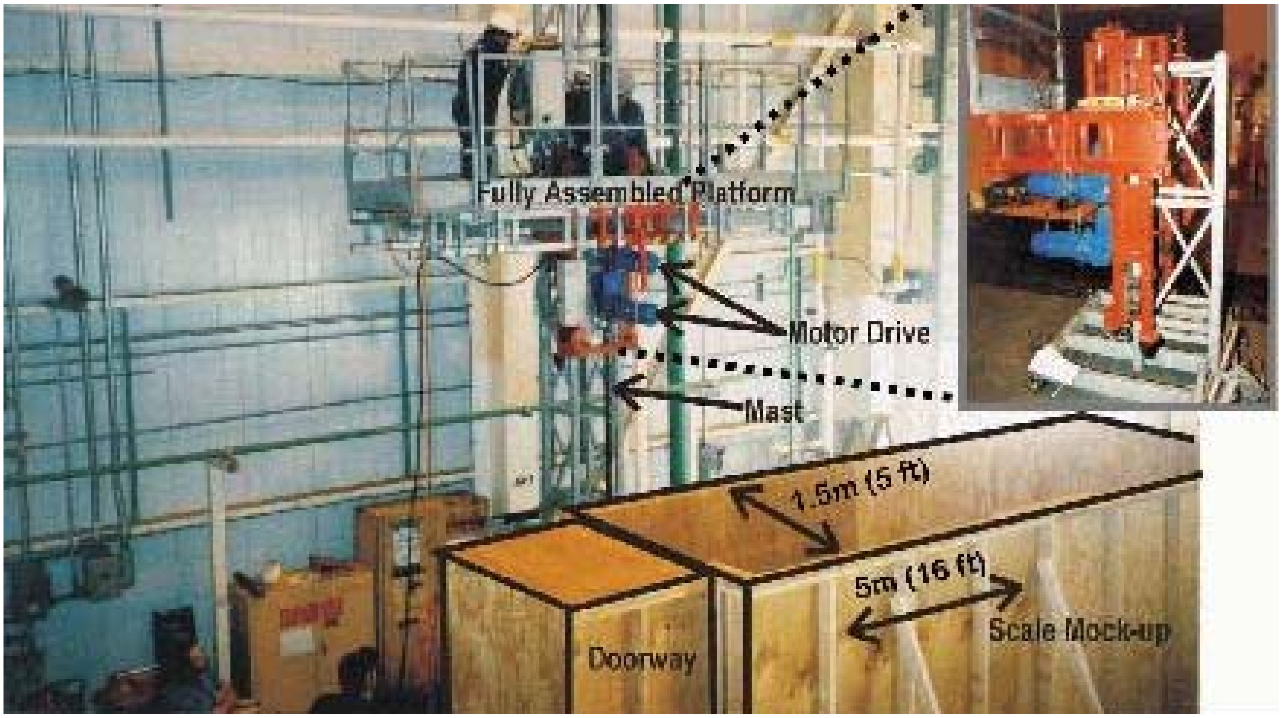

Fig. 2 Mast climber - Unit and full-scale mock-up used for advanced training in unit assembly

Although it was possible to confirm general in-cell conditions through review, inspection, and preliminary sampling activities, access restrictions to the PPC-S precluded gathering samples that could be used to confirm the amount of fissile material actually present inside equipment and piping before decontamination operations began. Access restrictions also limited the ability to determine contamination levels by using non-destructive assay techniques prior to entry. To ensure worker safety during decontamination and material handling operations, it was therefore necessary to develop special screening and handling techniques that could be used to maintain criticality safety as these operations were being carried out. Materials requiring special handling controls during decontamination operations fell into three main areas: residual liquids found in piping or vessels; process piping; and vessels and other large process components.

The method developed to ensure safe handling of residual liquids involved a series of discrete activities to identify points to be sampled, confirm each point during entry, and then apply a custom machined, stainless-steel block assembly known as a "tell-tale" to each point once confirmed. Made up of two small ball valves, a tee, drill bit and saddle assembly contoured to fit the outer diameter of a line of pipe, the tell-tale assemblies employed are simple, multipurpose devices that can be used to vent, drain, and draw samples from a line of pipe. Once applied to selected points, these devices were used to draw a 50 ml sample from the point if liquid was present and sent it to the on-site Analytical and Process Chemistry (A&PC) lab to determine the concentration of fissile materials in any liquid to be drained from the line. To support expedited analytical turn-around, the concentration of fissile material in the liquid was determined from a screening analysis that provided concentrations of gross alpha, gross beta, and gamma activity in the liquid.

Fissile isotopes of concern for liquids drained from sampled lines included U-233, U-235, Pu-239, and Pu-241. Quantities of U-235 and Am-241 were derived from a gamma scan of the liquid. The concentration of Pu-239 in the sample was determined by subtracting the activity of Am-241 (an alpha-emitter and daughter product of Pu-241) from the gross alpha activity. The concentration of Pu-241 was determined from known ratios of Pu-239 to Pu-241. The concentration of U-233 was determined from known ratios of U-235 to U-233. Once concentrations of fissile materials in the liquid were established, a safe volume limit for the liquid collection container was determined and provided to personnel involved in draining and packaging liquids to meet site requirements. (Results from the screening analysis of liquids was used to support draining and removal of about 64 liters (17 gallons) of liquid from in-cell piping removed during PPC-S decontamination operations.)

Through an evaluation of historical process information assembled to help establish the condition and configuration of PPC-S, it was determined that, under certain operating conditions, normally acidic liquids that were present in process piping could have formed gel-like insoluble hydroxides that would not have been removed through flushing or other methods. This was a particular concern as there are no standard in-situ methods for determining the presence of Pu in stainless steel system piping like that in the PPC-S. Bench marking of similar decontamination efforts conducted within the DOE complex indicated that visual inspection was the method most commonly used to identify Pu holdups in piping. Since this is a qualitative technique, conducting visual inspections would not yield the type of quantitative information necessary to meet site safety requirements for handling this type of contaminated material. Consequently, a decision was made to manage process piping based on process knowledge (i.e., either Pu or U). Separate controls were then established for packaging piping from each system. Utility piping that may have come in contact with process solutions, such as steam lines and instrumentation and sensing lines, also was managed as U or Pu process waste to ensure safe handling.

The method developed for safely handling and packaging U system pipe was based on the maximum possible fissile mass that could be contained in a section of U system pipe. Process knowledge indicated that uranium product solutions had been concentrated to 200 g total U per liter to prepare U product for packaging. To determine the allowable number of pipe sections that could be placed into the type of waste containers selected for use during decontamination operations, a 208 liter (55-gallon) drum, the assumption

was made that the entire volume of a U system pipe was filled with this maximally-enriched solution. Limits on the number of pipe sections that could be packaged in a waste drum were then determined using the concentration of uranium in product solutions and the volume of a pipe section assuming that the pipe had been cut to a length equal to the internal height of a waste drum. Although this resulted in very conservative estimates of fissile material in a drum, it produced limits that were operationally practical while ensuring that fissile mass limits for the drum would not be exceeded.

Because the method developed to handle and package U system pipe resulted in limits that were impractically small for handling Pu pipe, another method was developed for Pu system piping. To establish a baseline for acceptable methods, bench marks of analytical methods were obtained through communication with analysts at several DOE facilities involved in the handling and packaging of Pu contaminated wastes. Following this bench marking and a detailed review of methods and guidance for measuring nuclear materials, a method was established for determining fissile content that makes use of instrumentation and techniques recommended by the U.S. Nuclear Regulatory Commission (USNRC) Office of Nuclear Regulatory Research guidance for detecting gamma rays spontaneously emitted by Pu isotopes. (2)

The instrumentation selected for use included an inexpensive scintillation detector that uses a sodium iodide (NaI) crystal with thallium atoms added NaI(Tl) as the detection medium and a scalar-rate meter.

This detection device, commonly referred to as a “sodium iodide”or NaI Tl detector, has wide application in both laboratory and field settings because it can detect and separate out energies in the gamma spectrum with very good efficiency. The type of detector selected, a Ludlum Model 44-10 Gamma Scintillator, contains a crystal 5 cm (2-inch) thick with a 5 cm diameter that is capable of identifying gamma energies. The scalar-rate meter used, a Ludlum Model 2350-1 Data Logger, is a microprocessor-based unit designed for use in field analysis and data logging that is compatible with Geiger-Muller, proportional, and scintillation detectors.

The technique employed uses a portion of the Pu gamma ray complex as the energy range to be identified by the detector, 390 to 450 keV. Slightly less than the portion of the spectrum represented by the Pu- 239 gamma ray complex (i.e., 375 keV to 450 keV), this 60 keV range makes it possible to target Pu-239 as the primary isotope to be detected while avoiding interference from other gamma rays in the Pu complex, such as Pu-241 and Am-241. (As noted in the USNRC’s guidance, a detection sensitivity of less that 1-gram is generally attainable within this range.) After setting a Ludlum Model 44-10 Gamma Scintillator (i.e., the NaI Tl detector) to detect the established target range by calibrating it with known sources, modeling was done using MicroShield computer software to simulate conditions under which actual assay of the pipe would be conducted. The geometry used for modeling purposes was a 76 cm (30-inch) by 76 cm plane with one gram of Pu-239 evenly distributed across its surface. The distance at which gamma readings were to be taken was 60.9 cm (24-inches) above the surface of the metal plane. Rates of emission determined from modeling were then used to develop a table that correlates measured count rates (counts per minute) to grams of Pu-239 (fissile mass). These tabulated values then served as the limits for the packaging of plutonium system piping. To maintain an efficient material flow of Pu contaminated piping from the cell during decontamination operations, a means for staging piping also was developed to allow for the batch accumulation and transfer during pipe removal.

The method developed to safely handle and stage Pu piping assumed that the cut pipe sections were half-full of Pu nitrate solution at a concentration equal to the Pu product concentration of 200 g/L. The selected approach used to stage pipe inside the cell specified that a narrow basket attached to the rail of the mast climber be used to hold piping as it was being prepared for removal. Sections of cut pipe were prepared in a slab configuration that allowed several sections of pipe to be staged so that criticality safety was maintained.

The final type of contaminated material that required special handling during PPC-S decontamination included larger equipment items such as process vessels and tanks. These items presented a unique challenge because a single large item could potentially contain an amount of fissile material in excess of site fissile material packaging limits. The method developed to maintain criticality safety during the removal, packaging, and staging of larger items relied on minimizing the interaction of these items with other sources of fissile material. Specific criticality safety analyses were performed to evaluate each individual container removed from the cell. With limited data available for use in determining fissile content, the assumption was made that each item removed was half full of product solution containing fissile material at the maximum product concentration. This was a conservative assumption because samples were to be taken and all lines drained before removing vessels from the cell. Taking this approach, analyses were performed that demonstrated the criticality safety of the packaged wastes when the containers holding equipment items were isolated from other fissile material sources. To ensure that other unevaluated materials were not brought into proximity with these staged materials, waste containers holding equipment items removed from the PPC-S were transported to criticality control zones. Once established, these zones provided a safe staging area for waste containers holding these equipment items until analytical results were available for use in refining the fissile content of larger equipment items.

DECONTAMINATION OPERATIONS

Decontamination of the PPC-S began after field work to prepare containment and waste staging areas was completed, including the installation of containment tents, equipment, and supply carts needed to conduct entries. Once these areas were established, work began to install the new doorway at the point selected for access and egress by using concrete chainsaws to cut through the first 60 centimeters (24-inches) of the cold side of the cell wall at this location. Concrete was removed from the area as cutting took place. After this portion of the concrete shield wall had been cut through and removed, holes were drilled in the remaining wall surface and injected with expanding grout to reduce the amount of hammering needed to breakthrough the remaining 30 centimeters (1-ft) of the wall. Sledge hammers and demolition hammers were then used to break through the remaining concrete. Once the rebar in the wall was exposed, the remaining concrete was knocked into the cell and the rebar removed by cutting it with portaband saws. A pre-hung metal Dutch door was installed in the new opening after it was fully cut and finished. A horizontal division at the upper section of this door made it possible to keep the upper section closed off until larger items were moved out of the PPC-S, helping to maintain ventilation and contamination control during the first stages of decontamination operations.

Initial Entry and Debris Removal

Conducting the initial entry into the PPC-S involved opening the newly installed door, applying strippable coatings, and gathering preliminary radiological data reflective of current in-cell conditions (e.g., dose rate measurements and air monitoring samples). Clearing floor debris proceeded after confirming that levels of in-cell airborne contamination at the 30 m (100-ft) elevation were within a manageable radiological safety condition. Activities conducted during the first stages of debris removal involved the progressive clearing of debris from the cell floor by removing, packaging, and staging it for transfer as specified in work instruction packages. Concurrently, samples were gathered to satisfy objectives identified in the Sampling and Analysis Plan for characterizing the cell.

Once packaged, the 208 liter (55-gallon) drums used as waste containers were moved to the load out area for staging and transfer to on-site Lag storage facilities. Strippable coatings were applied to in-cell surfaces both during and at the conclusion of cell entries to prevent loose contamination in the immediate work area from becoming airborne (e.g., dust, debris, or particulate matter). Use of the portable flex-duct connected to the ventilation duct for the cell and HEPA vacuums provided additional contamination control as debris was picked up off the floor, size-reduced as needed, placed into poly-bags, and moved out of the cell for packaging. At the conclusion of each entry made into the cell, surfaces inside the containment areas were decontaminated and surveyed to ensure that contamination levels remained within prescribed limits before the door was closed (i.e., < 2000 DPM alpha/100cm^2, < 10,000 beta/gamma/100cm^2). When the floor was cleared and requisite samples collected, a thick coating of fixative was applied to the floor and allowed to dry in preparation for clearing piping, equipment, and structures from the cell beginning at its lowest level.

Piping and Equipment Removal

Removal work was structured to clear the PPC-S of piping, equipment, and in-cell supports (i.e., ladders, beams, platforms, or other structural members) by level, beginning at the lowest elevation of the cell and progressing upward. Following the same operational sequence used to enter and exit the cell during debris removal, the process of clearing each level began by identifying lines of process and utility pipe to be removed at that level, selecting points where lines were to be sampled and drained before removal, and recording progress as each line was marked, sampled, and drained. As entries were conducted, engineering staff, in two-way communication with work crews, guided crew members as they confirmed and marked each point with individual identification tags. Small diameter video cameras were used to assist in pipeline

confirmation. This made it possible to obtain closer views of the lines being identified and tagged. Once line numbers were confirmed, lines were vented and sampled. Liquid samples collected using tell-tale assemblies were sent to the A&PC Laboratory to prepare an estimate of the fissile content of the liquid and identify the size of container to be used to hold liquids drained from the line.

Prior to initiating pipe removal, engineering staff reviewed plant drawings to confirm the configuration of piping and ensure accurate identification and tracking of in-cell piping during removal activities. The three-dimensional computer model of the PPC-S developed through drawing review was used to support this effort. Once each line of pipe was identified, it was marked with both a line number tag and color-coded tag corresponding to system type (i.e., Pu, U, or utility piping). Pipe removal was conducted by cutting tagged lines from interconnecting pipes, valves, or equipment, and size-reducing cut lines into smaller segments as needed for ease of removal and packaging. Size-reduction was accomplished by using localized ventilation and hand-held saws (primarily "portaband" saws). Each length of pipe removed from the cell was marked and packaged according to a color-coding scheme to ensure that Pu and U process and utility piping was bundled and packaged to meet criticality safety and waste segregation requirements. To ensure criticality safety during initial packaging operations, all Pu process piping removed from the cell was staged and later assayed using screening techniques developed to help determine the amount of fissile material present in the piping.

Process tanks, vessels and other equipment items were removed from the PPC-S after connective piping and structures obstructing the access to these items had been cleared away. Removal was accomplished by rigging the item to be removed, detaching it from its structural supports, placing a preliminary layer of plastic or herculite wrapping over the item, and moving the wrapped item into position so that it could be lowered down through the cell. After piping and equipment had been cleared up to 35 m (114-ft) elevation, the mast climber was brought into the cell, assembled, and used to support the removal of contaminated material from upper levels. Existing structural supports were used as hoisting/rigging points to the extent possible during the removal of large equipment items. When necessary, additional hoisting and rigging points were installed and used to lower the item into position on the mast climber or one of several custom-built transfer carts that were used to complete the removal of large items from the cell. After initially decontaminating the wrapped item and securing it onto a transfer cart, the cart was moved over to a set of rollers installed across the threshold of the cell door. Once positioned at the threshold of the PPC-S doorway, a jib crane installed in the containment area was used to lift the item off the cart and move it over to an open area where the wrapped item could be decontaminated again (if needed), covered with additional wrapping, and placed into a custom waste container fabricated for safe staging and handling. A layout diagram illustrating the cart and doorway as it was configured for equipment removal is shown in Fig. 3. Removal operations being conducted through the doorway are shown in Fig. 4 Once securely wrapped and closed, packaged items were moved out through the load out area for staging and transfer to interim storage locations. Removal operations were conducted progressively until the cell was clear of piping, equipment, and associated support structures and ready for final cleaning and radiological survey.

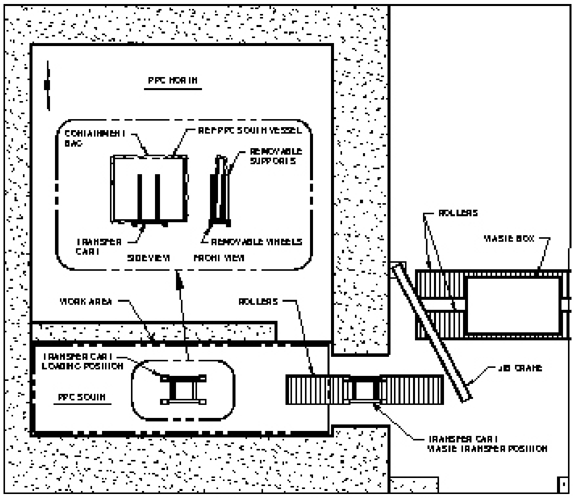

Fig. 3 Configuration of transfer cart and doorway during removal operations

Fig. 4 Removing contaminated process vessel through PPC-S doorway

SUMMARY

Decontamination of the PPC-S was undertaken to significantly reduce the level of radiological hazard and risk associated with contaminated materials remaining in the cell, including piping, valves, tanks, vessels, support structures and components contaminated through U and Pu product purification. The physical structure and radiological condition of the cell represented a considerable challenge to developing an effective technical approach for safely conducting this work.

The overall technical approach developed to conduct decontamination operations involved performing a series of preliminary evaluations to establish and verify current in-cell conditions; preparing to enter the cell; and removing contaminated material from the cell by level until it was clear and ready for final cleaning and radiological survey. Preparations made in advance of conducting initial and routine entries included conducting a detailed evaluation of alternative methods for entering and working within the narrow, silo-like dimensions of the cell; establishing a point of access and egress for conducting decontamination operations; developing radiological controls and protective measures to ensure worker safety; and developing techniques to ensure safe material handling, staging and transfer during decontamination. Particular attention was given to developing techniques for controlling the spread of contamination, conducting in-cell work while wearing a Bubblesuit (the multilayered suit-up selected to provide the level of protection needed to work inside the cell), accessing high elevations of the cell, and handling piping and equipment for which limited characterization data existed.

A key factor in the selection of equipment and techniques used was the ability to access all levels of the cell while reducing personnel fatigue caused by wearing the bubblesuit. This guided the evaluation and selection of the single-mast, single-platform mast climber used during decontamination operations. Selection of the mast climber, combined with extensive training provided to work crews to prepare them entering and working in the PPC-S, allowed for the progressive removal of contaminated piping and equipment after clearing the cell to the 35m (114-ft) elevation. It also made it possible to conduct more than 240 entries, remove more than 900 m (3000 linear feet) of contaminated process and utility piping, 28 equipment items (including eleven major process tanks and vessels), and support structures from the cell with no OSHA recordable injuries or illnesses during performance of removal work. Operational safety achieved during decontamination operations was matched by the degree of protection provided by the contamination control techniques and protective measures that were used. Out of an assigned As Low

As Reasonably Achievable (ALARA) budget of 8.77 rem for performing the work, a measured dose rate of 6.98 rem was achieved.

REFERENCES

1 WVDP Radiological Controls Manual, WVDP-010; WVNSCO Radiological Control and Protection Procedures: RC-ALAR-8, Contamination Control for Radiological Activities and Operations; RC-ALAR-10, Estimating Airborne Radioactivity Concentrations; RC-ALAR-301, Air Sampling and Monitoring.

2 U.S. Nuclear Regulatory Commission Regulatory Guide 5.23, In-Situ Assay of Plutonium Residual Holdup, Rev. 1, February 1984.

FOOTNOTE