DECOMMISSIONING OF B&W'S FUEL CONVERSION PLANT

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ABSTRACT

B&W is managing an ongoing $65 million Project involving the site characterization, decontamination, and deconstruction of its former nuclear fuel fabrication plant in Apollo, Pennsylvania. This 90,000 ft^2 facility was used from the late 1950's until the early 1980's for the conversion of uranium hexafluoride to various fuel forms, including uranium dioxide powder and pellets. Both high- and low-enriched uranium as well as thorium were processed in the facility. Upon discontinuing fuel manufacturing operations, the chemical processing equipment was decontaminated, removed, packaged, and shipped to a licensed low-level radioactive waste (LLRW) burial site. As a result of plant operations, uranium contamination existed within the building and in the soils on the plant site. A detailed site characterization program was completed to establish the extent of contamination and to plan the subsequent soil remediation and building deconstruction efforts.

As a result of several factors, B&W made the decision in 1990 to accelerate the final decommissioning of the Apollo site. These factors also became constraints on the completion of the project:

- Rapidly escalating waste disposal costs, with LLRW burial site surcharges scheduled to increase from $40 to $120 per cubic foot in January 1992.
- Increasing regulatory confusion on the criteria for the residual radioactivity contamination levels that can remain on an NRC-licensed site being remediated for unlicensed, unrestricted use.
- The probable loss of burial site alternatives in January 1993 due to the provisions of the Low-Level Radioactive Waste Policy Amendments Act of 1985.
- Delays in the siting and construction of the Appalachian Compact's burial site which is projected to have a capacity insufficient to handle the large volume of waste produced by a major decommissioning project.

This paper presents an overview of this decontamination and decommissioning project with emphasis on the key business issues which established constraints for the project.

BACKGROUND

The B&W Apollo site is located within a 22-acre industrial complex along the Kiskiminetas River in the Borough of Apollo, Pennsylvania, 25 miles northeast of Pittsburgh. Steel production activities were conducted on the site from the mid 1800's until about 1950. In the late 1950's the 90,000 ft^2 shipping/receiving building of the former steel operations was purchased by the Nuclear Materials and Equipment Corp. (NUMEC).

Major areas on the site are shown in Fig. 1 and include the main building, the parking lot, and the offsite area. These site designations will be used throughout this paper and are described in more detail below.

The main building is a two-story structure of block, brick, and steel construction which housed:

- Several processing lines for the chemical conversion of both low-enriched and high-enriched uranium hexafluoride into UO_2 powder, pellets, and other nuclear fuel forms used in commercial nuclear power plants and for U.S. Navy ship propulsion.
- Wet scrap recovery facilities to convert production scrap into product-quality uranyl nitrate, and a dry scrap recovery line to produce pure uranium hexafluoride.
- Analytical laboratories, health physics laboratories, building support systems, maintenance shops, and office areas.

At various times, thorium oxide was also produced in the facility.

Manufacturing operations were terminated in 1983. At that time, process equipment was cleaned, removed, packaged, and disposed of at a licensed LLRW burial site.

Because of its history as part of an integrated steel processing facility, the main building shares several common walls and foundations with the neighboring metal processing facility buildings, which further complicates decontamination and deconstruction activities.

The parking lot is an approximately 2.5-acre, L-shaped area on the south and east sides of the site. This area was used for contaminated equipment storage in the 1960's and included an NRC-licensed laundry building. This facility was used for washing protective apparel generated at the site and at several commercial nuclear power plants and government nuclear facilities and for the decontamination of control rod drive mechanisms for the U.S. Navy. These operations were terminated in 1984.

The offsite area, which is not owned by B&W, is located on the west and north sides of the site. Located on the offsite area is a metals processing complex where operations are conducted in a total of fourteen production buildings and an office building.

The Apollo industrial complex has four sewer rights-of-way which cross the site:

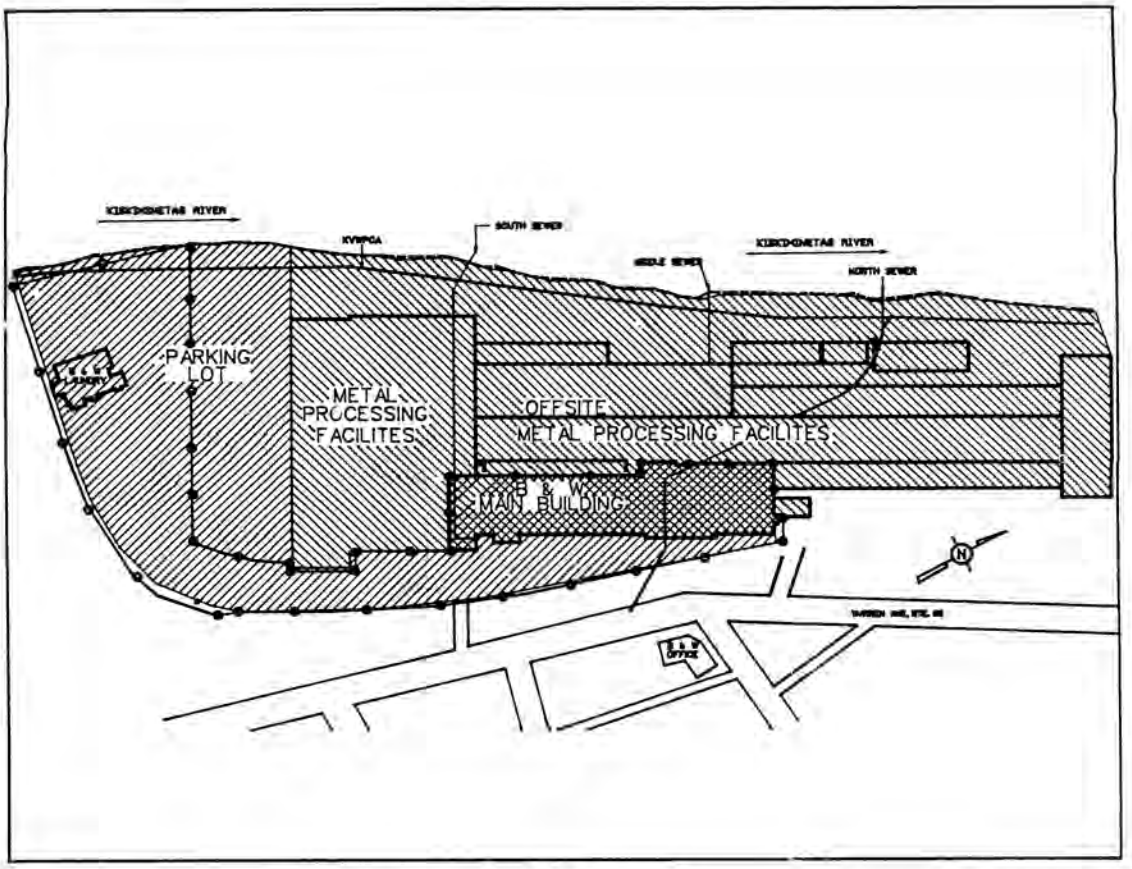

Fig. 1. Apollo Nuclear Fuel Plant: site arrangement.

- the Kiski Valley Water Pollution Control Authority (KVWPCA) sewer which connects local communities to a central sanitary waste treatment plant,
- the north sewer which carries the site's sanitary and storm water to the KVWPCA sewer,
- the middle sewer which is abandoned and whose service origins are presently unknown, and
- the south sewer which carried treated process wastes from the B&W fuel facility to the Kiskiminetas River.

Because of age and service conditions, the south sewer has deteriorated, permitting uranium contaminated effluents to leak into the surrounding soils.

SITE CHARACTERIZATION

Uranium contamination of the interior of the main building occurred primarily as the result of occasional process leaks and spills. In general, this liquid included uranyl nitrate solutions and ammonium diuranate slurries, both of which contained nitric and hydrofluoric acids. Contamination of the parking lot soils is presumed to have occurred during the 1960's when the area was used for contaminated equipment storage. The roof of the main building and the adjacent grounds were contaminated presumably as the result of building exhaust stack discharges within regulatory limits which occurred over a 25-year period. To quantify the extent of uranium contamination, an extensive site characterization program was conducted.

Site Soils

Approximately 7,000 soil samples have been taken around the site at depths ranging from shallow surface to over 40 feet. Samples were taken beneath the main building, in the parking lot, and in the offsite area. Figure 2 summarizes the aerial extent of uranium contamination at >30 pCi/g. An estimated 800,000 cubic feet of soil is contaminated above 30 pCiU/g at depths varying from shallow surface to more than 25 feet. Contamination has been found in the north, south, and middle sewers and in the surrounding soils. In addition, soils along the river bank contain contamination presumably originating from the sewer outfalls.

Main Building Walls

Approximately 700 samples have been taken of the main building block and brick walls. The majority of the wall contamination is <30 pCiU/g, with some selective areas containing up to 2,000 pCiU/g.

Main Building Concrete Floors

Over 300 samples of the main building concrete floors have been characterized. This effort was complicated by the heterogeneous nature of the contamination and the number of overlying pours that were made to form the floor (some floor areas are over 44 inches thick and were made in 3 or 4 successive pours, with each pour covering contaminated surfaces). Contamination levels in some areas exceeded 2,000 pCiU/g.

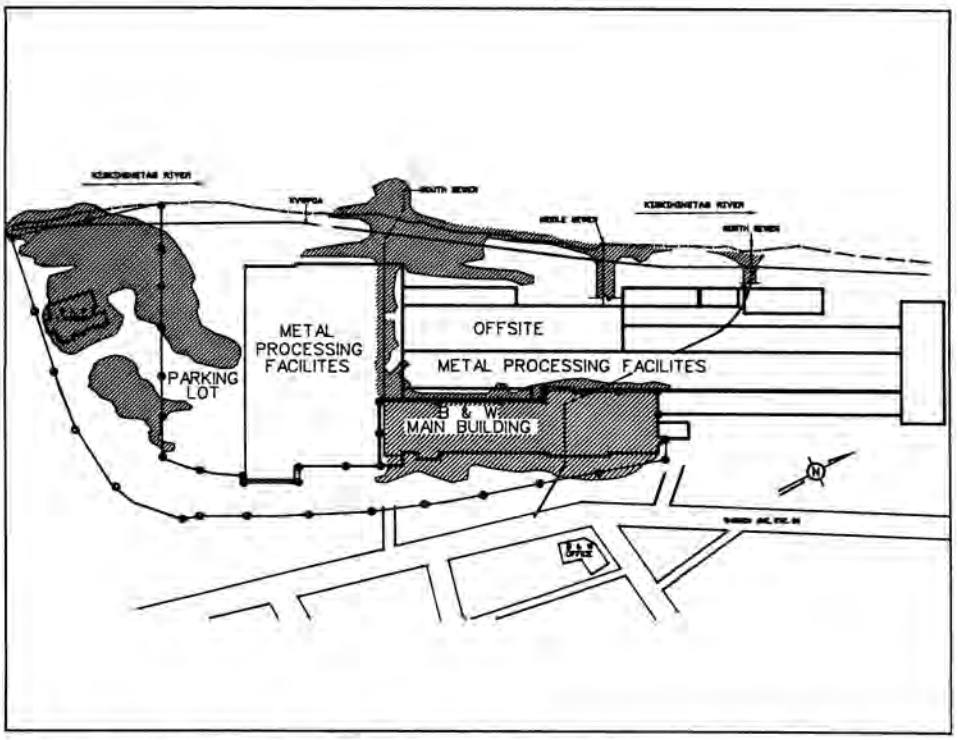

Fig. 2. Apollo Nuclear Fuel Plant: Uranium contamination greater than 30 PCI/G.

Main Building Roof

The main building roof is constructed from steel decking with multiple layers of asphalt composite. Over 100 samples have been taken and analyzed. Uranium contamination varies from 11 to 5,600 pCi/g.

Ground Water

A total of 22 monitoring wells have been sunk around the site to monitor ground water quality. None of the analyzed water samples exceeded NRC limits for unrestricted release to the environment.

Kiskiminetas River Water and Sediments

Kiskiminetas River water and sediments have been sampled for a number of years at thirteen permanent sampling points located upstream, adjacent, and downstream of the Apollo plant site. None of the water samples exceeded the NRC limits for unrestricted release to the environment. Uranium contamination on the river bank adjacent to the site range from 5 to 57 pCi/g.

DECOMMISSIONING OBJECTIVES

B&W's objectives for the Apollo uranium fuel plant D&D Project are:

- To perform decommissioning activities on the facilities and remediation of the site soils (offsite and parking lot) leading to the termination of B&W's NRC License No. SNM-145 and the release of the site for unrestricted use.
- To perform the decommissioning and remediation activities in a carefully controlled manner consistent with applicable federal, state, and local regulations for maintaining the health and safety of workers, other onsite personnel, and the general public.

KEY MANAGEMENT ISSUES

The quantity of radiologically contaminated wastes resulting from the remediation of the Apollo site (nearly 1 million cubic feet) created several issues that had to be carefully managed as a part of the successful execution of the D&D Project. Of primary importance was the Low-Level Radioactive Waste Policy Amendments Act of 1985. It contains three provisions that had a major impact on the cost and schedule for the Project:

- Burial at the three existing LLRW disposal sites is subject to a surcharge of $\$40/ft^3$.
- A penalty surcharge of $\$120/ft^3$ is effective January 1, 1992, for Apollo waste since Pennsylvania did not attain the stated milestones in the development of its burial site for the Appalachian Compact.
- After January 1993, the three existing LLRW disposal sites are not required to accept radwaste from outside their Compact area. None of these sites is within the Appalachian Compact.

The resolution of the following management issues led to the overall strategy and approach for the Apollo D&D Project.

Key Management Issue 1: Site Release Criteria

A critical question for managing any D&D project is "How clean is clean?" Government regulatory agencies (e.g., the U.S. NRC and the U.S. EPA) have not completed formal rule making to answer this question for the clean up of radiologically contaminated sites. Further, it appears that formal definition of such regulatory limits will take at least several more years. Establishing the residual contamination limit is critical because it defines the volume of soil to be remediated

and buried and, hence, is a major factor in establishing the Project cost and schedule.

The NRC has published a Branch Technical Position (SECY-81-576), which defines 30 pCiU/g as one of the criteria for release of a site to unrestricted use. This position was developed using a pathway analysis considering terrestrial pathways for exposure of the public (i.e., direct radiation exposure from uranium left in place, exposure from inhalation of dusts containing residual uranium, ingestion of residual uranium taken up from soils into food products, etc.)

B&W performed a more detailed pathway analysis, including consideration of groundwater pathways, based on the specific characteristics of the Apollo site. These results indicated that the regulatory dose rate limit for exposure of the public could be met with a residual contamination limit well above 30 pCiU/g. This would have reduced the volume of material for disposal by over 50% and resulted in a significant cost savings. However it became apparent that the time required to secure approval for a limit exceeding that in the Branch Technical Position would be lengthy and could expose the Project to unacceptable cost increases due to escalation of burial costs and surcharges. Therefore B&W chose to accept 30 pCiU/g as the residual contamination limit for the site.

Key Management Issue 2: Burial Schedule

There is a significant probability that none of the existing LLRW disposal sites would be available to accept the Apollo Project's waste after 1992 due to a provision in the Low-Level Radioactive Waste Policy Amendments Act of 1985, as noted above. The Pennsylvania LLRW burial site for the Appalachian Compact is not scheduled to open before 1996. This imposed December 1992 as an absolute deadline for burial of LLRW from the Apollo Project.

Another major burial schedule consideration was the $120/ft^3 penalty surcharge that would be effective at existing LLRW disposal sites in January 1992. This would result in an unacceptable Project cost. Therefore a sequence of work was established to ensure that all waste to be buried at an LLRW disposal site was removed and shipped from Apollo by December 1991. This sequence did not result in the most efficient utilization of labor and resulted in higher logistics costs, but it was the more cost effective choice on an overall Project basis.

Key Management Issue 3: Low-Cost Burial

The total quantity of soil, crushed concrete, cement block and brick resulting from the Project will approach 1 million cubic feet. Only about 10 percent of this amount has uranium contamination exceeding 2000 pCi/g, a value B&W selected as a reasonable lower limit for material to be buried at an LLRW site. For the remaining 90 percent of the Project's waste, it is B&W's view that burial at an existing licensed LLRW facility is neither financially feasible nor technically justified. Therefore it was necessary to develop a low-cost alternative for the burial of high-volume, very-low-activity wastes. After considering several options, B&W selected the Envirocare site in Clive, Utah for disposal of the material contaminated at less than 2000 pCiU/g. This site is licensed by Utah, an NRC Agreement state, and is currently scheduled to be able to accept the Project's very-low-level uranium waste in the second quarter of 1992. Both the Northwest and Appalachian compacts have agreed to the use of Envirocare as a disposal site for the Project's radwaste contaminated to less than 2000 pCiU/g.

DECOMMISSIONING APPROACH

Decommissioning activities were initiated in 1978 when high-enriched uranium operations were terminated. These activities were continued and expanded during the 1980s as other operations terminated (i.e., low-enriched uranium oxide powder production in 1982 and laundry operations in 1984). During this period, the decommissioning operations primarily involved the removal and disposal of process and production equipment. Only minor decommissioning and removal of building services occurred.

In early 1990, B&W made the decision to accelerate substantially the final decommissioning of the Apollo site to avoid the major cost and schedule issues associated with the Low-Level Radioactive Waste Policy Amendments Act of 1985. Work was immediately initiated on activities that could be accomplished while site characterization activities were completed and the above noted three key management issues were being resolved. By early 1991 it was clear that the fundamental constraints on the project were:

- The residual contamination must be below 30 pCiU/g.
- Radwaste above 2000 pCiU/g must be burial at an existing LLRW disposal site by December 1991.
- Waste between 30 and 2000 pCiU/g would be buried at the Envirocare site in 1992.

Current estimates indicate that in the three years of accelerated work, the Apollo D&D Project will have processed 725 tons of steel, 122,000 ft^3 of rubble, and 787,000 ft^3 of contaminated soil. All structures on the B&W site will have been deconstructed and soil contamination above 30 pCiU/g will have been removed.

KEY ENGINEERING ISSUES

Deconstruction of a nuclear fuel manufacturing plant that had been licensed to handle metric tonnes of low- and high-enriched uranium presented a number of first-of-a-kind engineering issues that are not encountered in typical remediation activities. The following is a brief synopsis of three of these issues.

Key Engineering Issue 1: Airborne Contamination Control

Deconstruction of the internal walls and floors of a building involve the use of heavy construction equipment as well as the use of manual methods (i.e., jackhammers, backhoes, etc.). To provide protection to the public and work force from airborne contamination during such work, an engineered system was developed. Principal elements of this system include:

- The installation of two new 22,000 CFM nuclear air cleaning systems that exhaust air from the main building through roughing filters, prefilters, and HEPA filters. These nuclear air cleaning systems are operated either singly or in parallel and create a negative pressure within the main building with respect to the outside. Air turnover rates within the building are between one and two per hour.
- Erection of a plastic enclosure (Herculite 60 fire retardant membrane) around the area being

deconstructed. Typical enclosures are 20' x 40' x 20' (16,000 ft^3).

- The installation of 6,500 CFM capacity nuclear air cleaning units in the walls of the temporary enclosure to produce a negative pressure in the enclosure with respect the main building. Air turnover rates within the enclosure are greater than six per hour. This concept results in contamination being captured at its source. Plant air emissions during deconstruction operations have typically been 1-2 percent of the allowable discharge limits.

Key Engineering Issue 2: Nuclear Criticality Safety

The high-enriched uranium processing area of the plant was located on a 6,000 ft^2 elevated mezzanine. The floor was a four-inch concrete slab which had become contaminated with kilogram quantities of U-235 from occasional spills and leaks. As a result, nuclear criticality control measures were required during the deconstruction. Deconstruction steps involved:

- Manually breaking up the concrete floor with jackhammers while maintaining a safe slab thickness.
- Loading the concrete rubble into five-gallon pails, which is a critically safe volume for this material.
- Surge storage of these loaded pails in a critically safe array.
- Non-destructive assay of the contents of the pails so final packaging could be conducted under mass control criteria.

A total of 2,000 ft^3 of concrete was broken up and removed from the site using this technique. Approximately 6 Kg of uranium-235 was measured to be in this material.

Key Issue 3: Main Building Deconstruction

Removal of the main building will involve the deconstruction of a contaminated structure. This will be performed in 70-foot sections while maintaining containment with a mobile temporary enclosure over the building. This enclosure consists of a pre-engineered rigid steel frame building utilizing tapered columns and rafters for optimum clear span capability and the elimination of end cross bracing. The structure will be attached to 50- or 100-ton rail trucks. The rail trucks will be placed on railroad tracks installed on the sides of the building. The pre-engineered frame building will be lined with Herculite 60 flame retardant membrane and sealed.

Each 70-foot building section will be isolated on the inside by a curtain wall and exhausted with two 6,500 CFM nuclear air cleaning machines to create a negative pressure within the enclosure. A hydraulic shear mounted on a 90,000 lb. class excavator will be used to deconstruct the remaining walls and floors, producing rubble of a size of less than 12-inches. The structural steel will also be sheared into manageable sizes. The rubble will be further processed to produce a granular product that can be sampled, conveyed, and packaged in a reliable, efficient manner. A standard screening/crushing plant is being designed and procured for this purpose.

CONCLUSION

By successfully addressing the key constraints placed on the project and adapting conventional construction techniques to this non-traditional situation, the project has met all schedule and financial milestones to date and should continue to do so. Most importantly, the health and safety of the project personnel has been maintained (no lost work days and no measurable radiation exposure to date) and the residents of the community have been protected (no measurable off-site contamination has occurred).