UNITED STATES DEPARTMENT OF ENERGY
COLUMBUS ENVIRONMENTAL MANAGEMENT PROJECT

COST AND PERFORMANCE REPORT
Diamond Wire Saw for Demolition and Size Reduction of Reactor Bioshield

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National Energy Technology Laboratory

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List of Acronyms

ASTD................................ Accelerated Site Technology Deployment
BCLDP ....Battelle Columbus Laboratories Decommissioning Project
CEMP .... Columbus Environmental Management Project
D&D .... Decontamination and Decommissioning
DDFA .... Deactivation and Decommissioning Focus Area
DOE .... U.S. Department of Energy
EBWR................................Experimental Boiling Water Reactor
LLW .... Low-level Waste
NRC .... U.S. Nuclear Regulatory Commission
PBS .... Project Breakdown Summary
PPE................................... Personal Protective Equipment
STCG .... Site Technology Coordinating
TRU .... Transuranic (Materials above 100nCi/gm)
WJN .... West Jefferson North

1.0 Summary

A previously operating reactor facility, JN-3, had a radioactively contaminated bioshield which contained over 95 % of the radioactive inventory in the building. The steel reinforcement bars and components of the concrete, such as Barium, became irradiated to low levels when the reactor was operational. A means was required to remove the bioshield with the building still standing, and which would minimize the spread of contamination.

Construction of the reactor facility in Building JN-3 began in 1955 and the reactor became operational in 1956. Building JN-3 is 131 feet long and 66 feet wide. It is constructed of cement block faced with brick and aluminum siding. The building is serviced by a 10-ton crane and a drive-through truck port. A 2 ½ story bioshield was situated in a large, open high bay enclosure where it surrounded the swimming pool type reactor. The 2-megawatt Battelle Research Reactor was designed to provide an intense source of neutrons and gamma rays for irradiation of various materials during experimentation. The core of the MTR-type aluminum fuel assemblies was suspended in demineralized water, 25 feet below a mobile bridge crane. The reactor operations ended in 1974. After the reactor fuel was shipped for reprocessing and the reactor pool was drained, an initial reactor decontamination and dismantling operation took place over a 9-month period beginning January, 1975. This included removal of the primary coolant pumps, associated piping, and the reactor pool liner. The bioshield was sealed with paint to eliminate smearable contamination.

In the current D&D effort, diamond wire saw technology was used to cut the bioshield into removable pieces without cross-contaminating the rest of the building. Diamond wire saw technology was used to cut 83 concrete blocks with a total weight of 700 tons. The size of the blocks which could be cut was limited to under 10 tons each because of the 10-ton capacity of the building's overhead crane. The diamond wire sawing technology minimized the disturbance of the contamination. New methodologies to minimize the water used and maximize the containment of the contamination were developed as part of the deployment. Figures 1 and 2 show the bioshield before and after removal using the diamond wire saw.

No specific baseline technology was previously approved for the bioshield removal activity. Traditional methods for mechanically breaking reinforced concrete were considered including jack hammering and use of controlled explosives. Both of these methods would have generated significant dust, potentially contaminating all interior surfaces of the building. Also, removal of small rubble pieces and reinforcement bar would have been extremely time consuming based on previous experience. The diamond wire saw technology has now been incorporated into the BCLDP baseline for hot cell removal activities.

EM-50 ASTD funds of $386K were provided through the deactivation and decommissioning focus area and were matched by an in-kind project outlay (EM-31 funded). The ASTD funds leveraged the use of the diamond wire saw and enabled BCLDP to remove the JN-3 bioshield a year earlier than scheduled, at a $221K overall cost savings. The deployment also resulted in a demonstration of radiological and secondary waste controls required with this technology. During deployment, BCLDP developed improved water control, a water recycle system and on-site wire rebuild capabilities.

Figure 1 Before: Bioshield in 1956 when reactor was operational.
Figure 2 After: Former bioshield area in 2001.

Figure 1

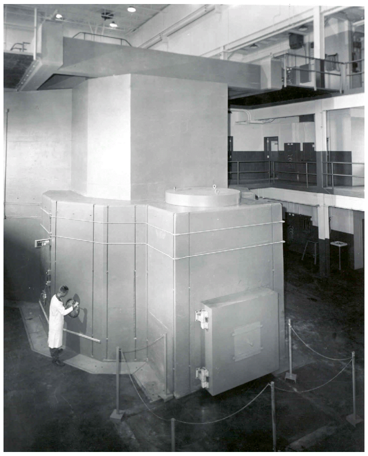

Figure 2

.2.0 Site Information

The Battelle Columbus Laboratories Decommissioning Project (BCLDP) is removing radioactive contamination from Battelle-owned facilities and grounds known as the West Jefferson North (WJN) site located near West Jefferson, Ohio. The site is about 15 miles west of the city of Columbus, Ohio and approximately 1.5 miles south of I-70. Figures 3 and 4 show the overall site location and JN-3's relationship to the West Jefferson site. Three buildings at the WJN site are to be decontaminated and/or demolished: JN-1, which contains nuclear hot cells; JN-2, which contains radio chemistry laboratories; and JN-3, a partially decontaminated nuclear research reactor facility which contained the bioshield demolished using diamond wire saw technology. It is anticipated that the shell of JN-1 will be disposed of as LLW, while JN-2 and JN-3 are expected to be free released prior to demolition. The radioactive contaminants at the WJN site are primarily Transuranic (TRU) materials, mixed fission products, and activation materials.

Figure 3 *West Jefferson Location Map*
Figure 4 *Building JN-3 in relationship to other site buildings*

Figure 3

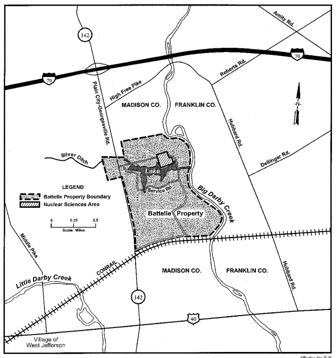

Figure 4

Construction of the JN-3 reactor facility began in 1955 and the reactor became operational in 1956. The building was constructed to be shockproof, fireproof, and relatively gas tight. JN-3 is 131 feet long, 66 feet wide and about 44 feet above ground. The building is constructed of cement block faced with brick up to 24 feet above ground and aluminum siding the rest of the way. The building is serviced by a 10-ton crane and a drive-through truck port. A 2 ½ story bioshield situated in a large, open high bay enclosure surrounded the reactor. Partial floors at the second- and third-floor levels are supported by the reactor's material pool and building walls. The first, or experimental floor level is 12 ft below ground level.

The two-megawatt Battelle Research Reactor was designed to provide an intense source of neutrons and gamma rays for irradiation of various materials during experimentation. The core of the MTR-type aluminum fuel assemblies was suspended in demineralized water, 25 feet below a mobile bridge crane. In the "stall" position, specimens could be irradiated by placing them in the water adjacent to the core, by utilizing the vertical in-core test cells, or by using the horizontal beam tubes. Additional facilities included a vertical and horizontal thermal column and a pneumatic tube for short-time irradiations. When needed, the bridge and core could be moved to the adjacent "pool". In this position, bulk shielding or other large experiments could be conducted. After the reactor fuel was shipped for reprocessing and the reactor pool was drained, an initial decontamination and reactor dismantling operation took place over a 9-month period beginning January, 1975.

At Battelle's King Avenue site, demolition of large reinforced concrete machine pedestals set in pits below building grade was accomplished with a large jackhammer head mounted on a backhoe unit. A very large tent structure was required to control airborne dust and radioactive contamination. Progress with the jackhammer was slow because of the extensive reinforcing bar which inhibited development of large fractures, and hindered removal of rubble. Two-shift work was required; one shift fractured the concrete and the second shift removed the rubble. Noise, vibration, dust, and tripping hazards required special attention. The quantity of waste generated was extensive. The bioshield for the JN-3 reactor was significantly larger than any of the concrete structures demolished previously. Over 700 tons of material existed within the bioshield structure. The bioshield and associated structures had massive reinforcement, and the bioshield/reactor pool liner also had 2" to 3" thick steel in connection with a bridge crane. The bioshield structure height was 2½ stories from the building basement level and the partial building floors had insufficient strength to support heavy demolition equipment.

The original project baseline (Revision 2) approach did not recognize the irradiation levels associated with the reinforcing bar within the bioshield. It also considered the bioshield to be an integral part of the building structure such that removal was not an option. Thus, the earlier concept was to leave the bioshield in place and perform surface decontamination and release of the rest of the structure. When exploratory core borings of the bioshield were taken, the irradiation levels in the bioshield were revealed. Given the project end state goals and recent knowledge of internal activation products in the concrete, leaving the bioshield in place became unacceptable. The BCLDP project deployed diamond wire sawing technology to demolish and remove a radioactively contaminated bioshield and associated structures. The new approach took the latest structural and radiological data into account and allowed the irradiated bioshield to be disposed of as LLW in the largest manageable pieces.

In Building JN-3, Battelle used a backhoe mounted jackhammer to break up/rubblize a radioactively clean pool wall and pedestal into manageable pieces prior to the bioshield removal. It was found that creating rubble and separating the concrete from the re-bar was much more time consuming and expensive; and significantly increased the quantity of waste and worker exposure risk in comparison to the diamond wire saw method. Figure 5 shows jackhammer demolition of the pool wall: It was necessary to cut all of the steel reinforcement bars after the concrete was broken. Mechanically rubblizing the one pool wall took almost a month for demolition, clean-up and packaging. The entire bioshield, which is seven times the volume of the pool wall, took slightly over five months to remove and package with the diamond wire saw. Rubblizing the pool wall generated 2½ times the waste volume as the same weight of bioshield being diamond wire cut. Moreover, rubblizing required eight times the water (for dust control) than the recycling water process used with the diamond wire saw.

Diamond wire sawing not only reduced the cost of the bioshield and associated structures removal but also enhanced the radiological control during the removal and subsequent waste disposal. The use of the diamond wire saw in the bioshield application reduced the known radioactive inventory of Building JN-3 by over 95%. Because this approach worked well for the JN-3 bioshield removal, Battelle plans to deploy this technology to accelerate hot cell removal in Building JN-1.

Figure 5 Jackhammer demolition of pool wall.

Figure 5

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3.0 Matrix and Contaminant Description

The base of the bioshield and the reactor structure consisted of high-density concrete approximately eight feet thick with an extensive internal latticework of carbon steel reinforcement bars which became activated during reactor operations. The bioshield concrete weighed approximately 208 pounds per cubic foot. The upper parts of the structure consisted of six to eight-foot thick reinforced boron impregnated concrete which weighed approximately 180 pounds per cubic foot. The concrete was found to be contaminated with Cesium-137 and other fission products in addition to the irradiated re-bar. The thermal column and beam tube areas were extensively contaminated with Carbon-14 and Barium-66, mainly due to the experiments and the graphite used in moderating the neutron flux. Isotopes of Europium, Strontium, and Yttrium were also present. Loose and fixed contamination on the bioshield wall was minimal which allowed the work to proceed without extensive Personal Protective Equipment (PPE) other than standard industrial requirements (hard hats, safety glasses, safety shoes, hearing protection, gloves, etc.) Demolition of the bioshield took place within the JN-3 facility, in close proximity to other D&D activities.

Like many DOE remediation projects, this project needed a technology which could be used to rapidly demolish large concrete structures (e.g., shield walls, heavy equipment pedestals) where work space was physically constrained. As part of an on-going baseline revision within BCLDP, the benefits of removing activated and contaminated structures while still contained in the building became apparent. After removing elemental lead from the bioshield structure in order to ship the waste to an approved waste site, operational requirements were optimized to minimize the volume of the waste and associated handling by maintaining the high density blocks as large as possible. Overall demolition costs can be greatly reduced if the building can be demolished with minimal radiological controls once these structures have been removed. The diamond wire saw technique, which could be adapted to close working spaces, generated little or no airborne contamination, and could effectively cut heavily-reinforced concrete met these needs. Control of airborne contamination would normally have been difficult due to the large size of the bioshield structure itself, but the diamond wire operation used water as a coolant which also helped control and contain the contamination.

4.0 Remediation System Description

Diamond wire saw cutting has been used for years in the quarrying and ornamental stone industries. More recently the technique has seen increasing application in the demolition industry, especially where only portions of a structure are being removed. Diamond wire demolition (non-radiological) was first used in the DOE complex in 1983 during modifications of the T-Building at the Mound Plant in Miamisburg, Ohio. Several commercial nuclear decontamination efforts have begun to explore diamond wire sawing, including the Fort St. Vrain and Shoreham Nuclear Plant decommissioning efforts. The diamond wire saw approach was demonstrated at Argonne National Laboratory (ANL) as one technique for D&D of the Experimental Boiling Water Reactor (EBWR) facility. Although experience in using diamond wire saws in radiological settings has increased in recent years, the technique is still not widespread within the DOE system.

The more common approach within the DOE; however, is to demolish large concrete monoliths using any of various mechanical (jackhammer, wrecking ball, pulverizer), explosive, or exotic (laser lance) techniques. Extensive reinforcement of the concrete, radiation levels, and space limitations complicate the choice of any technique.

In this case, diamond wire saw technology was successfully deployed to size-reduce the activated bioshield and associated structures of the JN-3 decommissioned research reactor. Diamond wire saws are very effective for cutting large, highly reinforced radioactive concrete structures, such as shielding and containment structures, especially where layers of differential hardness are present (e.g., steel lining of concrete surfaces). Target structures for the diamond wire saw include large radioactive steel structures as well as internally activated, highly reinforced concrete monoliths. Because only the diamond wire is in direct contact with the radioactive material, and because it can cut dissimilar materials "remotely" with one operation, this technology provides more efficient material disposal, more effective contamination control, and better personnel exposure control than more conventional methods.

The diamond wire incorporates beads of diamond impregnated material spaced (approximately 40 beads per meter) along a continuous loop of wire cable. The wire is usually passed through small diameter starter holes which have been drilled through the structure to be cut. By controlling the orientation of the holes and the wire loop, the operator can very carefully control the size of the pieces being cut. Wire tension is maintained automatically by spring mounted pulleys on the motor unit and by placing the heavy movable drive wheel vertically to constantly pull the wire taunt. Very little of the radioactive material in the bioshield and associated structures was disturbed since the cut from the diamond wire saw was typically less than an inch wide. These conditions lead to minimum secondary waste generation during the removal process. Aside from the initial setup, wire saw cutting is controlled from a distance, reducing worker exposure. Since less hands-on work and Personal Protective Equipment (PPE) are required with this approach, these secondary wastes generated by this technique are also significantly reduced compared to traditional demolition methods. The diamond wire rapidly cuts through dissimilar materials such as concrete, re-bar and steel plate, generating minimal fugitive dust from the material cut. This eliminated the need for separation of the concrete from the re-bar, the liners from the shielding, and the crane rails from the bioshield. The water coolant used with the diamond wire aids in control of any loose contamination. The water was collected in a sump, filtered and reused.

Battelle found that, with the proper control and speed of the saw, the operations could be optimized. Unless unanticipated wire breakage occurs, the wire can be changed out and rebuilt based on wear. Unexpected breakage occurs when tension changes due to snags, voids, or drastic material density changes. Breakage decreased drastically as the wire speed slowed down and the wire was allowed to run continuously. For the bioshield, a cutting speed of approximately 25 square feet of cut per hour and a water flow of five gallons per minute produced an optimal operating condition for JN-3's radiological condition. "Square feet of cut" is calculated by multiplying the linear feet of wire in contact with the structure times the depth of cut. These parameters will change with differing radiological conditions. Figure 6 illustrates the key components of the diamond wire saw. Figures 7 and 8 show the diamond wire saw mounted inside the bioshield and on top of the bioshield. Figure 9 shows the motor assembly and Figure 10 shows the diamond wire.

Figure 6 Schematic of diamond wire saw.
Figure 7 Diamond wire saw mounted inside bioshield.

Figure 6

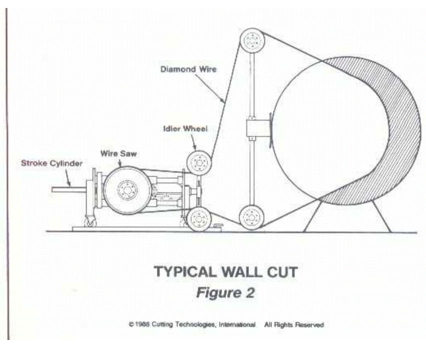

Figure 7

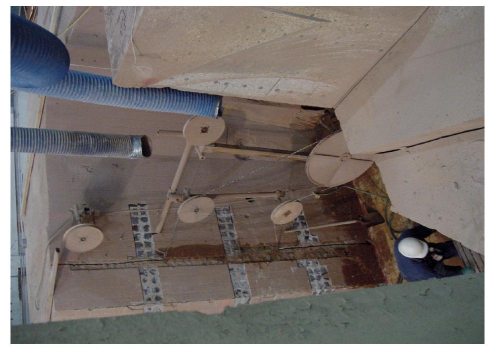

Figure 8 Diamond wire saw mounted on top of bioshield.
Figure 9 Motor assembly to drive diamond wire saw.
Figure 10 Diamond impregnated beads mounted on wire cable.

Figure 8

Figure 9

Figure 10

With remediation efforts accelerating within the DOE complex, the diamond wire saw technology will become an important tool for the future. The BCLDP's use of the diamond wire saw in its removal of the JN-3 bioshield provided costing standards and performance data for subsequent removals in the DOE complex. BCLDP's baseline reflects using the diamond wire saw technology again. Other sites with use for this technology include the West Valley Demonstration Project, Mound, Rocky Flats, the Savannah River Site and the Hanford Site. Rocky Flats has identified this technique as one of the preferred technologies in their ASTD proposal for "in-situ size reduction".

5.0 Remediation System Performance

The following is a summary of performance-related information demonstrating the effectiveness of the diamond wire saw system. This analysis was performed after completion of the JN-3 bioshield removal using the diamond wire saw. The major cost advantages of the diamond wire saw system are in the radiological control requirements and in the overall waste volume minimization. The table below provides a comparison of mechanical/rubble techniques with diamond wire saw technology. The left "MECHANICAL/RUBBLE" column is based on actual data for removal of the pool wall in JN-3 which was not radiologically contaminated ("actual non-rad"). The right "MECHANICAL/RUBBLE" column is based on projections for removal of the bioshield in JN-3 which was radiologically contaminated ("projected rad"). The "DIAMOND WIRE SAW" column is based on the actual removal of the radiologically contaminated bioshield in JN-3 ("actual rad").

COMPARISON OF TECHNOLOGIES:
MECHANICAL/RUBBLE VS. DIAMOND WIRE SAW

CATEGORY	MECHANICAL/ RUBBLE 1,000 cf (actual non-rad)	MECHANICAL/ RUBBLE 6,730 cf (projected rad)	DIAMOND WIRE SAW 6,730 cf (actual rad)
VOLUME OF CONCRETE (cf)	1,000	6,730	6,730
WEIGHT OF CONCRETE (lb)	170,000	1,400,000	1,400,000
CONCRETE DENSITY	170	208	208
CONCRETE CONTAINERS	25	206	83
SECONDARY WASTE CONTAINERS FOR PPE	0	40 (PROJECTED)	5
WEIGHT/ CONTAINER (lb)	6,800	6,800	16,868
WATER USE (gal)	1,400	29,400	3,050
PROJECTED SCHEDULE (wk)	4	38 (6.3x vol.)(1.5x rad)	24
SOLIDS WASTE COST	$42,500	$418,200	$223,860
WATER WASTE COST	$23,800	$499,800	$51,850

DEMOLITION SUPPORT LABOR COST ($18,000/wk)	$72,000	$684,000	$428,000
DEMOLITION CONTRACT LABOR COST	$83,000	$523,000	$328,900
TOTAL COSTS	$221,300	$2,125,000	$1,032,610

Figures 11, 12, 13 and 14 show dust controls and the bioshield demolition progress. Figures 15, 16, and 17 show the resulting concrete blocks being processed. Figures 18 and 19 show the water recycling process schematic and the equipment used for the process.

Figure 11 Cutting through top of bioshield.
Figure 12 HEPA filters suspended in cutting area to control potential dust.

Figure 11

Figure 12

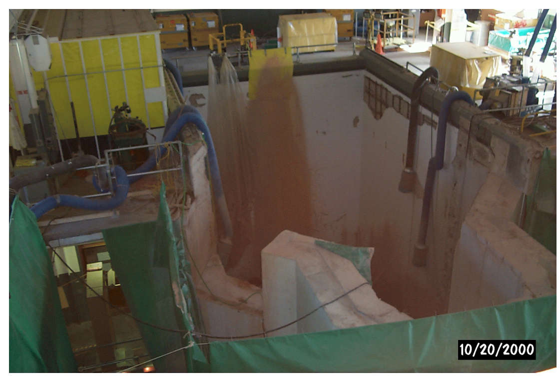

Figure 13 Bioshield with 20% remaining.
Figure 14 HEPA filters and plastic tent used to control potential dust.

Figure 13

Figure 14

Figure 15 10-ton hoist used to remove resulting concrete blocks.
Figure 16 Each concrete block was radiologically surveyed and wrapped in plastic.

Figure 15

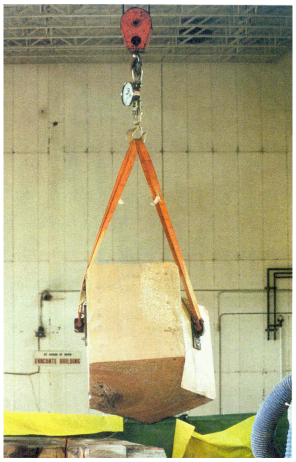

Figure 16

Figure 17 The concrete blocks were staged until shipment for disposal.
Figure 18 Schematic of water recycle for diamond wire saw.

Figure 17

Figure 18

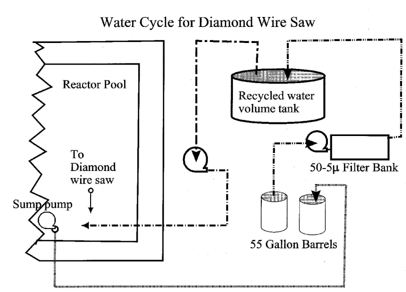

Figure 19 Equipment used to recycle water and process sludge.

Figure 19

6.0 Remediation System Cost

Actual operation of the diamond wire saw was accomplished under a competitively procured subcontract. The selected subcontractor, Cutting Edge Services Corporation, demonstrated experience in demolition of large reinforced concrete structures and experience working in a radiological environment.

The cost to design, procure, contract and demolish the JN-3 bioshield structures with the diamond wire saw was estimated to be $780K, in FY 2000 dollars. This included the generation of a design-build contract to diamond wire cut the material and remove the material, the radiological control and in-house support during material cutting, and the transport, handling and packaging of the blocks. Waste disposal costs were not included. The DOE is paying 90 % of the D&D cost of the Battelle owned facilities and Battelle is paying 10 %.

The time and labor savings of the diamond wire technology led to significant cost savings for the CEMP over past practice (see Section 5.0). Because the approved BCLDP project baseline approach of decontaminating only external surfaces would not have accomplished the required D&D of the bioshield, past practice was used in place of the baseline approach. At the time the project baseline (Revision 2) was prepared, it was not known that the bioshield in JN-3 was internally irradiated and, therefore, the demolition of the bioshield was not specifically included in the project baseline. In the past, a large jackhammer mounted on a backhoe was used for demolition of a large reinforced concrete block in Battelle's Building KA-2. Traditional mechanical demolition approaches such as a heavy jackhammer, may not have been possible in the constrained setting of the JN-3 bioshield; therefore, the cost savings shown by this analysis are the absolute minimum savings. The estimated cost for the Building JN-3 bioshield remediation in the Accelerated Site Technology Deployment (ASTD) proposal was reduced from an estimated $1,051K based on past practice (e.g. heavy jackhammer) to $780K due to the diamond wire saw technology. Thus, the resulting one-time cost savings was initially estimated to be $271K, in FY 2000 dollars. As discussed below, the actual cost was $50K greater than estimated, reducing the cost savings to $221K. In addition, as shown in the table in Section 5.0, the savings could have been as much as $450K ($684,000+523,000-428,000-328,900) for demolition costs or $1092K ($2,125,000-1032,610) for total costs.

The experience gained demolishing the bioshield in Building JN-3 will facilitate application of this technology within the CEMP and at other DOE sites. This deployment helped establish actual "implementation costs" for this technology in radiological applications within the CEMP and can be applied to other DOE sites. The massive concrete in Battelle's West Jefferson Building JN-1 is planned to be removed using the diamond wire saw to reduce the cost and accelerate the schedule with no additional funding from OST.

The comparison of the estimated cost provided in the ASTD proposal to the actual cost is as follows:

Activity	**ASTD Estimated $K**	**Actual $K**	**Variance $K**
Design & Procedures	117	74	(43)
BCLDP Oversite & Support	342	428	86
Diamond Wire Saw Contractor	321	328	7
Total	**780**	**830**	**50**

This does not include shipping and burial costs (see costing in Section 5.0). The variances are primarily a result of the need to make more cuts with the diamond wire saw than expected and the need to process more water and sludge than expected as discussed in Section 9.0 Observations and Lessons Learned.

7.0 Regulatory/Institutional Issues

The CEMP is being performed under regulatory authority of the U.S. NRC. The approved Decommissioning Plan for the D&D effort is non-specific as far as remediation technologies are concerned. Use of a diamond wire saw in the decommissioning of commercial nuclear power plants shows that the technique is acceptable to the primary regulator.

The Environmental Assessment for the project, issued in 1990, evaluated a number of demolition techniques. The radiological releases and secondary waste generation from diamond wire sawing are less than the reference demolition techniques, and thus will not create unassessed ES&H impacts.

In comparison to conventional demolition techniques, the diamond wire saw generates less noise, less dust, and less vibration affecting adjacent research activities. It also improves the CEMP's D&D schedule significantly: This is an important benefit for all stakeholders.

8.0 Schedule

Battelle's baseline generated in the May 2000 time frame incorporated the diamond wire technology into the FY 01 work plan. Battelle's present path to closure requires the removal of the JN-3 bioshield and associated structures in order to proceed with the interior decontamination of the remainder of Building JN-3. The leveraged ASTD funding allowed the statement of work, contract generation, award of bid, field deployment of the diamond wire saw and removal of the bioshield to be completed as required, saving six months to a year of the activity's schedule. The deployment date of the diamond wire saw was September 30, 2000 and the completion date was March 7, 2001.

9.0 Observations and Lessons Learned

Initially, the density of the bioshield concrete was determined by the construction drawings and by physically weighing the core borings removed for radiological characterization purposes. The size of the resulting concrete blocks needed to be safely handled using the existing 10-ton building hoist. After the first block was cut, lifted, and weighed, however, it was learned that the concrete in the upper regions of the bioshield was more dense than the construction drawings indicated. This resulted in the necessity to make an extra row of cuts at a higher cost.

Water control and containment in the diamond wire sawing process are key to radiological success, both from a personnel exposure standpoint as well as the control of airborne and surface contamination. Secondary waste was also minimized by confining saw cutting operation and utilizing its “remote” capabilities. The bioshield was cut from the least to the most radiological condition so that continuous improvements could be made in these areas. Water control was achieved in a variety of ways. The sump area was located in a confined area of the reactor pool. The minimum amount of water needed for cooling was established for wire cutting purposes and for dust control. The water spray was contained within enclosures while the diamond wire saw workers were placed back from the spray. Slowing the saw speed down also controlled the required amount of water spray. This slowed the cutting process but significantly improved the radiological control. A “most efficient” speed was established. By plugging the starter holes and initial cuts with caulk shortly after the start of a block cut, the water (and water spray) could be directed into the confined sump area. Achieving radiological control through containment included the use of enclosures, HEPA filtration of enclosures and the area, establishment of radiological areas and step-off pads, and continuous radiological monitoring, both from an airborne and surface contamination standpoint.

While these control measures provided demonstrated radiological control, they also concentrated the dust and cutting fines into considerably more sludge than originally expected. Three full-time support personnel were required to separate the sludge from the water, to package the sludge for disposal, and to recycle the water.

Figure 18 provides a schematic diagram of the water recycling system which was developed to support the diamond wire sawing process in Building JN-3. The cutting water supply was provided from the Recycled Water Volume Tank. This large tank is shown on the right in Figure 19. The water was pumped to the supply lines which discharged the water at the locations where the diamond wire saws were cutting. Up to four supply lines were used simultaneously to provide water for up to four saws. After the water was used, it was collected in a sump which was part of the original reactor configuration. At this point in the process, the water contained fine particles of material resulting from the cutting operation. The particle-containing water was then pumped into empty 55-gallon drums where several hours were required for the particles to settle to the bottom of the drums and the water to become clear. As seen in Figure 19, several drums were required to provide sufficient settling capacity. The resulting clear water was then pumped through a system of four filters ranging from 50 microns at the inlet to 5 microns at the outlet. The filtered water was the returned to the Recycled Water Volume Tank where it was stored for reuse. The particle-containing sludge remaining in the drums was then mixed with absorbent for disposal as Low Level Radioactive Waste.

Although this process was somewhat labor intensive, the overall waste volume minimization from this diamond wire saw process was significant. By using the diamond wire process, the volume of concrete block waste generated was limited to the volume of the resulting blocks, rather than an expanded volume which would have resulted from rubblizing. By the control measures above, much of the secondary PPE and waste was minimized. By recycling the cutting water, generation of thousands of gallons of radioactive waste water was avoided. In general, the waste volumes (and disposal costs) were as much as four times less than would have resulted from other removal methods.

Improvements in the cutting process also led to greater project productivity and less downtime. Establishment of the appropriate and proper sized beads to use for the material minimized the breakage. Tension in the wire was also critical. When cutting through voids, plastic-coated wire helped. The more continuous the cut, the less chance there was to break a wire. The start and end of the cuts were the most likely areas to experience breakage of wire. Productivity was significantly improved when cleaning of the cutting diamonds and the rebuilding of the wire could be performed without leaving the established radiological area. This operation utilized a small area for these repairs in conjunction with an ultrasonic cleaning unit.

The experience gained removing the bioshield from Building JN-3 confirmed that this technology will also be applicable in Building JN-1 at the Battelle West Jefferson site and should be considered for application throughout the DOE. Large cost savings have been realized. Diamond rope sawing can minimize the TRU waste, minimize RCRA concerns, minimize D&D requirements, and minimize the spread of radioactive inventory bound in concrete structures. Many hot cell and heavily shielded facilities, including those at the West Valley Demonstration Project, the Mound site, Hanford, SRS, and Rocky Flats could benefit by the application of the diamond wire saw technology. Rocky Flats has identified this technique as one of the preferred technologies in their ASTD proposal for “in-situ size reduction”.

10.0 References

Battelle/DOE Contract Number: W-7405-ENG-92
Columbus Environmental Management Project (CEMP)
PBS # and Name: OH-CL-02-D West Jefferson Site Decontamination (Defense)
Tech ID: 1000007908
Site Need #: OH-C003
Focus Area: DDFA

11.0 Validation Statement

This analysis accurately reflects the performance and costs of the remediation.

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Thomas A. Baillieul
Director DOE/CEMP