Survey and Remediation Project at the DOE Bannister Site -16280

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ABSTRACT

The Department of Energy Kansas City office has operated the Bannister site with a variety of contractors since the late 1940's. This facility has had a number of missions, some of which included using natural and depleted uranium. In order to prepare for the demolition of the site, ANTECH was contracted to perform radiometric surveys of the areas where these uranium operations took place. In the process of performing these surveys, areas with low levels of fixed radioactive contamination were identified; ANTECH then remediated these areas using a variety of techniques. In all areas surveyed, the only radioactive contaminant of interest was uranium and members of its decay chain. In no cases were other radionuclides found. The detection equipment used for the surveys included a Ludlum model 239-1F Floor Monitor, a Ludlum 2360 Alpha Beta Data Logger Scaler/Ratemeter, and an ORTEC IDM-200-V High Purity Germanium Detector. The Ludlum instruments were used for bulk surveys and the ORTEC instrument was used to determine an accurate radioactive background spectra and subsequent spectra for areas where radioactive contamination was identified. Contamination was located on concrete floors and columns, cinder block walls, steel beams, inside ductwork and in floor drain piping. After these areas were identified, a number of methods were used to remove the contamination for disposal including scabbling, core drilling and wholesale removal. Extensive use of Pentek scabbling equipment on the concrete sections proved to be very effective at removing the contaminated layer. Upon completion, the waste materials were consolidated and packaged in a strong tight sea land container and shipped to the Energy Solutions waste facility in Utah. The completed work at the Bannister site serves as an example and demonstration of an effective and comprehensive decommissioning project. It involved the integration of a variety of decommissioning activities all executed and managed by a single contractor. These included radiometric measurement surveying using a variety of detection technologies to identify and locate uranium contamination, decontamination and removal of low level radioactive waste including some deconstruction activities and finally the management of low level radioactive waste including packaging, consignment and shipping of waste to a remediation site. The effective and efficient identification and removal of radioactive contamination at the Bannister site has contributed to the overall goal of returning the site to unrestricted use.

INTRODUCTION

The work that is reported involved ANTECH in the performance of radiological assessment and remediation activities at the Bannister Federal Complex located

Kansas City, Missouri. ANTECH have previous experience in performing radiological surveys, decontamination and decommissioning nuclear facilities [1, 2].

Historical information provided by on-site personnel at the facility identified the potential contaminant as mixtures of ^{234}U, ^{235}U and ^{238}U isotopes, along with their decay products, present in several locations in the facility since the 1950's. Surveys were performed to characterize radiological conditions in support of redeveloping the property. Results of those surveys indicated a need to perform remediation steps to remove residual radioactive contamination.

The remediation actions were based on the analysis of the surveys. The work of remediating the various areas where contamination was found involved three primary steps, each applying available technology and good radiological practices. The first step was to perform characterization to locate and determine the depth of penetration into the concrete and cinderblocks so that the appropriate level of scabbling could be applied. The second step was to perform the scabbling and collect the waste. While this step was occurring, surveys continued until each area was confirmed "clean". The final step was to ship the waste offsite to a disposal facility.

RADIOLOGICAL ASSESSMENT AND CHARACTERIZATION

The three primary isotopes of uranium are long-lived alpha-emitters with energies between 4.15 and 4.8 MeV. Their progeny include numerous other radionuclides, some of which are of radiological significance and likely to be present because they have been in place for an extended period of time. The mixture classes reportedly include both natural and depleted uranium.

All three radionuclides undergo radioactive decay by alpha particle emission. The ^{235}U and ^{234}U isotopes emit gamma radiation as well. The natural abundances of these uranium isotopes, as well as the weight percentages of the isotopes in depleted uranium, are listed in TABLES I, II and III below.

TABLE I. Isotopic Mass Ratios

Isotope	Natural	Depleted
^{238}U	99.28	99.8
^{235}U	0.72	0.20
^{234}U	0.0055	0.0007

TABLE II. Primary Uranium Isotopes

Nuclide	Half-Life	Alpha Energy/Yield	Beta	Gamma
^{238}U	4.51 x 10^9 y	4.15 MeV @ 21% 4.20 MeV @ 97%	None	None
^{235}U	7.1 x 10^8 y	4.21 MeV @ 6% 4.37 MeV @ 17% 4.40 MeV @ 55%	None	144 keV @ 11% 163 keV @ 5% 186 keV @ 57%

		4.60 MeV @ 5%		205 keV @ 5%
^{234}U	2.47 x 10^5 y	4.72 MeV @ 28% 4.77 MeV @ 72%	None	5.3 keV @ 0.12%

Since it is likely, due to the age of material, that all of the nuclides are in equilibrium, one would expect detection sensitivity for the beta/gamma radiations of about five times more than the detection sensitivity of the alpha particles alone [3].

TABLE III. Decay Products

Nuclide	**Half-Life**	**Alpha Energy/Yield**	**Beta**	**Gamma**
^{234}Th From ^{238}U	24.1 d	None	103 keV @ 20% 193 keV @ 79%	13 keV @ 9.8% 63 keV @ 3.5% 92 keV @ 3% 93 keV @ 4%
^{234m}Pa From ^{234}Th	1.17 m	None	2290 keV @ 98%	765 keV @ 0.3% 1001 keV @ 0.6%
^{231}Th From ^{235}U	25.5 h	None	206 keV @ 13% 287 keV @ 12% 288 keV @ 37% 305 keV @ 35%	26 keV @ 2% 84 keV @ 10%

The spectrum below represents a measurement at the floor surface of the Kansas City Plant, Building 1, former department 49X where contamination was detected. A high purity germanium detector was used to attain the spectrum, and it was qualitatively analysed with ORTEC GammaVision. This spectrum clearly demonstrates the presence of many of the uranium-series progeny.

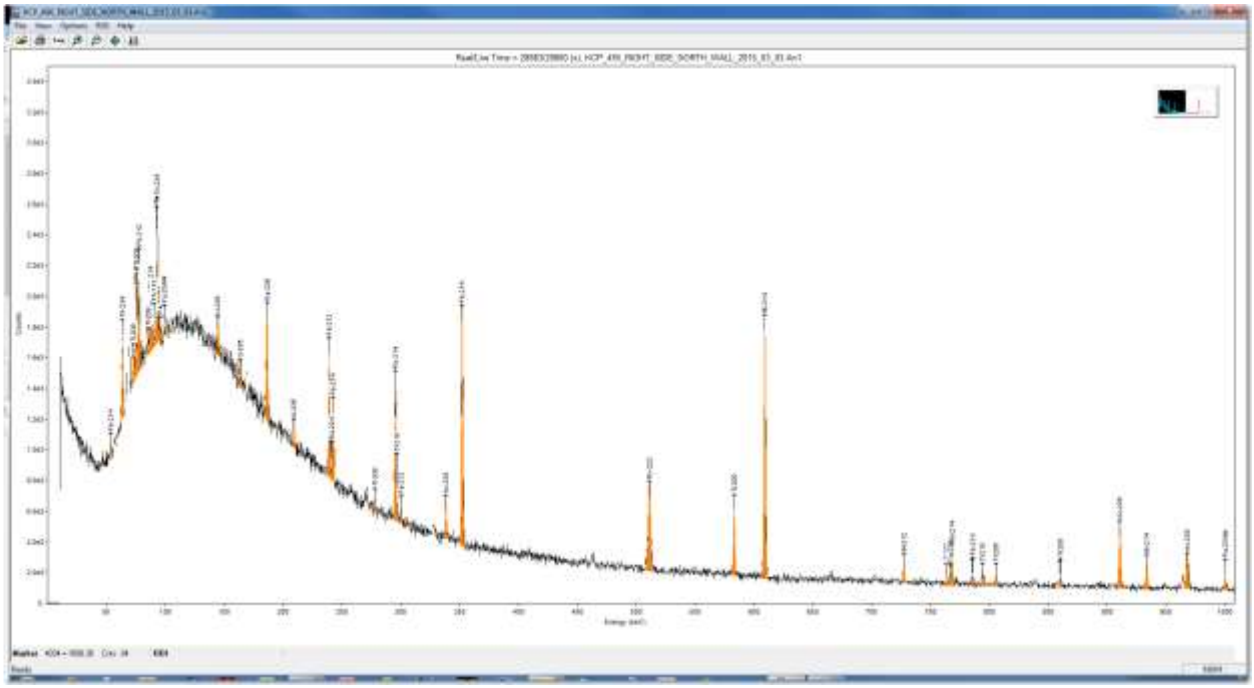

Fig. 1. High Resolution Gamma Spectrum of 49X Floor.

The characterization surveys generated during the assessment phase of the work precisely defined the extent and magnitude of contamination. The resulting data was used to assist in planning for the decontamination effort, including decontamination techniques and health and safety considerations during decommissioning. Characterization continued during remediation by taking a number of core samples in the locations where contamination was found. This was only necessary in the locations with contaminated concrete. Pipes and ductwork that were identified as contaminated were remediated as described later in the paper.

Measurement Methods

ANTECH personnel made radiation measurements beginning January 28, 2015 and ending March 5, 2015. At over 1,000 independent locations, total contamination levels were measured and recorded using large area (100 cm^2) dual-phosphor scintillation probes and very large area (609cm^2) gas-flow proportional floor monitors. This equipment made it possible to detect and quantify alpha and beta particle emissions. Each survey was recorded on a Radiological Survey Report (RSR), which is the official document used to retain and validate each measurement. Nearly 40 RSRs were completed in that period, documenting characterization of specific areas or items, coverage of jobs involving potentially contaminated areas, or decontamination activities.

Each RSR documents from one to several dozen measurement points. The location of each measurement point is documented graphically on the RSR, and typically has associated with it, two Direct (or Total) measurement values (one for beta, and one for alpha) as well as two Removable (or Smear) values, again for beta and alpha. The RSR data is not included in this paper.

Instrumentation

One model of portable survey meter with two types of probes was used for making direct beta and alpha measurements. These included Ludlum Model 2360 portable survey meters with either a Ludlum Model 43-93 dual phosphor scintillation probe or Model 43-37-1 gas-flow proportional probe. These instruments provide the electronics for alpha-beta radiation discrimination through pulse height analysis. For desktop measurements of removable activity on smears, a Ludlum Model 2929 dual-channel scaler with a Ludlum Model 43-10-1 dual phosphor scintillation probes was used.

Efficiency Assessment

Each measurement was converted to an activity concentration value by application of instrument efficiency and probe area corrections to arrive at units of disintegrations per 100 square centimetres (dpm/100 cm^2), an industry standard which allows direct comparison to the surface contamination limits specified in 10 CFR § 835 Appendix D, Surface Contamination Values. Those limits are presented in TABLE IV.

TABLE IV. Surface Activity Limits

Radionuclide	**Removable**	**Total (Fixed + Removable)**
U-natural, U-235, U-238, and associated decay products.	1,000	5,000
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129.	20	500
Th-natural, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133.	200	1,000
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above.	1,000	5,000

Survey Design Considerations

The goal of the survey work is to locate and identify any residual radioactivity in the areas identified by Honeywell using the best available technology and experienced personnel. Where contamination is found, industry-standard remediation techniques will be employed to remove and disposition the contaminant. Follow-up surveys will then be performed to document that no residual radioactivity remains outside of the identified normal background range.

It is the expectation that buildings being surveyed will be completely demolished and they will not be released for unrestricted use. The radiological measurements are therefore operational in nature; the objective is to identify, locate, and remove contaminant. Although the project has followed the guidance of the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) [4] in the planning and execution of the surveys, the work does not constitute a comprehensive site investigation and final status survey.

For the survey results, all of the measurements are corrected using instrument-specific calibration efficiencies provided by a calibration laboratory. All measurements are corrected using MARSSIM methods. The reported beta activity is calculated by dividing the net count rate by the 2π Sr-90 efficiency corrected with a surface efficiency factor of 0.5. Alpha measurements are similarly corrected using the Th-230 efficiency. These final efficiencies and limits were adopted and applied to all measurements.

Removable (Smear) Measurements

Smears were collected by rubbing a piece of filter paper over a potentially contaminated surface using moderate pressure over a 100 cm^2 area. The smears were then transported to a counting station and counted using the Ludlum Model 2929 scaler. Results were converted to activity concentration.

Scanning Measurements

The majority of effort during surveys was devoted to performing scanning measurements. ANTECH personnel are trained to scan at a fixed rate slow enough to assure the desired activity concentration, if present, will likely be detected. For most surveys, this is no greater than two inches per second at a distance of ¼ inch from the surface.

During the scan, the technician listens to the audio output of the instrument or, when in a high noise environment, watches the deflection of the meter. If a discernible difference between the background rate and the measured rate is detected, the technician will stop at that location for at least four seconds. If the count rate appears to remain elevated, a static measurement is made to quantify the activity under the probe. Often, the highest count rate in a designated area is sought for this quantifying measurement.

Static Measurements

When the health physics technician desires to quantify and record the activity concentration, the probe is held steady at a fixed distance of approximately ¼ inch from the surface. The portable meter is then used in scaler mode and a timed count is made. The length of the count can vary with the background to assure that the Minimum Detectable Concentration (MDC) can be met, but is typically one minute.

Static Measurement Sensitivity

Prior to performing field measurements, the detection sensitivity of equipment to be used must be determined to ensure that contamination at the limits can be detected. After a direct measurement has been made, it is then necessary to determine whether or not the result can be distinguished from the instrument background response of the measurement system. The terms that are used to define detection sensitivity for fixed point counts and sample analyses are: Decision Level (DL) and Minimum Detectable Concentration (MDC) or Minimum Detectable Activity (MDA). The methods described in MARSSIM were employed for these calculations.

The Decision level (DL) is the quantity of material in a measurement above which the analyte is interpreted as being present (i.e., analyte is detected). This is also called the critical level (L_c) for decision. This decision level is used in the present work to make the determination about each measurement as to whether activity is present or not. Mathematically, with a 5% probability of false detection, the Lc is:

$$L_C = 2.33\sqrt{C_B}$$

where,

C_B = number of background counts that are expected to occur while performing an actual measurement.

Another important statistical concept is the minimum detectable activity (MDA). This is an estimate of the smallest quantity that can be measured in a sample such that the risk for false detection and false non-detection are at a specified level of confidence, typically 5% or less for each. In other words, how low can we measure with the equipment we have? Since our interest is in units of activity per unit area, the static and scanning MDC (minimum detectable concentration) are calculated.

$$MDC_{Static} = \frac{3 + 4.65\sqrt{C_B}}{T \times E_{total} \times \frac{A}{100cm^2}}$$

where:

MDC = minimum detectable concentration level in dpm/100 cm^2
C_B = number of background counts in time, T
T = time in minutes for paired observations of sample and background
E_{total} = Total detector efficiency
A = Area that was smeared for loose surface contamination

Scanning Measurement Sensitivity

The ability to identify a small area of elevated radioactivity during surface scanning is dependent upon the surveyor's skill in recognizing an increase in the audible or display output of an instrument. The greater the sensitivity, the lower the level of contamination that can be detected.

From Chapter 6 of the MARSSIM Manual [4], the following relationship can be derived for the minimum detectable concentration for a scan survey:

$$MDC_{Scanning} = \frac{\left(\text{d'}\sqrt{\frac{R_B}{60} X \frac{w}{v}}\right) \times \left(\frac{60}{w/v}\right)}{\sqrt{p} \times E_i \times E_s \times \frac{A}{100cm^2}}$$

where:

d' = desired performance (value from Table 6.5 of MARSSIM)
R_b = Background Rate
w = probe width in direction of scan
v = scan speed
p = surveyor efficiency
E_i = instrument efficiency
E_s = surface efficiency
A = Probe Area

Both static and scanning MDC values were calculated to insure that all instruments used to make beta measurements were capable of detecting contamination below the DOE surface contamination limits.

Instrumentation Quality Assurance

Technicians associated with the project were trained to perform instrument battery checks, instrument integrity checks, verification that the calibration of the instrumentation was current, that high voltage, where applicable, was within an acceptable tolerance, and that the instrument had been source checked.

Source checks were performed daily on the instrumentation used. Acceptable response ranges for the sources were established, and prior to daily use, measurements were made to ensure the response was within the accepted range. As an added conservatism these source checks were also performed at the end of every shift.

Instrument calibration was performed prior to the project, and was typically good for one year. The instrument vendors supplied certificates of calibration.

Instrument Background

Field measurements of radioactive material that is also present in building materials requires performing an assessment of the level of radioactivity present in "clean" areas. Multiple locations were chosen throughout the facility that are similar in construction and have a history indicating that there is no contaminant present. The raw instrument response was measured at these locations to generate a Representative Background for each surface type and for each instrument. The values, which were then subtracted from subsequent measurements, are listed in TABLE VI.

Sampling

To determine the depth to which contamination has penetrated the various surfaces, core samples (see Figure 4) were collected and samples were removed from surfaces using a scabbler or needle gun. When taking core samples, the area was prepared by removing the coating material from a small area using a small needle gun similar to the one in Figure 2. The scabbler debris was collected in a HEPA vacuum similar to the unit in Figure 3.

Figure 2. Needle Gun.

Figure 3, HEPA vacuum for collecting debris

Figure 4, Core drill.

Good practice was followed by having the suction from a HEPA vacuum within ½ of the hose diameter from the drill face. In addition, the core drill bit was removed and wiped several times during operation in order to mitigate pushing contamination from the surface further down into the concrete than where it is currently present. Cleanliness is critical to successfully determining depth of penetration.

The core samples were analysed to determine the depth of penetration of contaminates. It should be noted that in almost every circumstance contaminates were located in the cement portion of the concrete; it is rare that they are found in the aggregate.

Results of Core Drilling/Depth of Penetration Operations

In the areas where contamination was indicated with the survey instruments, the depth of penetration was determined by both core drilling and by scabbling small areas while continuously surveying. The areas considered were 49X, floors and walls, 34C, floors, walls and columns, and 20D floors. Combinations of techniques were used to determine the depth of penetration.

Analysis of the core samples indicated that the contamination in the floor was limited to the top layer of cement, approximately 3/8 inch. The samples were sectioned and measured for contamination on the sections.

In addition, small floor areas and cinder block wall sections were tested for the effectiveness of removing thin layers of material and surveying between each pass. This technique was successful as removing the top ¼ to 3/8 inch of material lead to measurements at the same level as background.

Measurement Results

The principal work product of the survey activities was the Radiological Survey Report (RSR). All survey data obtained from the Kansas City site were recorded in a Microsoft Access™ database. Key information from that database is ordered by location.

By maintaining an electronic record of field measurements, it was possible to continuously provide accurate activity concentration data as measurement conditions evolved. The database allowed selection and post-processing of measurement data. TABLE V shows some of the project metrics. TABLES VI and VII show the survey results and list remediation actions. Items above the limit were remediated and this activity is described in the remainder of the paper.

TABLE V. Metrics

Type of Measurement	Direct	Removable
No. of Measurements (Msmts)	1,063	108 α 252 β
No. of Msmts with beta activity detected (> L_c)	311	No removable activity was detected.
No. of Msmts with beta activity above Table 4 limit	60	
No. of Msmts with alpha activity detected (> L_c)	105	
No. of Msmt with alpha activity above Table 4 limit	0	

TABLE VI. Representative Background Data

Description	Surface Contamination Level (dpm/100cm^2)	Reference
Cinderblocks	1335-2140	KCP-0001
Floors	945-1690	KCP-0002

TABLE VII. Survey Findings and Remediation Actions

Room	Location	Approximate Surface Contamination Level (dpm/100cm^2)	Ref.	Remediation
20D	Berms	175-26,000	KCP-0018, KCP-0019	The berms in 20D were worked with HEPA vacuumed tooling, i.e. the Squirrel,

Room	Location	Approximate Surface Contamination Level (dpm/100cm²)	Ref.	Remediation
				Rotopeens and needle guns. In the event that the contamination was under the sheet metal walls, they were partially or totally removed and then the Moose was deployed. There was approximately 100 linear feet of berm to be treated. The spoils were collected in 7A type A drums.
20D	Inside ventilation housing.	250	KCP-0038	Within the DOE standard. ANTECH surveyed another ventilation housing elsewhere on site for comparison. Older ventilation systems tend to have buildup of naturally occurring radioactive elements in them – provided that the comparison is similar, no further may be necessary.
34C	Columns	1,500	KCP-0012	This is within the DOE limits on table 4, however, to practice ALARA, these columns were worked with HEPA vacuumed tooling as above and spoils packaged in 7A type A drums. There was approximately 50 square feet of contamination to be treated.
34C	Floors	70-220	KCP-0014, KCP-0015	Alpha contamination was found at levels between 20 and 70 dpm/100 cm^2 in an area approximately 50 square feet. Core sampling indicated contamination limited to top 3/8 inch or less, HEPA vacuumed tooling was be deployed in this area including the Moose. Spoils were collected in 7A type A drums.
49X	Ceiling	40-500	KCP-0017, KCP-0021, KCP-0022	This is within the DOE limits on Table 4.
49X	Floors	70-10,000	KCP-0004, KCP-0005, KCP-0011	The floor in room 49X has an area approximately 5000 square feet, which was scabbled with the Moose and the edges scabbled with a Rotopeen and/or needle gun. Spoils were collected in 7A type A drums.

Room	Location	Approximate Surface Contamination Level (dpm/100cm²)	Ref.	Remediation
49X	Walls	400-120,000	KCP-0003, KCP-0006, KCP-0007, KCP-0008, KCP-0009, KCP-0022	The contaminated layer of cinder block was removed by scabbling, followed by a radiological survey. This process was repeated until the net measured activity was consistent with expected background levels.
49X	Columns	170 – 18,000	KCP-0010	The columns with contamination were worked with HEPA vacuumed tooling, i.e. the Squirrel, Rotopeens and needle guns.
49X	6-inch Insulated Pipe & penetration	2,400-4,400	KCP-0017, KCP-0022	The contamination was found the top-side of the pipe lagging. Using a scissor lift, some of the pipe lagging was removed using the HEPA vacuum to maintain cleanliness. Spoils were collected in 7A type A container(s). The section is only a few feet long.
49X	Inside vent, North Wall	330	KCP-0023	This is within the DOE limits on Table 4.
49X	Duct over Shower Area	230-400	KCP-0031	This is within the DOE limits on Table 4.
96	HEPA housings and filters on Roof	4,300	KCP-0027	The HEPA housings and filters were removed and packaged in 7A type A packaging for disposal.
96	8” Ventilation duct	250-800	KCP-0030	The area was covered in plastic and the pipe was removed. Size reduction was done over plastic and with HEPA vacuum at the point of contact with the piping. A portable band saw was employed.

REMEDIATION

The scope of the remediation was to remove materials from the areas identified as being contaminated above the DOE limits. This was accomplished by removal of contamination and continuing the surveys until background levels were achieved. The work included the remediation activities and all the surveys necessary to document that decontamination was complete.

Remediation Techniques

The measurement data captured in the radiometric surveys indicated the presence of residual contamination in concrete floors, cinderblock walls, ducts, pipe and lagging. The remediation operations were conducted with the purpose of removing or reducing the level of contamination in each of these areas.

All the areas where surveys indicated activity above the Table 4 limits were remediated to background levels. In addition, areas where elevated activity was found above background and below the table for limits, additional work was performed to clean these areas to the extent practical. This is consistent with the "As Low As Reasonably Achievable" (ALARA) philosophy and will greatly decrease the potential for detection of residual activity during the Final Site Survey.

TABLE VII shows details of what levels of contamination were found, where that contamination was found and what remediation techniques were applied. Depending upon the physical and chemical form of the uranium and the type of surface, uranium may become embedded in the surface. Removal of embedded material may require physical abrasion, such as scabbling, grinding, or chipping.

Concrete Removal

Concrete removal involved getting access to the surfaces – which was easy in some instances, and a more challenging in others. Where the general floor area was contaminated, a large scabbler was deployed such as the Pentek Moose, which is shown in Figure 5.

The floor scabbling operation removes approximately ¼ inch of material in a single pass. It is a dry operation, and all debris was collected using a high velocity HEPA vacuum. The scabbler was used in most of the floor and berm areas – many of the berms have sheet metal walls above them that were removed for the operation. The area identified through the surveys is approximately 5000 square feet between the different areas of the plant. Areas where the large-scale floor scabbler could not be used required using smaller hand operated tooling.

Figure 5. Pentek Moose HEPA vacuumed floor scabbler.

Figure 6. Pentek Rotopeen and Squirrel HEPA vacuumed scabblers being used.

Equipment Removal

In Building 96, there are two pipes and some HVAC ductwork that were removed. Both were size reduced enough to fit in a suitable container. In order to mitigate the possibility of contamination spread, all items were wrapped in plastic prior to packaging for shipment to the disposal facility.

Another significant equipment removal part of the project was the demolition of a large HVAC system from the roof of the facility. The configuration was in an “H” with the center portion being 2 stories tall and containing the fans, motors, steam and cold water piping. The legs included the duct work that delivered and returned air. The entire system was disassembled and disposed, segregating the radioactively contaminated materials from the clean.

Figure 7: HVAC system during demolition

In one of the areas, a drain was identified that had been covered with concrete at some point in the past, and was indicating contamination. This lead to the excavation of 120 feet of piping buried under a 12-inch-thick concrete floor. This pipe was then size reduced and packaged for disposal. The trench was filled in with concrete and the room placed back in service for future activities.

Safety Considerations Regarding Remediation Activities

During the operations, radiation protection staffs were tasked to insure that all equipment brought into the Bannister complex was free of removable radioactive contamination. All equipment removed from each decontamination site within the Bannister plant was surveyed clean or contained in a way as to not spread radioactive contamination when being moved from work site to work site within the plant. Air samples were taken at the perimeter boundaries while scabbling or other operations with the potential to generate airborne contamination were being performed.

As part of the safety and health physics activities, a close liaison was maintained with the customer's safety and health physics staff. Pre-job briefings were conducted before beginning decontamination operations in each job site. Staffs were required to use and were provided with appropriate Personal Protective Equipment (PPE).

Each job site within the facility that was "decontaminated" was surveyed to ensure that no removable contamination remains and that the activity in areas is within the range of background for the work site. At the end of the project, post decontamination surveys were generated. The management of all material-requiring disposal was coordinated with the customers waste management staff, include profiling, packaging, containing, and shipping of the waste. Finally, all job sites that were physically disturbed were returned to its previous industrial safe mode to prevent personnel injury.

Spoils Management

Remediation activities generate rubble, however, some of the rubble contained contaminants that must be managed within regulatory limits. The management of these materials, both with and without contaminants, was coordinated with site authorities. The process of waste handling involved the three stages of waste profile development, brokerage and shipment to an appropriate low-level waste (LLW) site.

Energy Solutions (ES) maintains an active disposition and disposal Program with Department of Energy and DOE Contactor Operated facilities. It operates the LLW commercial waste disposal facility at Clive, Utah. ES provided the compliant interface for the KC Plant materials that were directed to the LLW waste stream. The material from remediation operations that was known to contain contamination was packaged in a single 20-foot sea-land strong tight box for shipment. All three phases of the process were fully compliant and final oversight by Honeywell waste management staff ensured that the DOE Interface requirements with Energy Solutions are met.

Figure 8: Final waste package with all waste ready for shipment to Energy Solutions

CONCLUSIONS

The completed project at the Bannister site serves as an example and demonstration of an effective and comprehensive decommissioning project. It involved the integration of a variety of decommissioning activities all executed and managed by a single contractor. These activities included radiometric measurement and surveying using a variety of detection technologies to identify and locate uranium contamination, decontamination and removal of low level radioactive waste including some deconstruction activities and finally the management of low level radioactive waste including packaging, consignment and shipping of waste to a remediation site.

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