Lessons-Learned from D&D Activities at the Five Gaseous Diffusion Buildings (K-25, K-27, K-29, K-31 and K-33) East Tennessee Technology Park, Oak Ridge, TN – 13574

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ABSTRACT

The East Tennessee Technology Park (ETTP) is the site of five former gaseous diffusion plant (GDP) process buildings that were used to enrich uranium from 1945 to 1985. The process equipment in the original two buildings (K-25 and K-27) was used for the production of highly enriched uranium (HEU), while that in the three later buildings (K-29, K-31 and K-33) produced low enriched uranium (LEU). Equipment was contaminated primarily with uranium and to a lesser extent technetium (Tc). Decommissioning of the GDP process buildings has presented several unique challenges and produced many lessons-learned. Among these is the importance of good, upfront characterization in developing the best demolition approach. Also, chemical cleaning of process gas equipment and piping (PGE) prior to shutdown should be considered to minimize the amount of hold-up material that must be removed by demolition crews. Another lesson learned is to maintain shutdown buildings in a dry state to minimize structural degradation which can significantly complicate characterization, deactivation and demolition efforts. Perhaps the most important lesson learned is that decommissioning GDP process buildings is first and foremost a waste logistics challenge. Innovative solutions are required to effectively manage the sheer volume of waste generated from decontamination and demolition (D&D) of these enormous facilities. Finally, close coordination with Security is mandatory to effectively manage Special Nuclear Material (SNM) and classified equipment issues.

INTRODUCTION

The ETTP is located in the western portion of the DOE Oak Ridge Reservation. It is the site of

five former GDP process buildings: K-25, K-27, K-29, K-31 and K-33. Construction of these buildings started in the 1940s with a mission to supply HEU for nuclear weapons production as part of the Manhattan Project and then later to produce LEU for the civilian nuclear power program.

The footprint of these large multi-floor structures ranged in size from 6 acres under roof for the K-29 building to 44 acres for the K-25 building. The process equipment in the K-29, K-31 and K-33 process buildings was used for production of LEU. This equipment was removed from approximately 1997 through 2005 in anticipation of reindustrialization of the buildings. The equipment in K-25 and K-27 was used for producing HEU and has remained in place since the majority of these facilities were shutdown in the 1960's. The three units that comprised the K-25 Purge Cascade were not shutdown until the late 1970's.

Very little of the equipment such as converters, compressors, valves, process piping, and instrumentation from the five GDP process buildings was chemically decontaminated or cleaned prior to shutdown. This equipment was found to be contaminated primarily with uranium and to a lesser extent with Tc-99. The Tc-99 contamination was introduced through enrichment of recycled uranium in the 1960's and 70's. Other contaminants of concern in the process buildings are PCBs, mercury, and asbestos.

URS | CH2M Oak Ridge LLC (UCOR) is completing the D&D and environmental remediation of the ETTP for DOE, including the K-25 and K-27 GDP process buildings. UCOR has found that efficient decommissioning of these large, complex and contaminated process buildings requires innovative solutions to a variety of characterization, chemical cleaning, structural degradation, waste management and security issues. The lessons learned from implementing these solutions will benefit upcoming D&D projects at other uranium enrichment facilities.

CHARACTERIZATION

UCOR has used physical sampling, non destructive assay, and process knowledge to characterize the K-25 and K-27 process buildings. A key lesson learned is that good, upfront characterization of process equipment and structures is needed for planning and subsequent implementation of demolition activities. Timely and accurate characterization is essential in determining where and how to dispose of process equipment, piping and demolition debris. It is also needed to develop radiological and industrial hygiene controls, to implement adequate measures to prevent the environmental release of contamination, and to address nuclear criticality safety concerns.

UCOR developed bounding characterization data for Tc-99 contamination in K-25 building units K-309-3, K-310-1, K-310-2, K-310-3 and K-311-1, i.e. the Tc-area, that will result in significant deactivation and waste disposal cost savings. Before the Tc-area was adequately characterized

the baseline assumptions were that PGE from all 5 Tc-area units along with 1 unit of building debris would require disposal at the Nevada National Security Site (NNSS). After characterization UCOR determined that just 3 units of cell-floor only PGE and no building debris will require disposal at NNSS. The rest will be disposed of onsite at the Environmental Management Waste Management Facility (EMWMF) at considerable cost savings.

The characterization data showed that waste which will be generated from D&D of two Tc-area units (K-309-3 and K-310-1) could be managed in a manner similar to that from the K-25 East (non Tc-area) and North wings. The remaining 3 units (K-310-2, K-310-3, and K-311-01 or the "Purge Cascade") have significantly greater Tc-99 contamination and will be managed separately. As a result two waste handling plans will be prepared along with their associated sampling and analysis plans to reflect this division of the Tc-area. UCOR has also worked with the regulators to reduce the number of additional samples needed to support disposal of these two waste lots (a reduction of about 300 for K-309-2/K-310-1 and 150 for the Purge Cascade).

CHEMICAL CLEANING

The process equipment inside only 13 of 54 units in the K-25 process building, and none in the other 4 process buildings, was chemically cleaned prior to shutdown. As a result, demolition crews have had to contend with removal of hold-up material and the potential release of hydrogen fluoride (HF). Cleaning of process equipment is a step that should be evaluated prior to initiating shutdown and, or demolition activities. This evaluation will help to plan for demolition activities, address worker health and safety requirements such as personnel protective equipment, identify transportation and disposal requirements, support nuclear facility categorization, assist in implementing security requirements, and minimize impacts to planned demolition activities such as the potential release of HF.

The presence of high mass uranium deposits (i.e. greater than 350 g U-235) significantly complicates deactivation and demolition activities. These deposits are mostly uranyl fluoride (UO_2F_2) formed by the hydrolysis of uranium hexafluoride (UF_6). Deposits present potential criticality concerns, particularly where water may have infiltrated process systems. Of equal concern is the presence of HF which is a byproduct of the hydrolysis of UF_6. High mass deposits must be removed to achieve a "criticality incredible" determination which allows demolition to proceed. Removals are made under a strict regimen of criticality, health physics, industrial safety and operational controls. These controls include wet air purging of process equipment and piping to react water vapor with any residual UF_6 and to vent HF from the system. Consequently, the efficiency of deactivation activities, and in particular if high mass deposit removals are required, is severely constrained. Further, the high mass items (e.g. valves, sections of pipe) must then be mined and the resulting uranium grouted.

Chemical removal of uranium deposits with the cascade intact avoids or minimizes several constraints. And the technology for uranium deposit removal is based on several decades of GDP operating experience. For example, mixtures of chlorine trifluoride (ClF_3) and fluorine (F_2) were used to successfully remove UO_2F_2 deposits from GDP equipment. The same fundamental chemistry has been used at the Portsmouth Gaseous Diffusion Plant as part of "Cold Shutdown" and in England at the Capenhurst GDP to remove uranium deposits. While chemical removal involves its own set of hazards, including potential exposure to hazardous gases (e.g. ClF_3), it is performed under controlled conditions without many of the constraints encountered in the K-25 building with deposit removals.

STRUCTURAL DEGRADATION

Uranium enrichment activities ceased for K-25 and K-27 in the 1960's. The three LEU buildings operated until the mid-1980's, and structural degradation of these facilities occurred despite significant surveillance and maintenance efforts. Some portions of the K-25 Building are no longer accessible, i.e. the operating floor, which complicated characterization and demolition efforts, increased the potential for release of contaminants, and produced significant cost and schedule impacts for the demolition projects.

Most of the structural deficiencies in the K-25 Building are the result of water intrusion. Also, the transition from elevated building temperatures during operation of the gaseous diffusion process to variable ambient temperatures during shutdown further degraded key structural components, e.g. due to freeze/thaw cycles. The problems which resulted included cracked corbels and columns, exposed rebar, floor subsidence in some areas of up to 60-cm, spalling concrete, falling debris, and the failure of operating floor precast panels. In response to these types of structural issues a number of actions were taken to ensure deactivation could proceed safely. This included installation of modular work platforms, lifelines for accessing process piping ducts, corbel/beam repairs, cross bracing for wind loads, imposition of significant floor loading restrictions, and an intensive structural inspection program. These measures were expensive, required considerable time to implement and adversely impacted the efficiency of deactivation efforts.

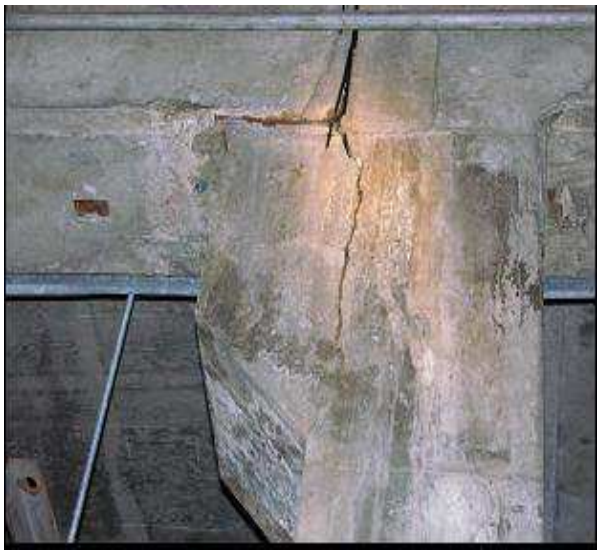

Figure 1. Structural failure of a corbel could have caused a catastrophic failure of the floor system.

In response to this latter issue, UCOR has minimized hands-on, "targeted" equipment and piping removals to the extent practical. Instead a controlled demolition approach is used with heavy equipment to keep the workers safely away from potential hazards. UCOR has developed a "GO ORANGE" approach in which piping which does not meet the EMWMF waste acceptance criteria will be painted orange and demolished with the building. The orange color will facilitate it's separation from the demolition debris pile for size reduction, packaging and subsequent disposal at NNSS. This approach minimizes hands-on piping removals, improves safety and reduces cost.

WASTE DISPOSAL

The demolition debris will be disposed in various onsite and offsite locations based on the characterization data. The sorting, segregation, packaging, and transporting of the huge quantities of material are a major operational and logistical challenge. For Oak Ridge, the onsite EMWMF disposal facility and dedicated haul road provide a significant benefit for waste transportation and disposal activities. It also minimized cost and schedule impacts for the projects. In the past 16 months the K-25 D&D project has shipped safely about 14,400 truck loads (~82,000 cubic meters) of demolition debris and process equipment for disposal at the EMWMF. In addition almost 200 shipments of process equipment have been made to NNSS. Efficient and carefully planned logistics have been key to waste management efforts. UCOR has employed a "pack as you go" strategy in which demolition debris is packed for disposal in near real time to its generation. This approach prevents the accumulation of massive debris piles which interfere with ongoing demolition operations, result in multiple handling of waste, and reduce safety.

Figure 2. The EMWMF, an onsite disposal facility, has reduced cost and minimized transportation risks.

Removal of equipment from the three LEU buildings began before the EMWMF disposal facility was constructed, and the large equipment had to be size reduced for transportation to NNSS. If the EMWMF been available, transportation costs could have been avoided, which was identified as a lessons-learned toward the end of the three LEU buildings project.

SECURITY

The level of security is driven by both SNM quantities and the equipment that remains classified. This leads to the need for security plans, cleared workers, and restraints on access and egress for personnel and material.

Effective planning between various project groups has been essential to compliance with security requirements. One example of this has been the coordination between D&D operations, characterization, and security groups to process items containing SNM at the desired production rate while staying below material at risk levels for the site.

A key lesson learned is to consider life cycle impacts in selecting approaches to reduce security cost. For example, when UCOR arrived at the site it was discovered that a number of items containing SNM had been encased in large concrete monoliths over a decade earlier to minimize security cost. UCOR has had to process these monoliths to disposition the SNM at significant cost and potential risk to the workers. Considering the final disposition of these items upfront could have lead to alternate, more effective strategies for minimizing security cost.

CONCLUSIONS

The key lessons learned from D&D of the GDP process buildings at the ETTP include:

- Keep the process buildings dry after operations cease,
- An on-site disposal facility with a dedicated haul road for low risk radioactive waste enhances transportation safety and reduces disposal cost,
- Chemical removal of uranium deposits after GDP shutdown should be considered to minimize deactivation cost and enhance safety,
- Distance the worker from the hazards by using heavy equipment in D&D operations where practical,
- Use process knowledge, perform bounding characterization and reduce sampling density where practical,
- Use a controlled demolition/pack-as-you-go strategy to eliminate accumulation of massive debris piles and enhance safety,
- Effective integration of Security into planning efforts is essential.