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EFCOG BEST PRACTICES – DEACTIVATION AND DECOMMISSIONING

Title: Open Air Demolition of Radiological Contaminated Structures (May 11, 2007)

Facility: Hanford Site, Richland, Washington

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ABSTRACT

Heavily contaminated facilities have typically required significant decontamination to near free release levels, prior to demolition, to prevent the spread of contamination. These extensive decontamination efforts can significantly increase both the cost and schedule needed to decommission a facility. Fluor Hanford has combined both proven processes and new techniques in innovative ways to allow the safe demolition of heavily contaminated facilities.

There are a variety of demolition methods that can be combined with decontamination practices, technologies, and fugitive dust control techniques to eliminate or significantly reduce the potential of airborne emissions during demolition. Different demolition methods and fugitive dust control techniques can be implemented based on the extent and type of contamination, the location of the contamination within the structure, and the level of effort of pre-demolition deactivation and decontamination activities. In addition, airborne dispersion modeling can be applied to a demolition project to identify the quantity, type, or location of contaminated material that can remain in a structure during open air demolition based on the demolition techniques and airborne emission control methods established. Therefore, based on a through evaluation of the specific attributes of a structure, the nature of contamination, and the tactical decontamination and demolition approach, radiological contaminated structures can be cost effectively demolished in an open air environment.

Brief Description of Best Practice:

Open air demolition of radiological contaminated structures at the Hanford site in Richland, Washington uses commercially available techniques and controls to safely conduct demolition activities in the open environment. Based on a thorough evaluation of the type and extent of radiological contamination in a structure, a systematic demolition approach can be developed to reduce the potential of generating a release of airborne emissions to a level that allows demolition to proceed without having to install and maintain an elaborate containment system or perform extensive pre-demolition decontamination. The key component to this approach is the review and understanding of the type and location of the contamination and the configuration of the structure. With this information, the overall project approach can be formulated with input of the air modeling information, deactivation and pre-decontamination requirements, demolition techniques and sequencing, and dust control alternatives.

Basing decontamination end points on technical requirements such as waste acceptance criteria and dispersion modeling rather than on emotional (that's the way it has always been done, or fear of the unknown) will provide defined and defensible results.

Why the Best Practice was used:

The Best Practice of implementing open air demolition allows for a safer work environment, reduced project costs, and accelerated periods of performance. Therefore, identifying and realizing best project management principles.

What are the benefits of the Best Practice:

There are several benefits associated with implementing open air demolition of contaminated structures. The benefits include executing the demolition task in a safer work space configuration, reduced costs, and an accelerated period of performance. By not having to construct an enclosure around a structure or perform extensive decontamination, significant ALARA, cost and schedule benefits are immediately realized. In order to successfully conduct demolition activities of a contaminated structure within an enclosure many elaborate engineering, safety, and radiological considerations have to be addressed. Examples of these constraints include: allowing for adequate working distances around the perimeter of the structure, establishing areas for waste debris processing and equipment and personnel staging areas, and maintaining safety and radiological controls (CO monitoring, HEPA filtration, etc.). Based on the dimensions of the structure to be demolished, the installation of environmental controls (air flow, filtration, heating and cooling), and the additional footprint necessary to maneuver equipment and personnel requires constructing an enclosure significantly larger then the structure being demolished. The additional costs and time requirements to plan, procure, construct, and dispose of this type of enclosure would adversely impact almost any project. In addition, the additional safety and radiological risks of working within a confined work space like an enclosure are magnified. Also, a less obvious benefit of conducting demolition in an open air environment is allowing all project personnel, including the owner, to directly observe demolition activities without entering the enclosure. This allows for a better field of view and increased communication between field and support personnel.

What problems/issues were associated with the Best Practice:

There are several primary issues associated with performing open air demolition. These issues can generally be divided into two groups. The first group can be classified as technical issues. Technical issues are typically identified and addressed based on a rigid systematic process. Examples of technical issues include specific details associated with deactivation such as survey methods, identification of process equipment, quantification of contamination, extent and location of decontamination efforts, application of fixatives, demolition method and sequence, air modeling, dust control methods, personnel protective equipment (PPE), etc. The second group consists of non-technical issues. Non-technical issues are issues that do not address the specifics of how the structure is to be prepared for demolition, how the structure will be demolished, or the specific controls to be implemented prior to or during demolition. These types of issues consist of issues such as work hours, lack of knowledge, or security. Although not directly associated with the basis for implementing open air demolition, non-technical issues can impact the ultimate success of the project and must be considered and integrated appropriately.

Technical issues are evaluated, analyzed, and reviewed by the project team, consisting of project management, engineering, radiological, safety, and supporting personnel, to ensure that the results are justifiable and can be implemented. In the event that the assumptions are a part of the process, such as in developing air modeling, the assumptions must be based on factual, historic, or reasonable information. The outcome is typically a conservative, but achievable or workable set of parameters that allows for open air demolition of radiological contaminated structures with reasonable and appropriate controls.

Non-technical issues are a bit tougher to define and resolve. The "lack of knowledge" for demolition was primarily an issue with personnel not associated with the project but in the near vicinity of the project. Using the technical data and experience, meetings were held with concerned personnel to alleviate concerns and answer questions.

With any outdoor type work, the environmental elements often dictate how a project is executed. For these projects, heat and wind had the biggest effects on progress. The heat required work rest regimes that, at times, precluded appreciable progress. By shifting to a grave yard type shift, we eliminated the heat stress issues. Wind was constantly monitored. These projects had a wind limitation of 19 kph (12 mph) average wind speed. At speeds over this, the demolition was suspended and the debris piles were sprayed with a fixative. The fixatives worked well, as winds as high as 100 kph (60 mph) were recorded during the demolition process.

232-Z, located in an operating nuclear facility, was veiled in a security program that required special considerations such as visual observations, heavy equipment controls, and communication protocols. From a security perspective, the open air demolition offered better observation opportunities than say a covered area.

How the success of the Best Practice was measured:

The process success is ultimately measured by the perimeter airborne emission and worker breathing zone data collected during the demolition process. Based on the successful implementation of the hazard mitigation controls, methods and techniques, airborne emissions were significantly below the prescribed action levels.

Description of Process Experience using the Best Practice:

At the Hanford site there have been two highly plutonium contaminated structures demolished in an open air environment. The two primary examples include the 233S – Plutonium Concentration Facility and the 232Z – Plutonium Waste Incineration Facility.

Construction of the 233S Building was completed in 1955. From 1956 to 1965, the 233S building was instrumental in the process of developing weapons grade plutonium. Plutonium concentration was performed in a process cell by evaporation and/or ion exchange treatment. The concentrated plutonium was containerized and shipped to other Hanford facilities for further processing. During operations, several incidents took place resulting in the release of significant amounts of plutonium throughout the building. Decontamination and deactivation activities began in 1997 and were completed in 2003. During this period, the majority of the "hold up" located in process equipment, piping, ventilation ducting, and other miscellaneous items were removed from the structure followed by an application of a fixative coating to encapsulate potentially dispersible contamination.

The 233-S Building was a reinforced concrete structure, with a footprint of 11.3-m (37 ft) x 25.7-m (86 ft), and roof elevations ranging from 3.7-m (12 ft) to 9.7 m (32 ft). Concrete wall thickness ranged from 23-cm (8 in.) to 30-cm (12 in.), and several exterior portions of the building were made of structural steel with corrugated metal exterior siding. The 233-SA Building, located just northeast of 233-S, was a single story, reinforced concrete structure with 6-inch thick walls. The roof was concrete over metal decking with insulation and built-up asphalt covering.

The 232Z Building was constructed in 1958. From 1961 to 1973 the building was used to recover plutonium through incineration of plutonium-contaminated combustible wastes. The building housed an enclosed system of gloveboxes, and hoods, scrubber equipment and high-efficiency particulate air (HEPA) filters. As with most processes of this time, process upsets and decommissioning activities left a sizable amount of contamination on the walls, ceiling, and floors.

The building was 11.3 m (37 ft) wide and 17.4 m (57 ft) long. It is a single story over the process and storage areas and two stories over the service areas at the north end. The walls are of cinder block construction and the two roofs are respectively 4.6 m (15 ft)and 5.8 m (19 ft) above grade. The roofs are constructed of concrete over metal decking with insulation and built-up asphalt covering.

In 1999, the building was determined to pose a significant hazard and planning for deactivation and demolition began. This facility was located in an operating nuclear facility with hundreds of personnel located within 200 meters of the building. The building was sandwiched between three other buildings, the closest of which was only 4" away. Furthermore, there was no intention of impacting ongoing operations nor that the area and nearby buildings would be negatively impacted upon completion of demolition.

Deactivation and demolition requirements, methods and controls were reviewed in conjunction with air modeling results and impacts to adjacent operating facilities. Based on the dispersion results, it was determined that the total mass of TRU in the building would have to one gram or less to demolish the structure in an open air environment. This was accomplished by removing or dismantling specific pieces of the process system including some equipment and ductwork. In addition, the remaining surfaces of the interior of the structure would have to be encapsulated to minimize it from becoming airborne during demolition activities. An encapsulant that was used to fix contamination levels as high as one billion dpm/100cm². For these projects, the encapsulant Polymeric Barrier System ™ was used.

Demolition methods also had to consider the proximity of adjacent structures (some as close as a few inches) and methods of dust control. Due to the concern of water run off, it was determined that dust control had to consist of more than the typical wetting with a hose while dismantling the building, it also would have to consist of an integrated misting system. The misting system would consist of 3 components, a misting system installed on the end-effector of the excavator, a misting system installed on the adjacent structures, and a misting system installed on the building being demolished. Therefore, based on an overall evaluation, it was determined that with the hazards addressed and the appropriate deactivation and demolition controls implemented, that an open air demolition of a plutonium contaminated structure could take place safely and efficiently.

The planning consisted of reviewing all available alternatives and developing the overall best practice approach that would be safe, cost efficient, and meet the overall project objectives. Key components to the deactivation and demolition planning process included characterization, air modeling, demolition methods, and impact to adjacent operating facilities. In preparation for characterization, the building was divided into seven functional areas. This allowed each of the areas to be individually characterized using a graded approach based on the specifics of the processes, hazards, and activities that took place in each area. Extensive radiological sampling and NDA measurements were collected and analyzed to determine the amount and extent of contamination. The data was used to determine the extent and type of decontamination work required in each functional area to allow eventual open air demolition of the building and to determine waste disposal pathways. Based on the modeling data, the appropriate demolition method was identified which allowed the buildings to be demolished without having to fully decontaminate all surfaces.

Atmospheric dispersion modeling was conducted using ISC3-PRIME because of its ability to model meteorological data and adjacent obstacle wake effects specific to the building site. The modeling was used to estimate potential radiological contamination levels at various distances from the building based on contamination levels and demolition methods and controls.

The objective of the modeling was to define the potential levels of airborne and soil exposures at surrounding control boundaries. Potential hourly emissions rate of plutonium were estimated for the days with planned demolition and loading activities. An air-dispersion model was used to compute air and surface concentration boundaries for each day of operations, accounting for local building wake effects, atmospheric dispersion climatology, and particle size distribution. The modeling used hourly meteorological data collected over ten years to examine the effects of wind speed, direction, and stability on projected concentrations of contaminants in the air and deposited on nearby surfaces. Using the long-term, worst case weather averages for the time frame of the demolition provided concise, defendable, and conservative dispersion pattern and peak air exposure limits.

As part of the air modeling process, several phases of demolition were modeled such as demolition of the highest contaminated functional area and waste loading operations. The modeling results indicated that downwind deposition is the main limitation for demolition of a highly alpha-contaminated building. The main downwind deposition contribution came from debris load out into the roll off cans. With this information, the projects positioned control boundaries for the demolition that provided safe operating distances for the project workers and other operational (non project) personnel in the surrounding area.

During the dispersion modeling for 232-Z, lessons learned from the 233S D&D Project were used to adjust modeling assumptions in accordance with actual data.

Primary areas adjusted included effectiveness of water misting during demolition and effectiveness of fixative applied prior to demolition and load out methods. After completion of 232-Z, post modeling was performed using actual survey and air monitoring result. Additional adjustments were identified that will be used in future modeling to make the predicted exposures be more consistent with the monitoring data.

Noteworthy lessons that can be applied to future demolition activities are key to improving on the existing process. The lessons found to be noteworthy are provided below.

- *Fixative Applications are Effective* – The fixing any smearable or removable contamination prior to the start of demolition proved effective. Furthermore, the fixatives applied during demolition, kept contamination locked down during loading and periods of inactivity.
- *Picking out a building among other buildings is difficult and more costly* – Selective demolition is more costly and time consuming due to adjacent facility protection, radiological contamination spread concerns, protection of non-demolition personnel, and mobilization/de-mobilization.
- *Waste Disposal Options tends to be limiting factor versus Dispersion Modeling Limitations* - In these demolition projects the Waste Acceptance Criteria of the onsite disposal facility was more limiting than the dispersion limitations.
- *Misting Devices and Water are Effective at Controlling Contamination* – The misting devices on and surround the building and on the shear controlled the dust and contamination. The fine mist performed well at capturing airborne particles and keeping them within the confines of our radiological boundaries. One down side to the misting is that during breezy periods, the effectiveness is reduced.
- *Dispersion Modeling Helped in Setting Radiological Boundaries and Provided a "Level of Comfort" for Plant Personnel* – The dispersion modeling supported our efforts to perform open air demolition, helped in setting boundary locations, picking demolition methods, and provided a "level of comfort" based on hold up and demolition methods. The modeling tends to be conservative; however, the project did revise the modeling inputs based on actual conditions for future use in dispersion modeling.
- *Removal of Highly Contaminated Debris Before the Remainder of the Building was Demolished Greatly Reduced the Potential for Contamination Spread* - By removing/packaging the highly contaminated material contained in the building before demolishing the remainder of the building reduces the potential for contamination spread, the contamination of the demolition equipment, and airborne concerns.

Conclusion

Open air demolition without decontamination to free release or near free release criteria, is safer, more cost effective and faster. Using conventional techniques and equipment in innovative ways produces tangible results.