WORKER PROTECTION AND TRANSPORTATION/PACKAGING ISSUES IN REMEDIATION OF AN ABANDONED SOURCE MANUFACTURING FACILITY

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ABSTRACT

Pangea Group was selected by the U.S. Army Corps of Engineers Kansas City District to perform the radiological decommissioning of a former radioactive material source manufacturing facility. The remediation of the site is being funded by the USEPA, Region 6. The EPA, the Texas Bureau of Radiation Control and the USACE Ft. Worth District will provide project oversight.

The former Gulf Nuclear facility, located in Odessa, Texas ceased operations in 1992, when the company declared bankruptcy. Cleanup of the site is being conducted as a removal action under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). The scope of the project includes the removal of abandoned radioactive material sources, contaminated soils and building debris. Dismantling and demolition of the facility, decontamination of selected building components, and transportation/disposal of contaminated and uncontaminated wastes are also part of the project.

Remediation of the site presents a number of unique challenges in terms of worker protection from external and internal exposure to radiation and radioactive materials. The primary radionuclides present at the site are Co-60, Cs-137 and Am-241. Smaller quantities of Ra-226 are also present as well as AmBe neutron sources.

This paper provides a discussion of the general approach to planning the implementation of the remediation of the site with emphasis on worker safety, waste treatment, waste minimization and transportation/disposal of the various radioactive wastes to be removed from the site.

INTRODUCTION

The Gulf Nuclear facility located in Odessa, Texas was abandoned in 1992. The facility was used for the production of radioactive sources used in oil/gas drilling and other industrial and medical applications since its startup in the early 1970’s. The facility was issued a license for operation by the Texas Department of Health, Bureau of Radiation Control (BRC).

In 1991, Gulf Nuclear ceased operations at another source manufacturing facility located in Webster, Texas, at which time radioactive materials from the Webster facility were shipped to the Odessa facility. It should be noted that the state of Texas has filed suit against the company, including one of the co-owners and several other individuals.

The facility consists of a 3000 square foot steel panel building located on a lot approximately 100’ by 220’. The building contains various drummed waste materials as well as manufacturing equipment, a waste compactor, lead pigs and other assorted equipment and debris. During its
operation, the facility was used for the production of sealed sources containing Am-241 and Cs-137 used in the evaluation of geological conditions during oil and gas drilling operations. Various other types of radioactive sources were also prepared at the site including sources using in nuclear medicine.

The USEPA Radiation and Indoor Environments (R&IE) National Laboratory, in conjunction with EPA Region 6 and the Texas BRC conducted a radiological characterization of the site in May 2000. Data from the characterization is presented in a report entitled *Interim Status Report, Gulf Nuclear Superfund Site, R&IE Assessment and Removal Project* issued in September 2000 (1). The report confirmed widespread contamination of the building, an underground septic system and soils adjacent to the building.

Based on the extent of contamination, it was evident that appropriate radioactive materials controls were lacking during the operation of the facility.

The objective of the remediation of the site is to remove the radioactive materials and radiological contamination at the facility in order to prevent further migration of contamination and to reduce the radiological risks present at the site for the protection of the public.

This paper addresses the key health physics and construction safety aspects of the project as well as waste treatment, packaging and transportation requirements applicable to the waste materials for compliance with applicable regulatory requirements.

**SUMMARY OF RADIOACTIVE MATERIALS AND CONTAMINATION**

The EPA characterization activity included identification of the radionuclides present at the facility with the use of a Berkeley Nucleonics SAM-935 portable gamma spectrometer. An on-site laboratory was also established for analysis of contamination wipe samples and wastes present at the site. Based on field measurements and/or laboratory analyses, activity estimates were made for all major containers and equipment located in the building. Removable surface contamination was measured using standard wipe samples and analysis via scintillation counting. Soil samples were collected using a 10’ x 20’ grid spacing over the entire portion of the lot and analyzed via gamma spectroscopy.

Due to the number of high activity sources in the building gamma dose rates were significantly elevated, particularly in areas where containerized materials had been staged from the initial characterization activities. External dose rates in the main building ranged from near background up to 130 mR/hr near some the containerized wastes.

The EPA R&IE characterization team identified the primary radionuclides present in drums and other containers and also the levels of surface contamination on various portions of the building. It was determined that Am-241 was the primary radiological contaminant on the building structures; whereas the primary nuclides present in the wastes containers were Co-60 and Cs-137 in addition to Am-241.
Appendix A provides a listing of the major types of wastes present in the building, including an estimate of the quantities of contaminated building materials.

The EPA characterization report indicated that Am-241 surface contamination was present in the building. Removable surface contamination levels ranged up to 20,000 dpm on standard wipe samples, significantly above the release limit of 20 dpm/100 cm$^2$ criterion specified in NRC Regulatory Guide 1.86.

Soil sampling indicated the presence of Am-241, Co-60 and Cs-137; however only Am-241 was present in excess of the cleanup levels established by the State and EPA. Approximately 40 cubic yards of soil are estimated to require removal, to a maximum depth of 1 foot below grade.

Wastewaters from the main building drained to a septic system located on the west side of the building. Sampling of the septic system resulted in the detection of Cs-137 in the sludge; however no radiological contamination was present in the water contained in the septic tank.

WORK SEQUENCE

The following is a summary of the general sequence for the major phases of the remediation project and the basis for the sequence.

Mobilization and Site Preparation (Clean Work)

Site preparation activities will include preparation of the site for the remediation activities. This includes installation of temporary office and personal decontamination facilities and connection of utilities for phone, water and electrical. A decontamination pad will be constructed to permit decontamination of equipment and collection of water from pressure washing activities. Air monitoring stations will be established for collection of work area perimeter air samples.

Characterization and Removal Activities

Drummed wastes not requiring treatment will be removed from the building and storage room “lean-to” structure located adjacent to the main building structure. The wastes will be loaded into roll-off containers and staged onsite for subsequent pickup and transportation for offsite disposal.

Wastes requiring treatment or special preparation prior to offsite transportation and disposal will be relocated to the north staging area where such activities will be performed. Wastes requiring special treatment or preparation include sealed sources, lead shot and various liquid waste materials.

Removal of the contaminated soils on the north and east sides of the building will begin. After the first foot of soil is removed, walkover surveys will be performed and soil samples will be collected to verify that the cleanup criterion of 6 pCi/g of Am-241 has been attained.
Concurrently with the soil removal activities, another crew will begin removing contaminated materials from within the building. Items to be removed will include contaminated insulation materials, wood, small equipment and other items that are presumed to be significantly contaminated and not amenable to decontamination. Spot radiological characterization surveys will be performed during this activity to confirm those building components likely to be releasable as-is or by using conventional pressure washing decontamination methods.

Contaminated soils and equipment/debris removed from the building will be placed into roll-off containers and staged for offsite shipment.

**Building Washdown**

Following removal of all major equipment, debris and non-load bearing walls, the building will be prepared for a final wash-down. This will require installation of a containment system consisting of plastic sheeting attached to the lower edges of the interior walls to allow wash water to be retained within the building. Temporary berms will also be installed to aid in retention of water within the building. The building will then be pressure washed from the top down using a manlift inside the building. Wash water will be collected and pumped to the decon pad sump.

**Removal and Decontamination of Building Components**

Building components determined (based on characterization surveys) to be releasable using conventional pressure-washing methods, such as roof and siding panels, will be removed by dismantling and staged at the decon pad.

These materials will be removed in such a manner as to prevent major damage or distortion to allow the surfaces to be fully and safely accessed for surveying. At the decon pad, technicians will conduct radiological surveys to verify the items meet release criteria. Building components not meeting release criteria will be pressure washed and resurveyed prior to release for recycling or disposal as non-radioactive material.

**Building Demolition**

After those components amenable to decontamination have been removed from the building and staged at the decon pad, the remaining structures will be demolished using conventional demolition methods. A grapple will be used to pull out structural steel for staging at the decon pad where it will be pressure-washed and surveyed for radiological contamination. Remaining debris will be loaded into roll-off containers and transported offsite for disposal as radwaste.

**Decontamination and Removal of Concrete Slab and Septic Systems**

After the building superstructure is removed, the building foundation will be available for decontamination and the septic systems will be accessible for removal.
The concrete building slab will be decontaminated with a scarifier with attached HEPA vacuum. Concrete dust collected in the HEPA vacuum will be disposed as radioactive waste. The scarified concrete surface will be subjected to a final release survey using the MARSSIM guidelines. Upon a determination that the slab is releasable, it will be broken up with a hoe-ram, and loaded with a front-end loader and placed in haul trucks for offsite release.

The septic tanks and sludges will then be removed and disposed as radwaste. It is assumed that dry soils will be required to be mixed with the sludges to meet the disposal facility’s moisture requirements. An appropriate quantity of contaminated soil will be retained onsite for this purpose.

Following removal of the slab and the septic systems, confirmatory walkover surveys and soil sampling will be performed to verify that residual soils meet release limits.

**Site Restoration/Demobilization**

Following removal of the concrete slab and septic systems final equipment decontamination will be completed and all remaining contaminated water will be treated. The decon pad will be removed and any remaining contaminated materials will be excavated and containerized. Following removal of the decon pad, a confirmatory walkover survey (and, if necessary soil sampling) will be performed to verify no residual contamination above release criteria exists.

The site will be backfilled, graded and seeded. Utilities will be disconnected and trailers and support equipment will be demobilized.

**WORKER PROTECTION ISSUES**

This section provides a discussion of the major health and safety aspects of the project. Construction safety and health physics aspects of the project are discussed in the following sections.

**Construction Safety**

Consideration of construction safety hazards and preventive measures is a key component in the planning the remediation of the Gulf Nuclear remediation project.

From the standpoint of construction safety, demolition of the building using conventional demolition equipment, such as a tracked excavator with a grapple attachment, is preferable to dismantling, due to the fact that the conventional demolition approach allows keeping personnel a greater distance from the hazardous conditions. Dismantling, on the other hand, generally requires more “hands-on” work in closer proximity to the hazards, thereby increasing the risk of injury.

Dismantling of the roofing and siding panels by manual means will be necessary to allow the panel surfaces to be kept intact (without significant damage/distortion) so they may be surveyed for radiological contamination prior to release from the site. Special fall protection measures
will be necessary to conduct this operation safely. Following removal of the roofing panels, the building will be demolished with the use the excavator/grappler.

Other construction safety hazards of special concern include hazards associated with heavy equipment traffic, materials handling, use of pressure-washing equipment, use of man lifts and heat stress. These hazards will be addressed in the Site Safety and Health Plan and appropriate controls will be implemented on the job site.

**Control of External Dose**

One of the primary measures for reducing radiation dose to workers from exposure to penetrating radiation will be removal of the sources and highly contaminated manufacturing equipment presently stored in the building.

A key measure to reduce external dose will be to remove high gamma emitting wastes to a remote location where they will be treated and prepared for offsite shipment. A forklift will be used to remove these materials from the building. These containers will be relocated to a staging area located in an offsite building approximately 200 feet to the north of the Gulf Nuclear site. One staged at that location, additional shielding may be used and access will be limited to prevent unnecessary exposures and stay time limits will be implemented to reduce external dose.

Based on existing dose rate measurements and expected material handling requirements, a project-specific administrative limit of 400 mrem Total Effective Dose Equivalent (TEDE) has been developed for the project. External exposures will be monitored on a routine basis by measurement of work area dose rates. In addition, all site workers will wear TLDs that will be changed out and analyzed at two-week intervals.

**Control of Internal Dose**

There will be significant potential for internal dose during the course of this remediation project. The most limiting radionuclide, from the standpoint of internal dose, is Am-241, which is known to be present as a removable contaminant on surfaces throughout the facility. The Derived Air Concentration for Am-241 is 1 E-14 µCi/ml, which is significantly more limiting than the Derived Air Concentrations (DACs) for Co-60 or Cs-137.

The primary methods to be used for protection against inhalation of airborne radioactivity will be the use of powered air purifying respirators (PAPRs), removal of loose contamination where practical, and use of water misting for suppression of airborne dust.

Initial work activities in the building, including removal and containerization of equipment will be performed using PAPRs with HEPA cartridges and protective clothing. The PAPRs provide a protection factor of 1000 per 10 CFR 20. All personnel will be fit-tested using quantitative methods to verify that the fit factor is satisfactory prior to respirator issuance. Equipment will also be wetted to minimize the generation of airborne dust.
Second, following removal of all major equipment from the building, the entire structure will be washed from the top down using pressure-washing equipment. This will reduce exposure to personnel performing follow-on activities including building dismantling and demolition operations.

Internal exposures will be limited to a less 50 mrem Committed Effective Dose Equivalent (CEDE) per individual. Internal doses will be monitored with the use of daily personal breathing zone air sampling coupled with monthly urine bioassays. As stated above, the administrative limit for the project is 400 mrem TEDE.

TRANSPORTATION AND DISPOSAL ISSUES

This section provides a discussion of the major waste management aspects of the project. Waste minimization and associated cost impacts, waste classifications for disposal, and Dept. of Transportation (DOT) Hazardous Materials Regulations (HMRs) are discussed below.

Waste Minimization/Cost Issues

Due to limitations in the scope of the characterization of the site, a number of key assumptions were required with regard to whether various building components could be cost-effectively decontaminated. The following assumptions were made:

1. Steel siding and roofing panels are assumed to releasable after a single pass with a pressure washer.
2. Steel building columns and the concrete foundation are assumed to be releasable after two passes with a pressure washer.
3. Interior walls and production equipment stored inside the building are assumed to require extensive decontamination and would therefore not be cost effective to decontaminate.

Once mobilized to the site, the practicality and cost-effectiveness of decontamination, survey and release will be further evaluated. The trade-off of labor costs for decontamination versus transportation/disposal costs to a remote disposal site (Envirocare) will determine how much of the material should be subjected to decontamination.

Waste Classification/Disposal

The bulk of the waste volume consists of contaminated soils, sludges, and building debris that meet the NRC criteria for Class A wastes. These wastes will be disposed at the Envirocare facility in Clive, Utah under an existing contract with the USACE.

Several radioactive sources are also present at the site that exceed NRC Class A criteria and therefore cannot be accepted at any of the LLRW disposal facilities under contract with the USACE. These sources, including several high-activity sources of Co-60 and Cs-137, will be transported to the GTS Duratek disposal facility in Barnwell, S.C.
There were also two Am/Be neutron sources present at the site. No LLRW disposal facilities currently accept these types of sources. Per DOE sources at Los Alamos National Laboratory, these sources may be accepted in the future at the DOE WIPP Site in Carlsbad, New Mexico however they currently will not accept them. Interim disposition of these sources is unknown at this time.

**DOT HMR Compliance**

As described above, high dose rate materials will be removed to a nearby staging area to reduce the external radiation hazard to workers engaged in the remediation of the structure itself. This will provide the opportunity to perform the wastes treatment operations in an area remote from the primary site cleanup activities. It will also allow the contractor to determine the optimum number and arrangement of the various containers in order to meet DOT dose rate limitations for the radioactive material shipments.

Contaminated soils and building debris/rubble will be placed in roll-off containers and staged in an uncontaminated area on the site where dose rate measurements will be taken. A portable gamma spectrometer unit will be used to evaluate the dose rates and to quantify the activities of the major nuclides present in the wastes. This information will be used to complete the DOT Hazard Class determination as well as the hazardous waste manifest and waste profile documents required for each shipment.

**SUMMARY AND CONCLUSIONS**

Remediation of the Gulf Nuclear Project presents special challenges in the areas of worker protection, contamination control, waste treatment, transportation and disposal. Project planning and scheduling requires consideration of these factors to incorporate ALARA principles and to ensure compliance with applicable regulations and guidelines. Key considerations in the planning of the project to account for these factors are summarized below.

Removal of major sources of external radiation is necessary to limit personnel exposures and to stage those materials requiring special treatment to be necessary to allow subsequent work to proceed. Special requirements to limit external dose such as shielding and stay time limits are then applicable to a smaller number of site workers.

Staging of high activity sources also provides an opportunity to evaluate packaging/shielding requirements and to determine optimum positioning of the wastes on the transport vehicle to ensure DOT limitations are met prior to actual loading of the materials onto the vehicle(s).

Methods for removal of those building components considered amenable to decontamination must maintain the building components intact in order that they may be safely accessed and thoroughly surveyed to allow release for unrestricted use.

There is an increased risk of falls and other construction hazards when dismantling building components intact vs. demolition with heavy equipment such as an excavator with a grappler
attachment. Control measures to protect the workers from these hazards must be carefully planned and implemented.

Finally, realistic administrative dose limits should be developed based on an assessment of the types and concentrations of the radioactive materials to be handled and the scope and duration of activities required to handle and treat the materials prior to disposal.

REFERENCES

(1) U.S. Environmental Protection Agency “Interim Status Report, Gulf Nuclear Superfund Site, R&IE Assessment and Removal Project, May 1-12, 2000”, undated.
APPENDIX A
SUMMARY OF RADIOACTIVE MATERIALS AT THE GULF NUCLEAR FACILITY

Misc. Contaminated Equipment in Main Building
Items Contain Surface Contamination or are Volumetrically Contaminated with Co-60, Cs-137, Ra-226, and/or Am-241)

Estimated Volume: 55 cu yd

Lead and Steel Pigs/Calibrators/Other Drummed Materials in Main Building
Lead pigs to be encapsulated in cement or other appropriate media.

Estimated Volume: 7 cu yd

Lead Shot (to be encapsulated in cement or other appropriate media)
Contaminated with Cs-137, specific activity concentrations not reported.

Estimated Volume: 4 cu yd

Radioactive Sources and Other Drummed Wastes in Bldg Lean-To
Information on isotopes present and adjacent exposure rates is identified in EPA Report

Estimated Volume: 10 cu yd

Septic Tank Sludge
Maximum activities are as follows:
- Cs-137 – 18 pCi/g
- Am-241 – 109 pCi/g
- Co-60 – < 0.4 pCi/g

Estimated Volume: 95 cu yd

Contaminated Soils
Maximum activities are as follows:
- Cs-137 – 9 pCi/g
- Am-241 – 25 pCi/g
- Co-60 – 3 pCi/g

Estimated Volume: 40 cu yd

7. Contaminated Building Debris (cinder block, wood, metal, insulation, etc.)
Estimated Volume: 233 cu yd

8. Contaminated Concrete
Estimated Volume: 70 cu yd

Estimated Total Volume: 507 cu yd