Lessons Learned from Shut-Down to Decommissioning Plan at the Army Pulse Radiation Facility

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ABSTRACT

The Army Pulse Radiation Facility (APRF) test and research reactor was established in 1967 to serve the needs of the U.S. Department of Defense (DoD), various U.S. Government agencies, and the North Atlantic Treaty Organization (NATO) for the evaluation of problems involving neutron and gamma radiation. The Army ceased APRF reactor operations in December 2003.

The Army is decommissioning the remaining buildings, reactor handling package, and other equipment at the former APRF at Aberdeen Proving Ground (APG), Maryland. The facility was used both in the irradiation of electronics with neutrons and gamma rays to ensure survivability, and as a source of radiation for air-over-ground radiation transport. The main working component of the APRF was a mobile fast-burst reactor (FBR). This portion of the facility was designed to produce neutron and gamma radiation in either a short burst ("pulsed") or at lower power levels for steady state operations. The FBR was supplemented with a four megavolt flash X-ray machine, which was operated independently or in concert with the FBR. In addition to the major radiation generators associated with the Reactor Building, numerous gamma sealed sources, neutron sealed sources, and neutron generators were used during the course of routine operations. Two large fixed gamma radiation sources were maintained and used at a laboratory building located at the outer security fence. Small amounts of radioactive material were occasionally used in tests conducted at the facility. The APRF operated under U.S. Nuclear Regulatory Commission (NRC) licenses, an Army Radioactive Material Authorization, and an Army Reactor Permit.

The APRF team was tasked with performing an All Hazards Assessment (AHA) of the APRF to fulfill responsibilities of the Army Reactor Program. The AHA is intended to identify the chemical, radiological, and other hazards that exist at the APRF, and to identify means of reducing these hazards to the extent that will permit the facility to achieve the desired end state, which is the free release of the APRF from further regulatory control.

INTRODUCTION

Army Regulation (AR) 50-7, Army Reactor Program (ARP) establishes Department of the Army (DA) policies, assigns responsibilities, and prescribes procedures for the ARP. The purpose of the ARP is to ensure that Army reactors are operated in a safe, secure, and reliable manner from activation through decommissioning. In accordance with AR 50-7, the Headquarters US Army Developmental Test Command (DTC) was assigned APRF decommissioning program management oversight. Among other things, the regulation assigns the Commander, U.S. Army Corps of Engineers (USACE) as the single point of contact at Headquarters, Department of the Army (HQDA) for nuclear reactor engineering and design, reactor construction, and decommissioning design and implementation.

As part of its responsibilities under the Army Reactor Program, the USACE developed and implemented the approach to assess all hazards that remain at a deactivated reactor. The All Hazards Assessment (AHA) is intended to identify the chemical, radiological, and other hazards that exist at a deactivated reactor, and to identify means of reducing these hazards to the extent that will permit the facility to achieve the desired end state. This objective is planned to be achieved in a four-phased effort:

- Phase I – Review historical design, operations, and surveillance related documents in order to prepare: Data Quality Objectives (DQOs) for a hazards assessment/characterization survey of each facility; an activation analysis to estimate radionuclide concentrations; and a Historical Site Assessment (HSA) identifying those areas of a facility that are impacted by residual radioactive contamination and those that may contain other hazardous materials, and other information necessary to meet the desired end state.
- Phase II – Conduct characterization surveys including radiological and non-radiological sampling and analysis, hazards assessment, disposal alternatives evaluation, and cost estimates for the decommissioning of a facility and associated waste disposal.
- Phase III – Development of the decommissioning plan and design documents, execution of the designs, disposal of identified hazardous and radioactive waste, and the transfer of radioactive material.
- Phase IV – Implement the Final Status Survey (FSS) and prepare all necessary correspondence to have the Army Reactor Office (ARO) Permit terminated. This phase will also ensure that any additional requirements for environmental compliance at facilities are complete.

APRF BACKGROUND

The APRF test and research reactor was established in 1967 to serve the needs of the U.S. Army, DoD, various U.S. Government agencies, and the North Atlantic Treaty Organization (NATO) for the evaluation of problems involving neutron and gamma radiation.

The facility is located at APG and was an operational element under the U.S. Army Test and Evaluation Command. The APRF utilized a large variety of radiation sources, with low to high intensities, producing alpha, beta-gamma, and neutron radiation. The source of radiation may have been sealed source radioisotopes or may have been produced by specialized equipment. Work associated with this facility supported radiological safety and protection for soldiers and radiation-effects testing on a variety of components and systems. The main working component of the APRF mobile fast-burst reactor was a bare unreflected and unmoderated cylindrical assembly of enriched uranium enclosed in an aluminum silo approximately 30 meters in diameter and 20 meters in height. This portion of the facility was designed to produce neutron radiation in either a short burst ("pulsed"), or at lower power levels for steady state operations. The reactor was suspended from a transporter device that allowed it to be moved to a number of experimental stations within the silo as well as being set up for external operations. For gamma radiation, the reactor was supplemented with a Four Megavolt flash X-ray machine, which was operated independently or in concert with the reactor. The APRF was operated within the ARP under permit from the Army Reactor Office (ARO). The APRF was not subject to regulation of the Atomic Energy Agency or Nuclear Regulatory Commission due to the provisions set forth in Sections 91(b) and 110(b) of the Atomic Energy Act of 1954, which exempted the Department of Defense from requirements to license atomic weapons, utilization facilities, and special nuclear materials (SNM) related to these facilities used for military purposes. A nuclear reactor such as the APRF was a utilization facility because it used SNM for atomic energy in such quantity as to be of significance to the common defense and security. As a result, the APRF reactor itself, the SNM that fueled the reactor, and the facilities and materials that were or became radioactive due to exposure to neutron fields produced by the reactor, are regulated under permits by the ARO as 91(b) materials.

In addition to the major radiation generators associated with the Reactor Building, numerous gamma sealed sources, neutron sealed sources, and neutron generators were used during the course of routine operations. Two large fixed radiation sources were maintained and used at a laboratory building located some distance from the main reactor complex. These minor sources were used either under a specific NRC License and/or an Army Radiation Authorization.

Although the ARO administers all 91(b) permitted activities in a regulatory capacity, the regulations and policies enforced by the ARO are consistent with NRC regulations (10CFR20, etc.). The Department of the Army Safety Office implements the Army Safety Program in accordance with AR 385-10 and publishes safety pamphlets (DA PAM series) that implement these regulations on all US Army sites. DA-PAM 385-24, *The Army Radiation Safety Program*, outlines radiation safety regulations and protocols that Army facilities implement and comply with. The Army's reference to guidance issued by the NRC ensures that any data collected to supports the termination of the Army Reactor Permit. can be used in the future to support the termination of any NRC license where radioactive material may have been used to support activities at the APRF complex.

APRF SITE DESCRIPTION

The APRF is located on a tract of land near the center of APG and consists of three separate main buildings (Building 860, Reactor and Control Building 861, and Building 862), including one subsurface building (Control Building 861), and surrounding Outdoor Areas with a total area of approximately 4.95 million square meters (m^2), or 1,200 acres. Three concentric security fences exist surrounding the APRF site. The outer fence runs along the perimeter of the APRF site, excluding Building 860, and is located approximately 1,372 m from the center of Reactor Building 861. The middle fence stands within the 1,372 m fence at approximately 411 m from the center of Reactor Building 861. The inner 100 meters is surrounded by a double fence with an approximate thirty-foot separation. These fences surround the perimeter of Buildings 861 and 862. Figure 1 depicts the APRF site.

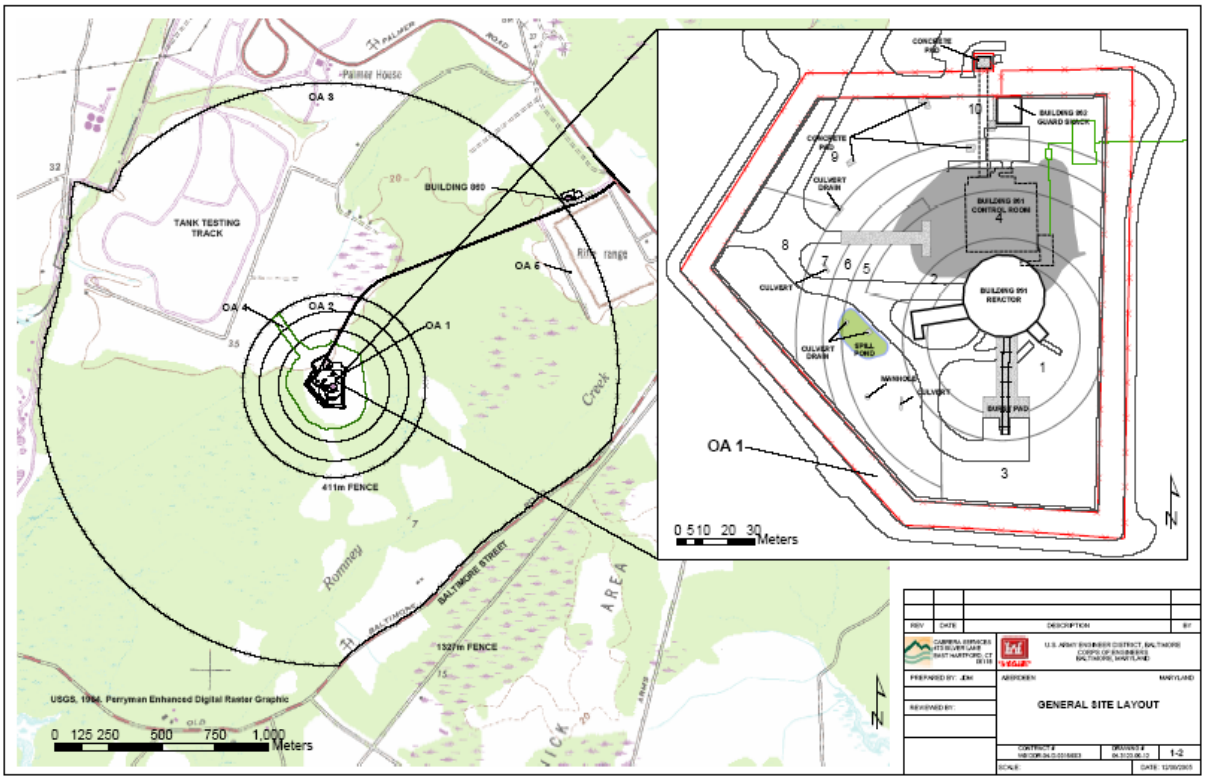

Figure 1 – APRF Site with an expanded view of the inner 100 meter fence

PHASE I – ALL HAZARDS ASSESSMENT

Deactivation and Source Term Removal

In 2003, the U.S. Army determined that the operation of the APRF would cease. The U.S. Army Developmental Test Command (DTC) understood that a key element in the decommissioning process was to relocate the reactor fuel and other radioactive source term. The removal of these radioactive sources would be required prior to the implementation of any characterization activities at the APRF. The reactor fuel was originally supplied by and owned by the U.S. Department of Energy (DOE). The U.S.

Army and DTC requested that the DOE make preparations for the retrieval of the fuel. The DTC identified additional radioactive source term and either relocated the material to other Army activities or staged certain materials for disposal during the decommissioning implementation.

Historical Site Assessment

As part of the All Hazards Assessment, the type and location of potential hazards at the facility and the surrounding environment was evaluated to determine potential impact to human health and the environment. Because of the nature of operations at the APRF, the greatest hazard potential is the presence of radioactive materials that remain at the facility either as source materials, fission products, or neutron induced radioactivity (activation). The HSA evaluated the past and current placement/use of radioactive and other hazardous materials at the APRF. It provided recommendations for characterization activities necessary to develop a decommissioning plan. The evaluation was performed in 2004, based on a review of written records pertaining to operation and maintenance of the facility, interviews with knowledgeable facility personnel, examination of the Nuclear Regulatory Commission (NRC) and Army permits and licenses, building and exterior ground walkthroughs, and neutron activation analysis associated with potentially activated building materials and soils. The HSA evaluated the impact of APRF use of radioactive materials in numerous forms and quantities during operations.

The Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) was the primary guidance document for conducting the studies leading to the decommissioning plan. In accordance with the MARSSIM, the HSA accomplished the following:

1. Determined which parts of the facility have been impacted (and non-impacted) by previous operations.
2. Identified current potential sources of radiological and hazardous contamination.
3. Assessed potential migration of contaminants.
4. Provided input into decisions to perform scoping and characterization surveys.
5. Determined if the site is a potential threat to human health and/or the environment.
6. Identified if there are additional potential radiation sites related to the site.

Based on the HSA results, all of the buildings and all of the outdoor areas were impacted by operations. The information presented in the HSA was used to develop an initial conceptual site model which supports:

1. The assessment of the nature and extent of contamination.
2. The determination of areas and media to be sampled, and
3. The development of strategies for data collection.

The information presented in the HSA also included initial classification of areas in accordance with the MARSSIM guidance. At this point in the process, the conceptual

site model should be considered a living document to be updated as additional information becomes available throughout the investigation process.

Technical Project Planning

The Technical Project Planning (TPP) process is a comprehensive and systematic process that involves four phases of planning activities. The TPP Process was developed for identifying project objectives and designing data collection programs for hazardous, toxic, and radioactive waste (HTRW) sites. Use of the TPP Process is consistent with the philosophy of taking a graded approach to planning that will produce the type and quality of results needed for site-specific decision making. In general, the four phases are defined below;

- Phase I – Identify Current Project
- Phase II – Determine Data Needs
- Phase III – Develop Data Collection Options
- Phase IV – Finalize Data Collection Program

The first phase of the TPP process was essentially eliminated because the APRF Decommissioning Project was identified by the Department of the Army's decision to close the facility. In July 2004, during the second phase of the TPP process, the APRF Decommissioning Project Managers brought together several phases of the TPP process into a multi-day meeting with technical personnel and decision makers/managers from all stakeholder organizations involved with the APRF Decommissioning. The meeting was held after completion of the Draft HSA (prior to finalization) and prior to the development of the characterization work plan. Day one of the meeting focused on each stakeholder organization's goals and objectives that would lead to project close out. Day two of the meeting was focused on the technical issues. Each specific area of concern was reviewed to identify project objectives for that area, radiological and chemical constituents of concern, media of interest, health and safety concerns, sampling and analysis methods, and the need for additional information.

PHASE II – ALL HAZARDS ASSESSMENT

Characterization Planning

The information from the TPP meeting was used to develop site specific data quality objectives and work plans for the characterization efforts at the APRF. During the TPP meeting, each stakeholder committed to providing review and comments to the draft documents. All comments were considered, responses provided, and characterization work plans were finalized with all parties intimately involved in the process.

One key topic identified in the TPP meeting was the need for the 1,200 acres of real property that would be made available upon the closure and release of the APRF and the

additional mission requirements being placed on the APG due to the Defense Base Closure and Realignment (BRAC). These additional mission requirements emphasized the need to release as much of the property for new usage, as soon as possible. With that in mind, the team designed an approach that would characterize the APRF with data that would be of sufficient quality and quantity to meet the more rigorous requirements of a MARSSIM Final Status Survey. This approach was only used for areas identified in the HSA to have low levels of residual radioactivity that could meet the NRC screening criteria for free release. A majority of the APRF property met these requirements, with the exception of the reactor building.

Characterization Efforts

The Characterization efforts were conducted from July to October 2005 in accordance with Site Work Plans, which consisted of the Field Sampling Plan, Quality Assurance Project Plan, Accident Prevention Plan, and Unexploded Ordnance (UXO) Avoidance Plan. The efforts were documented in a Characterization Survey Report. The report was used to support development of a Decommissioning Plan, in accordance with Army and NRC regulations and guidance. This Characterization Survey Report presented the nature and extent of site hazardous materials, focused especially on radiological contaminants. The APRF Conceptual Site Model was revised, based on the model originally presented in the HSA. The Characterization Survey gathered close to 10,000 pages of data that was finalized in a Characterization Report in July 2006. It would be used to prepare the decommissioning plan.

Technical Project Planning

The AHA is intended to identify the chemical, radiological, and other hazards that exist at the APRF, and to identify means of reducing these hazards to the extent that will permit the facility to achieve free release for unrestricted use. A second two day TPP meeting was held in May of 2007, with all stakeholders to review the data collected, identify any data gaps, and discuss the requirements to meet all needs for project closeout. Once again, both technical personnel and decision makers/managers were present to review the results of the characterization efforts, review the National Environmental Policy Act (NEPA) documentation completed by the DTC and APG, and to be presented with information developed for a Draft Decommissioning Plan.

This TPP meeting identified data gaps associated with the survey of the outdoor areas that would need to be addressed prior to the presentation of the Decommissioning Plan. During the meeting, there was a significant focus on the disposal options for the waste material that could be generated from the decommissioning activities. The majority of the waste was characterized as low activity activation products; which was generated from the activities operated under provisions set forth in Sections 91(b) and 110(b) of the Atomic Energy Act of 1954. This act exempted the Department of Defense from requirements to license atomic weapons, utilization facilities, and special nuclear materials (SNM) related to these facilities used for military purposes. Based on these findings, the USACE reviewed potential alternative disposal options. The options to be considered in the decommissioning planning were segregation and disposal of low

activity materials at a Resource Conservation and Recovery Act (RCRA) facility, as well as, disposal of higher activity materials at a DOE facility. It also identified the preferred approach for the NEPA Environmental Assessment and Decommissioning Plan to address the release of areas that complied with the MARSSIM requirements for Final Status Survey.

PHASE III – ALL HAZARDS ASSESSMENT

Decommissioning Planning

The final NEPA Environmental Assessment was completed by DTC and APG in June 2008. The Decommissioning Plan was developed in accordance with guidance from NUREG 1757 Volume 2, Consolidated Decommissioning Guidance and presented to the ARO and approved via the Decommissioning Permit APG-01-08 on 31 May 2008. There were specific requirements set fourth in the Decommissioning Permit. Significant permit requirements are identified below:

- This permit applies to all property and buildings inside APRF's 100 meter fence, the adjoining parking lot, and Room 21 of Building 860. This permit denies any dual use of any ARO permitted property or buildings. ARC approval is required before restoration activities to ARO permitted property and buildings may occur.

- The APRF Final Characterization Report data satisfies the requirements of a MARSSIM final status survey and demonstrates that the unrestricted release criteria for areas beyond the 100 meter fence have been achieved. This permit releases all property outside the 100 meter fence and Building 860, except for the APRF parking lot immediately outside the 100 meter fence and Room 21 of Building 860 from ARO permit oversight. The submission of a Final Status Survey to the ARO is required for the release of Building 860, Room 21.

- DTC shall provide the ARC with a risk based analysis for any waste disposal decision that deviates from the disposal in a licensed low-level radioactive waste disposal facility. The risk based analysis and disposal plan shall be submitted to the ARC for review and approval.

Decommissioning Implementation

The DTC teamed with the USACE Baltimore District to select a contract award for the decommissioning of the APRF. The USACE Baltimore District had a multiple award radiological services contract with five preselected contractors that competed for the design and implementation of the APRF decommissioning. The contract was awarded in September 2008 for the decommissioning of the APRF and included the development of the design for the demolition of the APRF Reactor Building, development of alternative disposal approach, and restoration of the site.

PHASE IV – ALL HAZARDS ASSESSMENT

This phase consists of the implementation of the Final Status Survey (FSS) and preparation of all necessary correspondence to have the Army Reactor Office (ARO) Permit terminated. This phase will also ensure that any additional requirements for the environmental compliance at facilities are complete.

LESSONS LEARNED

Technical Project Planning

Use of the TPP Process ensures effective and efficient progress to site closeout within all project constraints. Use of the TPP Process saves resources by reducing both the project duration and the project expenditures. Application of the TPP Process assisted in completing the EPA's 7-Step Data Quality Objective (DQO) Process. The key concepts of the TPP process are identified below.

- Site Closeout is achieving the "walk away goal," or final condition of a site, as envisioned by the customer. The team develops an effective site closeout statement after considering future land use; the site's regulatory compliance status and issues; and the customer's preferences for the final condition of the site.

- Project Objectives must be satisfied or resolved in order to progress from the current site status and condition to site closeout. Phase I efforts to identify and clearly document project objectives ensure that site-specific regulatory issues and environmental conditions are successfully addressed.

- Basic, Optimum, and Excessive are very powerful terms used for classifying project objectives, grouping data needs, and presenting data collection options for a customer's consideration.

- Data Quality Objective (DQO) statements are prepared during Phase IV, include nine data quality requirements, and meet EPA's definition of a DQO.

The TPP process was utilized at multiple phases during the APRF decommissioning process. The TPP process identified the data required to meet the regulators requirements for release of a large portion of the property early on in the decommissioning process by bringing the stakeholders into the process at the beginning of the project. The TPP process also identified the potential for the project to achieve significant cost savings with an alternative disposal approach for the waste generated from the decommissioning of the APRF.

Characterization to Meet Release

During the AHA Phase I TPP meeting, the APRF site was identified by several stakeholders as a potential property to be utilized by one of multiple agencies that were relocating to the APG as a part of the BRAC. With the understanding that the BRAC

implementation plan was more aggressive than that of the APRF decommissioning, the team agreed that the site characterization data would be utilized for not only the evaluation of site conditions, but would also be designed and utilized to demonstrate compliance with release criteria in accordance with MARSSIM Final Status Survey guidance. This approach was used for areas of the site where residual levels of radioactivity were expected to be low and compliance with applicable release criteria may be met without need for remediation.

During the AHA Phase II TPP meeting, several data gaps were identified in areas that were being considered for release. An additional sampling event was conducted to address the identified data gaps. Upon review of the additional data collected, all areas where residual radioactivity was expected to meet the applicable release criteria were presented in the decommissioning plan and released by the Decommissioning Permit APG 01-08 issued 31 May 2008. The permit released over 95% of the property for reuse by Army agencies relocating to APG under BRAC.

Alternative Waste Disposal

The USACE Baltimore District prepared an evaluation in support of alternate waste disposal procedures in accordance with provisions in 10 CFR 20.2002. The evaluation considers alternative disposal of soils, concrete, and metal debris contaminated with low levels of radioactive material at a RCRA permitted facility. The purpose of this evaluation is to support the DTC request of ARO approval for disposal of certain APRF contaminated materials at an authorized facility. The ARO reviewed DTC's request for alternate disposal and concluded that the exposure scenarios conservatively estimated the exposures to be less than 1 mrem total dose per year. The evaluation stated:

1. The permit holder adequately demonstrated that the alternative disposal approach meets the criteria established in DA PAM 385-24.
2. If this activity were a NRC regulated activity, it would meet the criteria for disposal under 10 CFR 20.2002.

Furthermore, the alternative disposal analysis demonstrates that the material is exempt from further Atomic Energy Act or Army Permit requirements. The APRF team provided the evaluation to the RCRA facility regulators and received approval for disposal of the APRF waste stream.

CONCLUSION

The APRF decommissioning project used the TPP process, which is a critical component of USACE's quality management system that conforms to the American National Standard for planning the collection and evaluation of environmental data. The systematic TPP Process enables a project manager to achieve an appropriate balance of project execution styles within a team, accelerate progress to site closeout, and reduce expensive time and efforts. The efforts allowed for a significant portion of the APRF real property to be released for use by APG and agencies being relocated under the BRAC. Additionally, the APRF project realized significant cost savings through the identification

and approval of alternative waste disposal methods from the APRF decommissioning activities.

REFERENCE

AR 50-7, Army Regulation: Army Reactor Program, (March 2009)

AR 385-10, Army Regulation: Army Safety Program, (September 2009)

DA PAM 385-24, Department of the Army Pamphlet; Army Radiation Safety Program, (March 2009)

EM 200-1-2, Engineering Manual: Technical Project Planning Process, (August 1998)

NUREG-1575, Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), EPA 402-4-97-016, (December 1997)

NUREG-1757, Vol. 2, Consolidated Decommissioning Guidance: Characterization, Survey, and Determination of Radiological Criteria, (October 2006)