

## 2-7 STATUS OF ENVIRONMENTAL RESPONSE EFFORTS AT RADIOACTIVELY CONTAMINATED SITES IN THE UNITED STATES AIR FORCE INSTALLATION RESTORATION PROGRAM

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### ABSTRACT

The United States Air Force has identified approximately 170 radioactively contaminated sites at its domestic installations. These sites contain a variety of low level radioactive and mixed wastes and are classified as burial sites, landfills, buildings, and other disposal sites. Of these 170, approximately 70 are presently being evaluated under the Air Force Installation Restoration Program (IRP) in accordance with applicable laws and regulations. Removal and/or remedial actions have been taken at specific sites using site-specific residual radioactivity criteria. The remaining sites are either under investigation to determine the need for possible action or have been classified as response complete based on restricted or unrestricted future use. This paper describes past Air Force operations that generated radioactive waste materials; examines the current inventory of resulting radioactively contaminated sites in the Air Force IRP; reviews criteria used to evaluate sites for removal and/or remedial actions; provides summary information on actions taken at sites; and focuses on response actions and cleanup levels at two completed sites. The paper concludes with an assessment of outstanding issues relevant to the remediation of radioactively contaminated sites.

### INTRODUCTION

The Air Force is in the process of planning and executing investigations, removal actions, interim remedial actions, and cleanups at thousands of contaminated sites across the country. These sites are being managed under the Air Force Installation Restoration Program (IRP) at both active installations and installations scheduled for closure, known as Base Realignment and Closure (BRAC) installations. The primary objective of the IRP is to complete response actions at contaminated sites so that risks to human health and the environment from contamination are reduced to acceptable levels.

The IRP was formally established in 1984 with the creation of a fund known as the Defense Environmental Restoration Account. The United States Congress funds this account each year at a level that allows the Air Force to execute many of its IRP projects, including those at radioactively contaminated sites.

Less than 5 percent of the 4100 sites addressed under the Air Force IRP are potentially contaminated with radioactive materials. Management of response actions for these sites is accomplished at both the headquarters and field level within the Air Force through several specific organizations and their functional representatives. Key Air Force organizations and associated functional responsibilities are listed in Table 1.

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TABLE 1. ORGANIZATIONAL RESPONSIBILITIES FOR RADIOACTIVELY CONTAMINATED SITES

ORGANIZATION	PRIMARY AREAS OF RESPONSIBILITY
Office of the Civil Engineer, Headquarters United States Air Force (HQ USAF/CEVR)	Develops policy, allocates resources, and oversees execution of the environmental restoration program throughout the Air Force at active (i.e., non-BRAC installations), including execution of response actions at radioactively contaminated sites.
Air Force Major Commands (MAJCOM)	Provide execution guidance and oversee implementation of the environmental restoration program, and related activities, at the installations and facilities under their jurisdictions.
Installation Commanders	Responsible for the environmental condition of an installation, including all environmental restoration activities. Restoration activities for all sites, including those containing radioactive materials, are usually assigned to the Environmental Management Office at an Air Force Installation.
AFBCA	Headquarters component is responsible for developing policy for radioactively contaminated sites at BRAC installations. Headquarters allocates resources and oversees execution of the environmental restoration program at all BRAC installations, including execution and response actions at radioactively contaminated sites.
Air Force Low-Level Radioactive Waste Office (SA-ALC/EMP)	Provides a contracting mechanism for executing environmental restoration activities at most of the radioactively contaminated sites in the Air Force. Directs wastes from restoration activities to cost-effective commercial burial sites. Receives disposition requests from Air Force generators; generates letters of instructions for packaging and shipping of low-level radioactive wastes; and maintains an inventory of all low-level radioactive waste disposal. Operates a recycling program for depleted uranium, Kr-85, and other isotopes. Provides technical services to installations on radioactive waste investigation and disposal issues.
Air Force Medical Operations Agency (AFMOA/SGP)	Develops radiation safety policy and policy for low-level radioactive waste disposal in the Air Force.
Air Force Radioisotope Committee Executive Secretariat (AFMOA/SGPR)	The Radioisotope Committee oversees Air Force use of radioactive materials; serves as the single point of contact for the Air Force Master Materials License issued by the U.S. Nuclear Regulatory Commission; and sets up administrative controls to acquire, receive, store, distribute, use, transfer, and dispose of radioactive materials. The Radioisotope Committee Executive Secretariat reviews and approves Air Force permit applications and other requests to use radioactive materials; responds to radioactive materials incidents and accidents to ensure that permittees comply with all rules and regulations; and approves Statements of Work for invasive characterizations or exhumations of radioactive materials at sites.
Deputy Chief of Staff for Logistics (HQ USAF/LG)	Maintains a program to manage and dispose of radioactive waste and coordinates radioactive waste disposal among Air Force components and other parties in accordance with Air Force technical requirements.

Roles and responsibilities of these and other Air Force organizations are described further in Air Force Instruction 40-201, *Managing Radioactive Materials in the USAF*, 25 July 1994.

## AIR FORCE USE AND DISPOSAL OF RADIOACTIVE MATERIALS

The Air Force has used and continues to use naturally occurring, reactor produced, and accelerator produced radioactive materials as part of its operations. Air Force uses of radioactive materials fall into six general categories. These are listed in Table 2 along with examples of operations and equipment that employ radioactive materials.

TABLE 2. AIR FORCE USES OF RADIOACTIVE MATERIALS

USE CATEGORY	EXAMPLES OF OPERATIONS/EQUIPMENT
Industrial	Calibration, depot maintenance (e.g. aircraft counterweights), radiography, fixed gauges, power sources
Weapon Systems	In-flight Blade Integrity System, target designations, airframe, munitions, dials and gauges, engine exciter, counterweights, Astroinertial Navigation System, aerospace payloads, weapon simulators
Research and Development	Gas chromatographs, biomedical studies, environmental tracers, irradiators, radioanalysis, munitions testing, space launches, radiation effects studies
Medical	Nuclear medicine, radiation oncology, clinical laboratories, clinical investigations
Commodities	Chemical agent detectors, lead paint analyzers, static meters, troxler gauges, exit signs, compasses, electron tubes, thoraited optics
Environmental	Waste site excavations, contaminated buildings, training sites, ranges (e.g. depleted uranium)

Most radioactively contaminated sites in the Air Force were created during the 1950s in accordance with the Atomic Energy Commission (AEC) policy and general industrial practices at that time. Detailed records of disposals were not generally required or kept. Wastes authorized for disposal consisted primarily of:

- Electron tubes containing both AEC and non-AEC regulated radioactive materials in solid form
  - Non-AEC regulated low-level solid and liquid wastes from weapons maintenance
  - Radioactive self-luminous dials, gauges, and circuit breakers containing non-AEC regulated radium-based paint
  - Wastes from non-AEC regulated radium dial painting operations
- Radioactively contaminated sites resulting from the use and disposal of these materials include "pipe sites," contaminated buildings, and landfills. Many onsite burials of licensed materials were made in accordance with the conditions of a specific AEC license issued to an installation. Onsite burial, however, was discontinued within the Air Force by 1965 unless granted on an exception basis.

Guidance on constructing and maintaining burial sites was published in technical order procedures which included identifying site location on appropriate maps, and posting and fencing to prevent unauthorized entry. The Air Force began radioactive waste disposal at licensed commercial sites in the late 1950s; previous technical order requirements for waste burial/site maintenance were rescinded. No alternative instructions were developed on radioactive site maintenance and a gradual loss of site records ensued.

In 1971, the Air Force initiated an effort to find and consolidate existing site records and reestablish maintenance requirements. In 1982, the U.S. Nuclear Regulatory Commission (NRC) approached the Air Force with a single broad license concept for all source, byproduct, or special nuclear material which eventually led to the issuance of a Master Materials License to the Air Force in 1985. Conditions of the Master Material License provided for the use of authorized materials as approved by the Air Force Radioisotope Committee, and gave the Radioisotope Committee responsibility for maintaining the Air Force Radioactive Materials Program (see Table 1).

Since issuance of the Master Materials License in 1985, onsite burials of radioactive materials have been prohibited. However, many former "pipe sites", contaminated buildings, and landfills have been identified for evaluation under the Air Force IRP. Pipe sites were constructed for the disposal of commodity items such as check sources, electron tubes, and self-luminous parts (e.g., radium).

A typical pipe site consists of a concrete/metal culvert pipe approximately 20–30 feet long, and 18–30 inches in diameter with one end capped. The capped end was placed vertically in the ground, leaving the open end flush with the ground surface. Commodities were placed inside the pipes until they were full, or until the Air Force discontinued onsite burial, at which time the remaining end of the pipe was capped. To date, no radiation levels above background (i.e., local naturally occurring levels) have been detected on the outside of these pipes.

In addition to pipe sites, there are a number of radium contaminated buildings that have been, or are currently being, addressed under the Air Force IRP. Informally known as paint shops, these facilities were used to repair and repaint luminous dials, gauges, and in some instances, signs.

#### **STATUS OF RADIOACTIVELY CONTAMINATED SITES**

To date, approximately 170 radioactively contaminated sites have been identified and evaluated for inclusion in the Air Force IRP. These sites are distributed across 84 domestic facilities including former Air Force properties and 14 BRAC installations. A review of Air Force databases for radioactively contaminated sites revealed preliminary investigations to be ongoing at 12 percent of the sites; in-depth investigations to be underway at 33 percent of the sites; remediation to be ongoing at 10 percent of the sites; and no further action or undetermined action planned at the remaining 45 percent of the sites. As mentioned, most sites are shallow burial or disposal areas and consist of radium dials, gauges, electron tubes, aircraft components, hospital wastes, counter weights, paint residues, radioactively contaminated clothing, and low-level radioactive wastewater. In some cases, these materials are mixed with other hazardous or non-hazardous solid wastes. Most remedial actions to date have involved complete site exhumation and disposal of waste materials in offsite commercial facilities. Pipe site exhumations have been conducted using background as the remedial action objective.

#### **CLEANUP HIGHLIGHTS**

Several successful remediation efforts at radioactively contaminated sites in the Air Force have been documented. Two such efforts are described below, one for a pipe site and the other for a contaminated building.

##### **Bergstrom Air Force Base**

Radioactive Waste Site No. 24 (RW-24) at Bergstrom Air Force Base, Texas was used for the disposal of low-level radioactive materials such as luminous aircraft dial gauges and electron tubes. RW-24 is typical of the many "pipe sites" that were constructed by the United States Air Force for the disposal of commodity items such as check sources, electron tubes, and self-luminous parts.

RW-24 consisted of three 20-foot long vertically emplaced cast iron pipes, two having 18-inch diameters and one having a 12-inch diameter. Following each deposit of low-level radioactive material in the pipes, a charge of concrete was reportedly added. The pipes were installed in the 1950s and were reportedly sealed with lead-lined metal caps in 1971. The pipes were backfilled with dirt and a 4-inch thick slab of concrete was poured to cover each pipe. Annual radiological surveys, conducted at the surface of the site, found no activity above background levels. Drinking water wells within a one-mile radius of RW-24 were tested by the Texas Department of Health in 1991 and all found to be below the U.S. Environmental Protection Agency (EPA) established limits for public drinking water supplies.

Remediation activities at site RW-24 were undertaken by the Air Force Base Conversion Agency, in coordination with the Air Force Low-Level Radioactive Waste Office (SA-ALC/EMP) and the U.S. Army Corps of Engineers. The remedy selected was a controlled excavation of the pipes followed by waste packaging in preparation for transport to a permitted low level radioactive waste disposal facility. Materials were disposed of as Naturally Occurring Radioactive Material based on a determination completed by the State of Washington. The site was designated for release to unrestricted use.

### McClellan Air Force Base

Building 252 at McClellan Air Force Base, California was built during the 1930s and operated as an instrument repair facility until the late 1980s. From 1940 to 1960, radium paint was applied to instrument dials. In early 1980, most of the existing operations were relocated and renovation activities were initiated to convert the building into office space. During renovation, asbestos was found throughout the building; mercury was found in portions of the building. Remediation of the asbestos and mercury was completed in 1992. A radiological characterization study in mid-1994 determined that several areas within Building 252 exceeded NRC Regulatory Guide 1.86 limits. Radiological decontamination of the facility was initiated in late 1994.

The primary objective was to decontaminate Building 252 sufficiently to allow the eventual release of the facility from licensing restrictions. Specifically, the decontamination activities were to: (1) decontaminate interior and exterior surfaces within the basement and two floors of the building to "unrestricted use" limits identified in NRC Regulatory Guide 1.86; (2) remove a contaminated drain pipe and surrounding soil until soil levels of 5 pCi/g or less were achieved; and (3) package all generated radioactive waste for disposal at a permitted low level radioactive waste disposal facility. Although NRC Regulatory Guide 1.86 was the decontamination standard, decontamination activities were conducted using the "As Low As Reasonably Achievable" (ALARA) concept.

Decontamination techniques employed at Building 252 included the use of vacuum blasters, shot blasters, abrasive grinders, and brush hammers. Portable high-efficiency particulate air vacuum systems were used to remove contaminated debris generated. Decontamination of Building 252 was completed with approximately 24,000 ft<sup>2</sup> of concrete floor surface, 850 ft<sup>2</sup> of wall and ceiling surface, and 500 linear feet of floor-wall junction remediated. In addition, approximately 30 feet of drain pipe and 1200 ft<sup>3</sup> of contaminated soil were removed and packaged for disposal. Typically, concrete floor and stair surfaces required the removal of 1/16 to 1/4 inches of the concrete surface using the shot blaster, abrasive grinder, and brush hammer. Floor-wall junctions were decontaminated by the removal of between 1/4 and 1/2 inches of material using a combination of abrasive grinders and brush hammers. Decontamination of wall surfaces was achieved using a combination of vacuum blasters and brush hammers. The majority of wall surfaces were remediated with approximately 1/32 inch of surface material being removed. Areas requiring the use of the brush hammer were remediated to depths of approximately 1/4 inch.

Approximately 1400 ft<sup>3</sup> of radioactive waste was generated during the decontamination activities. All waste was packaged in U.S. Department of Transportation-approved 55-gallon drums and sent to the permitted low level radioactive waste disposal facility.

The goal of the remediation of Building 252 was to decontaminate building surfaces to background levels. If this was not practical, surfaces were decontaminated until they met the project free release criteria of 100 dpm/100 cm<sup>2</sup> for average alpha contamination. Following completion of the initial decontamination activities in Building 252, a verification survey was conducted to determine the effectiveness of the remediation. For this verification survey, more than 6400 stationary survey readings were taken. 104 points in the building were identified during the survey to be still contaminated above project free release limits after primary decontamination was performed. All of these spots were marked and subsequently further decontaminated to meet the project free release limits. The final results of the verification survey confirm that the facility has been decontaminated to meet the free release limits of NRC Regulatory Guide 1.86.

### OUTSTANDING ISSUES

While the evaluation of radioactively contaminated sites will continue under the Air Force IRP, issues related to radiation cleanup criteria and access to commercial disposal facilities are of particular concern to Air Force organizations responsible for radiation site response actions. The question of risk-based criteria versus cleanup to background or tabulated numerical levels by media is currently unresolved at the national level. As indicated in the first case history, restoration to background typically is achieved by complete site exhumation and off-site disposal, as opposed to burial in place. Use of risk-based criteria would allow sites with low risk to remain in place. The Air Force is actively supporting studies on the benefits of using risk-based standards.

The question of access to commercial disposal facilities poses a potential waste disposal problem for the Air Force. Current access to commercial disposal facilities is limited given that some have closed, while the opening of new facilities has not occurred due to significant delays in the permitting process. As a result, the Air Force has resorted to a combination of storage and recycling of low-level radioactive waste. Recycling of depleted uranium, Kr-85, and other isotopes has been successful. Other types of radioactive waste must be stored or disposed of, although disposal may become increasingly expensive given the limited access to current commercial disposal facilities and lack of new facilities in the near term.