

**Identifying and Remediating Submunitions at the Tonopah Test Range  
(American Reinvestment and Recovery Act Funded) – 10327**

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**ABSTRACT**

The U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO) is responsible for managing the Environmental Restoration Project and assessing the environmental aspects of weapons testing on the Nevada Test Site and Tonopah Test Range. The large physical size of these sites means that environmental restoration projects must sometimes be prioritized based on the scale of the effort. One such project is a submunitions remediation on the Tonopah Test Range. This project was awaiting implementation in accordance with the *Federal Facility Agreement and Consent Order* (FFACO) established between NNSA/NSO and the Nevada Division of Environmental Protection. When funding became available in the summer of 2009 through the *American Reinvestment and Recovery Act*, this remediation effort was accelerated.

The project involves excavating disposal pits suspected of containing submunitions, and clearing the surface of submunitions on seven targets encompassing 1,900 acres at the Tonopah Test Range. The range had been used by Sandia National Laboratories from the late 1960s through the mid-1980s to conduct research into the deployment of submunitions. Although past efforts had been completed to identify, collect, and dispose of the various amounts of unexploded ordnance on this range, there has been no comprehensive effort to remediate the entire area for submunitions.

One of the processes under which corrective action units (CAUs) can be remediated in accordance with the FFACO is the Streamlined Approach for Environmental Restoration (SAFER). The SAFER process allows fieldwork to proceed based on incomplete but sufficient information. Data are gathered during the remediation to support the closure strategy. The SAFER process is being used for the submunition remediation effort at the Tonopah Test Range, which has been identified as CAU 408 Bomblet Target Area.

The SAFER document was developed in July 2009 with fieldwork commencing at the end of July for this yearlong effort. Fieldwork includes clearing the surface and excavating submunitions from disposal pits, sampling for contaminants, and eventual backfilling of a number of disposal pits. Any munitions identified during excavation will be segregated and explosively vented or vented in place. Fieldwork will also include identifying submunitions on the surface of the 1,200-acre range followed by explosive venting of those munitions and sampling of surface soil for contaminants. The objective of the closure is to identify locations where contamination is present as a result of U.S. Department of Energy operations and to render the 1,200-acre portion of this active U.S. Air Force range free from use restrictions. Safety of unexploded ordnance and environmental sampling personnel is also of paramount concern during the project.

This document describes how the SAFER approach was used and how cleanup activities were implemented throughout the process – including safety, sampling, logistics, and closure documentation – in order to share the lessons learned from this effort.

## INTRODUCTION

Environmental restoration at the Nevada Test Site, located 65 miles northwest of Las Vegas, Nevada, is conducted by the U.S. Department of Energy (DOE), National Nuclear Security Administration Nevada Site Office (NNSA/NSO). Environmental restoration is performed in areas where DOE activities have had the potential to impact the environment, which include areas located on and off of the Nevada Test Site. One of these offsite locations is the Tonopah Test Range, which is northwest of the Nevada Test Site near the town of Tonopah, Nevada.

The environmental restoration project under way at the Tonopah Test Range consists of clean closing an area used by the DOE's Sandia National Laboratories to test the dropping of cluster bombs and the dispersal of bomblets (submunitions) from those cluster bombs (see Figure 1). This testing was conducted by Sandia National Laboratories from the 1960s through 1985 [1] and is now undergoing remediation by NNSA/NSO through an agreement between the DOE, National Nuclear Security Administration Service Center and NNSA/NSO.

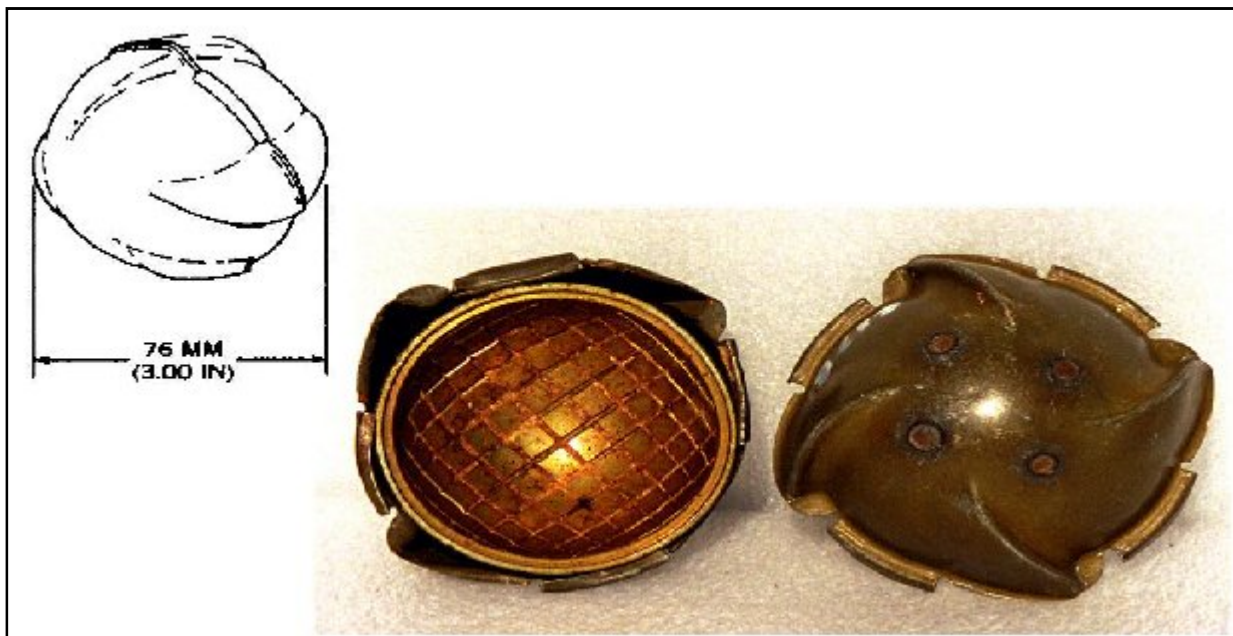


Fig. 1. Cluster bomb (submunition) example.

The remediation conducted by NNSA/NSO is done in accordance with the *Federal Facility Agreement and Consent Order* (FFACO) [2]. The FFACO sets the requirements and expectations between the NNSA/NSO and the Nevada Division of Environmental Protection (NDEP), which is the regulatory agency for the overall remediation effort on the Nevada Test Site under the FFACO. Corrective action units (CAUs) were established in the mid- to late 1990s by NNSA/NSO and agreed upon by NDEP, including CAU 408, defined as the Bomblet Target Area at the Tonopah Test Range.

The areas of CAU 408 that require investigation and remediation at the Tonopah Test Range consist of seven distinct targets [3] (Figure 2). The largest target is a dry lake bed known as South Antelope Lake. The area of remediation on the lake bed is approximately 800 acres. The other six target areas are smaller in size and cumulatively comprise approximately 400 acres. South Antelope Lake remediation consists of subsurface investigation to excavate disposal pits where spent munitions were buried after testing and the surface clearance of munitions that remain where they landed after deployment. The remediation at the remaining six targets consists of surface clearance only.

The first phase of the closure was the development of a document that describes the remediation that will occur. This document is known as the Streamlined Approach for Environmental Restoration (SAFER). The SAFER for CAU 408 was developed in the summer of 2009 and finalized in September 2009, including NDEP review [4]. Field activities were initiated in July 2009, while the SAFER was under development, and are scheduled for completion in July 2010.

### **FEDERAL FACILITY AGREEMENT AND CONSENT ORDER PROCESS**

The FFACO [2] governs the process for identifying, characterizing and providing corrective actions for NNSA/NSO remediation projects within the State of Nevada. The FFACO is a tri-party agreement entered into by the State of Nevada, acting by and through the Department of Conservation and Natural Resources, NDEP; NNSA/NSO; and the U.S. Department of Defense. The FFACO was created in the mid-1990s with the identification of several thousand potential sites on the Nevada Test Site and at other locations off the Nevada Test Site that require investigation.

### **AMERICAN RECOVERY AND REINVESTMENT ACT**

Corrective Action Unit 408, identified as Bomblet Target Area, had originally been planned for investigation and remediation in 2007 but could not be completed at that time. A SAFER document had been drafted and agreed upon by NNSA/NSO and NDEP, but completion of the work remained. In 2009, with passage of the *American Recovery and Reinvestment Act*, funding became available to proceed with the fieldwork. The SAFER document [4] was re-examined and resubmitted to NDEP for review. Fieldwork was planned and budget established in the spring of 2009. Deployment to the field was executed on July 27, 2009. Implementation of the closure work at CAU 408 in 2009 is a direct result of funding made available under the *American Recovery and Reinvestment Act*.

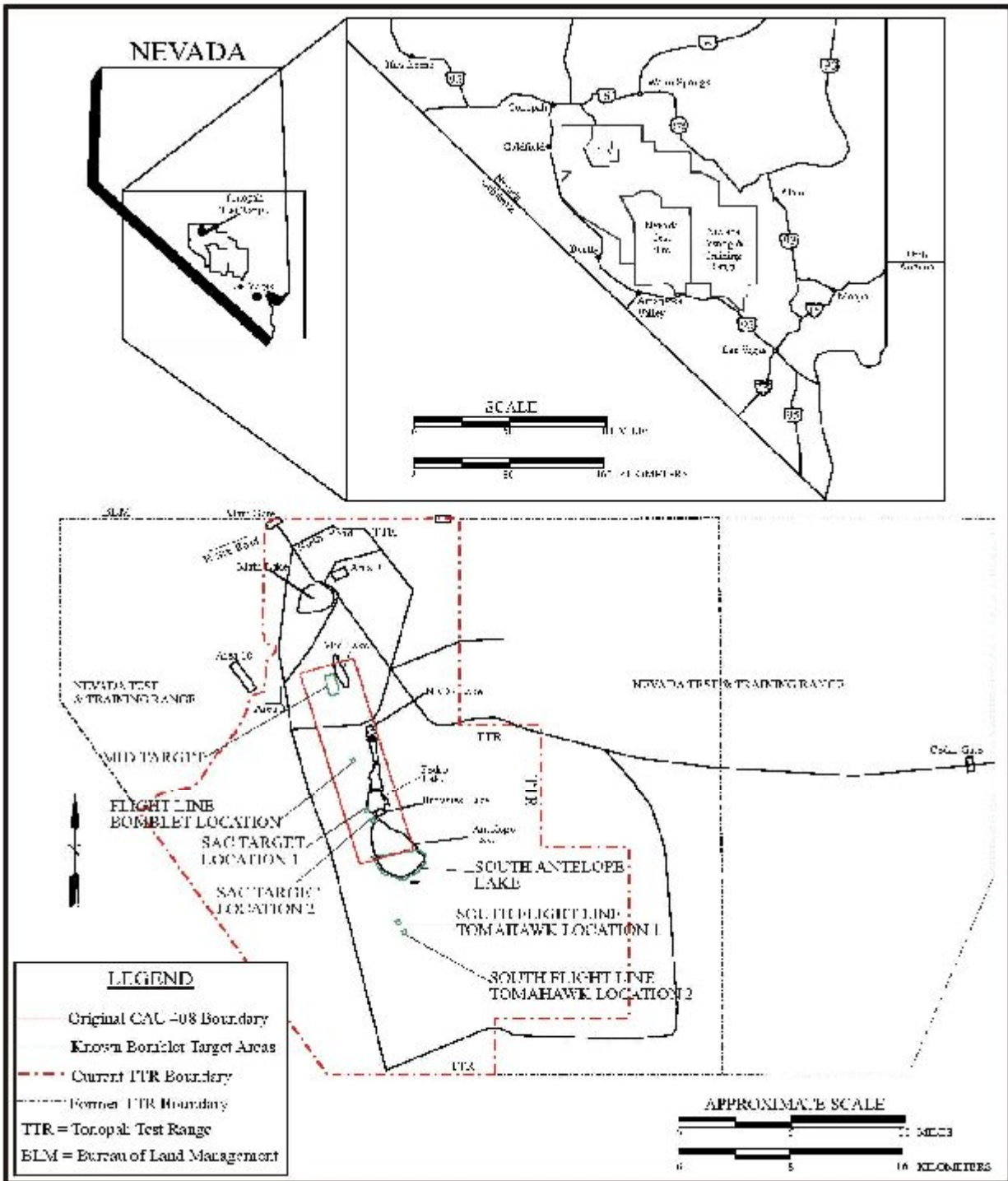


Fig. 2. Corrective Action Unit 408 Bomblet Target Areas.

**CORRECTIVE ACTION UNIT 408**

The FFACO [2] identifies characterization efforts by CAU, within which are defined specific corrective action sites. Corrective Action Unit 408 defines an area on the Tonopah Test Range of approximately 19 square miles [4] that contains seven specific targets (Figure 2). These targets were used for testing the dispersal of submunitions dropped from aircraft. A cluster

bomb would be deployed from an aircraft, and the submunitions would be released from the cluster bomb. Sandia National Laboratories conducted these tests to evaluate and refine dispersal patterns. Though cleanup of submunitions at the Tonopah Test Range had been conducted in the past, no comprehensive investigation of the area to establish clean closure had been conducted. Corrective Action Unit 408 was created to ensure that clean closure of submunitions was performed.

The closure requires two phases to complete. The first phase consists of investigating anomalies on the dry lake bed target known as South Antelope Lake. These anomalies were established during geophysical investigation of the lake bed and are areas that demonstrate potential as a subsurface disposal pit. Historical knowledge showed that submunitions disposal had occurred during past operations, and those pits require investigation as part of CAU 408. A total of 25 anomalies were identified during the geophysical investigation [5]. During excavation, metal debris was found at each of the 25 locations; however, 22 of the 25 anomalies proved to have metal only at the surface or near surface (less than 6 inches deep). At the remaining three anomalies, significant quantities of metal, including munitions, were found at depths ranging from 5 to 15 feet. These locations were determined to be disposal pits, and the material was excavated, sorted to remove the metal items and submunitions, and the soil stockpiled for return to the excavation. The scrap metal will be disposed as solid waste, and the submunitions will be rendered inert with a donor explosive and disposed as solid waste.

As excavations were completed and construction debris removed, it was also necessary to perform sampling along the bottom and side walls of excavations to determine whether contaminants of concern might be present. These contaminants included the chemical constituents of the explosives; metals, such as lead; and radionuclides. The excavations remained open during the analysis phase and upon determination that contaminants were non-detect, the excavations would be backfilled. Documentation of the sampling and analysis will be a key component of the Closure Report, demonstrating that clean closure of the site was achieved.

The second phase of the closure involves the surface clearance of approximately 1,200 acres of submunitions. Using hand-held geophysical instrumentation, personnel walk predefined grids covering 100 percent of the surface area looking for metal to a depth of 1 foot below ground surface. Submunitions found during surface clearance are excavated if necessary and rendered inert with a donor explosive, or moved and centrally located with other submunitions to be rendered inert. The inert submunitions are then collected and disposed as solid waste (Figures 3 and 4).



Fig. 3. Surface clearance.



Fig. 4. Submunitions on target surface.

Although other munitions (e.g., bombs, artillery shells) may be located during excavation and surface clearance, the primary scope of the NNSA/NSO effort is the removal of submunitions. These submunitions were generated during DOE operations and are the responsibility of NNSA/NSO with regard to clean closure of the area.

Although each of the 25 anomalies is located on South Antelope Lake and the largest surface clearance area is located on this dry lake bed, six other targets adjacent to the lake bed were also used for submunition testing (Figure 2). These other targets are along a common flight line, distinct and separate from one another, and cover approximately 400 acres of the total 1,200 acres that define CAU 408. The distance across which the separate targets are located is approximately 10 miles. While no disposal pits are present at any of the six target locations, each must undergo surface clearance to identify and remove submunitions present on the target surface and to a depth of 1 foot.

### **STREAMLINED APPROACH FOR ENVIRONMENTAL RESTORATION**

The process of conducting environmental restoration under the FFACO at the Nevada Test Site is well defined and consistent [2]. One of the primary components for documenting the planned restoration effort is the SAFER document. The SAFER process was developed to allow for fieldwork to proceed with the implementation of corrective actions based on available and sufficient information regarding the release and extent of contamination.

Corrective Action Unit 408 proceeded under development of the SAFER process. One of the initial steps in completing the SAFER is the development of a conceptual site model. The model developed for CAU 408 specified that no munitions would be expected to found buried at depths of greater than 15 feet. During excavation activities, if munitions were located at a depth of greater than 15 feet, a revision to the SAFER and the conceptual model would be required [4]. A second aspect to the conceptual model was that submunitions were dropped only on the target areas. The historical data on submunition dispersal indicated that drops were made along the full length of the targets and most of the width. Documentation could not be found that indicated the submunitions were confined to the original target boundaries nor that submunition drops were always on target. The decision was made to establish a buffer zone around the known target areas where visual surface clearance would be conducted to ensure that an entire missed drop of

submunitions did not exist outside of established target areas [4]. Establishing the conceptual model is a key aspect of the SAFER process in that it provides the expectations for remediation and defines parameters to ensure that the proper remediation is implemented. This allows for fieldwork to proceed with limited information about the contaminants and for work to continue as long as the conceptual site model is not violated.

Employing the SAFER process for the implementation of CAU 408 allowed for the fieldwork to begin in July 2009 while the development of the investigation process was still under way. The SAFER was provided to NDEP in August 2009, was revised with NDEP comments, and was finalized in September 2009. As a tool that allows for field investigation and environmental restoration while approval of the characterization document is completed, the SAFER has been proven to be effective and efficient.

## **PERSONNEL**

Implementation of submunition investigation, excavation, and explosive inerting must be conducted by properly trained personnel. Unexploded Ordnance Technicians were contracted to conduct the physical work of identifying, excavating, and rendering inert the submunitions. These individuals receive special training on these activities, including the operation of geophysical instruments, the identification of munitions (in particular for CAU 408 various submunitions), the excavation of these items, and the techniques required for placing explosive charges on munitions to render them inert.

Technicians working the field are overseen by a Senior Unexploded Ordnance Supervisor who is the senior subject matter expert for munitions issues during the execution of CAU 408. An Unexploded Ordnance Safety/Quality Control Officer is onsite to coordinate and supervise site activities and ensure technicians are working safely and in compliance with procedures. These personnel form a team that is overseen by a Project Site Supervisor responsible for ensuring that the additional work required outside of unexploded ordnance operations – such as soil sampling, excavation backfill, and documentation of environmental restoration – are completed.

The Project Site Supervisor plays a significant role in ensuring that data are developed during field activities that can be used to demonstrate closure in accordance with the SAFER [4]. The implementation of CAU 408 requires the employment of 8 to 10 Unexploded Ordnance Technicians, a Senior Unexploded Ordnance Supervisor, an Unexploded Ordnance Safety Officer/Quality Control Representative, a Site Supervisor, and a Radiological Control Technician (due to the potential for the presence of radioactive material at the site). Together, these 12 to 14 individuals form a team responsible for implementing the project in accordance with the SAFER, following the requirements of the Integrated Safety Management System, and completing the project on schedule and within the estimated costs.

## **DISPOSAL**

During the investigation of the disposal pits on South Antelope Lake, a significant quantity of scrap metal and wood debris was generated. Past operations resulted in destroyed targets, spent munitions, and construction debris that would be placed into disposal pits along with unspent munitions. This material was separated from the excavated munitions during CAU 408 restoration activities and required disposal after separation.

Characterization of the solid waste was documented based on the soil samples obtained from open excavations. These data are used to categorize the waste and determine whether it must be disposed of as hazardous or solid waste. Physical identification of the waste also provided characterization data such as the segregation of spent lead battery plates found during CAU 408 activities.

The munitions and submunitions rendered inert were also inspected to ensure that no propellant or explosives remained in or on the items, and that a clear physical penetration of the device was present. These items were then certified as inert and added to the other solid waste for disposal. Disposal of the solid waste and hazardous waste was accomplished at the appropriate landfill.

Stockpiled soil that was set aside during excavation would be returned to the empty excavation upon determination through sampling that no contaminants of concern were present.

## **CLOSURE DOCUMENTATION**

Upon completion of fieldwork, the FFACO process requires that documentation be produced detailing the work that was conducted and the state of the site. This Closure Report documents field activities, the restoration that was performed, and the results of the sampling conducted during the effort. The Closure Report is the final documentation provided to NDEP demonstrating that clean closure was achieved and the requirements of the SAFER were implemented.

## **STATUS**

The effort to perform clean closure under CAU 408 began in 2006 but was placed on hold at that time. The project was restarted in early 2009 and after initiating the SAFER document and completing pre-field planning, personnel deployed to conduct field operations at the Tonopah Test Range in July 2009. By the end of September 2009, the 25 anomalies identified on South Antelope Lake had been excavated, and the first phase of the project was complete. The second phase of the project, surface clearance of seven targets, was initiated in early October 2009 and is scheduled for completion by the end of July 2010. With the completion of fieldwork in the summer of 2010, the Closure Report is scheduled to be finalized and submitted to NDEP by September 30, 2010.

## **SUMMARY**

The NNSA/NSO is implementing environmental restoration activities through the implementation of the FFACO process. Corrective Action Unit 408, designated as the Bomblet Target Area, entails the remediation of disposal pits and surface clearance of submunitions of approximately 1,200 acres of former test grounds. The project was originally planned for implementation in 2006 and was then delayed at that time, but with the identification of funds under the *American Recovery and Reinvestment Act* was restarted in 2009 and deployed to the field in July.

Upon completion of the project in mid-2010, CAU 408 will be considered as “clean closed,” and environmental restoration under this CAU will be complete.



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