NUCLEAR ROCKET FACILITY Decommissioning Project: Controlled Explosive demolition of neutron-activated shield wall

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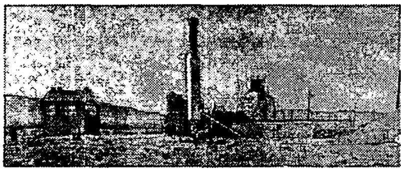
Located in Area 25 of the Nevada Test Site (NTS), the Test Cell A (TCA)Facility (Figure 1) was used in the early to mid-1960s for the testing of nuclear rocket engines, as part of the Nuclear Rocket Development Program, to further space travel. Nuclear rocket testing resulted in the activation of materials around the reactors and the release of fission products and fuel particles in the immediate area.



Identified as Corrective Action Unit 115, the TCA facility was decontaminated and decommissioned (D&D) from December 2004 to July 2005 using the Streamlined Approach for Environmental Restoration (SAFER) process, under the *Federal Facility Agreement and Consent Order*. The SAFER process allows environmental remediation and facility closure activities (i.e., decommissioning) to occur simultaneously provided technical decisions are made by an experienced decision maker within the site conceptual site model, identified in the Data Quality Objective process. Facility closure involved a seven-step decommissioning strategy.

First, preliminary investigation activities were performed, including review of process knowledge documentation, targeted facility radiological and hazardous material surveys and verification, concrete core drilling and analysis (used to plan controlled explosive demolition of the shield wall and air dispersion calculations), shield wall radiological characterization using the In-Situ Object Counting System, and discrete sampling. Selected characterization activities, performed early in the project, proved to be very useful in subsequent decommissioning planning and execution, and worker safety. Second, site setup and mobilization of equipment and personnel were completed.

Third, removal of hazardous materials, including asbestos, lead, cadmium, and oil, was performed early in the project. Asbestos insulation wrapped the exterior-run conduit as a heat shield. The asbestos-containing materials were also wrapped in a silver foil, which contained levels of cadmium that exceeded allowable sanitary landfill disposal requirements that remained on the asbestos after removal. Lead bricks were removed from the shield wall. Oil was drained and process piping verified it was void of contents. Electrical systems were de-energized and other systems were rendered free of residual energy. Early removal of hazardous materials ensured worker safety during more evasive demolition activities.

Fourth, areas of high radiological contamination, such as the concrete pad and roof, contaminated during testing and operation of the nuclear rockets, were decontaminated using multiple methods, followed by soil removal. Contamination levels varied across the facility. Fixed beta/gamma contamination levels ranged up to 2 million disintegrations per minute (dpm)/100 centimeters squared (cm^2) beta/gamma. Removable beta/gamma contamination levels seldom exceeded 1,000 dpm/100 cm^2, but in railroad trenches on the reactor pad containing soil on the concrete pad in front of the shield wall the beta dose rates ranged up to 120 milli-radians per hour from radioactivity entrained in the soil. General area dose rates were less than 100 micro-roentgens per hour. The higher levels of contamination and radiation were generally confined to the reactor pad, concrete shield wall, and on some stainless steel piping. Prior to demolition of the reactor shield wall, removable and fixed contaminated surfaces were decontaminated to the best extent possible. Various decontamination techniques were used, including masslin wiping, debris/material removal, pressure washing, scabbling, and high-efficiency particular air vacuuming, which minimized the suspension of contamination into the atmosphere during mechanical and explosive demolition.

Fifth, large sections of the remaining structures were demolished by mechanical and open-air controlled explosive demolition (CED). Mechanical demolition methods included the use of conventional demolition equipment (hydraulic hammer and processors) for removal of three main buildings, an exhaust stack, and a mobile shed. The 5-foot (ft), 5-inch (in) thick, neutron-activated reinforced concrete shield was demolished by CED, which had never been performed at the NTS.

A 100,000-gallon steel, liquid-hydrogen cryogenic tank (i.e., dewar) was also systematically demolished during the project. The demolition of this structure proved difficult, as the dewar contained a 3-foot void space between two steel shells, which contained perlite insulation. The perlite had been impacted by moisture, and had partially solidified over time. With a consistency and similar properties to talcum powder, the perlite was vacuumed from small holes cut into the outer shell. The remaining structure was size-reduced using burn rods and hydraulic shears.

The shield wall has contaminated with significant levels of ^{60}Co, ^{152}Eu, ^{154}Eu, and ^{155}Eu. Concrete core sample analysis showed induced radioactivity to a depth of 20-in(Figure 2). The highest level of activated concrete was at the center point of the exposed surface of the shield wall in front of where the reactors were operated. Radioactivity levels diminished laterally and horizontally with distance from that point. The major radiological hazard in CED was the release of airborne dust with high levels of radioactivity.

Conventional explosives (i.e., C-4) were loaded into over 400 pre-drilled holes, to a minimum depth of 36-in approximately 2 ½ ft apart, so the explosives generating the fine dust were pulverizing clean concrete instead of radiologically-impacted concrete on the outer 20 in. Sticky pads were placed radially around the shield wall in the direction of the prevailing winds, which allowed for direct analysis of radiological dust dispersion, immediately following the blast. The U.S. Environmental Protection Agency CAP-88C program (i.e., Gaussian plume model) was used for atmospheric dispersion modeling to determine the bounding airborne radioactivity concentrations that could be expected from CED. The CED was closely monitored and resulted in no radiological exposure or atmospheric release resulting radiological analysis of the sticky pads revealed levels less than 1,000 dpm/100 $cm^2$for all sticky pads.

The holes were drilled in the shield wall, and explosives loaded. Then the wall was covered with a layer of geotextile material, secured via draping and tying chain-link fence to the wall (Figure 3). The cover was intended to minimize the velocity of ejected materials, control the area where the materials would spread, and minimize dust to some extent. Successful CED of the shield wall performed by world-renown experts ,Controlled Demolition Inc., demonstrated that this technique is cost efficient, and can contribute to accelerated D&D timelines. More importantly, this method increased safety by removing personnel from repeated exposure to heights, noise, radiation, and other hazardous working conditions.

Sixth, final radiological release surveys were performed to document the final status and radiological conditions of the remaining concrete pads and surrounding soil. Surveys also continued during the seventh phase, waste management. Over 1,800 cubic yards of remaining radiologically-impacted building debris was containerized into 140 bags and disposed of as low-level waste.

Key lessons learned from the project included: (1) Targeted preliminary investigation activities provided a more solid technical approach, reduced surprises and scope creep, and made the working environment safer for the D&D worker. (2) Early identification of risks and uncertainties provided opportunities for risk management and mitigation planning to address challenges and unanticipated conditions. (3) Team reviews provided an excellent mechanism to consider all aspects of the task, integrated safety into activity performance, increase team unity and 'buy-in' and promoted innovative and time saving ideas. (4) Development of CED protocols ensured safety and control. (5) The same proven D&D strategy is now being employed on the larger 'sister' facility, Test Cell C.

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