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Final Report of the Decontamination and Decommissioning of the Initial Engine Test Facility and the IET Two-Inch Hot-Waste Line

Fred E. Stoll

F O R M A L   R E P O R T

EG&G Idaho

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Fred E. Stoll

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ABSTRACT

The Initial Engine Test Decommissioning Project is described in this report. The Initial Engine Test facility was constructed and operated at the National Reactor Testing Station, now known as the Idaho National Engineering Laboratory, to support the Aircraft Nuclear Propulsion Program and the Systems for Nuclear Auxiliary Power Transient test program, circa 1950 through 1960s. Due to the severe nature of these nuclear test programs, a significant amount of radioactive contamination was deposited in various portions of the Initial Engine Test facility. Characterizations, decision analyses, and plans for decontamination and decommissioning were prepared from 1982 through 1985. Decontamination and decommissioning activities were performed in such a way that no radiological health or safety hazard to the public or to personnel at the Idaho National Engineering Laboratory remains . These decontamination and decommissioning activities began in 1985 and were completed in 1987.

SUMMARY

This final report is a description of the Initial Engine Test (IET) facility decontamination and decommissioning (D&D) activities at the Idaho National Engineering Laboratory (INEL) at the north end of the Test Area North (TAN). The primary objective of the IET D&D Project was to prepare the area in such a way that it would present no radiological, health, or safety hazard to the public or to INEL personnel. The IET facility was constructed during the 1950s for use in the Aircraft Nuclear Propulsion (ANP) Program, which was terminated in 1961. The experimental engines were referred to as heat transfer reactor experiments (HTRE). Each of the HTRE power plants or test assemblies, now stored in the TAN area, consists of the core test facility and the nuclear reactor. The core components are mounted on a structural steel platform called a dolly. The HTRE power plants were transported over a four-rail railroad track so the assembly could be moved between TAN/Technical Support Facility (TAN/TSF) and IET, where the tests were conducted. The experiments were performed by operating reactor-driven turbojet engines, which exhausted through a long duct and up a 150-ft-high[a] stack.

The IET facility consists of several buildings and structures both above and below ground level. The main building at the facility is the dirt-covered control and equipment building, which is constructed of high-density reinforced concrete. There are several other aboveground auxiliary support buildings at IET. The facility also includes numerous waste and fuel storage tanks, a coupling station (reactor test pad), exhaust duct and stack, a monitoring vault, and a liquid radioactive hot-waste transfer line about a mile long from IET to TAN.

The IET and the associated waste line were radiologically characterized in 1982 and 1984. Decision analyses, which determined the best decommissioning alternative, were performed in 1985. Six alternatives were considered and compared based on estimated cost, material reuse, facility reuse, surveillance and maintenance costs, volume of waste generated, radiation exposure to involved workers, short-term impact on INEL personnel and operations, and long-term impact on the public. The preferred alternative was used to prepare the D&D Plan that was approved in 1986. The planned scope of the D&D work was to demolish all contaminated structures, remove contaminated soil, and remove contaminated equipment at the IET facility, including the exhaust duct and stack, the monitoring vault, the hot-waste tank, hot-waste lines, and the concrete test pad. Major D&D activities were started in 1985 and completed in 1986. Closeout activities were performed in 1987 with this final report.

Cost-saving techniques were applied to some of the activities. For example, the exhaust stack was buried in place by felling it into a trench by blasting. The concrete test pad was decontaminated by scabbling several small areas rather than demolishing the entire structure. An explosive cutting technique was applied to the six-foot-diameter, 150-foot-long stainless steel exhaust duct.

The total cost of decommissioning the IET facility was approximately $900,000. The waste generated was 768 ft^3 of contaminated soil, 640 ft^3 of contaminated carbon steel, 17,500 ft^3 of contaminated concrete rubble, and 544 ft^3 of radioactive mixed hazardous sludge with carbon steel. Approximately 65 mR beta-gamma whole body external radiation exposure above background was the combined amount received by the D&D workers.

a. Hard English units are used throughout this report, since SI conversions of many of the measurements (specifically, repeated references to pipe dimensions) are not normally done.

ACKNOWLEDGEMENTS

This document is the culmination of the efforts of many individuals. Special recognition is given to Wyndell C. Banister, who was the project manager for the D&D work performed, as described in this report.

Appreciation is extended to all of the EG&G Idaho, MK-Ferguson, BECO Corporation, Blasting and Vibration Consultants, and DOE-ID employees who participated in the project.

CONTENTS

FIGURES

TABLES

FINAL REPORT OF THE DECONTAMINATION AND DECOMMISSIONING OF THE INITIAL ENGINE TEST FACILITY AND THE IET TWO-INCH HOT-WASTE LINE

INTRODUCTION

This final report describes tasks performed by the EG&G Idaho Decontamination and Decommissioning (D&D) Program to accomplish the D&D of the Initial Engine Test (IET) facility and the associated IET two-inch hot-waste line at the Idaho National Engineering Laboratory (INEL). The report also summarizes the cost and duration of the project, radiation exposure to personnel, and the waste volume generated.

IET History

The IET facility was constructed during the 1950s on the National Reactor Testing Station (NRTS) for the Aircraft Nuclear Propulsion (ANP) program at the Test Area North (TAN). The ANP program began in 1951 and was terminated in 1961.[1] Experiments conducted under this program were referred to as heat transfer reactor experiments (HTRE). Each of the HTRE power plants or test assemblies (HTRE-2 and HTRE-3 which are presently stored in the TAN area) consisted of a core test facility and a nuclear reactor. The nuclear fuel was removed when the program was terminated. The core components and propulsion equipment are mounted on a structural steel platform supported by a double-wide four-track railroad car system. The assembly was moved between the IET and TAN/Technical Support Facilities (TSF). The tests were performed at the IET, with construction, modification, and maintenance being performed at TAN/TSF. HTRE experiments performed at the IET facility included the following:

- The HTRE-1 reactor operated a modified J46 turbojet engine exclusively on nuclear power in January 1956. It accumulated a total of about 150 hours of operation at power levels up to 20 megawatts (thermal).
- The HTRE-2 reactor was a modification of the HTRE-1 assembly. Testing began in July 1957. Operating at power levels up to 14 megawatts (thermal), the reactor accumulated about 1300 hours of operation.
- The HTRE-3 reactor was built in a full-scale aircraft reactor configuration. Two modified J47 turbojet engines were operated by this reactor. Full power of 32 megawatts (thermal) was achieved in 1959, and the system operated for a total of 126 hours.

The facility was later used for the Safety Test Experiment Program (STEP). As part of the STEP research, the Systems for Nuclear Auxiliary Power Transient (SNAP-TRAN) program was conducted at the facility from 1961 through 1967.[2] It involved the following tests:

- A series of tests was aimed at providing information about reactor performance under atmospheric conditions and assessing hazards during reactor assembly and launch
- Nuclear excursions resulted from immersion of the reactor in water or wet earth
- Nondestructive tests included static tests and kinetic tests by which minor damage to the reactor occurred
- Destructive tests were performed on several reactors.

Components from the dismantled Hallam Nuclear Power Plant near Lincoln, Nebraska, were shipped to the INEL in 1968 and stored at TAN. The IET facility was used for space to perform the

Hallam D&D in 1977 and 1978.[3] D&D of the Hallam components consisted of the following:

- Components were moved to the IET for sodium removal
- Components were decontaminated, when feasible, for use in research and development, or excessed as surplus materials
- Material that could not be decontaminated was sent to the Radioactive Waste Management Complex (RWMC)
- Noncontaminated material was sent to the sanitary landfill for disposal.

IET Decommissioning Project Background

The U. S. Department of Energy, Idaho Operations Office (DOE-ID), has assigned EG&G Idaho the responsibility for implementing the Decontamination and Decommissioning Program at the INEL.

The radiological characterization[4] for the IET facility was performed in 1982 and the decision analysis[5] completed in 1985. The radiological characterization and decision analysis[6] of the two-inch[a] hot-waste line were completed in 1984.

A D&D plan[7] (based on the decision analysis) was written and published in May 1985, with Revision A[8] released in February 1985. The primary tasks were completed in 1986 and final surveys, cleanup, and Environmental Protection Agency closure requirements completed in 1987. Funding for the project has been provided by DOE through the Surplus Facilities Management Program (Defense).

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a. Hard English units are used throughout this report, since SI conversion of many of the measurements (specifically, repeated references to pipe dimensions) are not normally done.

IET FACILITY DESCRIPTION PRIOR TO DECOMMISSIONING

Physical Description

The IET facility and the associated two-inch hot-waste line were located on the INEL at the north end of the TAN area, as shown in Figure 1. The aerial view in Figure 2 shows the buildings, structures, and equipment that comprise the facility. Table 1 is a building description summary. The plot plans in Figures 3 and 4 further specify the relative locations of key IET components described in this report. Since earthen berms were used for radiation

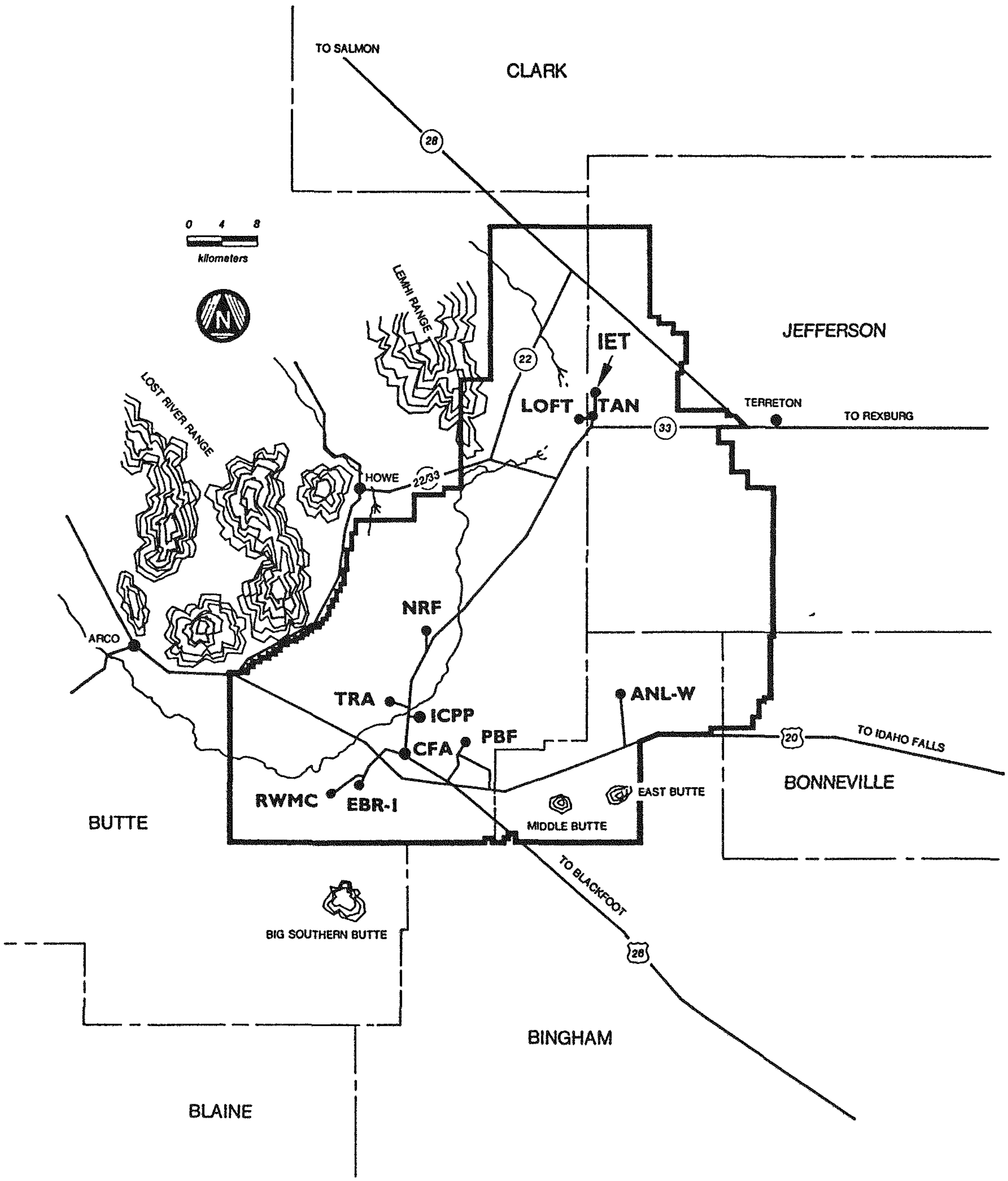


Figure 1. Map of the INEL showing the location of IET.

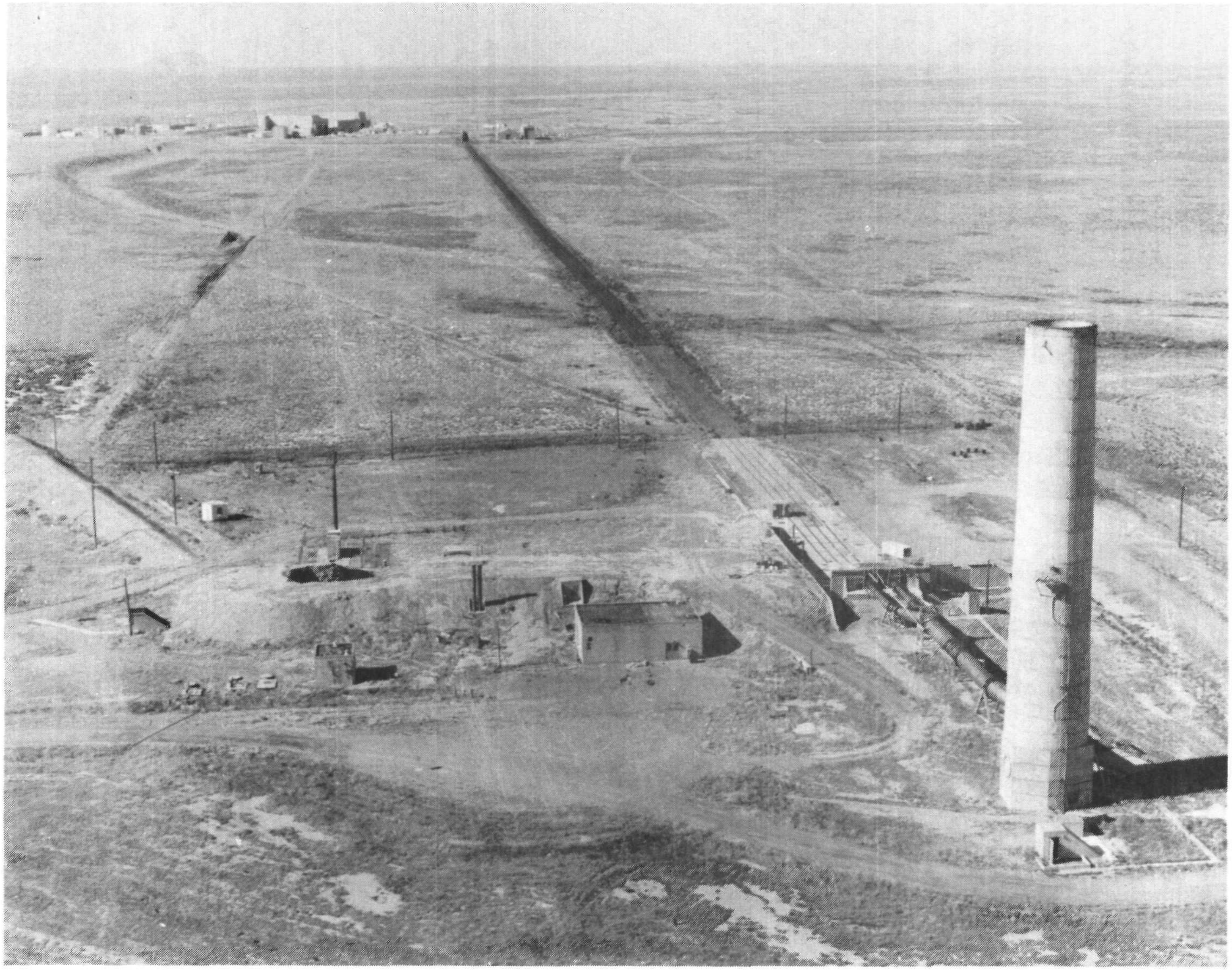


Figure 2. Aerial view of the IET facility.

Table 1. TAN/IET building description summary

Building Number	Name	Use	Building Type and Special Features	Interior Area (ft^2)	Contents
TAN-620	IET control and equipment building	Vacant	Underground building built of high-density, reinforced concrete. Walls are 2 ft thick and the ceiling is 3 ft thick. The floor of the building is 15 ft below grade with an additional 14 ft of dirt shielding over the top.	12,200	Much of the equipment and piping has been removed for use by other projects.
TAN-621	Exclusion guardhouse	Vacant	One story, concrete block walls, corrugated metal roof.	281	—
TAN-622	Unit substation (concrete transformer slab)	—	—	—	Transformers to transform 13.8-kV power from TAN/TSF to 1000 kVA for supply to the IET area.
TAN-625	Fuel transfer pumping building	Vacant	One story, masonry walls, corrugated metal roof.	218	Miscellaneous pumping equipment.
TAN-626	Chlorination building	Vacant	Wood frame, shake shingle exterior walls, hardboard interior walls, sloped asphalt roof.	81	—
TAN-627	Tank building	Storage	One story, masonry walls, corrugated sheet metal roofing.	1,242	—
TAN-656	Change room	Vacant	Portion of the west end of TAN-620—included with TAN-620.	—	—

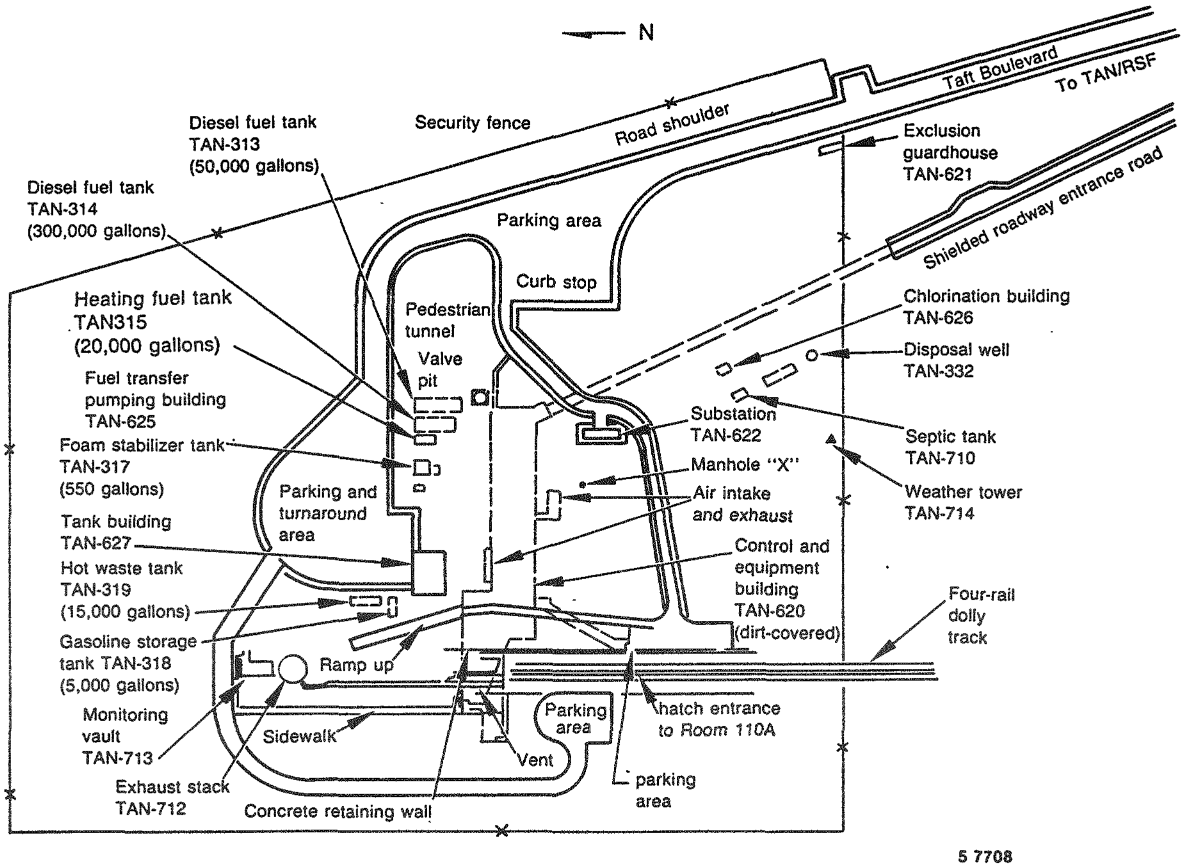


Figure 3. Plot plan of the IET facility.

shielding, the control and administrative areas are below grade. This earth-covered building is TAN-620 (Control and Equipment Building), Figure 5 and Table 2. Other noncontaminated structures at IET are as follows: TAN-627 (Tank Building), TAN-625 (Fuel Transfer Pump Building), TAN-621 (Exclusion Guardhouse), TAN-622 (Unit Substation), TAN-626 (Chlorinator Building), and TAN-710 (Septic Tank).

Radiologically contaminated structures or areas within the scope of the project were as follows: TAN-712 (Exhaust Stack and duct), TAN-713

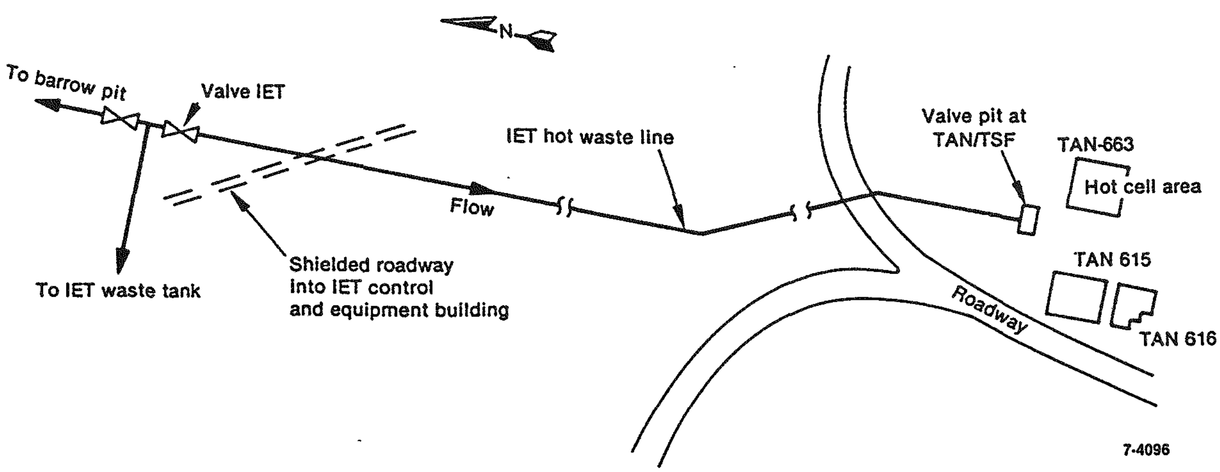


Figure 4. Diagram of the IET two-inch hot-waste line location.

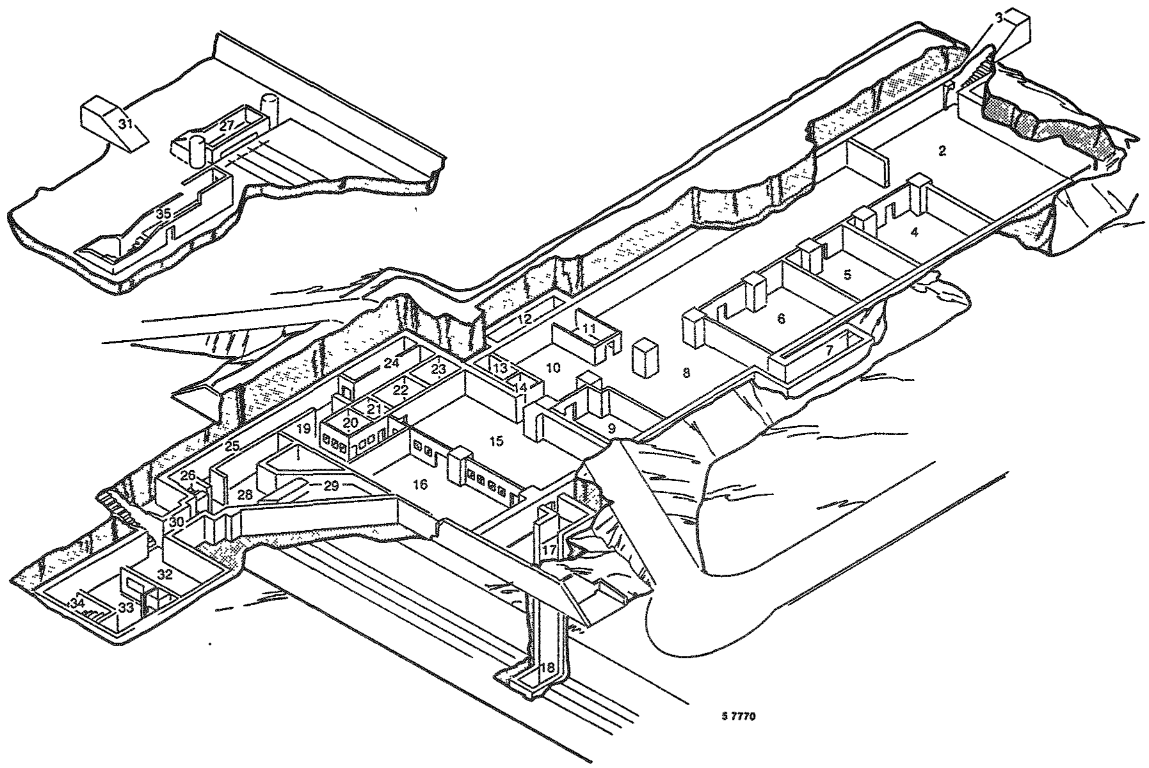


Figure 5. Isometric layout of IET Control and Equipment Building—TAN-620.

Table 2. Key for isometric of TAN-620 (see Figure 5)

Key	Room Number	Description
1	—	Shielded roadway
2	124	Turnaround room
3	—	Shielded pedestrian entrance from the east side of the control and equipment building
4	101	Diesel room
5	101A	Electrical-equipment room
6	102	Boiler room
7	—	Air intake and exhaust
8	—	Heating and ventilating
9	125	Readout room
10	103	Equipment room

Table 2. (continued)

Key	Room Number	Description
11	104	Tool crib room (previously darkroom)
12	—	Air intake and exhaust
13	105	Men's room
14	107	Women's room
15	108 109 124	Data and instrument room Instrument-repair room Unidentified (partitions have been removed)
16	109	Control room
17	—	Pedestrian tunnel
18	—	Personnel hatch entry from the track area on the southwest side of the control and equipment building
19	114	Corridor
20	118	Office
21	111	Monitoring room
22	123	Offices (previously undivided)
23	112	Offices (used as a counting room during the Initial Engine Test Program)
24	113	Mechanical-equipment room (at present divided into two rooms; a mechanical equipment room and a supply room)
25	115	Tunnel
26	—	Stairs to the coupling station
27	117	Coupling station
28	116	Service room
29	—	Periscope tunnel
30	119	Corridor
31	—	Stairs leading outside to the northwest corner of the control and equipment building
32	120	Change room
33	121	Change room
34	—	Stairs leading to the shielded entrance on the west end of the control and equipment building
35	—	Shielded entrance that led into the test cell (now removed)

(Monitoring Vault), TAN-319 (Hot-Waste Tank and connecting piping), the concrete test pad, contaminated air filters from TAN-620, and contaminated soil. These structures are described in Table 3.

Radiological Description

The IET facility was radiologically characterized in 1982 (see Reference 4) and the associated two-inch hot-waste line was characterized in 1984 (see Reference 6). To initially locate and identify the areas of concern at the IET facility, a direct radiation and smear survey of all buildings, structures, equipment, and systems was conducted. This initial radiation survey included general area measurements as well as detailed scans and smears of all floors, walls, piping, pumps, valves, sumps, drains, and ventilation systems.

All systems, tanks, structures, and equipment known to be contaminated, found to be contaminated, or suspected of being contaminated were sampled and the samples analyzed to identify radionuclides and to determine their concentrations and distribution.

A beta-gamma radiation survey of the entire site soil surface was performed by traversing an established grid system with an integrated ratemeter and a shielded GM detector. Soil samples were collected from grid squares found to be contaminated, or having the potential for being contaminated. The samples were analyzed for radionuclides.

In situ gamma-ray spectral measurements were made at several different locations at the IET to obtain on-site isotopic data that would show the relative abundance of the gamma-ray-emitting radionuclides.

The two-inch hot-waste line characterization consisted of collecting and analyzing samples at each end of the pipe and at two locations between the ends. The 6100-ft line was excavated at locations 2000 and 4000 ft distance from the TAN/TSF valve pit. A two-inch-long and a ten-inch-long section were removed at each location.

Major radioactivity was found to be ^{137}Cs and ^{90}Sr, with smaller quantities of ^{60}Co and ^{235}U. Natural and manmade backgrounds were recorded for comparison purposes. A summary of the sampling results is found in the following subsections.

Buildings. No transferable surface contamination and no direct radiation readings above background were detected in any of the buildings. No activity was detected in any of the building sumps. Building TAN-620 ventilation system intake filters were found to have small concentrations of ^{60}Co, ^{90}Sr, ^{137}Cs, and ^{235}U. The ^{137}Cs and ^{90}Sr concentrations were in the 10 to 15 pCi/g range, amounting to 99% of the activity.

Subsurface Storage Tanks. The hot-waste tank and septic tank were the only tanks having any measurable activity. No activity was found in the hot-waste or septic tank liquids; however, ^{90}Sr and ^{137}Cs activity was found in the sludge, with concentrations ranging from a few hundred to a few thousand pCi/g.

Concrete Test Pad. Three areas on the test pad had measurable concentrations of ^{60}Co, ^{90}Sr, ^{137}Cs, and ^{235}U. The areas of radiological interest were the north and south drains and a hot spot on the concrete pad itself. The hot spot was apparently from a radioactive spill. Both drains had 3 to 4 inches of contaminated soil deposited along their entire length.

Coupling Station. Loose rust and paint chips on the floor contained some low-level activity.

Exhaust Duct and Exhaust Stack. Direct radiation readings of 12 mR/h were found on the exterior of the exhaust duct. The internal surfaces of the duct and stack were significantly contaminated with loose radioactive debris. Approximately 94% of the activity in the exhaust duct was due to ^{137}Cs, while ^{90}Sr made up approximately 6%. The ^{60}Co and ^{235}U contributed $<1\%$ of the total activity.

Surface Survey. The soil directly under the exhaust duct was found to have beta-gamma count rates of about a factor of two or three above background. It was assumed that the access holes into the duct leaked during the tests. The north end of the test pad showed count rates of about a factor of 10 above background, due primarily to a hot spot on the concrete and the contamination in the north drain. The north half of Quadrant IV (downwind from the stack) had a few isolated areas that were approximately twice background levels. Of the 86 soil samples analyzed, most showed activities no higher than background. Only a few samples contained concentrations that required soil removal. In situ measurements confirmed that the

Table 3. TAN/IET structure description summary

Number	Name	Description
TAN-710	Septic tank	1870-gal capacity; contains approximately 187 gal of sludge (25 ft^3).
TAN-712	Exhaust stack and duct	Stack: concrete with firebrick lining; 30-ft diameter at base; 15-ft diameter at top. Duct: stainless steel, 1/4-in. thick; one large section 6.5 ft diameter by 156 ft long; two small sections 3 ft diameter by 51 ft and 54 ft long.
TAN-713	Monitoring vault	Concrete slab with aboveground staircase leading to underground concrete room approximately 12 by 20 ft.
TAN-714	Weather tower	—
TAN-313	Engine-fuel tank	50,000-gal capacity; in use; full
TAN-314	Diesel-fuel tank	30,000-gal capacity; in use; full
TAN-315	Heating-fuel tank	20,000-gal capacity; in use; full
TAN-316	Lube-oil tank	550-gal capacity; in use; full
TAN-317	Foam-stabilizer tank	550-gal capacity; in use; full
TAN-318	Gasoline storage tank	5,000-gal capacity; empty
TAN-319	Hot-waste tank	15,000-gal capacity; in use; full
TAN-322	Disposal well	No longer used as a disposal well. Modifications have been made to extend piping to the surface for monitoring by the United States Geological Survey.

major gamma-ray-emitting isotope was ^{137}Cs. No radioactive isotopes were observed in the in situ measurements that were not found in the soil analysis.

Hazardous Chemical Conditions

Although a formal hazardous chemical characterization was not performed at the time of the radiological characterizations, it was later discovered that mercury existed in the hot-waste system. It was verified that mercury was used in one of the experimental engines (HTRE-3) as a maintenance shield. About 54,000 lb of metallic mercury had been pumped into, and drained out of, the shield tank that enclosed the reactor vessel. Some of this metallic mercury ended up in the hot-waste tank and also in the ten-inch hot-waste line from the test pad to the hot-waste tank.

DECOMMISSIONING OBJECTIVES AND WORK SCOPE

Objectives

The objectives of this project were to prepare the area so that it would present no radiological, health, or safety hazard to the public or to INEL personnel, to condition the area so that structures requiring no decommissioning work are available for reuse, and to remove decommissioned structures from the Surplus Facilities Management Program priority list.

Work Scope

The work performed consisted of removing the TAN-620 air filters, removing the stainless steel exhaust duct, removing the monitoring vault, demolishing the exhaust stack, decontaminating the concrete test pad, removing the hot-waste tank and associated piping, and removing contaminated soil. These tasks are shown in the work breakdown structure, Figure 6.

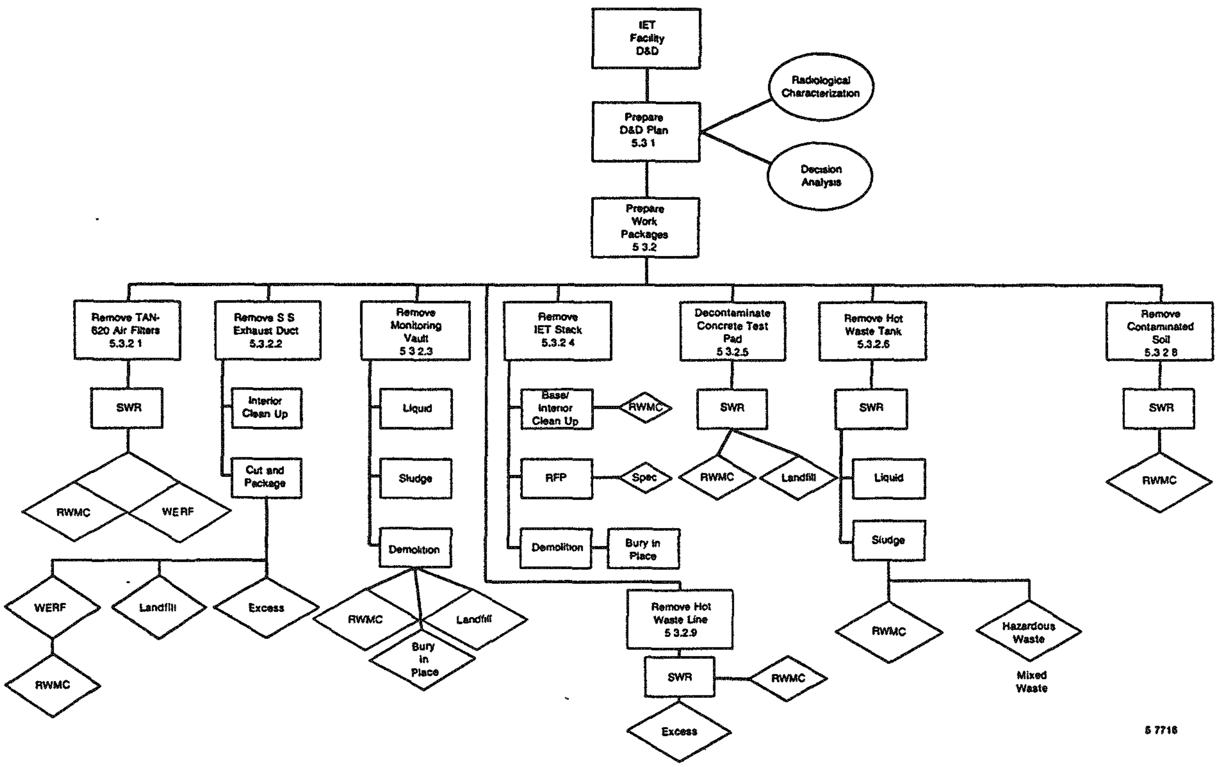


Figure 6. IET facility D&D work breakdown structure.

WORK PERFORMED

Project Management/Engineering

EG&G Idaho Waste Management Programs provided D&D project management and project engineering. A project manager was responsible for planning, coordination, and overall direction of the project, as well as all associated budgeting, scheduling, and reporting. Review and approval of the D&D Plan work packages and safety engineering were obtained from EG&G Idaho Health and Safety.

Decision Analyses. The decision analyses for the IET facility (see Reference 5) and the associated two-inch hot-waste line (see Reference 6) were performed in 1984 and 1985.

IET Decision Analysis. Six alternatives were considered.

Alternative 1—Take no action; continue surveillance and maintenance mode.

Alternative 2—Perform limited demolition as follows.

Soil. Remove all contaminated soil to a depth of one foot and send it to the RWMC. Fill the space left with a layer of noncontaminated topsoil, and seed with crested wheatgrass.

Exhaust Stack. Remove the loose contaminated particles at the base of the interior of the exhaust stack. Demolish and remove the rubble by transporting it to the RWMC.

Exhaust Duct. Remove the loose contaminated particles along the interior of the duct. Dismantle and cut up the stainless steel exhaust duct and ship the pieces to WERF.

Concrete Test Pad. Remove the contaminated portion of the concrete test pad. This amounts to approximately 25% of the entire pad, all in the northern portion. Box and ship concrete chips to the RWMC.

Hot-Waste Tank. Leave the hot-waste tank as is for possible reuse.

Septic Tank. Leave the septic tank as is for possible reuse.

Monitoring Vault (TAN-713). The monitoring vault would be drained of the noncontaminated liquid and the sludge removed and sent to the RWMC with the contaminated soil and the contaminated portion of the vault. The major portion of the vault would be demolished and sent to the sanitary landfill.

D&D Marker. In accordance with the applicable EG&G Idaho project directive, a D&D marker would be installed to indicate the condition and status of the IET area and the location of the data concerning the facility.

Alternative 3—The same as Alternative 2, with the following exceptions: Remove the hot-waste tank and associated piping; drain the nonncontaminated liquid from the tank; remove contaminated sludge from the tank and send to the RWMC; excavate, remove, and section the hot-waste tank and send to the Waste Experimental Reduction Facility (WERF); excavate and package the hot-waste tank piping and send either to the RWMC for burial or to WERF for processing.

Alternative 4—The same as Alternative 2, with the following exceptions: Remove the hot-waste tank and its associated piping, as described in Alternative 3; remove the septic tank, which would be drained of noncontaminated liquid, the sludge removed and shipped to the RWMC, and the tank demolished and shipped to the sanitary landfill; leave the exhaust stack for reuse, removing the loose contaminated particles at the base of the interior of the exhaust stack; and remove the entire concrete test pad.

Alternative 5—The same as Alternative 2, except remove the hot-waste tank, the septic tank, and the entire concrete test pad. The hot-waste tank would be treated, as described in Alternative 3. The septic tank would be treated as described in Alternative 4. Approximately 160 ft of two sets of railroad track would be removed and sent to TAN for reuse.

Alternative 6—All radioactively contaminated structures would be demolished as in Alternative 5, with the exception of using proven blasting techniques to fell the exhaust stack into a trench and burying it in place rather than hauling the rubble to the RWMC.

Two-Inch Hot-Waste Line Decision Analysis. The detailed analysis for the two-inch hot-waste line considered three alternatives.

Alternative 1—Remove the entire waste line from valve No. 1 at IET to the valve pit at TAN/TSF. The entire waste line would be excavated and the pipe processed at WERF. The ditch formed during excavation would be backfilled and the area restored to its natural condition by grading and reseeding.

Alternative 2—Cap both ends of the pipe and leave in place.

Alternative 3—Do nothing.

Final Decision Analysis. All of the alternatives were compared, based on estimated cost, material reuse, facility reuse, surveillance and maintenance costs, volume of waste generated, radiation to D&D workers, short-term impact on INEL personnel and operations, and long-term impact on the public. Alternative One (Remove the entire waste line) was recommended for the decommissioning of the IET two-inch hot-waste line. The decision analysis for the IET facility [(see Reference 5) documented in February 1985] recommended Alternative Six, as listed above. However, during the preparation of Revision A of the D&D Plan (see Reference 8), further characterization and analysis were accomplished. Therefore, some previously planned work was deleted, other work was added, and alternative D&D methods were applied to other parts of the project. The final recommended alternative performed at the IET facility was Alternative Six, with the following additional exceptions:

- The monitor vault concrete structures that were verified free of radioactivity were buried in place, three feet below grade
- The noncontaminated portion of the concrete test pad remained in place
- The mercury-contaminated portions of the hot-waste system and contents were handled according to mixed (a waste that is both radioactive and hazardous) waste requirements
- The septic tank was left in place for possible reuse.

D&D Plan and Work Packages. A D&D plan was published in May 1985 (see Reference 7) and Revision A released in March 1986 (see Reference 8). It addressed the details of the project such as the work scope description, suggested modes of demolition, cited potential problems, projected waste volumes, and predicted personnel exposure. An environmental evaluation was performed, including a report as an attachment to the D&D plan. Estimated cost and schedule to perform the project were included in the report. Evaluations were provided for safety considerations and environmental effects. Review and approval were obtained from the Earth and Life Sciences, Health and Safety, and Waste Management Programs Groups, and from the Department of Energy-Idaho Operations Office (DOE-ID).

Work packages with detailed work instructions were prepared for each of the tasks by the TAN Maintenance Planning Unit, with review and approval by the Safety and D&D Programs. Blasting plans, with detailed procedures for the related tasks, were provided. These were reviewed and approved by Safety and Waste Management, and by DOE-ID. In order to document activities that were performed, photography was also arranged.

Site Preparation

Install Temporary Electrical Power. An electrical power line was placed in service to provide lighting in the underground control building to meet surveillance and maintenance requirements. This temporary lighting will remain in service, at least until the two-year post-D&D surveillance and maintenance period has elapsed.

Coupling Station. The upper portion of the coupling station was dismantled. This included the fan enclosure, two large fan assemblies, two periscopes, the furnace, and a telescoping crane, along with other general items such as conduits, piping, etc. This was required in order to ensure that any areas that had a high probability of radioactive contamination, but that were inaccessible due to irregularities of the structures, would be cleaned up. Also, this dismantlement was deemed necessary, in order to gain access to some areas of lower elevation that were known to be contaminated, thereby supporting cleanup of the test pad.

Install Test Pad Drain Line. The original drain line was disconnected and a new ten-inch-diameter plastic drain pipe was permanently connected to the test pad drain. This new plastic drain pipe for surface water runoff was placed at a shallow depth in a westerly direction from the test pad and terminated in a new gravelled area. This was required to control surface water runoff, in order to allow D&D work to proceed on the original drain line, sump, remainder of the hot-waste system, and on the test pad without being hampered by surface water runoff.

Decommissioning Operations

Air Filters. Removal of the TAN-620 air filters included both the main ventilation and the air wash system in Building 620 (see Figure 5). These filters were in rooms designated Key 8 and 24, respectively (see Table 2). The filters were disposed of as radioactive solid waste and sent to the RWMC.

Monitor Vault. The inside components and sludge were surveyed, removed, and shipped to the RWMC or the sanitary landfill for disposal. Nearly all of the waste generated from the monitor vault qualified as clean and was shipped to the sanitary landfill. The concrete structure was collapsed into itself with a demolition ball and covered with dirt so that the rubble was buried three feet or more below grade.

Test Pad. The entire pad was surveyed and the contaminated areas identified with magenta paint. The contaminated concrete surface was then broken up by mechanical means (scabbled). The waste generated from the scabbling process was carefully retained by the equipment, properly disposed of as radioactive solid waste, and shipped to the RWMC. All contaminated metal surfaces were cleaned by wirebrushing, grinding, or cutting out and vacuuming. A significant savings of both money and waste generation was realized by scabbling instead of demolishing entire sections of the concrete pad. The test pad drain sump cap and strainer were surveyed, found clean, and sent to the sanitary landfill. The sump discharge was grouted. The sump was then caved in and filled with compacted topsoil.

The test pad was officially identified and used as the IET Container Storage Area for the remainder of the project (see the next section under Hot-Waste Tank for related information). Up to 74 drums (55 gallons each) of mixed waste were stored on the test pad until the drums were shipped to the INEL Radioactive Mixed Waste Storage Facility. Specific regulations under the Resource Conservation and Recovery Act (RCRA) were applied to the test pad. A closure plan[9] for this container storage area was submitted to the EPA.

Hot-Waste Tank. Removal and disposition of the hot-waste tank and the associated ten-inch-diameter drain piping were complicated by the discovery of metallic mercury in the ten-inch pipe during installation of the ten-inch plastic drain discussed in the Site Preparation section. Procedures were modified to account for the existence of a hazardous material mixed in with radioactive material. The ten-inch drain line was carefully removed, cut into sections (approximately 30 inches long and cut in half lengthwise), and packaged along with the contaminated soil, contaminated sludge, and moisture absorbent into 55-gallon drums. These drums were then temporarily stored on the test pad.

The soil was excavated down to the top of the 15,000-gallon hot-waste tank, after which entry was made into the tank by D&D workers to remove the residual water and sludge, which were manually scooped out of the tank and placed into 55-gallon drums. Moisture absorbent was added to each drum to stabilize all of the free liquid. The drums were temporarily stored on the test pad. Excavation continued and the tank was removed from the ground. The tank was sectioned with a cutting torch. Since the bottom third of the tank had residual radioactive and hazardous contaminants, it was cut into small pieces (about 18 by 30 inches) and placed into 55-gallon drums. The drums were placed on the test pad for temporary storage. The upper two-thirds of the tank was radioactively contaminated only, and not contaminated with hazardous material; it was therefore cut into much larger sections, about 8.5 feet wide by 14 feet long by 5 feet high. These sections were sent to WERF for volume reduction prior to disposal at the RWMC. The pipe trench and tank holes were backfilled and topsoil added, where required. The disturbed area was graded and seeded with crested wheatgrass.

Two-Inch Hot-Waste Line. Excavation of the IET two-inch hot-waste line was performed on the entire 6100-foot length of the line, with the exception of the area adjacent to Building 620 (under the shielded roadway) and an approximately 300-foot section about halfway to TAN/TSF, where the pipe was too deep to reach with the backhoe. These sections of the line were left in place. About 800 feet of the pipe were surveyed, found radioactively clean, and excessed. The remainder was cut into 7.5-foot sections and placed into boxes for shipment to the RWMC. The trench was backfilled and the disturbed area was seeded with crested wheatgrass.

Exhaust Duct. The loose radioactively contaminated particles were cleaned from the inside of the exhaust duct with a HEPA-filtered vacuum. Instead of cutting the duct into sections with the manual operation of a cutting torch or mechanical sawing, a suggestion to sever the sections by an explosive cutting technique using a shaped charge was evaluated, accepted, and designed. Primary concerns about the proposed explosive severing technique were:

- Could a blast strong enough to cut the metal but not scatter pieces of radioactively contaminated metal be controlled sufficiently?
- Could the energy of the explosion be directed to the narrow circumferential cutting lines desired?
- Could the radioactive contaminants adhering to the inside surface of the duct be kept in place without spreading to the environment?

All of the concerns were adequately answered. The design specified a flexible linear shaped charge (FLSC) consisting of a V-shaped metal tube containing a core of high explosive. The FLSC, which was commercially available, had the density required to cut the 1/4-inch stainless steel and satisfy the first two concerns above. The third concern was satisfied by applying moisture to the inside of the duct prior to detonation.

A blasting plan[10], which contained detailed sign-off procedures to perform this explosive severing, was written and approved. The 156-foot-long (approximately 6 feet in diameter and 1/4 inch thick) duct was severed into 20 sections up to 16 feet in length (see Figure 7). All these sections were radioactively contaminated and were transported to WERF for volume reduction prior to shipment to the RWMC for disposal.

Exhaust Stack. Radioactively contaminated deposits from the exhaust stack base interior were removed and sent to the RWMC. During cleanup inside the stack at the base, it was discovered that the sand under the subfloor contained some silver. However, after sampling and an EP toxicity test, it was proved that the silver was not leachable. The existence of silver did not, therefore, constitute a hazardous waste. A contract[11] was issued to BECO Corporation for the stack demolition. BECO subcontracted the blasting work to Blasting and Vibration Consultants. A blasting plan for demolition of the stack was written and approved. It included analysis, design, and detailed procedures for performance of the task. A trench was excavated to receive the stack for burial. The base of the stack was drilled and explosive charges placed in it to demolish the base simultaneously with the felling of the stack, rather than breaking up the base with mechanical equipment after felling the stack. After the stack collapsed into the trench (see Figure 8), the trench was backfilled with topsoil. The disturbed area was then graded and seeded with crested wheatgrass.

Contaminated Soil. Contaminated soil associated with the D&D project was removed from several places, specifically:

- An area north of the test pad by the coupling station
- An area directly below the entire length of the exhaust duct
- An area near the base of the stack
- A few areas downwind of the exhaust stack
- An area near the IET valve pit at the TAN/TSF end of the two-inch hot-waste line.

Marker Placement. A permanent marker (see Figure 9) depicting the burial site of the exhaust stack was placed as required.

Final Surveys

Radiological Survey. A surface survey of the IET facility was completed in August 1986 using the Vehicle-Mounted Roadway Monitor (VRM-1) (see Figure 10). This monitor is a microprocessor-based instrument that uses a solid organic scintillator in the internal and external detector assemblies.[12] The external detector assembly will detect a 10-microcurie source of ^{137}Cs at a distance of eight feet. Radioactive contamination was detected at two places during this survey. One area on the north side of the coupling station and another in the northwest corner of the IET fenced area were flagged for cleanup. Excavation of these soil areas to no more than a depth of one foot was sufficient to remove all of the contamination. This contaminated soil was shipped to the RWMC and replaced with clean topsoil.

Hazardous Chemical Survey. An independent professional engineer verified[13] the removal of the mixed waste drums from the IET Hazardous Waste Container Storage Area (test pad) and inspected the area, as a requirement of the closure plan (see Reference 9).

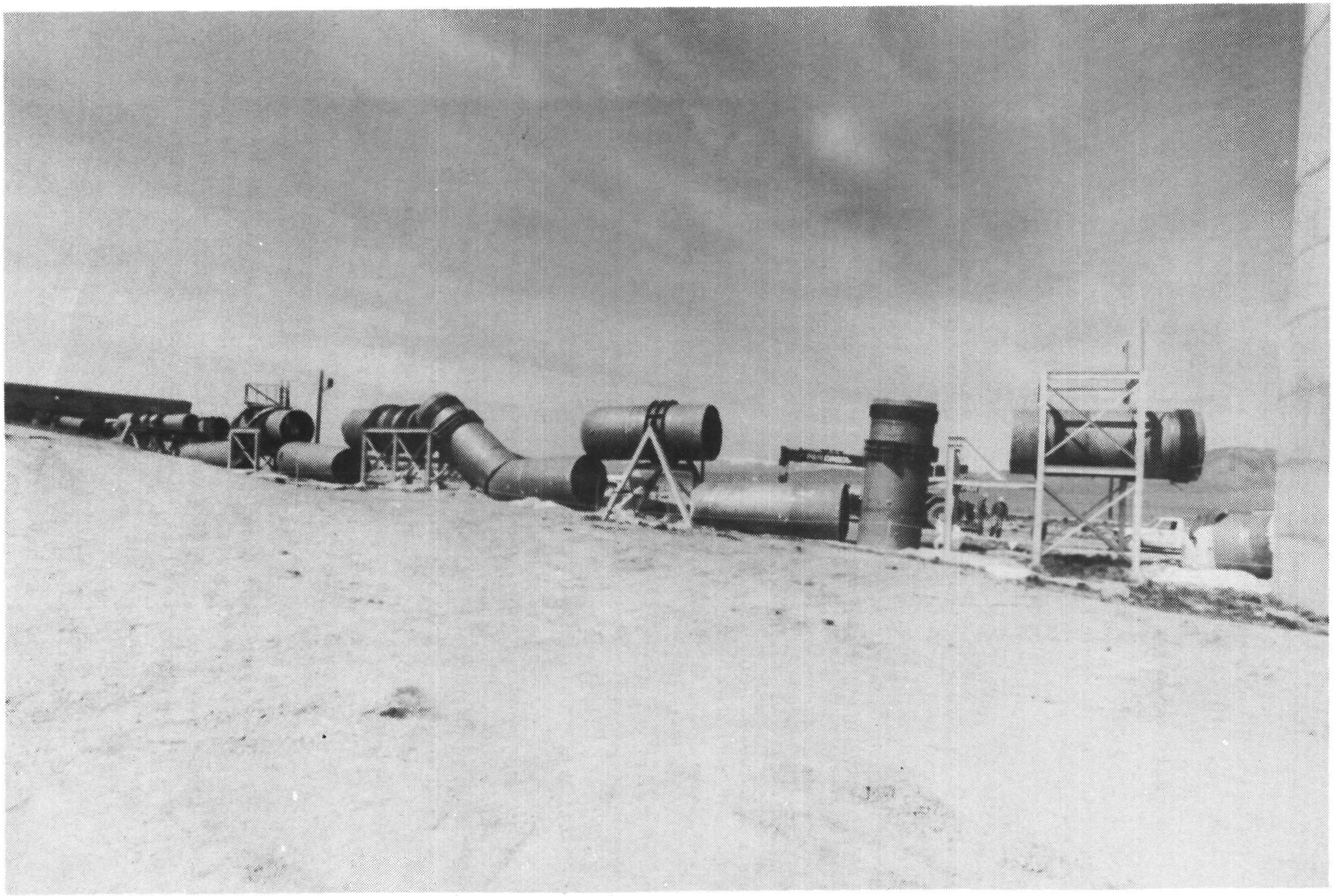


Figure 7. Exhaust duct sections.

Figure 8. Demolished exhaust stack collapsed in trench.

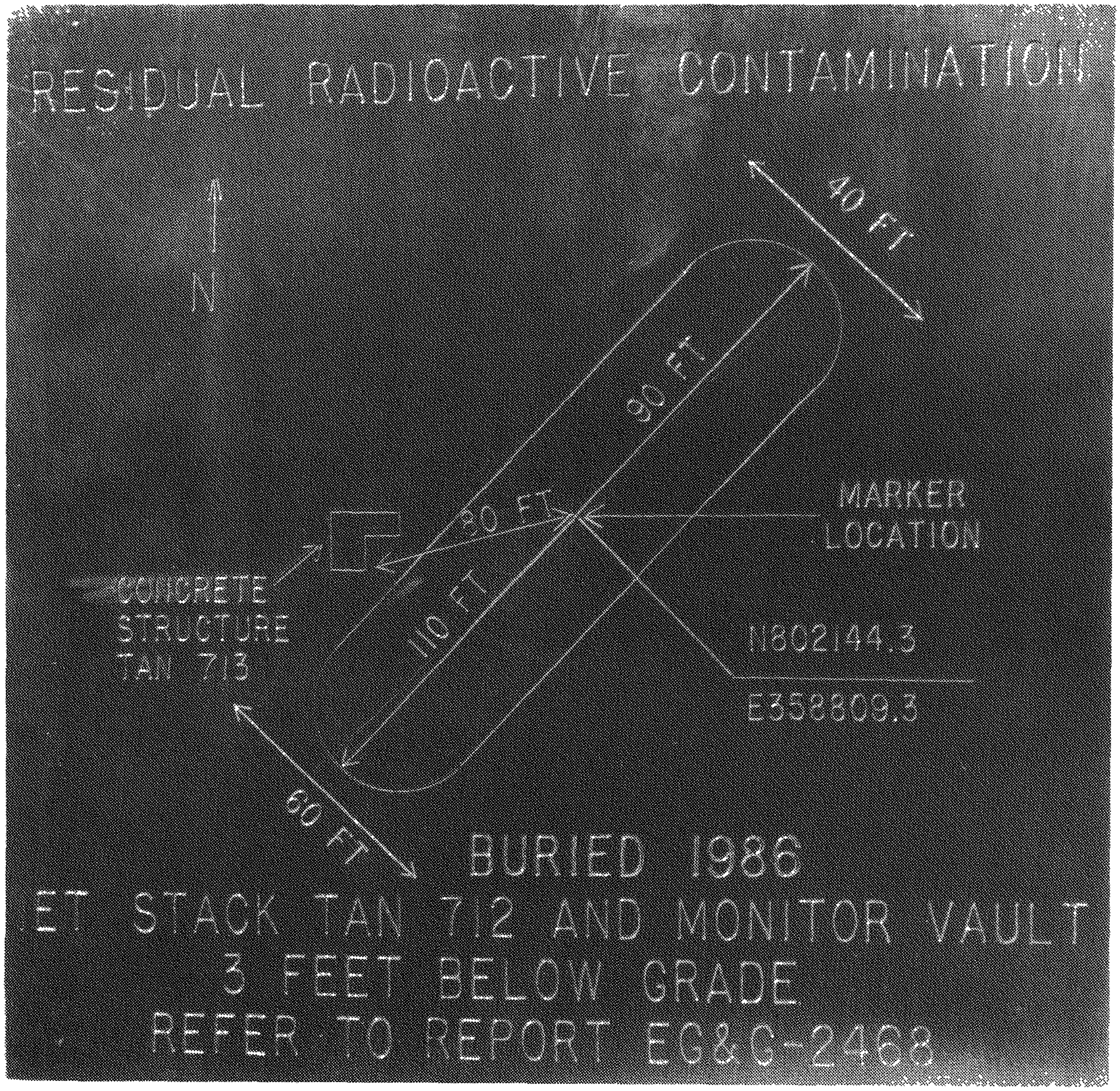
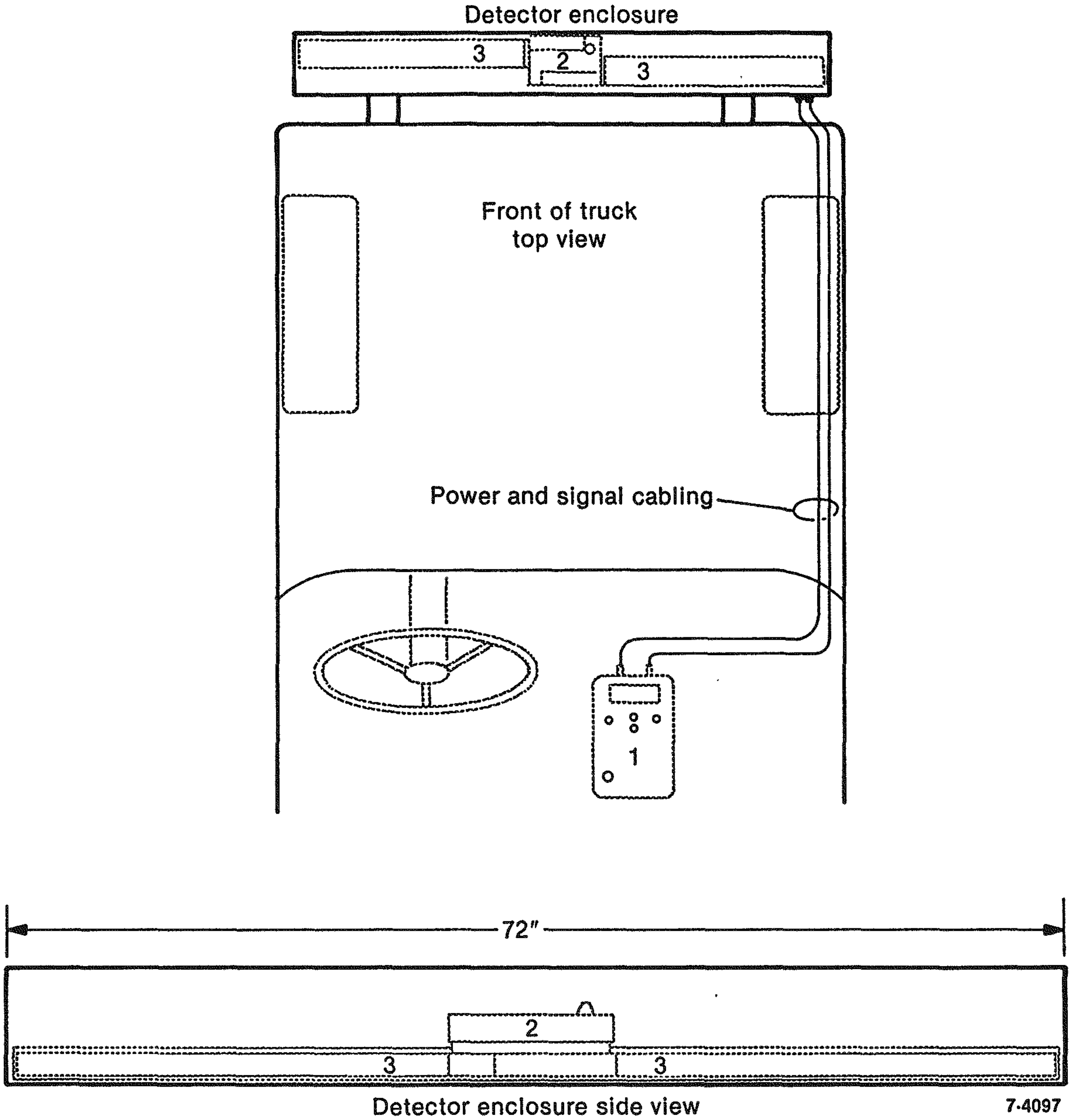


Figure 9. Permanent marker over buried stack.



Legend

1. VMC-250A vehicle monitor controller
2. SCA-253A single channel analyzer
3. Detector assembly
   (26″ x 4″-diameter light pipe)
   1/8″ lead shielding top-sides-outer ends

Figure 10. Vehicle-Mounted Roadway Monitor.

COST AND SCHEDULE

Figure 11 shows a schedule summary of the activities performed for the IET D&D project. The cost breakdown summary is shown in Table 4. The total project costs were well below those originally estimated, due to the specific cost savings from explosive severing of the exhaust duct and scabbling of the test pad. The project was also completed ahead of schedule.

Table 4. Cost breakdown summary

Major Components of Effort	$K
Characterization	84
Decision analyses and D&D plans	80
D&D operations	680
Final report and cleanup	81
Total	895

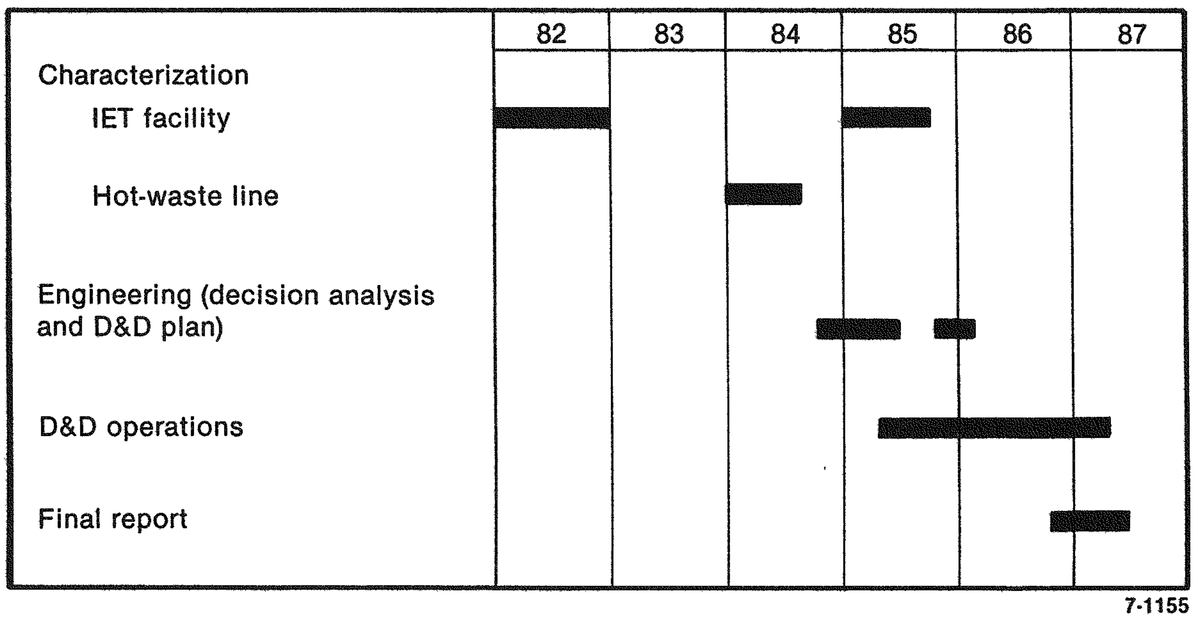


Figure 11. Schedule summary.

VOLUME OF WASTE GENERATED

Six 4- x 4- x 8-foot boxes of radioactively contaminated soil and one box of general radioactively contaminated trash were sent to the RWMC. Ten 2- x 4- x 8-foot boxes of contaminated steel pipe were sent to the RWMC. The volume envelope for the exhaust duct and hot-waste tank prior to size reduction was 12,085 ft^3, which was reduced to approximately 1,200 ft^3 at WERF prior to shipment to the RWMC for disposal. The concrete and brick volume of the exhaust stack buried at the IET is approximately 18,000 ft^3.

PERSONNEL EXPOSURE

D&D workers were required to wear thermoluminescent dosimeters to measure any radiation exposure received. The total from all personnel combined was 65 mR of beta-gamma external whole body radiation exposure for the entire project duration.

POST-DECOMMISSIONING CONDITION

The final physical condition of the IET facility is shown in Figure 12. All contaminated buildings and structures have been cleaned, removed, or buried to greater than three feet below grade. Specifically, the exhaust stack was buried, the exhaust duct was removed, the hot-waste tank and the majority of the hot-waste piping have been removed, and a significant amount of contaminated soil was removed. A permanent marker was placed over the buried stack and the ground surface contoured to match the surrounding terrain.

The radiological condition is basically contamination free, as ascertained by the post-D&D survey described above.

The IET facility is available for further use at the INEL. A two-year post-D&D surveillance and maintenance monitoring will be performed. The area will be surveyed for subsidence and radioactivity during this period. Upon completion of the two-year monitoring period, the facility will be removed from the Surplus Facilities Management Program Inventory. No further D&D action is planned or anticipated.

A project data package containing all reports, contracts, procedures, work packages, and other pertinent information has been assembled and will be stored at the INEL Records Storage Center.

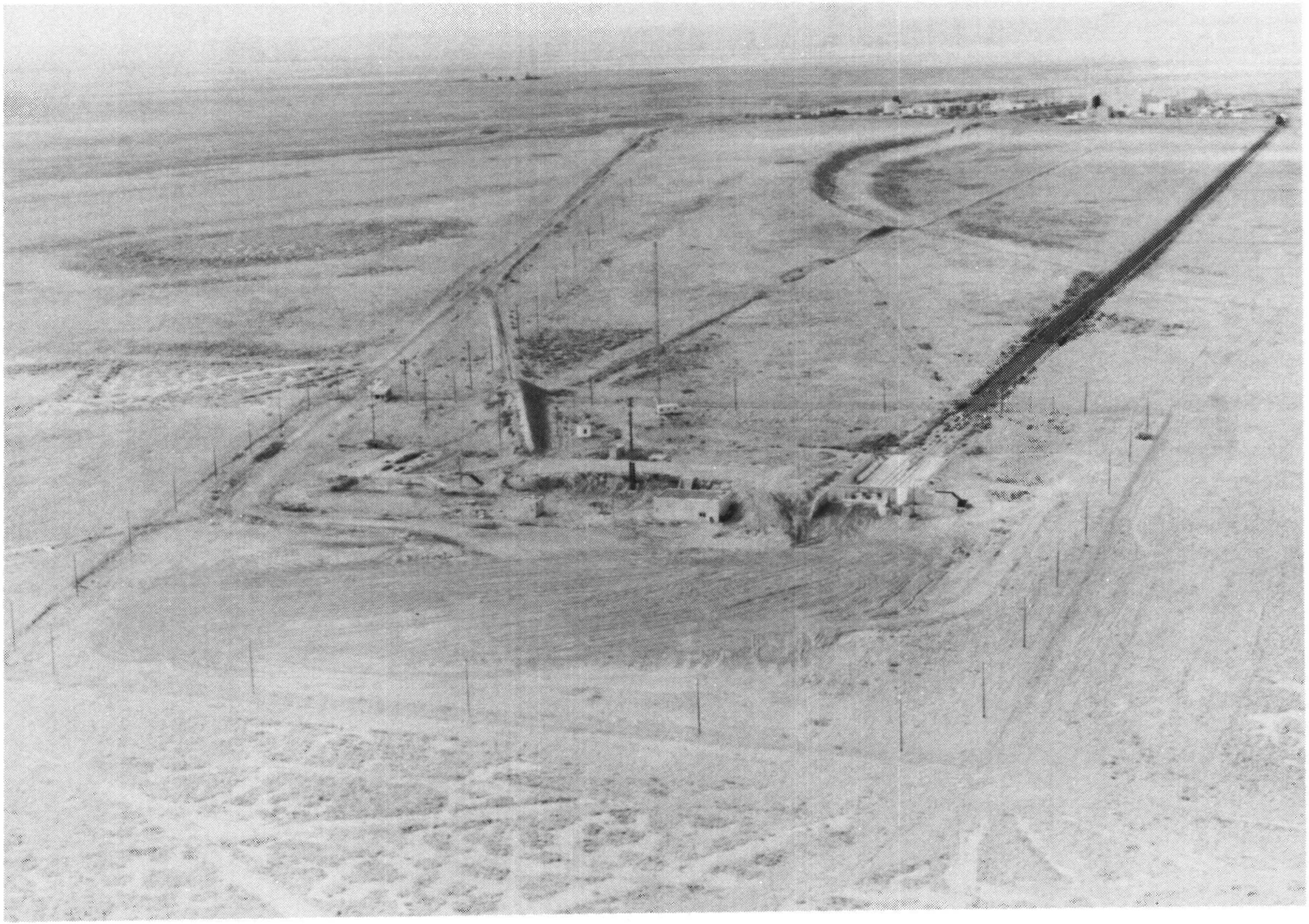


Figure 12. Post-D&D of IET facility.

LESSONS LEARNED

A suggestion to use innovative cutting methods on the exhaust duct was evaluated and accepted. The major advantage of using explosive severing of the exhaust duct was the large reduction in the amount of labor required, as compared to torch cutting or mechanical sawing methods. This minimization of labor results in a reduction of the ALARA radiation exposure, the cost of the labor, the cost of protective clothing and equipment, and shortening of the project schedule. An industrial safety advantage was gained by removing the need for block shoring and rigging. This had been a serious safety concern, since the north portion of the duct was under cantilever and rotational stress by design. Also, a reduction in radioactive waste volume was realized with fewer anti-Cs used and no shoring and blocking material required.

A significant reduction in waste volume was realized by sizing the exhaust duct and hot-waste tank sections at WERF prior to disposal at the RWMC. Although this activity was included in the original planning, the capabilities at WERF (a relatively new facility) had not been used on a major D&D project. Therefore, these particular large metal items provided some excellent D&D experience. Metal densities should be within a certain range at the INEL, in order to make size reduction at WERF attractive. Generally speaking, cylindrical shapes of six-inch diameter or greater and large vessels with a wall thickness of less than two inches are within the attractive density range for size reduction at the INEL.

The mixed waste caused a great deal of concern, due to recent agreements with the involved federal and state agencies. Since mixed waste had not been addressed in the original planning, the discovery of radioactively contaminated mercury required a work scope change, which resulted in an increase in the project cost and schedule. In the future, it would be wise to investigate the program history thoroughly enough to identify potential mixed waste sources prior to D&D operations.

The exhaust stack demolition was designed and performed in a slightly different manner than usual. Specifically, the supporting piers were blasted out from under the base, rather than the customary notching of the stack and blowing it over. Also, the base of the stack was demolished simultaneously with blasting of the piers, rather than going back after felling the stack to break up the base.

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