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REMOVAL OF THE MATERIALS TEST REACTOR OVERHEAD WORKING RESERVOIR

Aerojet Nuclear Company

IDAHO NATIONAL ENGINEERING LABORATORY

Idaho Falls, Idaho — 83401

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by

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ABSTRACT

This paper covers the salient features of the removal of an excessed contaminated facility, the Materials Test Reactor (MTR) overhead working reservoir (OWR) from the Test Reactor Area to the Radioactive Waste Management Complex at the Idaho National Engineering Laboratory. The 125-ton OWR was an overhead 160,000-gallon-capacity tank approximately 193 feet high which supplied cooling water to the MTR. Radiation at ground level beneath the tank was 5 mR/hr and approximately 600 mR/hr at the exterior surface of the tank. Sources ranging from 3 R/hr to in excess of 500 R/hr exist within the tank. The tank interior is contaminated with uranium, plutonium, and miscellaneous fission products. The OWR was lowered to ground level with the use of explosive cutters. Dismantling, decontamination, and disposal was performed by Aerojet Nuclear Company maintenance forces.

SUMMARY

The Materials Test Reactor (MTR) overhead working reservoir (OWR) was one of the Idaho National Engineering Laboratory (INEL) facilities meeting the U.S. Energy Research and Development Administration established criteria for decontamination and decommissioning (D&D) work. Alternate methods were pursued to remove the structure whose internal surfaces became radioactively contaminated during its active service by particulate matter which was carried with the MTR primary cooling water and deposited on the OWR tank interior. The deposited sources exceeded 500 R/hr within the OWR tank and produced readings averaging about 600 mR/hr on the OWR tank exterior.

Special shaped charge explosives were selected to cut the supporting structure and drop the OWR to ground level. The OWR tank interior was sprayed with a special spray to fix the contamination. The impact area was prepared to cushion the drop of the OWR tank to prevent tank rupture. The prerelease preparations were successful since the OWR tank did not rupture, and contamination releases were insignificant. Subsequent to the explosive release of the OWR, the OWR tank was cut free from its supporting members, and the contaminated service piping was cut into sections for disposal at the INEL Radioactive Waste Management Complex. Noncontaminated items were surplused, and the general area was cleared except for buried piping and supports that will be removed when future planned MTR D&D work is performed.

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REMOVAL OF THE MATERIALS TEST REACTOR OVERHEAD WORKING RESERVOIR

1. INTRODUCTION

During August 1973, the AEC Idaho Operations Office [now the Energy Research and Development Administration (ERDA-ID)] requested Aerojet Nuclear Company (ANC) to assume the responsibility for carrying out ERDA's decontamination and decommissioning (D&D) program for excess contaminated facilities at the Idaho National Engineering Laboratory (INEL). The Materials Test Reactor (MTR) Overhead Working Reservoir (OWR) at the Test Reactor Area (TRA) was one of the INEL facilities meeting the established criteria for D&D work and was the first phase of the D&D of the MTR complex. The program called for the total removal and disposal of the OWR.

This report presents a review of the program plan which was prepared by ANC and a discussion covering the execution of the program.

2. OBJECTIVE

The objective of this activity was to remove an excessed radioactively contaminated facility from TRA to comply with ERDA's decontamination and decommissioning plan and to remove a source contributing to the background radiation at the TRA.

3. TECHNICAL APPROACH

Planning for the activity included: Conducting of radiation and contamination surveys of the OWR internal and external portions; and development of activity specifications, detailed procedures, and safety analysis to assure safe execution of the program.

4. SCOPE OF THE WORK

The program scope included: removal of security fence around a 60-foot-square area; removal and replacement of area fencing and overhead electrical service; preparation of an impact area; spraying the interior of the tank with a contamination fixative; preparatory work on the structure; explosive release of the structure; sectioning the piping and support structure; removal of contaminated material to the Radioactive Waste Management Complex (RWMC); surplusing noncontaminated items; and cleanup and restoration of the area. Removal of underground supports and piping was not included in this program but will be a part of the future MTR D&D work.

5. DISCUSSION

The MTR overhead working reservoir became radioactively contaminated with ^{60}Co and fission products during its active service by the particulate matter which was carried with the MTR primary cooling water. The development of the methods and the performance of the work to remove the OWR from the Test Reactor Area to the RWMC is briefly discussed as follows.

5.1 General Description

The location of the OWR and its position in relation to other facilities and structures at TRA is shown in Figure 1. The OWR, as shown on the left of Figure 2, was a stainless steel clad insulated water storage tank, 32 feet in diameter and approximately 46 feet tall, supported on four 30-inch-diameter legs with intermediate structural supports giving a total overall height of 193 feet. Tank wall thicknesses range from 5/16 inches at the bottom to 3/16 inches at the top. The insulated inlet and outlet lines were 30 inches in diameter, providing primary cooling water to the MTR when it was in operation. An 18-inch stainless steel clad overflow line was attached to one leg. Caged ladders and a catwalk provided access to the tank exterior and interior. A floating roof, similar to a large pie pan with pie shape segments included, was lodged within the tank approximately at the spring line.

5.2 Radiation and Contamination Hazard Evaluation

The interior surfaces of the OWR became radioactively contaminated (primarily ^{60}Co and traces of ^{137}Cs) during its active service by particulate matter which was carried with the MTR primary cooling water and was deposited in varying concentrations on the tank interior. The sources produced readings in excess of 500 R/hr inside the OWR tank and contact readings averaging 600 mR/hr exterior to the OWR tank. A 5 mR/hr field existed at ground level directly beneath the OWR. The total curie content of the OWR was approximately 7 curies of ^{60}Co.

An unofficial estimate for calendar year 1974 indicated that accumulated exposures to all personnel working in the area of the OWR could be about 4.6 man rem. Assuming that TRA operational activity remains similar to current conditions, exposures of approximately 50 man rem could be accumulated over the next 30 years. Total accumulated exposures received by personnel during the OWR removal was approximately 20.8 man rem with no individual exposure exceeding allowable limits. Exposure and contamination were controlled and minimized by the utilization of portable steel and lead shielding, limitation of exposure time, air distance shielding, air monitors, Anti-C apparel, and continuing health physics monitoring and control. Refer to Section 7 for the results of the final contamination/radiation survey.

An extensive search of the MTR operational records was conducted to determine if the total quantity of fissionable material that could have been discharged into the MTR primary coolant system due to fission breaks, fuel alloy melting, etc., could constitute a

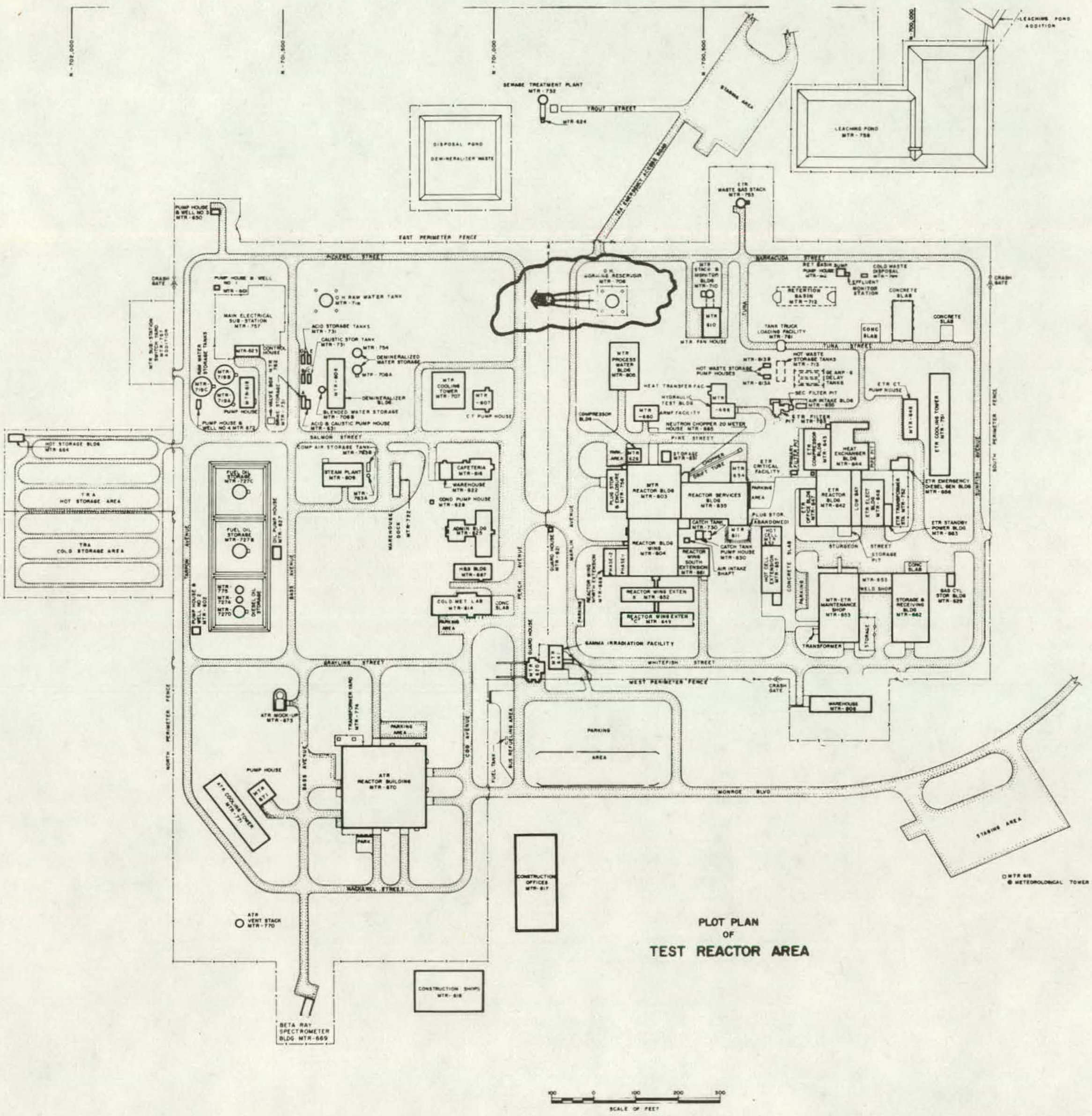

Fig. 1 Test Reactor Area plot plan.

Fig. 2 The Overhead Working Reservoir (OWR) prior to removal.

critical mass. It was determined that approximately 3.9 grams of plutonium oxide and approximately 114 grams of uranium oxide could have been released to the primary coolant system during the life of the MTR. (However, these quantities reflect total amounts contained in test specimens that failed, and not all of the fissionable material was necessarily released into the primary coolant system.) If the total quantity had been released, this would be only 14.5% of the amount required to form a critical mass. Additionally, the amount of plutonium oxide possibly entering the system was not great enough to require considering the OWR as transuranic waste.

The configuration and structural integrity of the OWR tank and piping portions were evaluated to determine the possibility of surface rupture when the OWR struck the ground after the explosive release. Since it was not proven conclusively that the tank would remain intact, precautionary methods were developed (and implemented) to reduce the possibility of the release of significant quantities of contaminated particles. This included the application (by spraying) of a commercially available contamination fixative agent to the interior of the OWR tank and the preparation of the tank impact area. TURCO 5580G was selected as the contamination fixative to be used, based on tests performed to evaluate the ability of different fixative agents to hold scrap material such as wire, bolts, etc., to a section of stainless steel plate in an explosive force field. The tank impact area was prepared by the placement of large plastic sheets for contamination migration control and dimpled loads of soft soil placed in an egg crate pattern to soften the landing of the OWR tank.

Consideration was given to decontamination of the OWR in place. Due to the high costs and the copious quantities of rinse water that would have had to be processed, this alternate was set aside. Procedures were developed (but discounted) for the decontamination of the tank after the OWR would be lowered to the ground. Decontamination of the tank to lower the radiation field appeared unwarranted since air distance and portable shielding could be effectively utilized to reduce exposures during disposal operations and at a lower cost.

Different methods were evaluated for the cuts to be made into the contaminated service piping. Mechanical cuts eliminated the problem of smoke generated by flame cutting. Urethane foam plugs at cut lines were utilized to contain surface contamination. (Experimentation during removal activities indicated that TURCO 5580G sprayed on the surface worked as well with less effort.) The flammability of the urethane foam required the incorporation of additional protective methods to prevent fires.

5.3 Explosives and Related Hazards Analysis

Extensive studies and evaluations were conducted to determine the effects of the use of explosives for the release of the OWR. Air shock data calculations indicated that the charges to be used would not damage windows, etc., in the blast area. (However, as a precautionary action, plywood sheets were placed over windows in the immediate vicinity of the OWR.) Calculations were made of possible seismic effects. These calculations indicated that the impact of the OWR would not affect the Advanced Test Reactor (ATR) seismic scram system. Also evaluated was the possibility of damage to utilities buried beneath the impact point. Minimal damage appeared probable, but none occurred. However, standby precautions were taken to maintain services in the event of an impact-produced failure. Procedures were developed for the proper handling and use of the explosives. Engineered explosive cuts were evaluated and selected in redundancy to assure proper directional falling of the OWR. A wind loading analysis of the structure was performed to assure that preparatory structure weakening would not permit the OWR to be blown over by high winds. It was determined that the structure would withstand 100 mph winds with the legs notched. The possibility of unauthorized personnel entering the blast area limits was evaluated and administrative restrictions were imposed for the protection of personnel. The possible effect of the explosive release upon Engineering Test Reactor (ETR) and MTR operations was evaluated, and detailed sequence procedures were instituted to assure proper coordination and control.

5.4 High Altitude Work Evaluation

Working at high altitudes on the OWR (to 193 feet above the ground) in a radiation zone was evaluated. Each operation was reviewed to assure that all work possible would be performed at ground level. Personnel reaction to high altitude work was evaluated and only properly qualified personnel were allowed to work on the standing structure.

5.5 Alternate Removal Methods Evaluation

A fault free analysis of optional removal methods was prepared. (See Figure 3 for a summary of this analysis.) Included were crane rigging, tilting, controlled fall, explosive release, helicopter or helium balloon lifts, and jacking. Deferral of the removal work to allow further decay of the fission products was also viewed. Initially, ANC personnel prepared a lump-sum subcontract package for the lowering of the OWR tank section and support structure using large mobile cranes. Bids ranging upwards from $236,000 were received and rejected due to funding limitations. The subcontract package was modified and reissued. The new low bid of $194,700 was also rejected since total program funding was limited to $105,000. Except for the explosive release method, the other removal alternates were evaluated and rejected as being unsafe, too costly, limited by equipment availability, or impractical. The explosive release method was determined to be the safest method to provide the least potential radiation exposures to personnel and to meet the program budget limitations.

5.6 Disposal Methods Evaluation

Different disposal methods for the removal of the OWR were evaluated. Due to the large size of the OWR tank portion, consideration was given to cutting the tank in half from top to bottom at TRA or hauling the OWR tank in one piece to the RWMC. Alternate travel routes were considered. A "back country" route over existing roads was chosen to permit transport of the OWR tank in one piece to reduce radiation exposures and clear power lines that could not be deenergized. However, when the tank impacted the ground, deformation occurred to the extent that the tank could be placed on a lowboy transport in such a manner as to provide the needed clearance under some of the power lines. This permitted

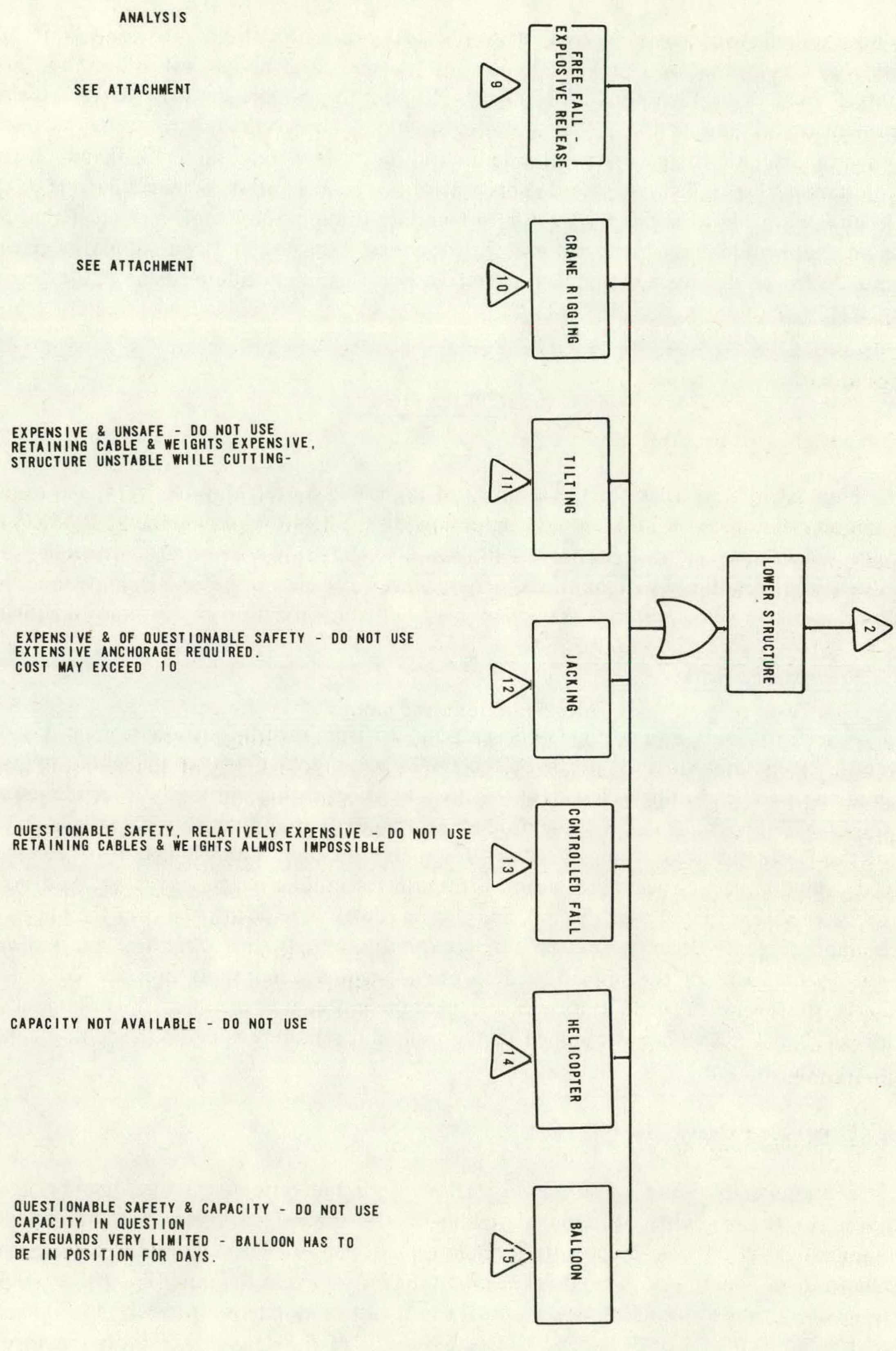

Fig. 3 Alternate removal methods.

hauling the tank over existing paved roadways for a portion of the trip to the RWMC and eliminated a potential problem with the lowboy transportation across soft soil on the "back country" road from TRA to U.S. Highways 20 and 26 near the Big Lost River Crossing. Interment of the tank at the RWMC was also evaluated. Due to the relatively shallow burial depths available, alternate tank volume reduction methods were considered. Flame cutting of the tank into sections was discarded because of smoke generation. Selected cutting of the tank with the blade of a crawler tractor to facilitate folding of the tank was selected as the method that would reduce the volume with the least exposure and contamination release potential. Procedures were prepared for the transport, hauling, and interment of the tank at the RWMC.

6. OPERATION

Preparatory site work for the removal of the OWR started May 14, 1975, and except for minor cleanup work at TRA and reduction of the OWR tank volume at RWMC, the project work was essentially completed June 30, 1975. The removal operations were conducted in accordance with approved activity specifications, procedures, maintenance job releases, and safe work permits. Following is a brief summarization of the removal activity.

6.1 Preparatory Work

A security fence around the OWR was removed from the 60-foot-square area. A 40 by 60 foot impact area directly north of the OWR was prepared by removing the security fencing and overhead utility services in this area. Plastic sheeting was placed over the impact area to facilitate removal of fission product contamination and activation particles in the event the OWR ruptured at impact allowing spillage to occur. Truck loads of soft soil were placed over the plastic sheets in a dimpled fashion resembling plastic egg trays. Additional plastic sheets were placed over the soil, and rigging cables were positioned over the plastic to accommodate load rigging after the OWR explosive release. Fire hose fog nozzles were placed on the sides of the impact area to provide a fine water spray over the OWR tank body in the event the tank ruptured and contamination was released. A contamination fixative, TURCO 5580G, was pumped to the tank and remotely sprayed inside the tank to fix the contamination.

6.2 Explosive Release

Sections of the inlet, outlet, and overflow pipes and certain structural members were removed to assure proper directional felling of the OWR (see Figure 4). Cuts into the contaminated piping were made with mechanical cutters (Wheiler-Fcin milling saw) through urethane foam which was injected between two balloons within the pipe. Torch-cut notches were made in the support legs (see Figure 4) to facilitate utilization of sections of flexible lineal shaped charge (FLSC) explosives (see Figure 5). Redundant charges were provided to assure proper removal of leg sections to control the direction of fall. A total of 47,200 grains of RDX-type explosive was used. The firing of different charges (the highest single

Fig. 4 View of the OWR showing removed sections of the inlet and outlet piping.

Fig. 5 View of a portion of the flexible lineal shaped charges (FLSC).

charge did not exceed 24,000 grains) were time delayed to reduce air blast effects. The charges were activated at 12:40 a.m. on June 5 (see Figure 6, special effects photograph). The prerelease preparations were successful since the tank impacted the ground at the predetermined location and did not rupture (Figures 7 and 8 provide views of the OWR on the ground prior to dismantling). Monitoring of the area indicated contamination releases were insignificant. Figure 9 shows a view of an FLSC cut in one of the 30-inch-diameter legs. (Note the coarseness of the preparatory notching flame cut as compared to the smoothness of the FLSC cut.)

6.3 Disposal

Following the successful explosive release of the OWR, the piping and support members were cut into sections up to 30 feet long for ease of hauling. Openings in contaminated items were sealed with plastic, and the items were transported to the RWMC for disposal. Reusable noncontaminated material was disposed of as surplus material. Contamination-free scrap was taken to the Central Facilities Area waste disposal site. Openings into the tank were sealed with plastic, and TURCO 5580G was sprayed over external areas of the tank body suspected of being contaminated. Two cranes were used to lift the approximate 45-ton tank onto a 100-ton lowboy trailer (see Figure 10). Soil bearing contamination was removed from the OWR site and disposed of at the RWMC. The area was cleaned up and restored as required with the project work being essentially completed as scheduled on June 30, 1975.

Fig. 6 Special effects photograph of the release of the OWR at night.

Fig. 7 Overhead view of the OWR on the ground.

Fig. 8 View of the OWR on the ground.

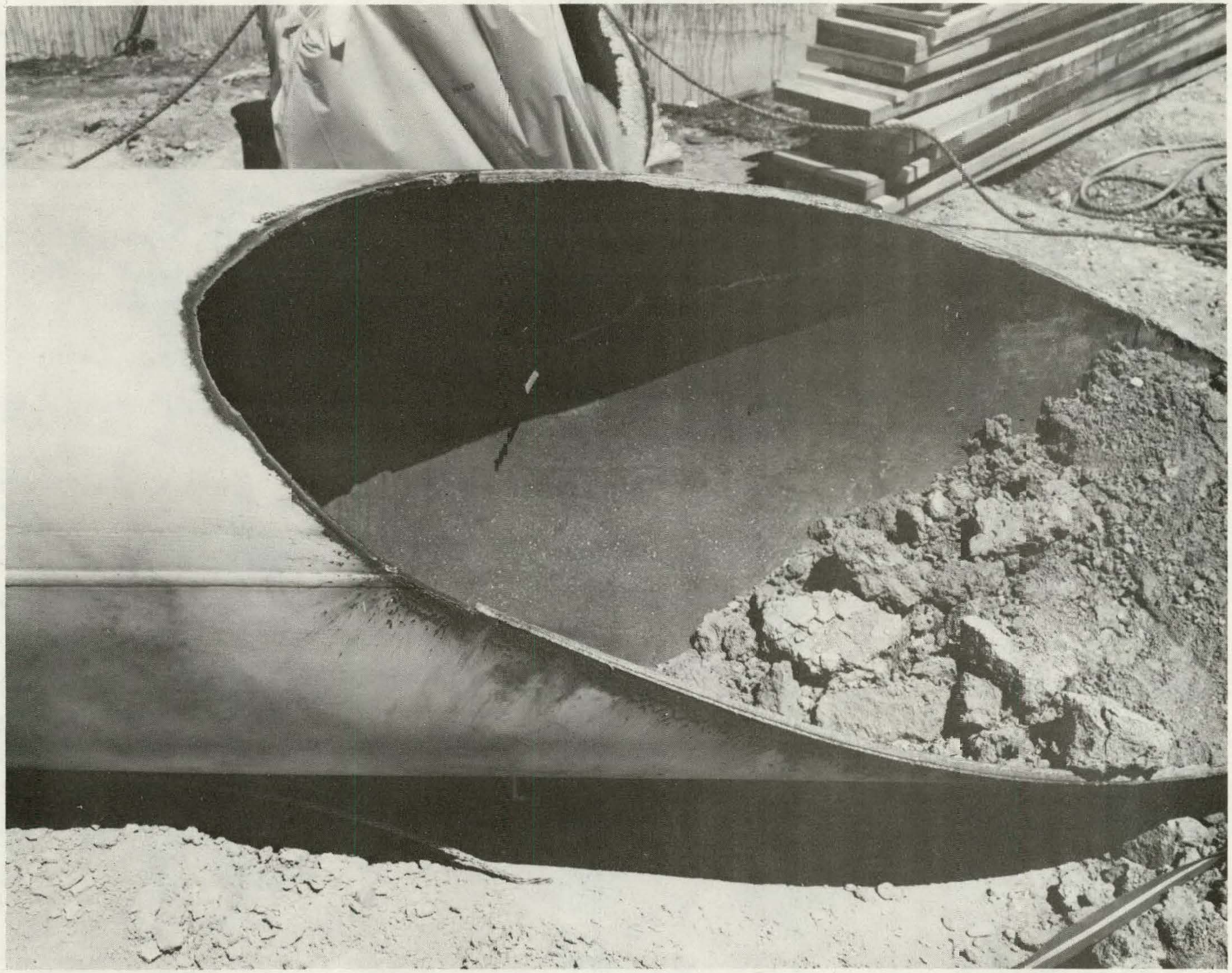

Fig. 9 View of an FLSC cut in one leg section.

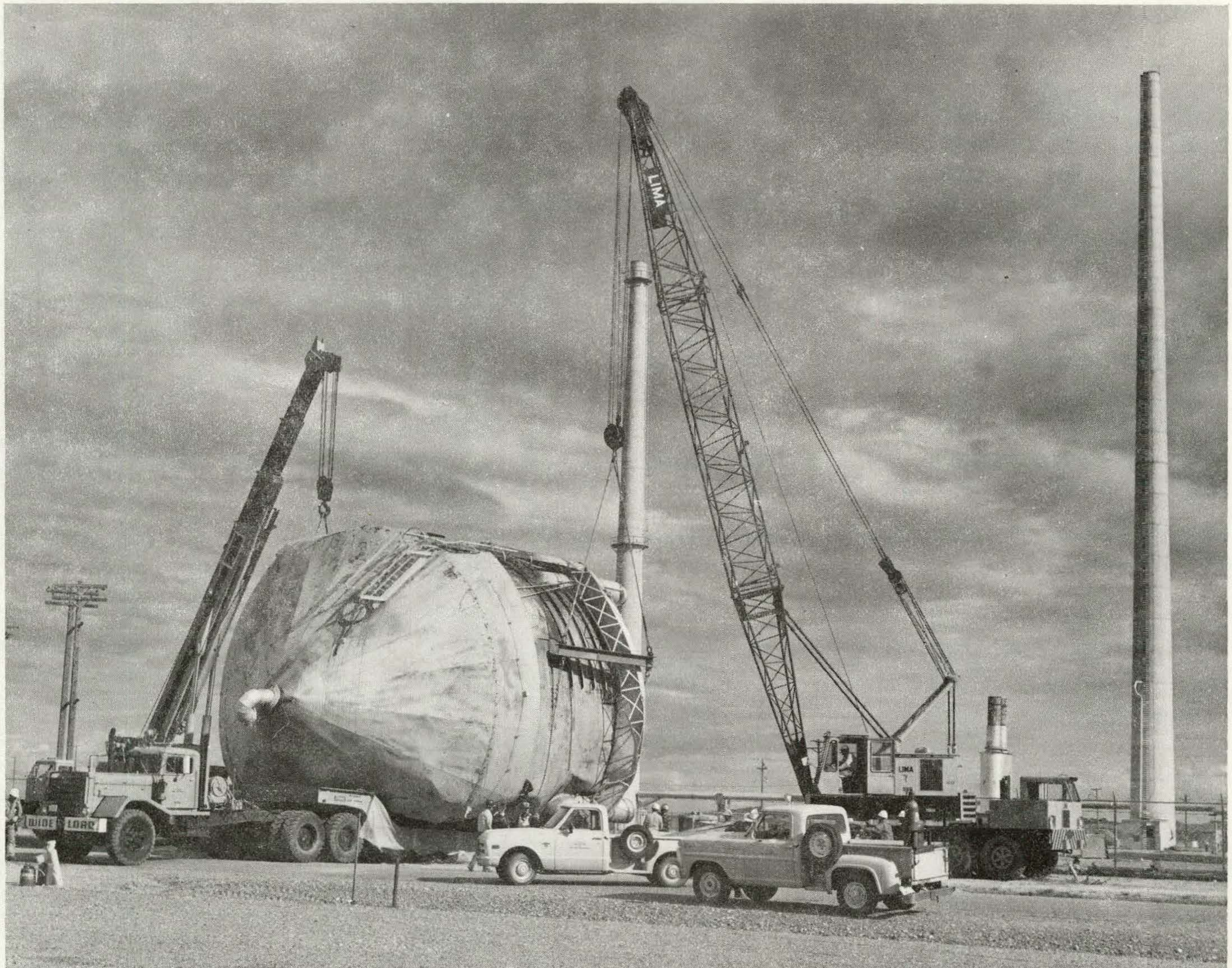

Fig. 10 View of the OWR being loaded for transportation.

7. CONCLUSIONS

The validity of the engineering calculations and evaluations were verified by the successful removal of the OWR. Utilization of explosives by qualified personnel was proven to be practical and economical in an operating test reactor area. No damage occurred to underground utility services or adjacent buildings and structures; the seismic sensing scram alarm for ATR was not activated; the tank did not rupture; and contamination releases were insignificant as a result of the preparatory work performed at the impact area. The work was completed in a very safe manner without exceeding allowable radiation exposures to involved personnel. The project work was completed within budget limitations.

An area survey of the OWR site was conducted after the D&D work was completed. This survey indicated that loose contamination levels in the drop zone area were less than 200 dpm/100 cm^2 beta and gamma; and direct radiation is less than 0.2 mR/hr. The area directly around the original OWR site was ribboned off since contamination does exist beneath ground level due to spills that occurred during operation of the MTR and existing contaminated piping that will be removed later as a part of the overall MTR D&D effort. This ribboned area is contamination free at the ground surface with direct radiation levels of less than 0.5 mR/hr.

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