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Decommissioning the Los Alamos Molten Plutonium Reactor Experiment (LAMPRE I)

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DECOMMISSIONING THE LOS ALAMOS MOLTEN PLUTONIUM REACTOR EXPERIMENT (LAMPRE I)

by

Johnny R. Harper and Raymond Garde

ABSTRACT

The Los Alamos Molten Plutonium Reactor Experiment (LAMPRE I) was decommissioned at the Los Alamos National Laboratory, Los Alamos, New Mexico, in 1980. The LAMPRE I was a sodium-cooled reactor built to develop plutonium fuels for fast breeder applications. It was retired in the mid-1960s.

This report describes the decommissioning procedures, the health physics programs, the waste management, and the costs for the operation.

I. INTRODUCTION

The Los Alamos Molten Plutonium Reactor Experiment (LAMPRE I) was built in the early 1960s at Technical Area (TA) 35, Los Alamos, New Mexico. The reactor was located in the southeast part of Building 2. It was a sodium-cooled experimental research reactor built to develop plutonium fuels for fast breeder applications. It was retired and defueled during the mid-1960s. The sodium and the sodium-treatment systems such as pumps, dump tank, hot traps, surge tank, and heat exchanger systems were removed at that time (Figs. 1 and 2). Activated metals in the reactor cell and lack of funding prevented further decommissioning.

Complete decommissioning was desirable to make available approximately 140 m^2 of floor space for Laboratory personnel and experiments.

II. DECOMMISSIONING PROGRAM

Planning began in late 1979 with the review of relevant design drawings and reports.[1-2] Individuals who had been involved with the experiment were consulted to gain design information needed for the decommissioning effort.

The decommissioning first focused on the reactor cell, which housed the remaining reactor systems and two sodium-coolant lines (Fig. 3), and the subbasement (Fig. 4) under the reactor cell, which housed the hydraulic control systems for the four control rods and the shim.

Decommissioning began by remotely drilling a hole into each sodium-coolant pipe next to the reactor (Fig. 5) so that expanding polyurethane foam could be introduced into each pipe to fix any sodium residue and/or internal plutonium contamination that might be encountered. The pipes were cut remotely with a portable band saw (Fig. 6), and the ends were sealed with metal caps (Fig. 7) and roofing tar. Supportive I-beams were removed by remotely unscrewing connecting bolts and nuts. The vessel was lifted vertically and placed into a retrievable cask (Figs. 8 and 9). The cask previously had been placed in the nearby heat exchanger pit where ample shielding existed for the ensuing removal and packaging of activated structures. The reactor vessel assembly (0.3 m in diameter and 3.8 m in length) had an average exposure rate at contact of 60 R/h. The cask was filled with standard concrete using vermiculite to provide additional protection of the sodium pipes. The loaded cask was stored retrievably in a shaft (Fig. 10) at the Los Alamos National Laboratory Radioactive Disposal/Storage Site.

Approximately 8 000 lead bricks were removed progressively from the reactor cell to allow access into its interior (Fig. 11). All bricks were surveyed for contamination. Although some had to be disposed of, most were recycled for reuse at the Los Alamos National Laboratory. The reactor and its components, such as flue, shim, control rods, and bottom vessel shield, had been surrounded by approximately 900 graphite rods. Each rod was 0.1 m in diameter and 1.8 m long. The maximum contact exposure rate on each rod was 50 mR/h due primarily to ^{60}Co. The rods adjacent to the reactor components were remotely removed with a wire-loop tool and pulled up into the bay area above the reactor cell where they were packaged in plastic-lined plywood boxes. A 20-cm thick by 210-cm high semicircular shaped lead shield weighing approximately 6 tons was built and lowered into the resultant space. The shield allowed workers to enter the reactor cell without unnecessary exposure from the 70-R/h-activated surfaces of the remaining reactor components (Fig. 12). About 780 graphite rods were removed, packaged, and stored at Los Alamos National Laboratory for possible reuse. Another 100 rods were broken, removed, packaged, and disposed of as waste.

The flue and the control-rod sleeve spacer (activated to 17 R/h at contact) were removed remotely (Fig. 13) and placed into a corrugated metal pipe culvert that had been brought into the heat exchanger pit. The culvert was then filled with standard concrete and transported to TA-54 for disposal. The activated shim (70 R/h contact) was treated in a similar manner (Fig. 14), except magnetite concrete was used for shielding in the cask.

The hydraulic systems (Fig. 15) in the subbasement were disconnected. The bottom-vessel shield, control rods, and floor-plug assembly were removed (Fig. 16) and placed into another culvert in the heat exchanger pit. The 0.75-m-diameter by 4-m-long unit was activated to 55 R/h at contact. The culvert was then filled with magnetite concrete.

The remaining activated metal structures (Fig. 17) in the reactor cell were cut with an oxyacetylene torch and removed to provide access to the two sodium-coolant lines and the remaining lead bricks (Fig. 18). The pipe interiors were contaminated with ^{239}Pu levels up to 10^4 dis/s/cm^2. The pipes were cut by a portable band saw, capped with plastic and cloth-backed tape, and disposed of at TA-54.

The remaining lead bricks were also removed, surveyed, and recycled for use at other Los Alamos National Laboratory facilities. The reactor control room was stripped of electrical systems, surveyed for radioactivity, and rehabilitated. The sodium equipment room, heat exchanger pit, subbasement, and the reactor cell (Fig. 19) were surveyed. All areas except the reactor cell were released for unrestricted use. The reactor cell, with a maximum of 70 mR/h from the activated cell liner and underlying concrete structures, was considered to be at a level that was as low as reasonably achievable. Plans are for the cell to become a secure vault storage area, freeing more usable floor space elsewhere in the building.

III. HEALTH PHYSICS

Personnel assigned to the project were experienced radiation workers. However, some were more familiar with alpha and beta radiation than with gamma radiation. Therefore, all were indoctrinated on working in penetrating radiation areas and on the health physics techniques required. Decommissioning work was not allowed without the presence of at least one health physics surveyor, but almost all of the work was overseen by two.

Workers were provided with anticontamination clothing such as underwear, coveralls, gloves, hoods, and booties. No personal decontamination beyond normal showering and washing procedures was required.

All workers participated in the Los Alamos National Laboratory's full-face respiratory fitting, testing, and training program. Full-face respirators equipped with high-efficiency particulate filters were used during phases involving a potential for airborne radioactive particulates and for asbestos work. Full-face respirators supplied with breathing air (provided by compressors and hoses) were used during oxyacetylene cutting of activated metals and during the melting of lead bricks. Nose swipes were collected from each worker after each risk period. Analyses of the swipes indicated no inhalation problem had occurred.

Air was sampled from the working areas by passing it through a HV-70 filter paper at a rate of 0.01 m^3/s. The papers were removed at the end of each workday and analyzed for alpha, beta, and gamma activity to provide a record of the workers' potential exposure to airborne radioactivity. The maximum airborne radioactivity detected never approached the DOE concentration guides for cobalt or plutonium.

All workers were provided with thermoluminescent dosimeters to record monthly accumulated radiation exposures. The total exposure received by 12 workers over a 7-month period was 7.26 rems. Individual exposures ranged from 0.26 to 0.95 rems. A calibrated Johnson pocket dosimeter was also worn by each individual. These dosimeters were read and recorded daily.

A variety of instrumentation was required. A Ludlum-129 with a 60-cm^2 air proportional probe was used to measure surface alpha activity. A Ludlum 14-C with GM-Probe or a Teletector Model 6112 was used to measure beta-gamma activity. Continuous air monitors, an Eberline Alpha-3 and an Eberline AMS-2, were used to provide continuous alpha and beta gamma airborne surveillance.

IV. WASTE MANAGEMENT

All wastes generated by this operation were buried, or retrievably stored, at the Los Alamos National Laboratory Radioactive Waste Disposal/Storage Site (TA-54) located 8 km from the decommissioning site. Burial was in pits, which are covered with a meter of uncontaminated soil and revegetated. Approximately 225 m^3 of debris were buried. The reactor vessel was placed in a cask, the space between the cask and reactor was filled with concrete, and because of plutonium levels, the cask was stored retrievably in a shaft at the Radioactive Disposal/Storage Site. The estimated level of ^{239}Pu in the reactor vessel was 12 Ci. The ^{239}Pu was released into the sodium during the experiments because of a ruptured fuel pin.

Most wastes were loaded into plywood boxes and transported to the disposal site in tarpaulin-covered, plastic-lined, dump or flatbed trucks with sides and tailgate. Some items, placed in modified corrugated metal pipe culverts that were filled with standard or magnetite concrete, were transported on flatbed trucks. Equipment and tools used during the operation were monitored routinely and decontaminated as necessary.

V. ENVIRONMENTAL SURVEILLANCE

The Laboratory's environmental surveillance group monitored the operation with its routine air sampling network and one additional station outside the reactor cell. Filter papers from the sampling locations were collected and analyzed after a 7- to 10-day decay period. No measurable increase above the Los Alamos National Laboratory norm was detected during the period of decommissioning for gross alpha, beta, or gamma activity.

VI. COSTS

The project required 140 working days. Subcontractor costs for craft manpower and equipment were $115 000, and Laboratory health physics and management costs were $30 000 for a total of $145 000.

REFERENCES

1. E. O. Swickard, "Los Alamos Molten Plutonium Reactor Experiment (LAMPRE) Hazard Report," Los Alamos Scientific Laboratory Report LA-2327 (June 1959).

2. K Division Personnel, "LAMPRE I Final Design Status Report," Los Alamos Scientific Laboratory Report LA-2833 (January 1962).

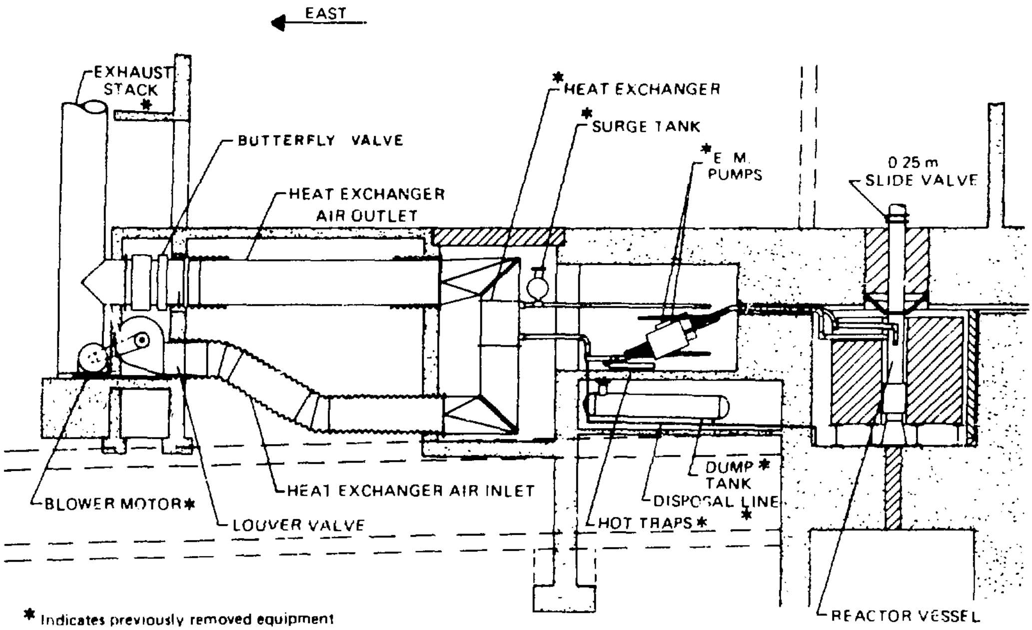

Fig. 1.
Elevation view of reactor installation.

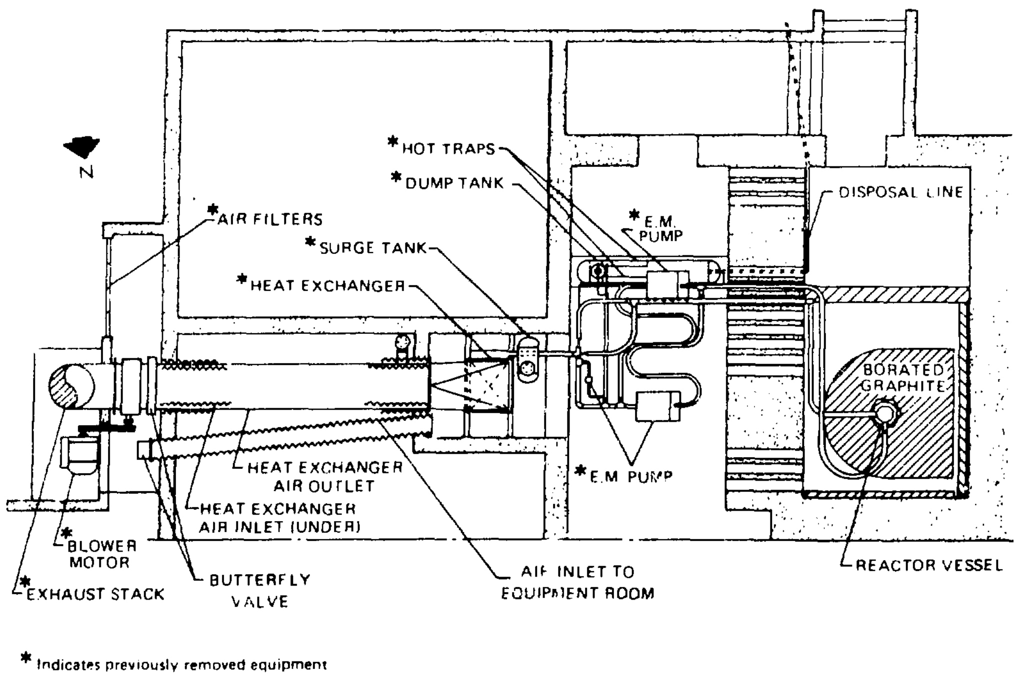

Fig. 2.
Plan view of reactor installation.

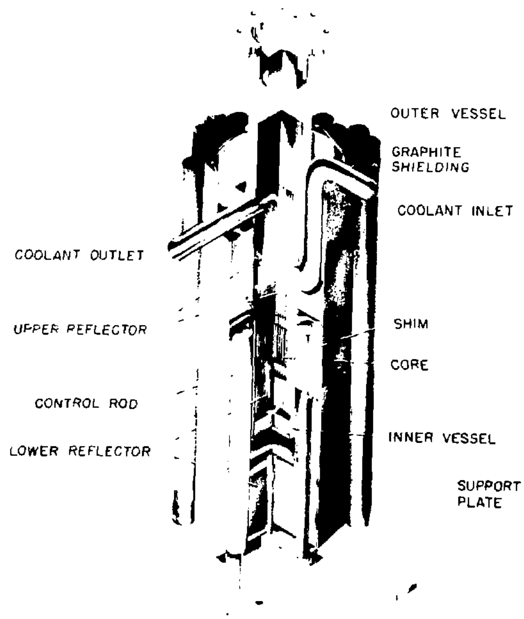

Fig. 3.
LAMPRE reactor.

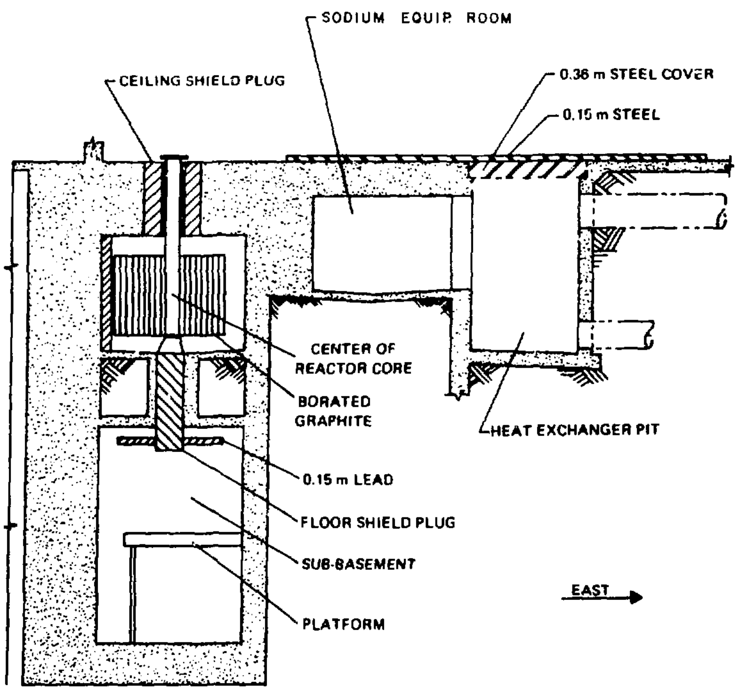

Fig. 4.
Vertical cross section showing core shielding.

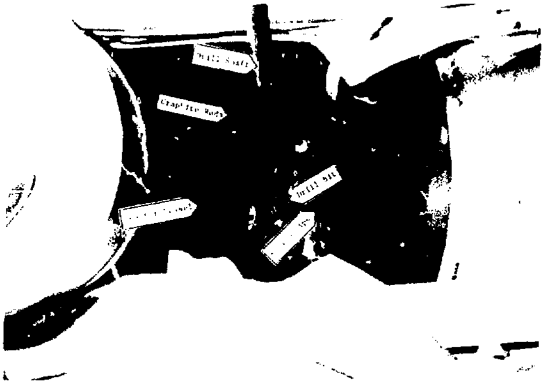

Fig. 5.
Remote drilling into sodium pipe. Drill shaft (center of figure) is 4 m long.

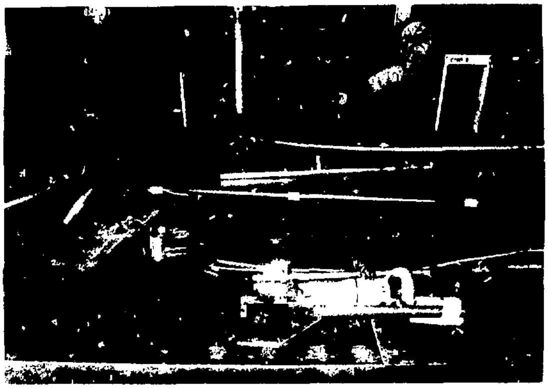

Fig. 6.
Conventional tools with extensions for remote operation.

Fig. 7.
Sodium pipe sections showing the foam prior to capping, and the tar and metal cap used to seal ends.

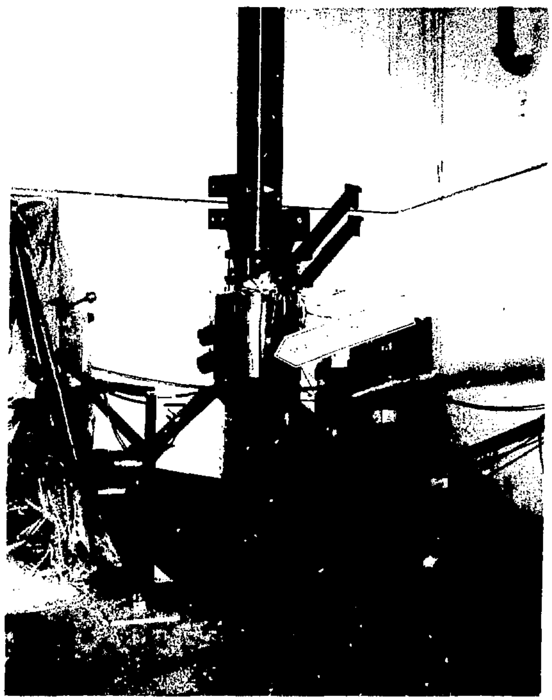

Fig. 8.
Reactor being lifted from the cell.

Fig. 9.
Remote cutting of unnecessary supports to minimize waste container size.

Fig. 10.
Reactor vessel cask being lowered into storage shaft.

Fig. 11.
View into reactor cell showing lead brick wall and graphite rods used for shielding.

Fig. 12.
Semicircular shaped lead shield permitted shielding removal with minimal exposure to personnel.

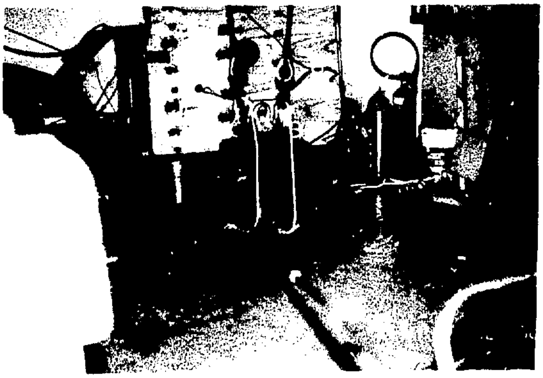

Fig. 13.
Reactor Flue and control rod spacer.

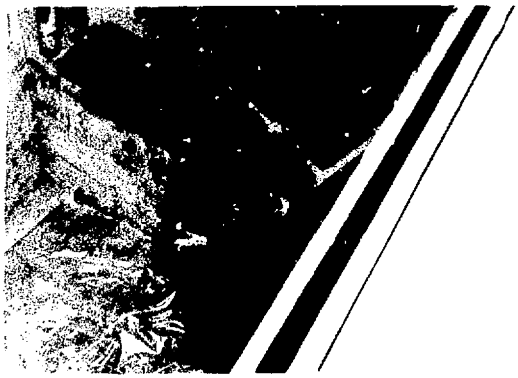

Fig. 14.
The reactor shim.

Fig. 15.
The hydraulic systems in the sub-basement.

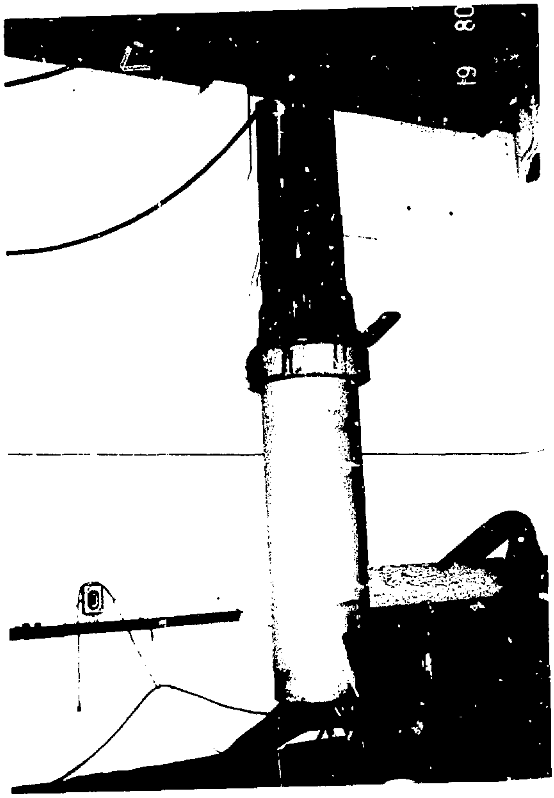

Fig. 16.
The bottom vessel shield, control rods, and floor plug.

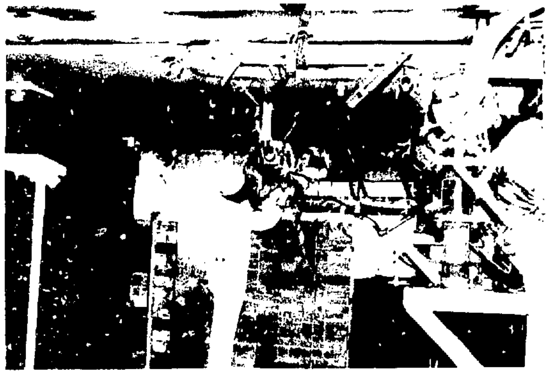

Fig. 18.
Removal of remaining sodium pipes.

Fig. 17.
View into the cell and beyond into the subbasement. Metal structures were cut with an oxyacetylene torch and removed with building crane.

Fig. 19.
Reactor cell after removal of the shielding.