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THE LOS ALAMOS OMEGA WEST REACTOR

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ABSTRACT

A description is given of the Omega West Reactor and associated experimental facilities, followed by a brief discussion of recent usage, new experiments, and future prospects.

REACTOR DESCRIPTION

The Omega West Reactor (OWR) is a thermal, light-water moderated and cooled, heterogeneous, tank-type research reactor[1] operated by the Isotope and Nuclear Chemistry Division of the Los Alamos National Laboratory. It was designed and built by Laboratory personnel, with the help of craftsmen supplied by a subcontractor. The reactor first went critical in 1956. The normal operating power level is 8 MW. At present, the OWR is operated 8 hours/day, 5 days/week. A cutaway view of the reactor is shown in Fig. 1, and a horizontal cross-sectional view is shown in Fig. 2.

The core assembly consists of an aluminum pedestal and grid assembly machined to accommodate a 6-position-deep by 9-position-wide grid for insertion of fuel elements similar to those designed for the Materials Test Reactor (MTR). The grid and pedestal assembly is slotted to allow passage of the 8 control rods, which are made of 3/8-in.-thick borated stainless steel plate assembled to head and tail pieces of aluminum. The rods are individually driven by small reversible electric motors. The first row of the fuel-element grid (nearest the thermal column head, *cf.* Fig. 2) is occupied by a 2-1/2-in. thick lead gamma-ray shield, and the sixth

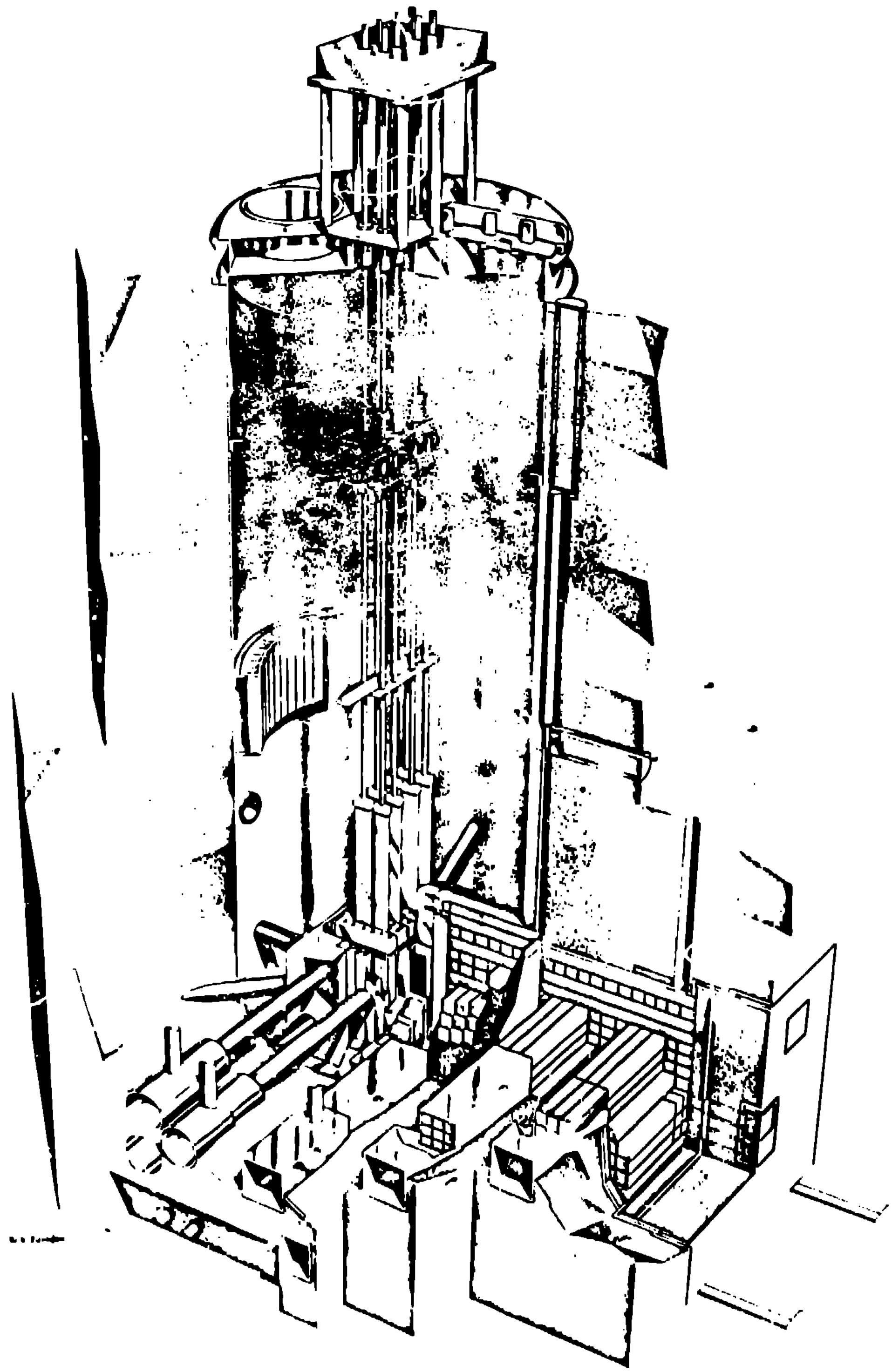

Fig. 1. Cutaway view of the Omega West Reactor.

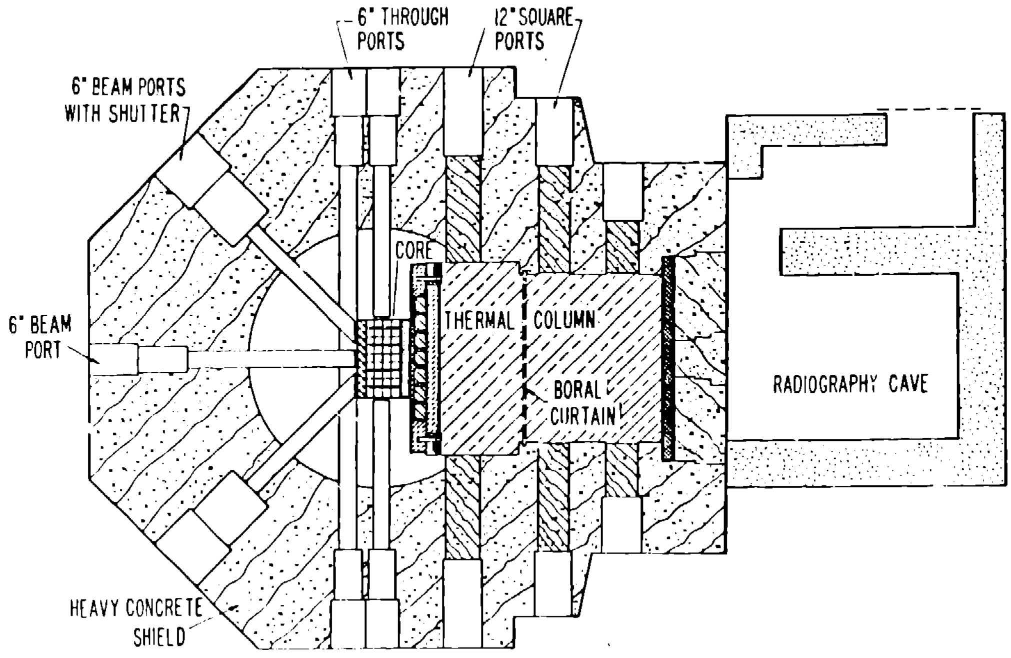

Fig. 2. Cross-sectional view of the Omega West Reactor.

row contains a 4-in. thick stack of beryllium blocks that enhances the thermal flux in that area and, from (γ,n) reactions, produces an abundance of photoneutrons to serve as a start-up source. The remaining positions in the grid (a 4 x 9 array) are available for installation of fuel, in-core experiments, samples for irradiation, or rabbit systems, as required. The current core loading consists of 33 fuel elements, each containing (when new) about 236 grams of uranium enriched to 93 percent ^{235}U. Typically, the elements remain in the reactor about 3 years, at which time the uranium burnup is about 36 percent.

The cooling water is forced downward through the core by a 100-hp pump, exiting the bottom of the tank into an anti-siphon loop inside the reactor shield, a side leg of which re-enters the tank well above the top of the core. The re-entry opening is closed during normal operation by a hinged flat-plate valve (flapper valve) actuated by the pressure drop across the core, but opens by force of gravity when the main pump shuts off, providing a convective cooling loop to remove afterheat in case of pump failure. Also, the convective loop allows operation of the reactor at powers up to 0.4 MW without forced flow. Among added safety features, there are two independent core spray systems, one of which goes into operation automatically if the tank water level begins to drop.

The reactor outlet water flows to the main pump entry through a 30-in. diameter pipe. The transit time in this large underground pipe is long enough that the radioactivity due to the ^{16}N produced in the core decreases to acceptable levels at the pump. The water is then pumped through an evaporative, coil-shed cooling tower and back to the reactor tank. Downstream from the main pump, about 2 percent of the flow is diverted through an auxiliary cooler to mixed-bed deionizers, which bring the water quality into the resistivity range of 2 to 8 Megohm·cm. The two deionizers also provide a capability for cleaning the water system in case of fuel element leakage.

The tank lid of the reactor provides support for the control rod drive mechanisms and is fitted with two hinged removable hatches to permit access to the core and tank interior for moving fuel elements or experimental facilities. The entire tank lid is removable to facilitate removal of major reactor components.

EXPERIMENTAL FACILITIES

The reactor is used for sample irradiations, external neutron-beam experiments, in-core irradiation of instrumented devices, neutron radiography, neutron-capture gamma-ray studies, neutron cross-section measurements, and neutron activation-analysis measurements. The neutron-activation-analysis system is computer automated and is capable of performing elemental analysis on as many as 400 samples per day.[2]

Access to the neutron flux is provided by numerous beam tubes, removable thermal-column stringers, and a variety of rabbit facilities. There are two empty fuel-element positions into which experimental devices up to 2 in. in diameter and 2 ft. long can be placed. One of the rabbits is hydraulically driven and delivers 3/4-in. diameter aluminum sample cans to a position in the reactor core, where the flux is about 9×10^{13} n/cm^{2}s. There are 13 other rabbits, all pneumatically driven, that deliver samples into the graphite thermal column or to positions near the core. One of the irradiation positions near the core is shielded with a thick layer of boron, providing a means of bombarding samples with neutrons of energy above ~200 eV. Several of the pneumatic rabbits are connected to the neutron-activation-analysis system.

Other internal facilities include two neutron-capture gamma-ray collimators, located in the thermal column, that direct gamma-ray beams to high-resolution Ge(Li) detectors. These capture gamma-ray setups are used both for nuclear-structure studies[3] and for prompt-gamma activation analysis.[4] A description of one of the spectrometer systems is given in Ref. 5.

A large neutron-diffraction spectrometer is situated outside each of the two rotary-shutter beam ports. One of these (a triple-axis spectrometer[6]) is automated and is currently being used to study the atomic structure of various metal hydrides.

Neutron radiography is conducted in a cave outside the thermal-column shield door (cf. Fig. 1). The neutron beam for this work is extracted from a pinhole collimator assembly located near the outer end of the thermal column. High-resolution radiographs as large as 9 x 22 in. can be made with this facility. Also, a video system has recently been put into operation that can be used for dynamic observation and recording of fluid or component motion inside a sealed assembly.

RECENT USAGE AND NEW EXPERIMENTS

During FY 1983, 25 Los Alamos National Laboratory technical groups and 6 outside laboratories made use of the reactor facilities. Approximately 12,000 samples were irradiated and over 1200 experiment-hours were logged by users. Many of the samples irradiated were subjected to neutron activation analysis. For example, over 3600 human urine samples were analyzed for fissile material, using a post-irradiation delayed-neutron counting technique.

New experimental activities at the OWR include the following:

1. An aluminum-iron-sulfur filter that transmits primarily 24-keV neutrons has been installed in the 6-in. port opposite the thermal column. This device was designed both as a 24-keV irradiation facility for radiochemical calibrations and as a potential 24-keV beam facility for prompt (n,γ) studies.

2. A fast-chemistry system utilizing high-speed centrifuges, known internationally as a SISAK system, has been set up on the south face of the OWR for the purpose of measuring absolute fission yields of several short-lived fission products. The fission products are generated by neutron irradiation of a ^{235}U solution, which is pumped through a loop of plastic tubing that penetrates the OWR thermal column.

3. An in-core furnace for testing radiation damage to metals proposed for use in fusion reactors is under construction at Lawrence Livermore Laboratory and will be installed in the OWR core in early 1984.

FUTURE PROSPECTS

During the past year, an in-depth study has been made of possible component failures that could result in a long-term or permanent shutdown of the OWR. The conclusion of the study was that with continued preventive maintenance and occasional replacement of components, the OWR can operate for at least another 10 to 15 years.

This conclusion is in part based on the fact that the components most subject to damage--the beryllium reflector and the aluminum-clad lead gamma-ray shield--were designed to be easily replaceable without disassembly of other core components or experimental ports. Also, the aluminum alloys used in high-flux regions--6061 and 6063--are highly resistant to radiation damage and have received fluences at least an order of magnitude below observed damage thresholds.

The most serious potential failures, which are considered to be very improbable, involve leakage of the stainless steel O-ring that seals the thermal-column head, and failure of the water cooling system for the bismuth gamma shield just inside the thermal column cavity. Repair of these failures would require several months shutdown and would involve significant radiation exposure to personnel.

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