MTR REFLECTOR GRAPHITE AFTER 13 OPERATING YEARS*

E. Fast, S. Cohen, and G. V. Wheeler
Idaho Nuclear Corporation, Idaho Falls, Idaho

An examination of the Materials Testing Reactor reflector graphite was made after 13 years of operation as a test reactor. During this time the MTR logged more than 112,000 MWD. The graphite was checked to determine the extent of neutron radiation damage suffered and what hazards might be associated with continued operation. This is a report of that study.

The MTR graphite reflector is outside the 4.5-foot diameter tank containing the reactor core and beryllium reflector. A 7-foot square region surrounding the tank contains one-inch diameter graphite spheres or balls, and the remainder of a 14-foot square contains block graphite. During the normal 40 MW operation a maximum fast flux (> 1 MeV) of about 10^{11} n/cm^2-sec exists in the ball zone, or an integrated total of about 2.5×10^{19} nvt since operation began.

In order to study actual samples from the maximum flux region, the metal liners were removed from three of the facilities located in the graphite near the tank. Graphite balls were retrieved at various levels for analysis. Similar balls with imbedded thermocouples were inserted to measure vertical temperature profiles, and provide a means for continuous surveillance of the reflector temperature. Additional samples were obtained from irradiations made of prepared samples in other graphite facilities.

A maximum of about 70 cal/g was found of stored energy released during an anneal in a 200 C constant temperature oven. The graphite balls releasing this amount of energy were obtained from 20 inches below the core horizontal center plane, or 8 inches below the plane along the bottom of the fuel in the core. This location is in the upstream direction of the air flow, hence lower temperatures are encountered, than are at the center. The results may be compared with those observed at about 69,000 MWD when the maximum was 50 cal/g at about 15 inches below center plane. Both X-ray and heat of combustion measurements, as well as nickel activation results, show that the maximum damaging (fast) neutron flux is about 5 inches below the center plane. Thus the stored energy has passed through a maximum of that which can be stored up at the ambient graphite temperature and released at 200 C. The scatter of data, however, indicates that individual balls were annealed without apparently triggering a general energy release in adjacent pebbles. Vertical temperature profiles show a channeling of air flow in some places.

*Work performed under the auspices of the U. S. Atomic Energy Commission.

Ignition temperatures, measured on single graphite balls with moderate air flow, were over 300 C higher than the maximum attained in a spontaneous energy release. However, the temperatures were about 100 C lower than those obtained with unused graphite. The lowering of ignition temperatures is probably the results of catalysis by the surface impurities deposited from the cooling air. Ignition in the above tests was defined as the point at which the rate of temperature rise showed a definite increase. The one-inch sample balls were heated by an induction heater with 10 l/min air flow in a glass tube 1.1 inch in diameter. The temperature at which a flame appeared was considerably higher and more erratic.

The average weight loss of the irradiated graphite balls varied linearly with length of time in the irradiation zone of the MTR reflector. However, the specimens from the top of the ball zone which are outside the principal irradiation region showed no significant loss in weight. Assuming the graphite is lost by oxidation, a maximum of about 4×10^{-2} $\mu c/cm^3$ is presently being released with the air discharged to the atmosphere through the stack.

An analysis of a maximum credible accident showed that no serious damage to the MTR would be expected during the next 5 years if an adiabatic spontaneous energy release should occur. In addition, the rise in temperature upon loss of coolant air during MTR operation, or because of a reactivity excursion, is sufficiently slow to give the operator ample time to initiate corrective measures before the point of a spontaneous energy release would be reached.