

Instrumentation and Controls Division

**MEASUREMENT OF THE AXIAL DISTRIBUTION OF RADIOACTIVITY
IN THE AUXILIARY CHARCOAL BED OF THE MOLTEN SALT
REACTOR EXPERIMENT AT ORNL***

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Measurement of the Axial Distribution of Radioactivity in the Auxiliary Charcoal Bed of the Molten Salt Reactor Experiment at ORNL

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The Molten Salt Reactor Experiment (MSRE) at Oak Ridge National Laboratory (ORNL) commenced operation in 1964 and was shut down in 1969¹. It was fueled with $^{233}\text{UF}_4$ in a carrier salt of $\text{LiF-Bef}_2\text{-ZrF}_4$, and it operated at 1200 $^{\circ}\text{F}$. After it was shut down the fuel was heated annually to 200 $^{\circ}\text{C}$ to recombine fluorine (with the fuel) released due to radiation-induced reactions in the fuel salt. However, a competing reaction oxidized uranium to UF_6 , which was released (along with F_2) from the fuel and trapped in one of four charcoal filters in the Auxiliary Charcoal Bed (ACB), which is illustrated in Figure 1.

One of the tasks for decommissioning of the MSRE requires that at least ninety percent of the estimated three kilograms of ^{233}U , and radioactive decay products, in this filter be removed and one of the proposed methods is to vacuum the charcoal above a specified axial position in the filter. This requires that the axial distribution of activity in the filter be measured in a sixty rad/hr radiation field to determine where this penetration can be made. In order to accomplish this, a shielded detector with a pin-hole collimator, and with a laser positioning capability, was remotely translated to various axial positions to accomplish these measurements.

It is apparent from the spectra obtained with this detector that relatively broad peaks in the spectra are due to summing of photons from several isotopes, and plots of net counts in each of the broad peaks as a function of axial position poorly delineate the axial profile of activity. This is apparently due to the fact that most of the detector signal, about ninety percent, is due to photons that pass through the shield rather than the collimator, as determined by measurements obtained with the pin hole plugged.

By subtracting the counts obtained with the pin hole plugged and unplugged at corresponding axial locations, a peak occurs in the "difference" spectrum at about 1.7 MeV, which is a sharp function of spatial location. Figure 2 illustrates the axial distribution of relative activity as defined by the net counts in the 1.7 MeV peak in the difference spectrum. Example spectra with the detector collimator plugged and unplugged are given in Figure 3. Even though the net counts in the peak at 1.7 MeV appear to be small relative to the total counts, they are statistically significant. It is assumed that the net counts in this peak are due to photons that pass through the pin hole.

Activities in the steel screen, and various regions of the charcoal bed, are estimated, and uncertainties in these estimates are generally less than one percent. Results from this analysis are used for continued operational decisions for decommissioning of the MSRE.

REFERENCES

1. R. H. Guymon, editor, MSRE Systems and Components Performance, ORNL-TM-3039, Oak Ridge National Laboratory, Oak Ridge, Tennessee (June 1973).

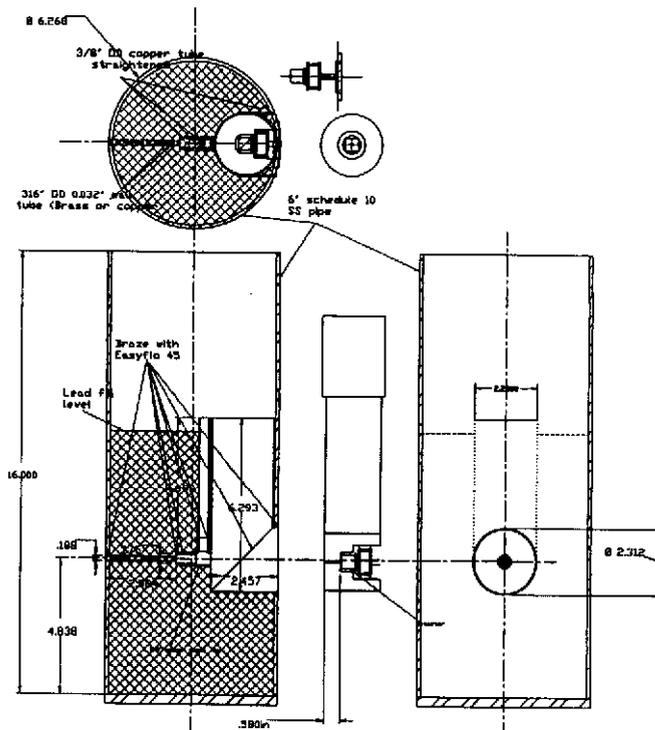
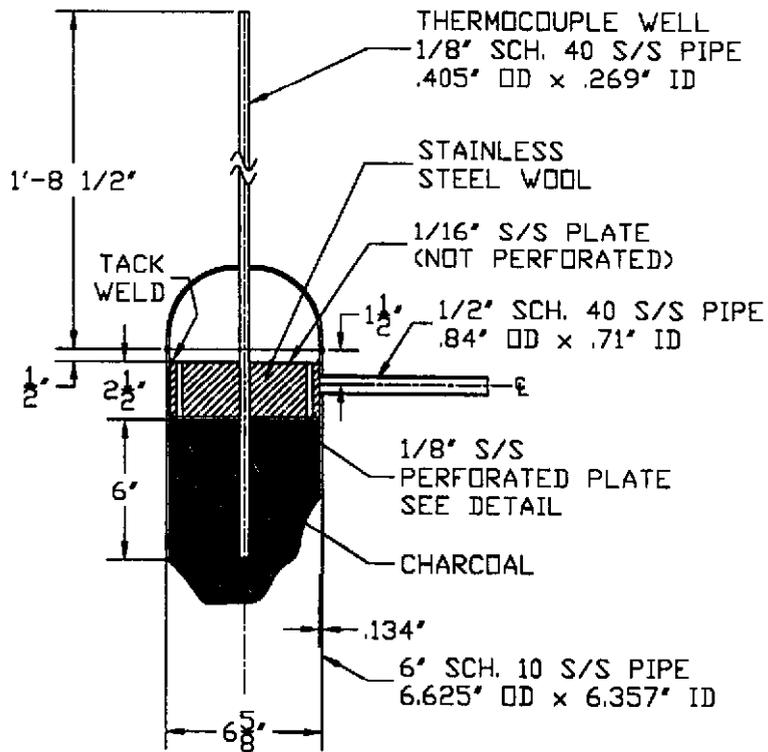


Figure 1. Diagrams of the Auxiliary Charcoal Bed and Detector

Relative Activity Vs. Length Outside the ACB

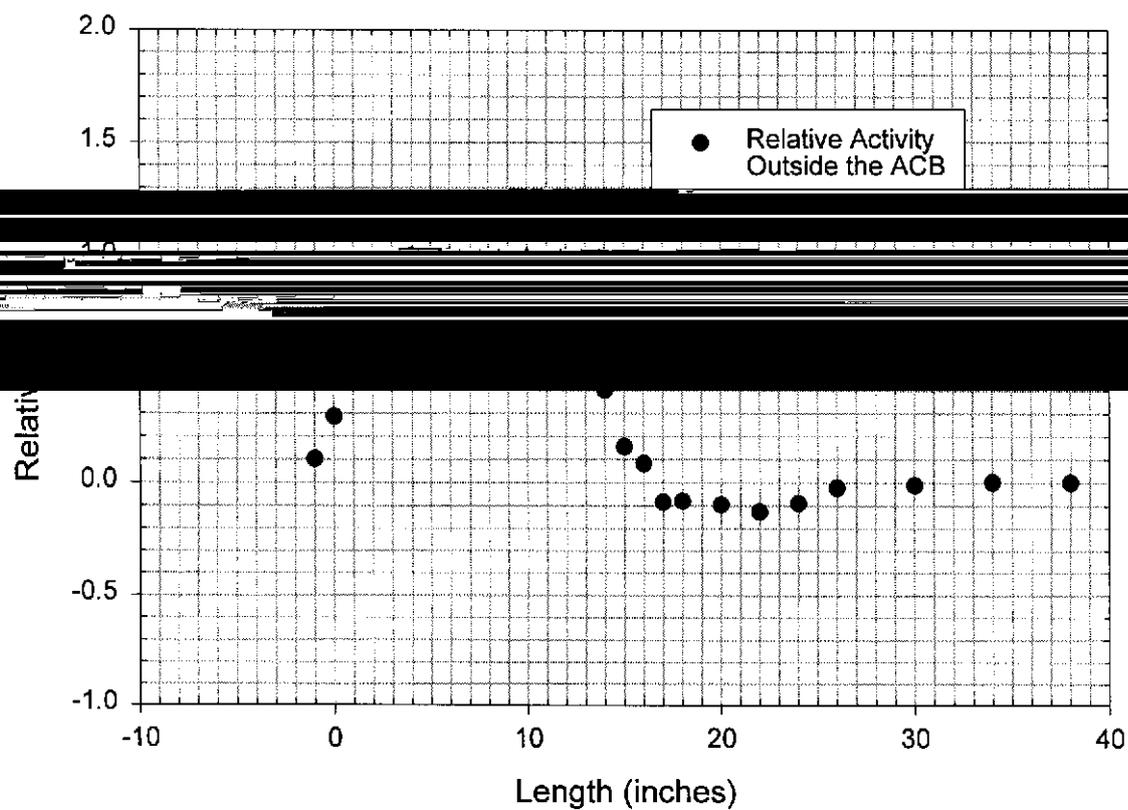


Figure 2. Relative Activity as a Function of Displacement from the Weld Outside the ACB

Spectra at 8" Inside the ACB With and Without the Plug

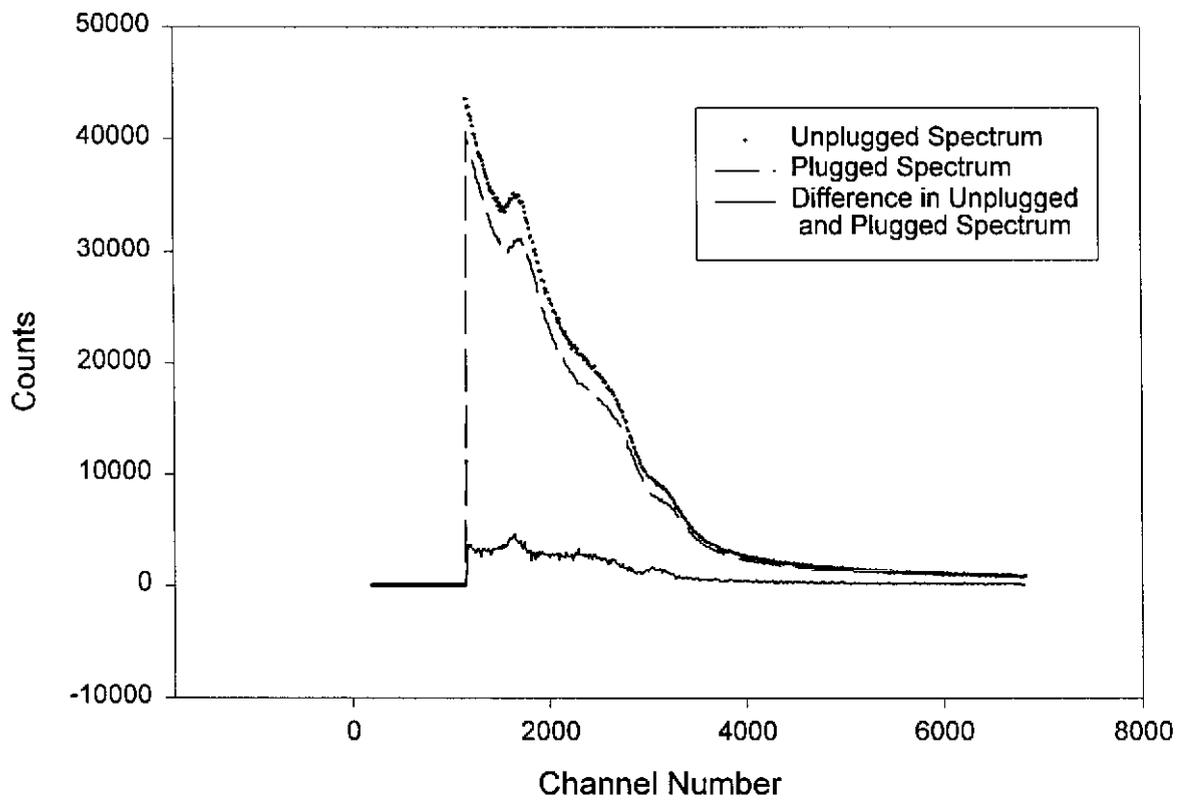


Figure 3. Spectra at a Displacement of 8 Inches From the Weld Outside the ACB.