GA-A14855

CONF-780622--44

GAMMA SPECTROSCOPIC EXAMINATION OF THE PEACH BOTTOM HTGR CORE

by

C. F. WALLROTH and J. F. HOLZGRAF

NOTICE

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Department of Energy, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

This is a preprint of a paper to be presented at the ANS Annual Meeting, June 18-22, 1978, San Diego, California.

Work supported in part by the Department of Energy, Contract EY-76-C-03-0167, Project Agreement No. 56 and in part by the Electric Power Research Institute

GENERAL ATOMIC PROJECT 3238

DATE PUBLISHED: APRIL 1978

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

GENERAL ATOMIC COMPANY

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

GAMMA SPECTROSCOPIC EXAMINATION OF THE PEACH BOTTOM HTGR CORE

Fission product distributions were established for individual core components after the final shutdown of the Peach Bottom High-Temperature Gas-Cooled Reactor (HTGR). The purpose was to provide information on relative axial and radial power distributions, thorium absorption rates, fuel stack length, and fission product release (Ref. 1).

A total of 55 driver elements, 21 fuel test elements, three reflector elements, and one control rod with sleeve were axially scanned with a high-resolution Ge(Li) detector. The intrinsic efficiency was cross-calibrated with quantitative gamma spectroscopy of one driver element at Oak Ridge National Laboratory (ORNL) (Ref. 2).

On a core average basis, the predicted and measured Cs-137 inventory was within the measurement uncertainty of ±0.4% (1σ), which can be considered an upper limit for the Cs-137 diffusion through the fuel element sleeve into the core. This is in good agreement with a fractional release of 2×10^{-4} assessed for the primary circuit (Ref. 3). Significant cesium migration was found within several fuel elements as shown in Fig. 1. Cesium was transported from the high-temperature region down the purge stream to the cooler portion of the element, where it accumulated. Figure 1 contains the in situ Cs-137 inventory measurements as well as the component measurements done at ORNL. Good agreement was found, which verifies the cross calibration between the two gamma spectroscopic methods.

Because of insignificant cesium release, element average burnups were established from the measured Cs-137 inventories. The average burnup of 48 selected driver elements agreed within ±0.7% (1σ) with GAUGE code (Ref. 4) predictions. Element to element differences between calculated and measured burnup were found to be significant with a ±6.8% root mean square

deviation when compared with a mean counting error of ±4.8%. The predictive accuracy of the radial power distribution for the Peach Bottom HTGR was therefore concluded to be ±6.8%, which falls within the ±3% to 8% accuracy for other reactor systems (Ref. 5).

The time history of the radial power distribution is presented in Fig. 2, which compares normalized isotope inventories with predicted power distributions. The Cs-137 distributions follow closely the time averaged power distribution, whereas the shorter half-life isotopes Zr-95 and La-140 are approaching the predicted end-of-life distribution. Time averaged and end-of-life axial power profiles were determined from Cs-137, Zr-95, and La-140 distributions and were also found to be in good agreement with predictions. Relative thorium absorption rates agreed reasonably well with measured relative Pa-233 profiles. An average 0.7% increase in fuel stack length was observed, which was within the design specification.

In summary, the gamma spectroscopic surveillance of about 10% of the Peach Bottom core provided the data base for nuclear design verification. Significant cesium movement within the fuel elements was detected for the majority of driver elements, but the overall release into the core was undetectable within the measurement uncertainty. The core average burnup was verified with an accuracy of ±0.7%.

REFERENCES

1. Holzgraf, J. F., F. McCord, and C. F. Wallroth, "Gamma Spectroscopic Examination of Peach Bottom HTGR Core Components," DOE Report GA-A13453, General Atomic Company, to be published.
2. Dyer, F. F., et al., "Distribution of Fission Products in Peach Bottom HTGR Fuel Element F03-01," DOE Report ORNL/TM-5996, Oak Ridge National Laboratory, to be published.
3. Hanson, D. L., N. L. Baldwin, and W. E. Selph, "Gamma Scanning the Primary Circuits of the Peach Bottom HTGR," General Atomic Report GA-A14161, October 31, 1976.

4. Wagner, M. R., "GAUGE, A Two-Dimensional Few Group Neutron Diffusion Depletion Program for a Uniform Triangular Mesh," USAEC Report GA-8307, Gulf General Atomic, March 15, 1968.

5. "Reactor Burn-up Physics," in Proceedings of a Panel on Reactor Burn-up Physics, Vienna, July 12-16, 1971, International Atomic Energy Agency, Vienna, 1973.

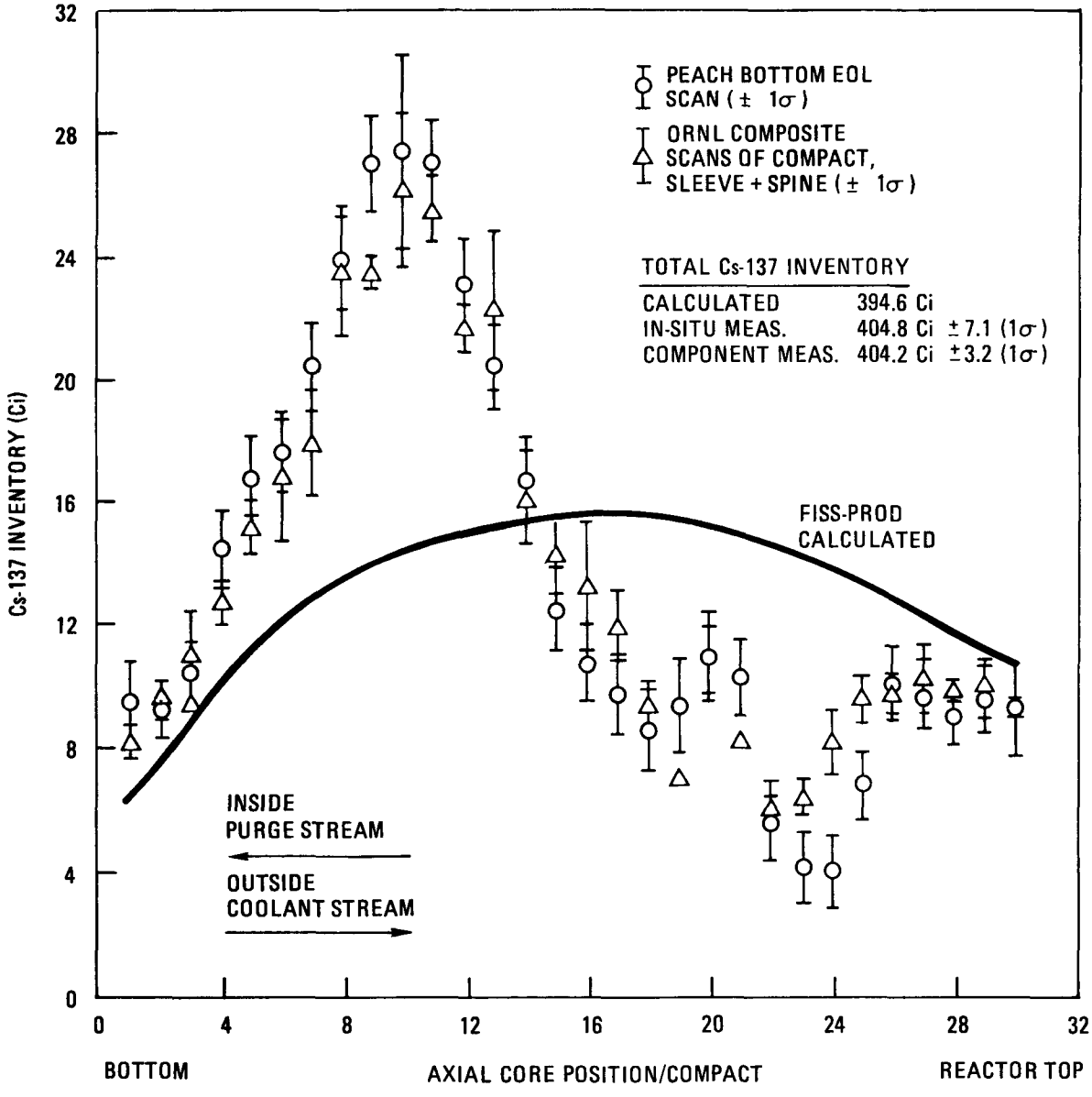

Fig. 1. Cs-137 inventory versus axial core position for Peach Bottom fuel element F03-01

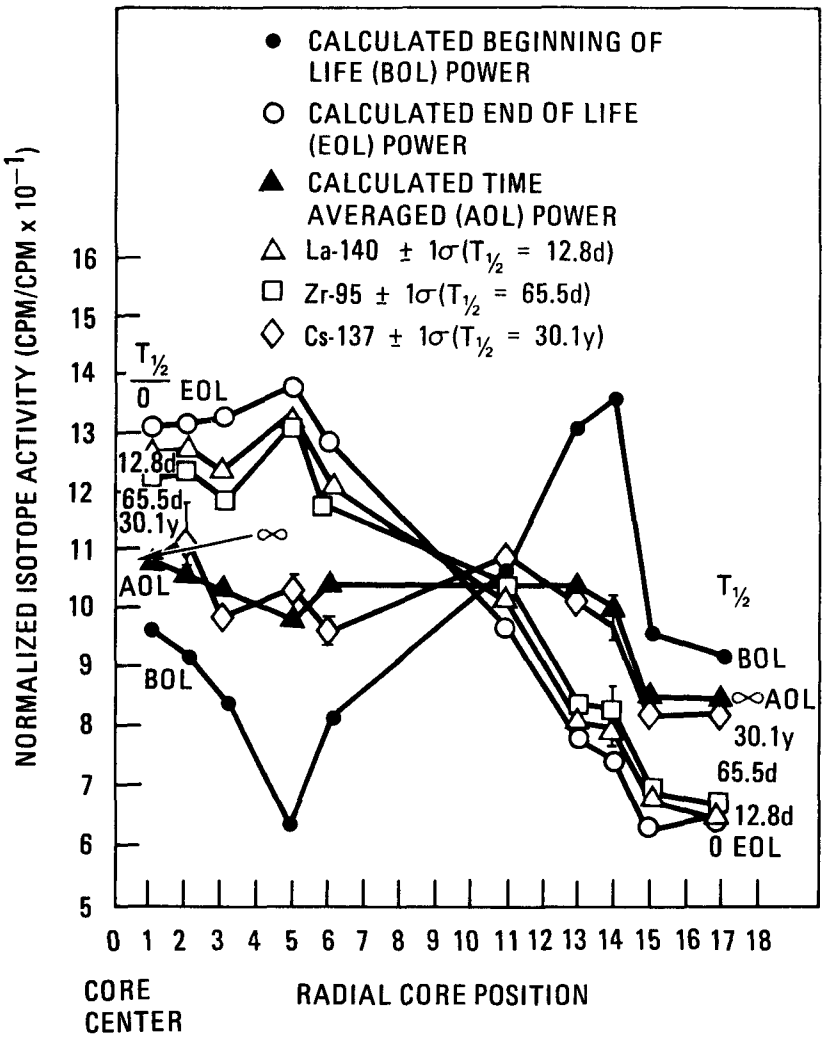

Fig. 2. Normalized radial isotope distribution for Peach Bottom Core 2