

UNCLASSIFIED

X-822

OAK RIDGE NATIONAL LABORATORY

Operated by

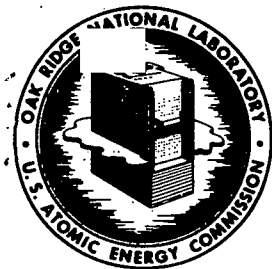
UNION CARBIDE NUCLEAR COMPANY

Division of Union Carbide Corporation



Post Office Box X

Oak Ridge, Tennessee



ORNL
CENTRAL FILES NUMBER
58-1-124

External Transmittal Authorized
COPY NO. 78

DATE: January 31, 1958
SUBJECT: Criticality in Dump Tanks for HRE-3 Blanket
TO: W. R. Gall
FROM: B. E. Prince and M. W. Rosenthal

DISTRIBUTION

- | | | |
|---|------------------------|--|
| 1. HRP Director's Office
Rm. 259, 9204-1 | 25. P. R. Kasten | 52. I. Spiewak |
| 2. G. M. Adamson | 26. R. B. Korsmeyer | 53. R. W. Stoughton |
| 3. S. E. Beall | 27. K. A. Kraus | 54. J. A. Swartout |
| 4. L. L. Bennett | 28. N. A. Krohn | 55. E. H. Taylor |
| 5. E. G. Bohlmann | 29. J. A. Lane | 56. D. G. Thomas |
| 6. E. S. Bomar | 30. R. E. Leuze | 57. M. Tobias |
| 7. F. R. Bruce | 31. M. I. Lundin | 58. D. S. Toomb |
| 8. W. D. Burch | 32. R. N. Lyon | 59. W. E. Unger |
| 9. R. H. Chapman | 33. W. L. Marshall | 60. R. Van Winkle |
| 10. R. D. Cheverton | 34. T. H. Mauney | 61. C. E. Winters |
| 11. H. C. Claiborne | 35. J. P. McBride | 62. F. C. Zapp |
| 12. E. L. Compere | 36. H. F. McDuffie | 63. ORNL Document Reference
Library, Y-12 |
| 13. J. S. Culver | 37. H. M. McLeod | 64. Central Research
Library |
| 14. D. E. Ferguson | 38. R. A. McNeas | 65-66. REED Library |
| 15. C. H. Gabbard | 39. W. R. Mixon | 67-68. Laboratory Records |
| 16. W. R. Gall | 40. C. S. Morgan | 69. F. C. Moesel, AEC,
Washington, D. C. |
| 17. J. C. Griess | 41. R. H. Nimmo | 70. M. J. Skinner |
| 18. P. A. Haas | 42. L. F. Parsly | 71-77. Westinghouse PAR
Project |
| 19. P. H. Harley | 43. R. N. Peebles | 78-92. TISE-AEC |
| 20. P. N. Haubenreich | 44-45. B. E. Prince | 93. E. Volk |
| 21. J. W. Hill | 46. R. C. Robertson | 94. ORNL-RC |
| 22. S. Jaye | 47. A. M. Rom | |
| 23. G. H. Jenks | 48-49. M. W. Rosenthal | |
| 24. S. I. Kaplan | 50. H. C. Savage | |
| | 51. C. L. Segaser | |

NOTICE

This document contains information of a preliminary nature and was prepared primarily for internal use at the Oak Ridge National Laboratory. It is subject to revision or correction and therefore does not represent a final report.

UNCLASSIFIED

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.

LEGAL NOTICE

This report was prepared as an account of Government sponsored work. Neither the United States, nor the Commission, nor any person acting on behalf of the Commission:

- A. Makes any warranty or representation, express or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this report, or that the use of any information, apparatus, method, or process disclosed in this report may not infringe privately owned rights; or
- B. Assumes any liabilities with respect to the use of, or for damages resulting from the use of any information, apparatus, method, or process disclosed in this report.

As used in the above, "person acting on behalf of the Commission" includes any employee or contractor of the Commission to the extent that such employee or contractor prepares, handles or distributes, or provides access to, any information pursuant to his employment or contract with the Commission.

CRITICALITY IN DUMP TANKS FOR HRE-3 BLANKET

B. E. Prince and M. W. Rosenthal

The possibility of criticality occurring in the HRE-3 slurry dump tanks has been examined by estimating the critical concentration for an infinite system and comparing it to the concentrations which might conceivably occur with mixing of the core fuel with the blanket. In addition to considering an infinite reactor, the following assumptions were made in obtaining the critical concentration:

1. The fuel is isotopically pure U^{233} .
2. No absorbers are present other than U^{233} and thorium.
3. Nuclear behavior is represented by a Fermi age model with modification to allow for resonance absorptions in fuel (Oracle program of Jaye and Lietzke for bare, one-region reactors). The η of U^{233} is taken to be independent of energy.

Assumptions 1 and 2 are conservative, since an operating reactor would contain protactinium, fission and corrosion products, and higher isotopes of uranium, all of which increase the critical concentration. Assumption 3 should be conservative, particularly since η of U^{233} appears to decrease at epithermal energies. The ratio of U^{233} to thorium required for criticality in an infinite reactor is plotted in Fig. 1 for 20°C and 280°C as a function of thorium concentration.

The maximum concentration of $U^{233} + U^{235} + Pa^{233}$ in the blanket will be about 3 g/kg Th. This concentration would be increased to 4.2 g/kg Th if the equilibrium core inventory of 17.56 kg were uniformly dispersed in the blanket thorium. The uranium will probably be associated with the

thorium in such a way that this ratio would remain constant, even though the thorium concentration changed. Thus, the value of 4.2 is plotted in Fig. 1 to represent the maximum fuel-to-thorium ratio which would occur in HRE-3 if the mixture were uniform. Under this circumstance, even an infinitely large dump tank at 20°C could not become critical.

Of course, if the core uranium were added to just part of the thorium inventory, higher uranium-to-thorium ratios could occur. However, to attain a ratio of 10 g U²³³/kg Th in a limited part of the system, all of the core uranium inventory would have to be added to just 1/5 of thorium.

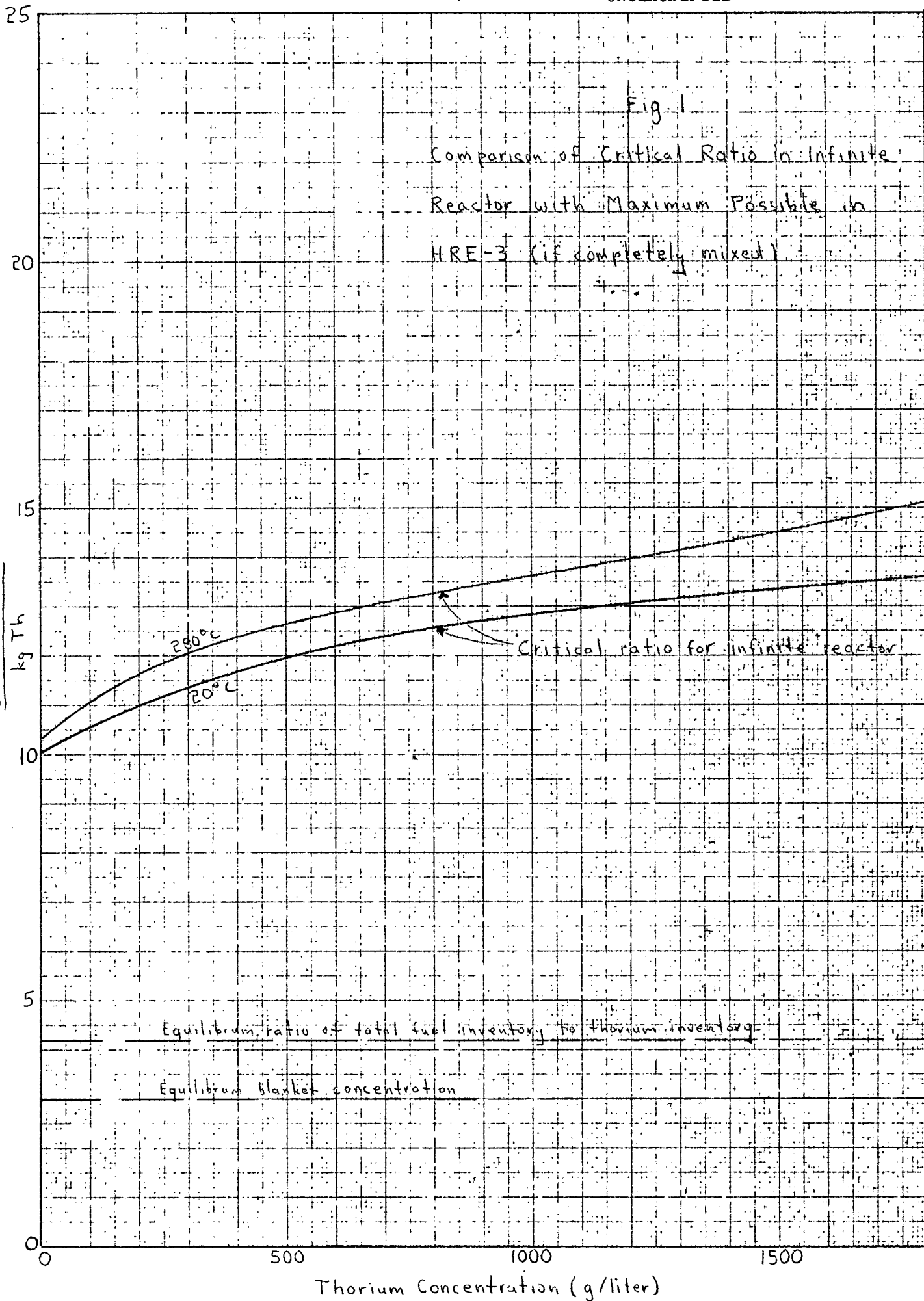
Since the uranium in the blanket dump tank is not likely to attain the concentration required for criticality in a cold, clean, infinite reactor, there should be no criticality problem in the actual dump tanks for the HRE-3 blanket.

gcb

CODEX BOOK COMPANY, INC., NORWOOD, MASSACHUSETTS.
PRINTED IN U.S.A.



NO. 319-CR. MILLIMETERS. 100 BY 250 DIVISIONS.



Equilibrium ratio of total fuel inventory to thorium inventory

Equilibrium blanket concentration

Thorium Concentration (g/liter)