# TRANSACTIONS

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S. Salah (W-NES) was inadvertently omitted from the list of Reviewers for the Chicago Meeting, June 1973.

## 5. Monte Carlo Analysis of Experimentally Critical Pipe Intersections, *N. F. Cross, G. E. Whitesides, R. J. Hinton (ORNL)*

Nuclear safety analysts often encounter situations in which criticality evaluations must be made for systems involving large tubing or piping arranged in various configurations. Those involving intersections cannot be calculated using the popular 1-D codes and no standards have been developed for the calculational reliability of other codes for this type of system. In this endeavor, calculations were made to determine the adequacy of the KENO[1] and CHERI[2] codes to treat critical systems of pipe intersections. Both the 16-group Hansen-Roach[3] cross-section set and the 123-group XSDRN[4] cross sections were used so cross-section effects could be evaluated. Ten of the critical experiments evaluated were performed at Rocky Flats[5] and the remaining 21 were done at Oak Ridge.[6,7]

The Rocky Flats experiments used a square central column and cylindrical arms filled with aqueous solutions of $U(93)O_2(NO_3)_2$. All the experiments were unreflected and the configurations included 2 square arms at 45 deg, 6 and 8 cylindrical arms at 45 deg to the central column, and 6, 8, 12, and 16 cylindrical arms at 90 deg to the central column. The average computed $k_{eff}$'s for the complete set of Rocky Flats experiments was 0.9994 ± 0.0027 when using the 123-group cross sections, indicating that these cross sections accurately reflect the criticality of the experiments. However, the 16-group Hansen-Roach cross sections yield an average $k_{eff}$ of 0.9776 ± 0.0027 for this set of experiments.

The critical experiments done at Oak Ridge involved a 30-deg lateral (2 cylindrical aluminum pipes intersecting at 30 deg, with one pipe extending below the intersection) and a 90-deg Plexiglas cross. Both sets of experiments were reflected by water. Six different solution concentrations of $U(5)O_2F_2$ were used in the 30-deg lateral experiments. The average calculated $k_{eff}$, using 16-group cross sections, was 0.9957 ± 0.0051, and the average calculated $k_{eff}$ for the 123-group set was 0.9960 ± 0.0034. Several different critical experiments were made utilizing the 90-deg Plexiglas cross filled with $U(5)O_2F_2$ solution. Four inside diameters and several solution concentrations were used for a total of 15 critical experiments. The average calculated $k_{eff}$ for the 16-group cross sections was 0.9967 ± 0.0022 and for the 123-group cross sections was 0.9999 ± 0.0022, indicating that both cross-section sets accurately predict the criticality of these 5% uranyl fluoride pipe intersection experiments.

It was concluded that when using the 123-group cross sections, both KENO and CHERI accurately predict criticality for pipe intersections filled with highly enriched uranyl nitrate and 5% uranyl fluoride, regardless of the number of arms involved in the intersection. The 16-group Hansen-Roach cross-section set accurately predicts criticality (less than 2 standard deviations from critical) for the fully reflected low-enriched uranyl fluoride systems, but gives nonconservative results for the bare optimumly moderated highly enriched uranyl nitrate systems.

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1. G. E. WHITESIDES and N. F. CROSS, "A Multigroup Monte Carlo Criticality Program," CTC-5, Computing Technology Center (Sept. 1969).

2. L. M. PETRIE, unpublished Monte Carlo code, Oak Ridge National Lab.

3. G. E. HANSEN and W. H. ROACH, "Six and Sixteen Group Cross Sections for Fast and Intermediate Critical Assemblies," LAMS-2543, Los Alamos Scientific Lab. (1961).

4. N. M. GREENE and C. W. CRAVEN, Jr., "XSDRN: A Discrete Ordinates Spectral Averaging Code," ORNL-TM-2500, Oak Ridge National Lab. (1969).

5. B. B. ERNST and C. L. SCHUSKE, "Empirical Method for Calculating Pipe Intersections Containing Fissile Solutions," RFP-1197, Dow Chemical Co., Rocky Flats Division (Sept. 1968).

6. E. B. JOHNSON, "The Nuclear Criticality of Intersecting Cylinders of $U(5)O_2F_2$ Aqueous Solution," *Trans. Am. Nucl. Soc.*, 14, 678 (1971).

7. E. B. JOHNSON, a report to be published, Critical Experiments Facility, Y-12.