MEASUREMENT OF RADIATION DOSES DUE TO NUCLEAR CRITICALITY ACCIDENTS

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Perfomance characteristics of biological and external dosimetry systems used to measure acute, high-level radiaton doses associated with nuclear criticality accidents have been determined based on results of twenty nuclear accident dosimetry intercomparison studies conducted annually at Oak Ridge National Laboratory since 1964. During these studies, more than 60 different agencies measured neutron and gamma radiation doses greater than 0.1 Gy at area monitoring stations and on anthropomorphic phantoms following simulated criticality accidents produced by operating the Health Physics Research Reactor in the pulse mode. Neutron doses were measured for a variety of energy spectra using foil activation, thermoluminescent, simulated blood sodium activation, and human hair activation methods. Thermoluminescent, radiophotoluminescent, and film dosimeters were used to measure associated gamma doses.

Performance standards for criticality accident dosimetry systems suggest that preliminary radiation doses should be determined with an accuracy of + 50% within 24 hours after exposure. Composite results of recent intercomparisons indicate that about 80% of the neutron measurements and about 70% of the gamma measurements satisfied this criteria relative to reference values. Performance standards for final dose estimates suggest accuracies of + 25% for neutron dose and + 20% for gamma dose. Analysis of the final reported experimental results shows that approximately half of the neutron and gamma dose measurements met the subject criteria. The greatest difficulties in measuring accident doses occurred for radiation fields with a large fraction of low energy neutrons and a high gamma component. Results of these studies emphasize the importance of considering measurement location, neutron energy distribution, and dosimeter sensitivity in the evaluaton of accident doses.