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ASSESSMENT OF EFFECTIVE DOSE EQUIVALENT FOR EXTERNAL PHOTON RADIATION

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Objectives: To describe EPRI's effective dose equivalent (EDE) research. To explain the enhanced methodology being developed by EPRI for assessing effective dose equivalent at nuclear power plants. The ICRP proposed specific organ radiation exposure weighting factors in 1977 to account for human organ and tissue differences. The ICRP recommendations were adopted in 1991 in 10CFR20. The regulations require licensees to evaluate radiation exposures in terms of EDE using the conservative assumption that the weighting factor for external exposure is one. However, the regulations allow the licensees to propose alternative methods for evaluating the external radiation component of EDE. The objective of the present study was to tabulate EDE under a broad variety of radiation exposure situations and examine dosimeter placement and how well isotropic dosimeters measure EDE. It was thought that Utilities could use this data to evaluate various ways to meet effective dose equivalent regulations.

Comments: Researchers performed Monte Carlo calculations of photon transport through the human body. They used mathematical models of the human adult male and female and, for a variety of external radiation sources, calculated energy deposition in a large number of human organs and tissues. Using published organ weighting factors, they calculated effective dose equivalents for these irradiations. They determined how EDE varies with photon energy for various beam source geometries, and for point sources both on and off the body. Calculations were made of photon energy fluence on the surface of the body as a function of location, source geometry, and photon energy. This allowed researchers to understand how dosimeter placement effects EDE assessments.

Remarks: For beam sources, beams striking the front of the body normal to the body's major axis (i.e., straight on) produce the largest effective dose equivalent falls significantly if the incident radiation departs from these two orientations. For point sources in contact with the body, the effective dose equivalent is highest for females when the source is on the front of the torso near the sternum. For males, it is highest when the source is on the front of the torso near the gonads. The widespread practice of supplementing a single front-worn dosimeter with additional dosimeters placed facing a radiation source should be abandoned, as this can significantly overestimate EDE. Using a single front-worn dosimeter as a measure of EDE is acceptable. Simple algorithms applied to two dosimeters (on the front and back) yield a more

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accurate and numerically lower EDE under all radiation exposure situations. Considerable benefits can be derived by U.S. nuclear utilities if they develop a technically rigorous approach for determining effective dose equivalents for their workforces. Their approach should be generally conservative, be acceptable to regulatory agencies, and be consistent with existing dosimetry practices.

References: 1. Hornibrook, C., "Radiation Protection - An overview," Proceedings, EPRI Radiation Field Control and Chemical Decontamination Seminar, Tampa, Florida, November 6, 1995, available from Electric Power Research Institute, EPRI Distribution Center, P.O. Box 23205, Pleasant Hill, CA 94523.

2. EPRI Technical Report TR-101909-V2, October 1995.

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