

In summary, the licensee's application dated January 8, 2003, requests an exemption from the 10 CFR 20.1003 definition of TEDE.

3.0 Discussion

Pursuant to 10 CFR 20.2301, the Commission may, upon application by a licensee or upon its own initiative, grant exemptions from the requirements of 10 CFR part 20 if it determines the exemptions are authorized by law and would not result in undue hazard to life or property.

The staff examined the licensee's rationale to support the exemption request and concluded that the new method for calculating TEDE, under certain conditions, is a more accurate means of estimating worker radiation exposure and therefore would not result in undue hazard to the workers. The basis for this follows.

4.0 Regulatory Evaluation

By letter dated January 8, 2003, the licensee requested an exemption from the current definition, and the approval to use an alternate definition of TEDE. The licensee requested that the definition of TEDE, as used in 10 CFR 20.1003 (*i.e.*, for the purpose of complying with the dose recording requirements, dose reporting requirements, or the dose limits), be changed to mean the sum of the effective dose equivalent or the deep dose equivalent (for external exposures), and the committed effective dose equivalent (for internal exposures). The licensee also requested approval to use a method for estimating the effective dose equivalent for external exposures (EDE_{ex}) published by the Electric Power Research Institute (EPRI) in Technical Report TR-101909, Volumes 1 and 2, and Implementation Guide TR-109446. The effect of granting this request would be to allow the licensee the option to control TEDE using EDE_{ex} in those cases where it is a more accurate predictor of the risk from occupational radiation exposure.

The radiation protection approach and dose limits contained in 10 CFR part 20 are based on the recommendations of the International Commission on Radiation Protection (ICRP) in their 1977 publication No. 26 (ICRP 26). For stochastic effects, the ICRP-recommended dose limitation is based on the principle that the risk should be equal, whether the whole body is irradiated uniformly or whether there is non-uniform irradiation (such as when radioactive materials are taken into the body and, depending on their physical and chemical properties,

concentrate in certain tissues and organs). This condition will be met if $\sum_T \omega_T H_T \leq H_{wb,L}$

where ω_T is a weighting factor representing the proportions of the stochastic risk resulting from tissue (T) to the total risk, when the whole body is irradiated uniformly; H_T is the annual dose equivalent in tissue (T); and $H_{wb,L}$ is the recommended annual dose-equivalent limit for uniform irradiation of the whole body, namely 5 rem (50 mSv). The sum $\sum_T \omega_T H_T$ is called effective dose equivalent (EDE). The values for ω_T are given in ICRP 26, for the various tissues (T), and are codified in 10 CFR part 20.

For the purposes of implementing workplace controls, and due to the difference in dosimetry, 10 CFR part 20 breaks this total EDE, or TEDE, into two components: (1) dose resulting from radioactive sources internal to the body, and (2) dose resulting from sources external to the body. For radioactive material taken into the body, the occupational dose limit is based on the resulting dose equivalent integrated over 50 years (H_{50}) of exposure such that $\sum_T \omega_T H_{50,T} \leq H_{wb,L}$.

This quantity $\sum_T \omega_T H_{50,T}$ is called the committed effective dose equivalent (CEDE) in 10 CFR part 20.

Demonstrating compliance with the dose limits from internal exposures is accomplished using direct measurements of concentrations of radioactivity in the air in the work areas, or quantities of radionuclides in the body, or quantities of radionuclides excreted from the body, or a combination of these. Having determined the quantities of radionuclides present or taken into the body, these can be compared to secondary or tertiary limits (*e.g.*, annual limits on intake or derived air concentrations) listed in Appendix B to 10 CFR part 20. These secondary and tertiary limits have been calculated using standard assumptions of the physical and chemical forms of the radionuclides, the standard physiological parameters from the Reference Man, and the bio-kinetic models adopted in ICRP 26. Alternatively, the regulations allow the licensee to adjust certain of these standard assumptions and calculate CEDE directly, using appropriate models.

The normal practice for determining radiation dose from external sources is to measure the radiation intensity at the surface of the body with a monitoring device (dosimeter) calibrated to read in terms of a tissue dose equivalent at a specified tissue depth. In 1991, when 10

CFR part 20 was revised to adopt the ICRP 26 recommendations on limits and controls, there was little guidance on how to determine the dose to the several tissues necessary to calculate EDE_{ex} . It is impractical to separately monitor (or measure) the dose received by the various organs and tissues that contribute to TEDE. As a practical, conservative simplification, 10 CFR part 20 limits the dose from external sources in terms of deep dose equivalent (DDE). The DDE is the dose equivalent at a tissue depth of one centimeter, and is required (by 10 CFR part 20.1201(c)) to be determined for the part of the body receiving the highest exposure. The TEDE annual limit is met if $DDE + \sum_T \omega_T H_{50,T} \leq 5$ rem (50 mSv).

In addition to the annual limit on TEDE, 10 CFR part 20 provides a non-stochastic annual limit of 50 rem (0.5 Sv) for each individual tissue such that $DDE + H_{50,T} \leq 50$ rem (0.5 Sv) for all tissues except the skin and lens of the eye.

Using the highest DDE, to bound the individual tissue doses from radioactive sources outside the body, generally results in a slightly conservative estimate of EDE_{ex} from uniform exposures. However, it can be overly conservative for non-uniform exposure situations. Since many high-dose jobs at nuclear power plants are performed under non-uniform exposure conditions, this can lead to a significant overestimation of the actual TEDE dose, and the risk, to the workers. To address this issue, the licensee has requested approval to provide a more accurate dose assessment by replacing DDE with EDE_{ex} when calculating TEDE from non-uniform exposures, where the EDE_{ex} is determined with a method developed by EPRI.

In developing this method, the EPRI investigators used mathematical equations developed by Cristy and Eckerman to model standard, adult human male and female subjects (phantoms). The Monte Carlo radiation transport computer code MCNP was used to calculate the dose to individual tissues modeled in the phantoms, and simulated dosimeter readings, for a range of different exposure geometries. Dosimeters with an isotropic response were modeled at several locations on the surface of the phantoms. Both broad beam and point radiation sources (with selected photon energies) were considered. Indicated doses (*e.g.*, simulated dosimeter readings) and the actual EDE_{ex} (*e.g.*, the sum of the products of the calculated phantom tissue doses and their respective ICRP 26 weighting factors) were calculated for