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Proposed Changes to 10CFR20 Regarding Averaging Shallow Dose Equivalent due Discrete Radioactive Particle Exposure
William. T. Bullard, CHP

Foot note 1 on page 36506 of the Federal Register reads as follows:

For example, one recent event at a nuclear power plant involved a Co-60 DRP with an activity of about 75 mCi. The deep dose equivalent estimated from this particle (had it been on the skin) was calculated to be about 10 rem/h per mCi. For particles in this activity range, the deep dose equivalent (DDE) limit of 5 rem per year can be exceeded in less than 1 minute. The proposed skin dose limit could be exceeded in even less time.

The above statement points to the need to revise the 10CFR20 definition for deep dose equivalent in favor of one recognizing the concept of effective dose for external exposures. It is inappropriate to use the DDE limit applicable to uniform body irradiation to describe the risk from exposure to the 1 cm deep tissue below the particle on the skin. This concept appears to be recognized by footnote 2 in the 10CFR20.1003 definition of weighting factor which permits use of weighting factors on a case basis for other than whole-body irradiation until additional guidance is issued. It is time for additional guidance.

By definition only, the case described is deep dose equivalent but it is incorrect to describe it as equivalent dose and to apply limits aimed at preventing biological effects in exposed workers. To better describe the potential risk of the exposure, the concept of effective dose equivalent needs to be incorporated in evaluations of dose especially with regard to exposures arising from a DRP on the skin.

Using the work of Reese et. al, the maximum effective dose equivalent arising from irradiation by a particle on the skin for 1 MeV photons would be for the adult female case. Table 10 of Reese's work provides effective dose equivalent as a function of point source location on the torso for the adult male and adult female and indicates a maximum of 1.79 E-13 rem per photon.

The data suggests that for a 1 mCi source of 1 MeV photons the maximum effective dose equivalent rate would be approximately 25 mrem per hour. Translating this to Cobalt-60 (2 photons per transformation) yields about 50 mrem per hour not the 10 rem per hour described. Conversion for the 75 mCi Co-60 source described in the Federal Register, results in the maximum effective dose equivalent of no more than 4 rem/hr for the adult female and about half this for the adult male. The SDE limit of 50 rem averaged over 10 cm2 is by far the limiting case and is still a small fraction of the point at which deterministic effects (observable skin changes e.g., small scabs that heal completely) would be expected (threshold ~ 6 krads).

Applying the DDE limit to tissue at 1 cm below the skin surface overstates the potential risk and may influence licensees to overestimate the record dose from DRPs. In turn, in an effort to avoid regulatory findings, licensees may impose inordinate field monitoring requirements that actually increases radiation exposure and attendant stochastic risk to technicians monitoring workers for the presence of DRPs and the workers themselves from work inefficiencies associated with performing the additional monitoring.

It is suggested that the discussion of deep dose equivalent arising from DRP exposure be eliminated from the rule making discussion concerning averaging shallow dose equivalent over 10cm2 versus 1cm2 and that new rulemaking recognizing the concept of effective dose equivalent is needed to avoid unnecessary real dose to workers attempting to avoid "paper doses" that have no significant biological endpoint or risk basis.

William T. Bullard
3600 Willowick
Bay City, TX 77414

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