7590-01 (P)

NUCLEAR REGULATORY COMMISSION

PROPOSED GENERIC COMMUNICATION

METHOD FOR ESTIMATING EFFECTIVE DOSE EQUIVALENT FROM EXTERNAL RADIATION SOURCES USING TWO DOSIMETERS

AGENCY: Nuclear Regulatory Commission

ACTION: Notice of opportunity for public comment

SUMMARY: The U.S. Nuclear Regulatory Commission (NRC) is proposing to issue a Regulatory Issue Summary (RIS) which approves and provides guidance on a two dosimeter monitoring method that can be used by licensees for estimating effective dose equivalent (EDE) from external radiation exposures. The NRC is seeking comment from interested parties on the clarity and utility of the guidance contained in the proposed RIS. In particular, comment is requested on the following questions:

1. Is the two dosimeter method a technically acceptable alternative to the current practice of estimating EDE from deep dose equivalent (DDE)?

2. Is the NRC use of a RIS to approve the two dosimeter method acceptable under the existing regulations?

3. Are algorithms that attempt to provide better estimates of the effective dose equivalent by using more than one dosimeter of importance to your industry?

4. Do you believe that this and similar algorithms, many of which were described in NCRP Publication 122, are sufficiently technically developed to serve as a basis for dosimetry of record?

5. Is the discussion of the issues provided in the RIS sufficiently detailed to provide a background for the reasons for approving the EPRI method generically?

6. Should different or more detailed guidance be provided in an NRC Regulatory Guide or generic communication?

7. Should the definition of the total effective dose equivalent (TEDE) in Part 20 be revised to replace the deep dose equivalent with the effective dose equivalent, and make that quantity more consistent with national and international definitions?

8. To what extent should accuracy replace conservatism as the goal for personnel monitoring?

The NRC will consider the comments received in its final evaluation of the proposed RIS.

This *Federal Register* notice is available through the NRC's Agencywide Documents Access and Management System (ADAMS) under accession number **ML031980001**.

DATES: Comment period expires **[60 days after FRN is published]**. Comments submitted after this date will be considered if it is practical to do so, but assurance of consideration cannot be given except for comments received on or before this date.

ADDRESS: Submit written comments to the Chief, Rules and Directives Branch, Division of Administrative Services, Office of Administration, U.S. Nuclear Regulatory Commission, Mail Stop T6-D59, Washington, DC 20555-0001, and cite the publication date and page number of this *Federal Register* notice. Written comments may also be delivered to NRC Headquarters, 11545 Rockville Pike (Room T-6D59), Rockville, Maryland, between 7:30 am and 4:15 pm on Federal workdays.

FOR FURTHER INFORMATION, CONTACT: Sami Sherbini at (301) 415-7853 or by E-mail to sxs2@nrc.gov, or Roger Pedersen at (301) 415-3162 or by E-mail to rlp1@nrc.gov.

SUPPLEMENTARY INFORMATION: DRAFT REGULATORY ISSUE SUMMARY METHOD FOR ESTIMATING EFFECTIVE DOSE EQUIVALENT FROM EXTERNAL RADIATION SOURCES USING TWO DOSIMETERS

ADDRESSEES

All U.S. Nuclear Regulatory Commission (NRC) licensees.

INTENT

NRC is issuing this regulatory issue summary (RIS) to provide guidance on an approved two-dosimeter monitoring method for estimating effective dose equivalent (EDE) from external radiation exposures. This EDE can be used instead of the deep dose equivalent (DDE) in complying with NRC regulatory requirements.

BACKGROUND

Total effective dose equivalent (TEDE) is used in 10 CFR Part 20 (Part 20) to specify dose limits for occupationally exposed workers, and for members of the public. Other requirements (in Part 20 and other parts of NRC's regulations), such as the criteria for license termination, are also specified in terms of the TEDE. Since EDE cannot be directly measured, Part 20 defines TEDE as "the sum of the deep-dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures)." Part 20 goes on to specify that this DDE be measured at the part of the whole body with the highest exposure. This DDE can be directly measured with available dosimeters, and, in most exposure situations, provides a reasonable, conservative, and often the best, estimate for EDE from external sources (EDE_{ex}). However, in non-uniform exposure situations, such as from a directional source, DDE measured at the part of the whole body with the highest exposure can be an overly conservative estimate.

The NRC recently published RIS 2003-04 to encourage licensees to use the EDE_{ex} for determining TEDE whenever the dose from external sources is calculated instead of measured with personnel dosimetry. The RIS discusses the limitations on, and the regulatory basis for, substituting the EDE_{ex} for DDE in determining compliance with TEDE based regulatory requirements. Estimating EDE_{ex} from dosimeter readings is very dependent on exposure geometry. Therefore, RIS 2003-04 also noted that methods for estimating TEDE from an EDE_{ex} determined from dosimeter readings, must be approved by the NRC. The 2003–04 RIS also noted that NRC approved the use of a two dosimeter method for estimating effective dose equivalent at Entergy sites (Reference 1).

This RIS describes the exposure situations in which NRC would regard the use of a monitoring method to estimate EDE_{ex} as appropriate and acceptable for estimating TEDE. This RIS does not affect the definition of other non-TEDE limits or criteria in Part 20.

SUMMARY OF ISSUES

Use of Effective Dose Equivalent

The NRC has approved a method for estimating EDE_{ex} from external photon exposure situations. The guidance in this RIS is based on the review and approval of the exemption for Entergy (Reference 1).

This method uses two dosimeter readings and is based on research conducted by the Electric Power Research Institute (EPRI). The EPRI work (References 2, 3, and 4) indicates that a single dosimeter, calibrated to read DDE and worn on the chest, provides a reasonably accurate estimate of EDE_{ex} when the individual is exposed to a number of randomly distributed radiation sources during the monitoring period. This is consistent with current allowable dosimetry practices and requires no special approval. However, for nonuniform exposures, such as from directional radiation fields or point sources, EDE_{ex} can be estimated from a reading of a dosimeter worn on the front (R_{front}) of the trunk of the body, combined with the reading of a dosimeter worn on the back (R_{back}) of the trunk of the body.

Two algorithms are given by EPRI for combining the dosimeter results:

9. Mean Method

The first algorithm is a simple, un-weighted, average (MEAN) of the two dosimeter readings. The MEAN is equal to ½ (R_{front} + R_{back}).

The EPRI technical reports state that the non-weighted average does not always give a conservative result. Since no method is provided to identify when the simple average gives non-conservative results, this algorithm is not approved for use at this time.

10. Weighted Method

The second algorithm, which was the subject of the Entergy exemption, is a weighted average algorithm such that:

$$EDE_{ex} = \frac{1}{2} (Hi + MEAN)$$

where Hi is the higher of R_{front} or R_{back} .

A mathematically simpler form of this weighted algorithm is:

$$EDE_{ex} = 3/4\ Hi + 1/4\ Lo$$

where Hi is the higher of R_{front} or R_{back} and Lo is the lower of R_{front} or R_{back}.

The data presented in the EPRI technical reports (references 1 and 2) indicate that this weighted two-dosimeter algorithm provides a reasonably conservative estimate of EDE_{ex} . Therefore, only the weighted two-dosimeter algorithm is approved for use at this time for exposures in a non-uniform field.

As a result of NRC approving the above weighted method, monitoring the DDE at the part of the body receiving the highest exposure as provided in 10 CFR 20.1201(c) is not needed for determining compliance with TEDE based requirements when the weighted method is used subject to the limitations which are set out below. This is because Footnote 2 in the "Organ Dose Weighting Factors" table in 10 CFR 20.1003, permits the use of weighting factors to determine external exposures without case-by-case approvals when specific NRC guidance has been issued. This RIS constitutes such guidance for using the above weighted method for determining the external exposure from weighted dosimeters measuring direct DDE. An exemption from Part 20 is not needed if the guidance in this RIS is followed for determining external exposures. However, 10 CFR 20.1201(c) still applies to the DDE required to be used in complying with the organ dose limit in 10 CFR 20.1201(a)(1)(ii).

Additional Issues and Limitations

Licensees may, subject to the following limitations, use this weighted two-dosimeter method for determining EDE_{ex} , and estimating TEDE, from external photon exposures without applying for further approval from the NRC.

Partial-body irradiations (i.e., exposure geometries that preferentially shield the dosimeters) could bias the EPRI method results in the non-conservative direction. Licensees must ensure that dosimeters are worn so that at least one of the two dosimeters "sees" the major source, or sources, of radiation (one dosimeter will normally be shielded from a source by the body). In other words, the radiological work will be conducted and the dosimeters worn in such a way, so that no shielding material is present between the radioactive source(s) and the whole body, that would cast a shadow on the dosimeter(s) and not over other portions of the whole body.

This method for estimating EDE_{ex} from dosimeter readings, is not valid for exposure situations where the individual is immersed in a shielding material (i.e., diving operations). Large dose-rate gradients resulting from such immersions over the space occupied by the body can bias the two dosimeter results.

Only dosimeters that have demonstrated angular response characteristics at least as good as those specified in Reference 5, are to be used. If the dosimeter's response decreases more rapidly than EDE_{ex}, as the angle of incident radiation increases, the resulting EDE_{ex} estimate will be biased in the non-conservative direction. In addition, the dosimeters should be calibrated to indicate DDE at the monitored location to ensure their readings reflect electronic equilibrium conditions.

This method for estimating EDE_{ex} from two dosimeter readings is not applicable to exposure situations where the sources of radiation are nearer than 12 inches (30 cm) from the surface of the body. This is the closest distance that the two-dosimeter algorithm has been demonstrated to provide conservative results for discrete (point) radiation sources.

The use of monitoring methods for estimating EDE_{ex}, from exposure to point sources (i.e., hot particles) on, or near the surface of the body, is outside the scope of this approval. Tables 5 though 7, in Reference 3, provide some calculated EDE_{ex} values resulting from exposure to point sources in contact with the torso of the body. However, the information provided in these tables does not bound all of the pertinent point source exposure situations.

Licensees using the weighted methodology need to maintain sufficient records to demonstrate the above limitations were satisfied.

CONCLUSIONS

The weighted two-dosimeter algorithm, described in this RIS , provides an acceptably conservative estimate of EDE_{ex}. The TEDE based on EDE_{ex} using this algorithm in accordance with its associated limitations is acceptable.

When recording or reporting doses in situations in which the EDE_{ex} is assessed instead of the DDE, the value of the EDE_{ex} is entered in place of the DDE in recording or reporting forms, such as NRC Forms 4 or 5.

REFERENCES

1. Exemption from the Requirements of 10 CFR Part 20, Section 20.1003 Definition of Total Effective Dose Equivalent issued to Arkansas Nuclear One, Units 1 and 2; Grand Gulf Nuclear Station; Indian Point Nuclear Station, Units 1, 2 and 3; James A. Fitzpatrick Nuclear Power Plant; Pilgrim Nuclear Power Station; River Bend Station; Vermont

Yankee Nuclear Power Plant; and Waterford Steam Electric Station, Unit 3 , 67 FR 58826 (September 18, 2002) (ML022550559)

2. EPRI Technical Report TR-101909, Volume 1, February 1993.

3. EPRI Technical Report TR-101909, Volume 2, June 1995.

4. EPRI Implementation Guide TR-109446, September 1998.

5. Xu, X. G.; Reese, W. D.; and Poston, J. W. , "A Study of the Angular Dependence Problem In Effective Dose Equivalent Assessment", *Health Physics*, Volume 68., No. 2, February 1995, pp. 214-224.

BACKFIT DISCUSSION

This RIS does not require any action nor written response nor require any modification to plant structures, systems, components, or design; therefore, the staff did not perform a backfit analysis.

FEDERAL REGISTER NOTICE

A notice of opportunity for public comment was published in the *Federal Register* **XXXXXXX**

PAPERWORK REDUCTION ACT STATEMENT

This RIS does not require any action nor written response nor require any modification to plant structures, systems, components, or design; therefore, the staff did not perform a backfit analysis.

PAPERWORK REDUCTION ACT STATEMENT

This RIS does not request any information collection.

END OF DRAFT REGULATORY ISSUE SUMMARY

Documents may be examined, and/or copied for a fee, at the NRC's Public Document Room at One White Flint North, 11555 Rockville Pike (first floor), Rockville, Maryland. Publicly available records will be accessible electronically from the Agencywide Documents Access and Management System (ADAMS) Public Electronic Reading Room on the Internet at the NRC Web site, http://www.nrc.gov/NRC/ADAMS/index.html. If you do not have access to ADAMS or if you have problems in accessing the documents in ADAMS, contact the NRC Public Document Room (PDR) reference staff at 1-800-397-4209 or 301-415-4737 or by e-mail to pdr@nrc.gov.

Dated at Rockville, Maryland, this 14TH day of July 2003.

FOR THE NUCLEAR REGULATORY COMMISSION

/RA/
William D. Beckner, Branch Chief
Reactor Operations Branch
Division of Inspection Program Management
Office of Nuclear Reactor Regulation

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