Withdrawn

NRC Regulatory Issue Summary 2004-01, “Method of Estimating Effective Does Equivalent from External Radiation Sources Using Two Dosimeters,” dated February 17, 2004, has been withdrawn.

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See *Federal Register* notice dated October 25, 2016

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, DC 20555-0001

February 17, 2004

NRC REGULATORY ISSUE SUMMARY 2004-01
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 certain NRC regulatory requirements. This RIS requires no action or written response on the part of an addressee.

BACKGROUND

Total effective dose equivalent (TEDE) is used in 10 CFR 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 nonuniform 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 personal dosimeters. 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 noted that methods for estimating TEDE from an EDE_{ex} determined from dosimeter readings must be approved by the NRC. RIS 2003–04 also noted that NRC approved the use of a two-dosimeter method for estimating effective dose equivalent at Entergy sites (Reference 1).

ML040420042

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.

EPRI gives two algorithms for combining the dosimeter results:

1. Mean Method (not approved for use at this time)

   The first algorithm is a simple, unweighted, average (MEAN) of the two dosimeter readings. The MEAN is equal to $\frac{1}{2}$ ($R_{front} + R_{back}$).

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

2. 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

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

   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 nonuniform field.

An exemption from Part 20 is not needed if the guidance in this RIS is followed for determining external exposures. 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 direct dosimeter measurements. When using this two dosimeter method, TEDE is the sum of the EDE_{ex} (for external exposures) and the committed effective dose equivalent (for internal exposures). The requirement in 10 CFR 20.1201(c) that the assigned DDE be measured at the highest exposed part of the whole body, does not apply *when EDE_{ex} is used in place of DDE to demonstrate compliance with TEDE based requirements*.

The use of this two-dosimeter method may not eliminate the current practice of monitoring whole-body exposure with multiple dosimeters to determine the highest exposed part of the whole body. It should be noted that 10 CFR Part 20.1201(a) and (c) still require doses to be measured at specific body locations for demonstrating compliance with the non-TEDE dose limits (i.e., dose to the lens of the eye, skin of the whole body and extremities, or the total organ dose). Licensees will, most likely, need to provide additional dosimeters if monitoring is required by 10 CFR 20.1502, to demonstrate compliance with any of these non-TEDE dose limits. See Regulatory Guide 8.34 for guidance on meeting the monitoring requirements of 10 CFR 20.1502.

Additional Issues and Limitations

Licensees may 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, subject to the following limitations:

1. Partial-body irradiations (i.e., exposure geometries that preferentially shield the dosimeters) could bias the EPRI method results in the nonconservative 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 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.

2. 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.

3. 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 nonconservative direction.

4. 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.

5. 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 that the above limitations were met.

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 or written response or 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* on July 24, 2003 (Vol. 68, No. 142, pp. 43769-43771).

PAPERWORK REDUCTION ACT STATEMENT

This RIS does not request any information collection.

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If you have any questions about this RIS, please contact the persons listed below or the appropriate Office of Nuclear Reactor Regulation project manager.

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Regulatory Issue Summary No.	Subject	Date of Issuance	Issued to
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2003-17	Complying with 10 CFR 35.59, "Recentness of Training," for Board-certified Individuals Whose Training and Experience Were Completed More than 7 Years Ago	10/03/2003	All U.S. Nuclear Regulatory Commission (NRC) medical-use licensees and NRC master materials license medical-use permittees.

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