Withdrawn

NRC Regulatory Issue Summary 2009-09, “Use of Multiple Dosimetry and Compartment Factors in Determining Effective Dose Equivalent from External Radiation Exposures,” dated July 13, 2009, has been withdrawn.

ADAMS Accession Number: ML082320040

See *Federal Register* notice dated October 25, 2016

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
OFFICE OF NUCLEAR MATERIAL SAFETY AND SAFEGUARDS
OFFICE OF FEDERAL AND STATE MATERIALS AND
ENVIRONMENTAL MANAGEMENT PROGRAMS
WASHINGTON, DC 20555-0001

July 13, 2009

NRC REGULATORY ISSUE SUMMARY 2009-09
USE OF MULTIPLE DOSIMETRY AND COMPARTMENT FACTORS IN DETERMINING EFFECTIVE DOSE EQUIVALENT FROM EXTERNAL RADIATION EXPOSURES

ADDRESSEES

All U.S. Nuclear Regulatory Commission (NRC) licensees, Agreement State Radiation Control Program Directors, and State Liaison Officers.

INTENT

The NRC is issuing this regulatory issue summary (RIS) to inform licensees of an acceptable method for determining effective dose equivalent (EDE) from external sources of radiation. This method is documented in a plant specific safety evaluation and has been determined to be generically applicable to licensees when employed consistent with the assumptions, limitations, and commitments identified in this safety evaluation. This RIS communicates the NRC's determination of generic applicability and provides a summary of the information contained in the safety evaluation. No specific action or written response is required. NRC is providing this RIS to the Agreement States for their information and for distribution to their licensees as appropriate.

The NRC staff will issue a Regulatory Guide that will combine and identify approved methods for determining EDE from external sources (EDE_{ex}), allowing the use of EDE_{ex} in place of deep dose equivalent (DDE) for demonstrating compliance with total effective dose equivalent (TEDE) requirements in Title 10 of the *Code of Federal Regulations* (10 CFR) Chapter 1.

BACKGROUND

Effective January 3, 2008, the definition of TEDE in 10 CFR Part 20, "Standards for Protection against Radiation," was amended (see Volume 72, page 68043, of the *Federal Register*, dated December 4, 2007). The amendment redefined TEDE as "the sum of the effective dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures)." This change clarified that the EDE_{ex} could be used to demonstrate compliance with TEDE-based regulations.

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In addition, the NRC revised 10 CFR 20.1201(c) to require that, when external exposure is determined by measurement with an external personal monitoring device, the DDE must be used in place of the EDE_{ex}, unless the licensee determines EDE_{ex} using a dosimetry method approved by the NRC. The NRC has approved several methods for determining EDE_{ex}, allowing the use of EDE_{ex} in place of DDE for demonstrating compliance with the TEDE requirements in 10 CFR Part 20. These methods are discussed in RIS 2002-06, "Evaluating Occupational Dose for Individuals Exposed to NRC-Licensed Material and Medical X-Rays," dated April 16, 2002; RIS 2003-04, "Use of the Effective Dose Equivalent in Place of the Deep Dose Equivalent in Dose Assessments," dated February 13, 2003; and RIS 2004-01, "Method for Estimating Effective Dose Equivalent from External Radiation Sources Using Two Dosimeters," dated February 17, 2004. The method described in this RIS is another approved method.

On December 20, 2004, Southern California Edison submitted a request to the NRC to use the compartment factors found in American National Standard Institute/Health Physics Society (ANSI/HPS) N13.41-1997 as part of a proposed method of multiple dosimetry (see Agencywide Documents Access and Management System (ADAMS) Accession No. ML043630036). The NRC staff found ANSI/HPS N13.41-1997 deficient in certain areas, thereby limiting its use for demonstrating compliance with TEDE-based regulations. For example, the ANSI/HPS standard lacks specificity for the placement of personal monitoring devices.

The NRC staff determined that the method proposed by Southern California Edison, to use the ANSI/HPS N13.41-1997 compartment factors for determining EDE_{ex}, including their commitment to monitor each compartment at the location of highest exposure, is acceptable. On May 10, 2005, the NRC approved the licensee's request (see Safety Evaluation at ADAMS Accession No. ML051320194) concluding that the proposed method, as discussed further in this RIS, was technically sound and acceptable for the purposes of determining compliance with the TEDE-based regulations in 10 CFR Chapter 1.

In developing this RIS, a stakeholder concern was raised by comment at a meeting, that some licensees using multiple dosimeters to monitor external radiation exposure (as with this EDE method) may inappropriately reduce their work place radiation survey programs. Nothing in this RIS relieves the licensee of the survey requirements in 10 CFR 20 .1501(a), nor the requirements in 10 CFR 19.12 to inform the workers of workplace radiological hazards.

SUMMARY OF ISSUE

The method for determining EDE_{ex} described in this RIS, includes the use of the "compartment factors" provided in ANSI/HPS N13.41-1997, "Criteria for Performing Multiple Dosimetry." The multiple dosimetry method in ANSI/HPS N13.41-1997 divides the whole body into seven separate compartments. Each compartment, or composite compartment (since the ANSI/HPS standard allows combining adjacent compartments), is monitored separately. The dose measurement for each compartment is the personal dose equivalent for penetrating radiation at a depth of 10 millimeters, or $H_p(10)$. This $H_p(10)$ is equivalent to the DDE as defined in 10 CFR Part 20. The $H_p(10)$, or measured DDE, value is then weighted with the associated "compartment factor" (W_c).

The factor for each compartment was developed by summing the stochastic weighting factors given in International Commission of Radiological Protection (ICRP) Publication 26 for all the organs located within that compartment. For each tissue that resides in more than one compartment (e.g., red bone marrow), the weighting factor is apportioned among the

compartments based on the fraction of the total mass of the tissue residing in each using the information in ICRP Publication 23, "Report of the Task Group on Reference Man."

Table 1 of ANSI/HPS N13.41-1997 lists the compartment factors as shown below:

Area of the Body/Compartment (c)	Compartment Factor (W_c)
Head and neck	0.10
Thorax, above the diaphragm	0.38
Abdomen, including the pelvis	0.50
Upper right arm	0.005
Upper left arm	0.005
Right thigh	0.005
Left thigh	0.005

EDE_{ex} is the sum of the products of the personal dose equivalent measured for each compartment and its associated compartment weighting factor, or:

$$H_E = \sum W_C \, H_{p,c}(10)$$

Where H_E = effective dose equivalent (or EDE_{ex}), W_c = compartment factor for compartment "c," and $H_{p,c}(10)$ = personal dose equivalent (or DDE) for compartment "c."

As noted above, ANSI/HPS N13.41-1997 allows two or more adjacent compartments to be combined into a single composite compartment. The compartment weighting factor for a composite compartment is the sum of the weighting factors of the individual compartments that make up the composite compartment. Although not a condition of the NRC approval, several of the licensees who have obtained a site-specific approval to use this method, monitor the thorax and abdomen compartments as a single composite compartment similar to the original proposal by Southern California Edison.

Fundamental to the compartment method of determining EDE_{ex} are the assumptions that (1) the average dose to the tissues in each compartment can be reasonably measured, and (2) the dose distribution across the compartment is sufficiently constant so that this average dose can be applied to each tissue in the compartment. The compartments defined in the standard are small enough so that under most normal exposure situations these assumptions are met and a single determination of DDE in each compartment is sufficient. However, this may not be the case in those unusual situations in which a significant dose gradient exists across one or more compartments (particularly the thorax and abdomen compartments). In these cases, the number and placement of dosimeters in each compartment becomes critical to ensuring that the EDE_{ex} is not underestimated.

To ensure that the estimates of EDE_{ex} are conservative, the licensee must measure the dose to each compartment (or composite compartment) by locating the dosimeter (calibrated to DDE) at the highest exposed portion of the respective compartment. The dosimeter location for each compartment is subject to the same criteria currently used to demonstrate compliance with 10 CFR 20.1201(c). [Note: monitoring each compartment, or composite compartment, at the location of highest exposure results in a conservative estimate of EDE_{ex} no matter what combination of compartments and composite compartments are used – even in the extreme case of combining all compartments into a single whole body composite compartment.]

CONCLUSION

NRC licensees may use the compartment factors of ANSI/HPS N13.41-1997 and the methodology described in this RIS for implementing a multiple dosimetry program in compliance with TEDE-based regulations. This methodology is consistent with the NRC Safety Evaluation issued to Southern California Edison on May 10, 2005 (ADAMS Accession No. ML051320194). It should be noted that the NRC has not directly approved ANSI/HPS N13.41-1997, in and of itself, for use by licensees in a personnel monitoring program. The NRC has only approved the use of the compartment factors and associated method for calculating EDE_{ex}, as described in this RIS, for use in a multiple dosimetry program when combined with the method presented herein.

This RIS communicates the generic applicability of this method to determine EDE_{ex} . Licensees may use this method for demonstrating compliance with TEDE-based regulations. Therefore, licensees are no longer required to apply for approval to use this method on a site-specific basis.

BACKFIT DISCUSSION

The purpose of this RIS is to inform licensees of a method for determining EDE_{ex} that has been approved by the NRC for use in determining TEDE in several site-specific licensee requests for approval (See additional safety evaluations at ADAMS Accession Nos. ML051320194, ML080570154, ML072220355, and ML061870512). The staff positions and guidance discussed in this RIS are the same as those that provide the technical basis for these site-specific approvals. This RIS requires no action or written response. 10 CFR Part 20 provides several options for demonstrating compliance with the TEDE dose limits. Any action on the part of addressees in accordance with the guidance contained in this RIS is voluntary. Consequently, the staff did not perform a backfit analysis.

FEDERAL REGISTER NOTIFICATION

The NRC did not publish a notice of opportunity for public comment on this RIS in the *Federal Register* because this RIS is informational and does not represent a departure from current regulatory requirements. Stakeholder comment was solicited in a September 10, 2008, public meeting. The draft RIS was attached to the meeting announcement (ADAMS ML082340248). A summary of the comments received, and their resolutions, can be found at ADAMS Accession No. ML082540738.

CONGRESSIONAL REVIEW ACT

This RIS is not a rule as designated by the Congressional Review Act (5 U.S.C. § 801-886) and therefore is not subject to the Act.

PAPERWORK REDUCTION ACT STATEMENT

This RIS does not contain new or amended information collection requirements subject to the Paperwork Reduction Act of 1995 (44 U.S.C. 3501 et. seq.). Existing requirements were approved by the Office of Management and Budget (OMB), approval numbers 3150-0114, 3150-0005, and 3150-0006.

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CONTACT

Please direct any questions about this matter to the technical contact listed below.

/RA by MTschiltz for/

Daniel Dorman, Director
Division of Fuel Cycle Safety
and Safeguards
Office of Nuclear Material Safety
and Safeguards

/RA/

Robert J. Lewis, Director
Division of Materials Safety
and State Agreements
Office of Federal and State Materials
and Environmental Management Programs

/RA/

Timothy J. McGinty, Director
Division Policy and Rulemaking
Office of Nuclear Reactor Regulation

Technical Contacts: Joshua Palotay
(301) 415-6231
E-mail: Joshua.Palotay@nrc.gov

Roger Pedersen
(301) 415-3162
E-mail: Roger.Pedersen@nrc.gov

Enclosure: List of Recently Issued Office of Federal and State Material and Environmental Management Programs Generic Communications

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Office of Federal and State Materials
and Environmental Management Programs

/RA/
Timothy J. McGinty, Director
Division Policy and Rulemaking
Office of Nuclear Reactor Regulation

Technical Contacts: Roger Pedersen
(301) 415-3162
E-mail: Roger.Pedersen@nrc.gov

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Distribution

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OFFICE	NRR/IRIB	NRR/IRIB	Tech Ed	NRR/IRIB	NRR/DIRS
NAME	JPalotay	RPedersen	email	TKobetz	FBrown
DATE	11/ 03 /08	11/ 03 /08	08/ 27 /08	11/10/08	11/10/08
OFFICE	D:NRR/DORL	FSME/DMSSA	FSME/DMSSA	D:FSME/DMSSA	D:NMSS/FCSS
NAME	JGitter	AMcIntosh	JDeCico	RLewis	DDorman
DATE	12/ 05/08	11/23/08	11/26/08	12/02/08	11/14/08
OFFICE	OGC-NLO	OGC-CRA	OE	NRO	PMDA
NAME	BJones	JAdler	CCarpenter NHilton for	GTracy	LHill
DATE	11/25/08	11/17/08	11/14/08	01/ /09	11/10/08
OFFICE	OIS	LA:PGCB	PGCB	BC:PGCB	D:NRR/DPR
NAME	GTrussell	CHawes	SStuchell	MMurphy	TMcGinty
DATE	11/17/08	06/10/09	06/11/09	07/06/09	07/13/09

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List of Recently Issued Office of Federal and State Material and Environmental Management Programs Generic Communications

Date	GC No.	Subject	Addressees
05/13/08	RIS-2008-10	Notice Regarding Forthcoming Federal Firearms Background Checks	All U.S. Nuclear Regulatory Commission licensees, certificate holders, and applicants for a license or certificate of compliance who use armed security personnel as part of their physical protection system and security organization. All Radiation Control Program Directors and State Liaison Officers.
05/12/08	RIS-2008-11	Precautions to Protect Children Who May Come in Contact with Patients Released After Therapeutic Administration of Iodine-131	All U.S. Nuclear Regulatory Commission medical-use licensees, master material licensees, Agreement State Radiation Control Program Directors, and State Liaison Officers
05/09/08	RIS-2008-12	Considerations for Extended Interim Storage of Low-level Radioactive Waste by Fuel Cycle and Materials Licensees	All holders of U.S. Nuclear Regulatory Commission fuel cycle and materials licenses. All Radiation Control Program Directors and State Liaison Officers
06/16/08	RIS-2008-13	Status And Plans for Implementation of NRC Regulatory Authority for Certain Naturally Occurring and Accelerator-Produced Radioactive Material	All U.S. Nuclear Regulatory Commission materials licensees, Radiation Control Program Directors, State Liaison Officers, and the NRC's Advisory Committee on the Medical Uses of Isotopes
07/18/08	RIS-2008-17	Voluntary Security Enhancements for Self-Contained Irradiators Containing Cesium Chloride Sources	All U.S. Nuclear Regulatory Commission Materials Licensees Authorized to Possess Self-Contained Irradiators Containing Cesium Chloride (CsCl) ; all Agreement State Radiation Control Program Directors and State Liaison Officers; all members of the Advisory Committee on the Medical Uses of Isotopes.
05/16/08	IN-2008-03	Precautions to Take Before Sharing Sensitive Security-Related Information	All U.S. Nuclear Regulatory Commission licensees who are implementing U.S. Nuclear Regulatory Commission's Order Imposing Increased Controls (IC Order) or implementing IC requirements by license condition; all Agreement State Radiation Control Program Directors and State Liaison Officers

Note: This list contains the six most recently issued generic communications, issued by the Office of Federal and State Materials and Environmental Management Programs (FSME). A full listing of all generic communications may be viewed at the NRC public website at the following address: http://www.nrc.gov/reading-rm/doc-collections/gen-comm/index.html