

# POLICY ISSUE

## (Notation Vote)

December 4, 2002

SECY-02-0214

FOR: The Commissioners

FROM: William D. Travers  
Executive Director for Operations /RA/

SUBJECT: GUIDANCE ON THE USE OF EFFECTIVE DOSE EQUIVALENT  
IN EXTERNAL DOSE ASSESSMENTS

### PURPOSE:

The Commission, in Staff Requirements Memorandum SRM-SECY-01-0127, directed the staff to "...develop guidance that specifies when it is appropriate to use effective dose equivalent rather than deep-dose equivalent for assessing the dose from external sources of radioactivity." The purpose of this paper is to obtain the Commission's approval to issue a proposed Regulatory Issue Summary (RIS) on the appropriate use of effective dose equivalent for assessing dose from external sources of radiation.

### BACKGROUND:

The use of Deep Dose Equivalent (DDE), as specified in Part 20, has provided a satisfactory method for licensees to show compliance with regulatory requirements in most ordinary exposure situations involving personnel monitoring. However, difficulties sometimes arise because the stochastic risk from radiation exposure is correlated with the effective dose equivalent, but not with the DDE. The DDE will provide a reasonable indication of risk only when its numerical value is close to that of the effective dose equivalent under the specified exposure conditions. This is the case when the whole body is exposed in a uniform or nearly

CONTACT: Sami Sherbini, NMSS/IMNS  
301-415-7853

uniform radiation field. It is not the case, however, when the radiation field is significantly non-uniform, or when parts of the body are shielded, or when the radiation is incident from an unusual angle, such as from underfoot or overhead. In such situations, the numerical value of the DDE is significantly different, and usually much higher, than that of the effective dose equivalent under the given exposure conditions.

An extreme example of the differences between the DDE and the effective dose equivalent is the case of localized contamination on the skin, such as that from a hot particle, or exposure to a narrow external radiation field. In such cases, the DDE at the exposure location may be very high, but the corresponding effective dose equivalent, and hence the stochastic risk, is low. Another, less extreme, example is the exposure of medical personnel wearing protective aprons during radiology procedures. Measuring DDE at the point of highest exposure may in this case overestimate the effective dose equivalent, and hence the radiation risk, by up to an order of magnitude or more outside the apron.

In an attempt to correct this situation, several methods have been developed that use the DDE as measured by one or more dosimeters, together with a suitable formula, to obtain a dose value that is numerically much closer to the effective dose equivalent. Underlying all of these methods is the idea that, regardless of the method used to assess and assign doses, the ultimate objective of any dose assessment situation is to obtain the most accurate estimate of the effective dose equivalent without underestimating that value. This is a necessary condition for any risk-based practice.

The DDE was defined by the International Commission on Radiation Units and Measurements (ICRU) to serve as an operational quantity and a surrogate to be used to provide a conservative estimate, based on measurements, of the effective dose equivalent, which cannot be measured directly. (Note: the ICRU calls the DDE the personal dose equivalent, but the definitions are identical). Therefore, in situations that do not involve personnel monitoring, as for example when the dose is calculated, the use of DDE to assess doses from external radiation fields is not justified under any circumstances. In such cases the effective dose equivalent is calculated directly.

## DISCUSSION

The attached RIS is written for the audience of radiation safety professionals, and thus uses the terms and acronyms specific to complying with the requirements of 10 CFR Part 20. The guidance encourages licensees to use the effective dose equivalent in all situations that do not involve dose measurements using personnel dosimetry. Such situations include environmental assessments, dose calculations for effluents, dose calculations in connection with proposed licensing actions, calculations to show compliance with non-occupational dose limits and, in general, any dose assessments based on calculations. Such calculations of the effective dose equivalent are in fact now used in many regulated activities, both by the NRC and by licensees, because the dose conversion factor tables that are used in these calculations, or that are incorporated into the computer codes used to perform these calculations, are in fact effective dose equivalent factors, and not DDE factors.

The RIS also specifies that licensees must still use the DDE, measured at the location of highest exposure on the body, whenever the doses are being assessed on the basis of the readings of personnel dosimetry. Exceptions would be considered and approved on a case-by-case basis. These exceptions include any method that is capable of providing more accurate estimates of the effective dose equivalent. One such exception has already been approved for use by medical personnel wearing protective aprons during radiology procedures. Another method was recently approved for use at the Entergy reactor sites.

#### RECOMMENDATION

The staff recommends that the proposed Regulatory Issue Summary (RIS) be issued to all NRC licensees.

*/RA/*

William D. Travers  
Executive Director  
for Operations

Attachment:  
Draft Regulatory Issues Summary

case basis. These exceptions include any method that is capable of providing more accurate estimates of the effective dose equivalent. One such exception has already been approved for use by medical personnel wearing protective aprons during radiology procedures. Another method was recently approved for use at the Entergy reactor sites.

RECOMMENDATION

The staff recommends that the proposed Regulatory Issue Summary (RIS) be issued to all NRC licensees. The staff also recommends that training on the issues involved in the RIS be provided to selected Headquarters and Regional staff who may be required to answer questions from licensees on this and related topics.

*/RA/*

William D. Travers  
Executive Director  
for Operations

Attachment:  
Draft Regulatory Issues Summary

G:\sherbini\commdde2.wpd -- ML022900651

<b>_ OFC</b>	IMNS		NMSS		IMNS		NRR		NRR	
<b>NAME</b>	SSherbini		EKraus		JDeCicco		RPedersen		BBoger	
<b>DATE</b>	10/7/02		7/ 17/02		10/7/02		10/8/02		10/8/02	
<b>OFC</b>	NRR		NRR		OGC		IMNS		NRR	
<b>NAME</b>	WBeckner		DMatthews		STreby		DCool		SCollins	
<b>DATE</b>	10/ 9/02		10/ 9 /02		10/17/02		10/25/02		10/ 9/02	
<b>OFC</b>	NMSS		OSTP		DEDMRS		EDO			
<b>NAME</b>	Mvirgilio mvf for		PLohaus		CPaperiello		WTravers			
<b>DATE</b>	11/14/02		12/ 3 /02		12/4/02		12/04/02			

UNITED STATES  
NUCLEAR REGULATORY COMMISSION

October XX, 2002

Draft

**NRC REGULATORY ISSUE SUMMARY 2002-XX  
USE OF THE EFFECTIVE DOSE EQUIVALENT IN PLACE  
OF THE DEEP DOSE EQUIVALENT IN DOSE ASSESSMENTS**

**ADDRESSEES**

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

**INTENT**

The NRC is issuing this Regulatory Issue Summary (RIS) to provide guidance on situations in which it is permissible to use the effective dose equivalent, in place of the deep dose equivalent (DDE), in showing compliance with regulatory requirements.

**BACKGROUND**

The dose limits in 10 CFR Part 20 for occupationally exposed workers, as well as for members of the public, are specified in terms of the quantity total effective dose equivalent (TEDE). Other Part 20 requirements, such as the criteria for license termination, are also specified in terms of the TEDE, as are requirements specified in other parts of NRC's regulations.

The TEDE is defined in Part 20 as the sum of the DDE resulting from exposure to external radiation, and the committed effective dose equivalent (CEDE) resulting from internal contamination. However, Footnote 2, in the "Organ Dose weighting Factors" table in 10 CFR 20.1003, does permit approval of the use of organ and tissue weighting factors for external exposures on a case-by-case basis, until specific guidance is issued. This RIS provides this guidance. NRC, reading Part 20 as a whole, concludes that the footnote provides the staff with the discretion to permit the use of effective dose equivalent for external exposures in place of the DDE, in the definition of TEDE. In accordance with the discretion thus provided by the footnote, TEDE may be redefined as the sum of the effective dose equivalent for external exposure and the committed effective dose equivalent for internal exposure. When this redefinition of TEDE is used, 10 CFR 20.1201(c) does not apply, because the DDE is no longer used in the definition of TEDE.

ML #####

This RIS describes the exposure situations in which the use of the effective dose equivalent, in place of the DDE, would be regarded by NRC as appropriate and acceptable. This RIS does not affect the definition and use of the CEDE.

## **SUMMARY OF ISSUES**

### **Use of Effective Dose equivalent**

Licensees are encouraged to use the effective dose equivalent in place of the DDE in all situations that do not involve direct monitoring of external exposures using personnel dosimetry. Such situations include, but are not limited to: (1) calculating offsite doses resulting from effluents; (2) calculating doses from contaminated soils and buildings; (3) assessing the effects of ALARA (As Low As Reasonably Achievable) measures, such as installation of shielding or system decontaminations; (4) assessing the environmental impacts of proposed licensing actions; (5) calculations in connection with license termination and release of sites, (6) assessing doses resulting from localized skin contaminations, and (7) all other situations in which the doses are calculated rather than measured with personnel dosimetry. No prior NRC approval is required when using the effective dose equivalent from external exposure in place of the DDE, in such situations. The tissue weighting factors to be used in these effective dose calculations must be those listed in 10 CFR 20.1003. Use of other weighting factors requires case-by-case approval from the NRC.

There are several reasons for adopting this position: (1) the effective dose equivalent is the primary radiation protection quantity, linked directly to the risks resulting from radiation exposure, whereas the DDE is a surrogate operational quantity intended to be used in monitoring situations as an approximation to the effective dose equivalent, which cannot be measured directly; (2) when doses are to be calculated, or otherwise estimated, in ways that do not involve personnel dosimetry, the effective dose equivalent is usually just as easily calculated as is the DDE, and in many situations it may be easier to estimate; (3) many of the tabulations of dose conversion factors currently used in dose assessments are in terms of the effective dose equivalent, not DDE; (4) most software used in dose assessments refer to tabulations of effective dose equivalent conversion factors, not DDE factors; (5) in situations involving dose calculations, the effective dose equivalent is a well-defined dosimetric quantity, whereas the DDE is not.

When recording or reporting doses in situations in which the effective dose equivalent from external fields is assessed in place of the DDE, the value of the effective dose equivalent is entered in place of the DDE in recording or reporting forms, such as NRC's Forms 4 or 5.

### **Use of Deep Dose equivalent**

The above guidance does not apply to situations in which individual doses from external radiation fields are to be measured using personnel dosimetry. In such situations, because the effective dose equivalent cannot be measured directly, NRC still requires the use of the DDE,

as defined in Part 20, as an estimator of the effective dose equivalent. It has been shown that, for most practical situations involving personnel monitoring, the DDE provides a reasonable, conservative, and often the best, estimate for the effective dose equivalent. It is also a quantity that is well-suited to measurement using dosimeters.

### **Need for NRC Approval when Estimating Effective Dose Equivalent by Measurements**

In personnel monitoring situations for which this use of the DDE measured at the location of highest exposure may not be desirable, NRC will grant approval for other methods of dose monitoring, on a case-by-case basis, if the proposed methods can be shown to be technically adequate for the intended use.

One such situation is monitoring of personnel working under conditions where a substantial part of the body is shielded as, for example, when wearing protective aprons in medical radiology. Another involves radiation fields that are very non-uniform, or that irradiate only small parts of the body, such as the upper extremities, but not the torso. Empirical and semi-empirical methods are available, in such cases, that involve the use of one or more dosimeters, together with an appropriate formula, to provide a better estimate of the effective dose equivalent than is possible using the DDE as described above. However, because these methods are often specific to certain limited exposure situations, and can be easily misapplied, NRC requires that licensees obtain approval before using them. NRC will grant such approvals on a case-by-case basis if the licensee is able to demonstrate that the proposed method will provide reasonable dose estimates under the exposure conditions for which it will be used. NRC may also provide generic approval for a specific method through issuance of a generic communication or other means of providing guidance to licensees. One such general approval has already been granted, and applies only to medical personnel wearing protective aprons during radiology procedures (see RIS 2002-006). In addition, Entergy has recently been granted approval to use an EPRI two-badge method for estimating effective dose equivalent at their sites.

### **BACKFIT DISCUSSION**

This RIS does not require any action or written response or require any modification to plant structures, systems, components, or designs of facilities; therefore, the staff did not perform a backfit analysis.

### **FEDERAL REGISTER NOTICE**

A notice of opportunity for public comment was not published in the *Federal register* because this RIS is information and pertains to a staff position that does not represent a departure from current regulatory requirements and practices.

**PAPERWORK REDUCTION ACT STATEMENT**

This RIS does not request any information collection.

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

Donald A Cool, Director  
Division of Industrial and  
Medical Nuclear Safety  
Office of Nuclear Material Safety  
and Safeguards

William D. Beckner, Program Director  
Operating Reactor Improvements Program  
Division of Regulatory Improvements Programs  
Office of Nuclear reactor Regulation

Technical contact: Sami Sherbini, NMSS  
301-415-7853  
E-mail:sxs2@nrc.gov

Roger Pedersen, NRR  
301-415-3162  
E-mail:rlpd@nrc.gov

<b>OFC</b>	IMNS		NMSS		NRR		IMNS		NRR	
<b>NAME</b>	SSherbini		EKraus		RPedersen		DCool		WBeckner	
<b>DATE</b>	/ /02		7/17/02		/ /02		/ /02		/ /02	