

October 2, 2006

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SUBJECT: ARKANSAS NUCLEAR ONE, UNIT 1, GRAND GULF NUCLEAR STATION, UNIT 1, INDIAN POINT NUCLEAR GENERATING UNIT NOS. 2 AND 3, PILGRIM NUCLEAR POWER STATION, RIVER BEND STATION, UNIT 1, VERMONT YANKEE NUCLEAR POWER STATION, AND WATERFORD STEAM ELECTRIC STATION, UNIT 3 - APPLICATION TO USE EFFECTIVE DOSE EQUIVALENT WEIGHTING FACTORS FOR EXTERNAL EXPOSURE (TAC NOS. MD1736, MD1739, MD1740, MD1741, MD1742, MD1743, MD1744, AND MD1745)

Dear Mr. Burford:

By letter dated May 16, 2006, Entergy Operations, Inc., and Entergy Nuclear Operating, Inc. (Entergy or the licensee), requested the U.S. Nuclear Regulatory Commission's (NRC's) approval for the use of the weighting factors provided in the American National Standard Institute (ANSI) HPS N13.41-1997 (the Standard) for external radiation exposures when demonstrating compliance with total effective dose equivalent (TEDE), based on requirements in Part 20 of Title 10 to the *Code of Federal Regulations* (10 CFR) for Arkansas Nuclear One, Unit 1 (ANO-1), Grand Gulf Nuclear Station, Unit 1 (GGNS), Indian Point Nuclear Generating Unit Nos. 2 and 3 (IP2 and IP3), Pilgrim Nuclear Power Station (Pilgrim), River Bend Station, Unit 1 (RBS), Vermont Yankee Nuclear Station (VY), and Waterford Steam Electric Station, Unit 3 (Waterford 3).

The NRC staff has completed its review. Enclosed is the NRC staff's related safety evaluation that concludes that your request for the use of the weighting factors provided in the Standard for external radiation exposures when demonstrating compliance with TEDE, based on requirements in Part 20 of 10 CFR for ANO-1, GGNS, IP2, IP3, Pilgrim, RBS, VY, and Waterford 3, is acceptable.

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Please contact me at (301) 415-1302 or Bhalchandra K. Vaidya at (301) 415-3308, if you have any questions on this matter.

Sincerely,

/RA/

David Terao, Chief
Plant Licensing Branch IV
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-313, 50-416, 50-247, 50-286,
50-293, 50-458, 50-271, and 50-382

Enclosure: Safety Evaluation

cc w/encl: See next page

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Enclosure: Safety Evaluation

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ACCESSION NO: ML062120154

NRR-106 * No substantial change in the SE Input

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DATE	8/3/06	8/3/06	6/23/2006	8/10/06	10/2/06

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION
RELATED TO THE APPROVAL TO USE WEIGHTING FACTORS
FOR EXTERNAL RADIATION EXPOSURES
ENTERGY OPERATIONS, INC., AND ENTERGY NUCLEAR OPERATING, INC.,
ARKANSAS NUCLEAR ONE, UNIT 1,
GRAND GULF NUCLEAR STATION, UNIT 1,
INDIAN POINT NUCLEAR GENERATING UNIT NOS. 2 AND 3,
PILGRIM NUCLEAR POWER STATION,
RIVER BEND STATION, UNIT 1,
VERMONT YANKEE NUCLEAR POWER STATION, AND
WATERFORD STEAM ELECTRIC STATION, UNIT 3
DOCKET NOS. 50-313, 50-416, 50-247, 50-286, 50-293, 50-458,
50-271, and 50-382

1.0 INTRODUCTION

By letter dated May 16, 2006 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML061430359), Entergy Operations, Inc., and Entergy Nuclear Operating, Inc. (Entergy or the licensee), requested the U.S. Nuclear Regulatory Commission's (NRC's) approval for the use of the weighting factors provided in the American National Standard Institute (ANSI) HPS N13.41-1997 (the Standard) for external radiation exposures when demonstrating compliance with total effective dose equivalent (TEDE), based on requirements in Part 20 of Title 10 of the *Code of Federal Regulations* (10 CFR) for Arkansas Nuclear One, Unit 1 (ANO-1), Grand Gulf Nuclear Station, Unit 1 (GGNS), Indian Point Nuclear Generating Unit Nos. 2 and 3 (IP2 and IP3), Pilgrim Nuclear Power Station (Pilgrim), River Bend Station, Unit 1 (RBS), Vermont Yankee Nuclear Station (VY), and Waterford Steam Electric Station, Unit 3 (Waterford 3). The effect of granting this request would be to allow the licensee the option to control TEDE using the weighted external exposure measurements in those cases where it is a more accurate predictor of the risk from occupational radiation exposure.

2.0 REGULATORY EVALUATION

The radiation protection approach, and dose limits contained in Part 20 of 10 CFR are based on the recommendations of the International Commission on Radiation Protection (ICRP) in their 1977 Publication No. 26 (ICRP 26). For stochastic effects, the ICRP's recommended dose limitation is based on the principle that the risk should be equal, whether the whole body is irradiated uniformly or there is non-uniform irradiation (such as when radioactive materials are taken into the body and, depending on their physical and chemical properties, concentrate in certain tissues and organs). Therefore, the ICRP 26 recommendations are based on controlling the sum of the risk weighted doses to selected organs.

Effective dose equivalent (EDE or H_E) is defined in 10 CFR 20.1003 as "the sum of the products of the dose equivalent to the organ or tissue (H_T) and the weighting factors (W_T) applicable to each of the body organs or tissues that are irradiated ($H_E = \sum W_T H_T$)."

For the purposes of implementing workplace controls, and due to the difference in dosimetry, 10 CFR Part 20 breaks this EDE into two components: (1) dose resulting from radioactive sources internal to the body, and (2) dose resulting from sources external to the body. Dose limits and other requirements in Part 20 are based on the sum of these external and internal exposures. For radioactive material taken into the body, the occupational dose limit is based on the resulting dose equivalent integrated over 50 years, or committed effective dose equivalent (CEDE) defined in 10 CFR 20.1003 as $\sum W_T H_{T,50}$.

The TEDE is defined in 10 CFR 20.1003 as the sum of the deep-dose equivalent (DDE) (for external exposures), and the committed effective dose equivalent (for internal exposures).

$$\text{TEDE} = \text{DDE} + \text{CEDE}$$

The organ weighting factors (W_T) are the proportion of the risk of stochastic effects resulting from the dose to that organ or tissue to the total risk of stochastic effects when the whole body is irradiated uniformly. The weighting factors are applicable to the organs and tissues whether the dose results from radiation sources internal or external to the body. However, measuring the dose to the various organs and tissues with a dosimeter worn outside the body, presents some practical difficulties. If the body is irradiated uniformly, the external component of TEDE can be determined with a single DDE measurement on any part of the whole body. However, if the body is not irradiated uniformly, a single-dose measurement cannot determine the dose to the various organs and tissues for an accurate determination of the external EDE (EDE_{ex}). To ensure a conservative determination of TEDE, 10 CFR 20.1201(c) requires that the DDE component be determined from the part of the whole body receiving the highest exposure.

Authority to permit the use of other weighting factors is found in footnote 2 to the table of organ weighting factors in 10 CFR 20.1003, which states, "[f]or the purpose of weighting the external whole body dose (for adding to the internal dose), a single weighting factor, of $W_T = 1.0$, has been specified. The use of other weighting factors for external exposure will be approved on a case-by-case basis until such time as specific guidance is issued."

This approach to determining TEDE can be overly conservative for extremely non-uniform irradiations (i.e., when only a small portion of the whole body is irradiated). As discussed in the NRC Regulatory Issue Summaries 2002-06, 2003-04, and 2004-01, the NRC has approved several methods for determining EDE_{ex} , and has encouraged the use of EDE_{ex} in place of DDE for demonstrating compliance with the TEDE requirements in Part 20 of 10 CFR.

3.0 TECHNICAL EVALUATION

3.1 Evaluation

The NRC staff has reviewed the technical approach for estimating EDE_{ex} provided in the Standard. This multiple dosimetry method divides the whole body into seven separate compartments. Each compartment, or composite compartment (since the Standard allows combining adjacent compartments), is monitored separately. The results of the dose measurement for each compartment are weighted with an associated “compartment factor.” The resulting weighted doses are then summed to determine the EDE_{ex} for the whole body. The compartment factors are listed in Table 1 of the Standard. The factor for each compartment was developed by summing the stochastic weighting factors given in ICRP 26 (Part 20 organ weighting factors) 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 was apportioned between the compartments based on the fraction of the total mass of the tissue residing in each, using the information in ICRP 23.

The ANSI/HPS 13.41 multiple dosimeter method of determining EDE_{ex} is based on the assumptions that (1) the average dose to the tissues in each compartment can be reasonably measured (with one or more dosimeters), and (2) that 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 where 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 become critical to ensuring that the EDE_{ex} is not underestimated.

To ensure that the estimates of EDE_{ex} are conservative, the licensee has committed to measuring the dose to each compartment (or composite compartment) by locating the dosimeter, calibrated to DDE, at the highest exposed portion of that compartment. The dosimeter location for each compartment will be subject to the same criteria currently used for demonstrating compliance with 10 CFR 20.1201(c).

The licensee has stated that in most normal exposure situations they intend to provide one dosimeter for a combined thorax-abdomen composite compartment, consistent with the Standard and their current multi-badging practice.

3.2 Regulatory Commitments

The following table identifies the regulatory commitments made by Entergy.

List of Regulatory Commitments

COMMITMENT	TYPE (Check one)		SCHEDULED COMPLETION DATE (If Required)
	ONE- TIME ACTION	CONTINUING COMPLIANCE	
Entergy will monitor the part of the whole body within each compartment (and/or composite compartment) that receives the highest dose. Entergy is developing a fleet wide Nuclear Management Manual procedure EN-RP-204, "Special Monitoring Requirements," for determining dosimeter selection and placement. This procedure guidance will be consistent with that found in NRC Inspection Procedure 71121.01, issue date 03/06/02.		x	
Based on the NRC's approval of this request, Entergy will account for dose consistent with the guidance of the Standard as follows: The DDE for each compartment will be determined from dosimeters worn at that location. When no dosimeter is worn at a particular compartment, the DDE will be determined from the dosimeter positioned where the exposure is judged to be similar. The assigned EDE will be the sum of each DDE measurement multiplied by its appropriate compartment factor. The assigned lens dose equivalent (LDE) will be the higher of the head or chest dosimeters. The assigned shallow dose equivalent (SDE) will be the highest of any whole body dosimeter.		x	

The NRC staff finds that reasonable controls for the implementation and for subsequent evaluation of proposed changes pertaining to the above regulatory commitments are provided by the licensee's administrative processes, including its commitment management program. Should the licensee choose to incorporate a regulatory commitment into the emergency plan,

the Updated Final Safety Analysis Report, or other documents with established regulatory controls, the associated regulations would define the appropriate change-control and reporting requirements. The NRC staff has determined that the commitments do not warrant the creation of regulatory requirements, which would require prior NRC approval of subsequent changes. The NRC staff has agreed that Nuclear Energy Institute 99-04, Revision 0, "Guidelines for Managing NRC Commitment Changes," provides reasonable guidance for the control of regulatory commitments made to the NRC staff (see Regulatory Issue Summary 2000-17, "Managing Regulatory Commitments Made by Power Reactor Licensees to the NRC Staff," dated September 21, 2000). The commitments should be controlled in accordance with industry guidance or comparable criteria employed by a specific licensee. The NRC staff may choose to verify the implementation and maintenance of these commitments in a future inspection or audit.

4.0 CONCLUSIONS

The NRC staff concludes that calculating TEDE using EDE_{ex} in place of DDE provides a more accurate estimate of the risk associated with the radiation exposures experienced by radiation workers at a nuclear power plant. The NRC staff finds that limiting TEDE such that

$$EDE_{ex} + CEDE < 5 \text{ rem}$$

is consistent with the basis for the dose limits, and footnote 2 to the "Organ Dose Weighting Factors" table in 10 CFR Part 20.1003.

Additionally, the NRC staff concludes that the multiple dosimetry method to estimate EDE_{ex} using the weighting factors listed in Table 1 of the Standard, as proposed by the licensee, is technically sound and is acceptable for the purposes of demonstrating compliance with the TEDE-based requirements in Part 20 of 10 CFR.

Therefore, based on the above discussion and the information provided by Entergy in its submittal, the NRC staff approves the use of the weighting factors provided in the ANSI HPS N13.41-1997 (the Standard) for external radiation exposures when demonstrating compliance with TEDE, based on requirements in 10 CFR Part 20 for ANO-1, GGNS, IP2, IP3, Pilgrim, RBS, VY, and Waterford 3.

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