Entergy

**Entergy Operations, Inc.**
1340 Echelon Parkway
Jackson, Mississippi 39213-8298
Tel 601-368-5758

**F. G. Burford**
Acting Director
Nuclear Safety & Licensing

CNRO-2006-00030

May 16, 2006

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555

SUBJECT: Application to Use Weighting Factors for External Exposure

| | |
|---|---|
| Arkansas Nuclear One<br>Unit Nos. 1 and 2<br>Docket No. 50-313 and 50-368<br>License No. DPR-51 and NPF-6 | Pilgrim Nuclear Power Station<br>Docket No. 50-293<br>License No. DPR-35 |
| Grand Gulf Nuclear Station<br>Docket No. 50-416<br>License No. NPF-29 | River Bend Station<br>Docket No. 50-458<br>License No. NPF-47 |
| James A. FitzPatrick Nuclear Power Plant<br>Docket No. 50-333<br>License No. DPR-59 | Vermont Yankee Nuclear Power Station<br>Docket No. 50-271<br>License No. DPR-28 |
| Indian Point Nuclear Generating Units Nos. 2 and 3<br>Docket Nos. 50-247, 50-286<br>License Nos. DPR-26, DPR-64 | Waterford 3 Steam Electric Station<br>Docket No. 50-382<br>License No. NPF-38 |

Dear Sir or Madam:

Pursuant to 10 CFR 20.1003, "Weighting factor $W_T$," Entergy Operations, Inc. and Entergy Nuclear Operating, Inc. (Entergy) hereby requests approval to use 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 to Title 10 of the *Code of Federal Regulations* (10 CFR) for Arkansas Nuclear One, Unit 1 and Unit 2 (ANO-1, ANO-2), James A. FitzPatrick Nuclear Power Plant (JAF), Grand Gulf Nuclear Station, Unit 1 (GGNS), Indian Point Nuclear Generating Units Nos. 2 and 3 (IP2, IP3), Pilgrim Nuclear Power Station (Pilgrim), River Bend Station, Unit 1 (RBS), Vermont Yankee Nuclear Power Station (VY), and Waterford Steam Electric Station, Unit 3 (Waterford 3).

As described in Attachment 1, use of the weighting factors would improve assessment of occupational dose to individuals from exposure to highly non-uniform radiation fields.

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The technical basis for this application is the consensus technical standard approved by the American National Standards Institute – Accredited HPS N13 Committee. The standard is practical and consistent with the organ or tissue weighting factors in 10 CFR 20.1003.

The request includes new commitments as summarized in Attachment 2. The NRC has approved a similar request for Southern California Edison (SCE) (TAC NOS. MC5476, 5477, MC5478).

Entergy requests approval of this change by August 1, 2006 to support planned fall refuel outages. Once approved, the request will be implemented within 60 days. Although this request is neither exigent nor emergency, your prompt review is requested.

If you have any questions or require additional information, please contact Dana Millar at 601-368-5445.

Sincerely,

FGB/DM/bal

Attachment:
1. Application to Use Weighting Factors for External Exposure
2. List of Regulatory Commitments

cc: see next page

cc: Mr. M. A. Balduzzi (PILG)
Mr. W.R. Campbell (ECH)
Mr. F. R. Dacimo (IPEC)
Mr. J. P. DeRoy (ECH)
Mr. P. T. Dietrich (JAF)
Mr. W. A. Eaton (ECH)
Mr. R. K. Edington (CNS)
Mr. J. S. Forbes (ANO)
Ms. C. L. Gaujacq (ECH)
Mr. J. T. Herron (WPO)
Mr. P. D. Hinnenkamp (RBS)
Mr. M. R. Kansler (WPO)
Mr. O. Limpias (WPO)
Mr. J. McGaha (ECH)
Mr. C. J. Schwarz (WPO)
Mr. T. A. Sullivan (VY)
Mr. G. J. Taylor (ECH)
Mr. J. E. Venable (W-3)
Mr. G. A. Williams (GGNS)

Mr. J. P. Boska, Project Manager, IP2, IP3, JAF
Mr. S. J. Collins, Regional Administrator, Region I
Mr. M. B. Fields, Project Manager, WF3
Mr. D. G. Holland, Project Manager, ANO-1&2
Dr. B. S. Mallett, NRC Regional Administrator, Region IV
Mr. J. J. Shea, Project Manager, PNPS, VY
Mr. B. K. Vaidya, Project Manager, GGNS & RBS
Mr. M. K. Webb, Project Manager, IP1
NRC Resident Inspectors (ANO, GGNS, IPEC, JAF, RBS, PNPS, WF3, VY)

American Nuclear Insurers (Attn: Library)
Mr. Bernard R. Bevill (Arkansas Dept. of Health (DRC & EM)
Mr. Paul Eddy (NYS Dept. of Public Service)
LA Dept. of Environmental Quality (OECSD)
Mr. D. E. Levanway (Wise Carter)
Mr. David O'Brien (Vermont DPS)
Mr. J. Smith (Wise Carter)
Mr. Peter R. Smith (NYSERDA)
Mr. H. L. Thomas (SMEPA)

**Attachment 1**

**CNRO-2006-00030**

**Application to Use Weighting Factors for External Exposure**

## 1.0 INTRODUCTION

### 1.1 PURPOSE

Pursuant to 10 CFR 20.1003, "Weighting factor $W_T$," Entergy Operations, Inc. (Entergy) hereby requests approval to use 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 to Title 10 of the *Code of Federal Regulations* (10 CFR) for Arkansas Nuclear One, Unit 1 and Unit 2 (ANO-1, ANO-2), James A. FitzPatrick Nuclear Power Plant (JAF), Grand Gulf Nuclear Station, Unit 1 (GGNS), Indian Point Nuclear Generating Units Nos. 2 and 3 (IP2, IP3), Pilgrim Nuclear Power Station (Pilgrim), River Bend Station, Unit 1 (RBS), Vermont Yankee Nuclear Power Station (VY), and Waterford Steam Electric Station, Unit 3 (Waterford 3).

Specifically, Entergy requests approval to calculate the external dose quantity effective dose equivalent (EDE) using the compartments, compartment factors, and method of summation specified in ANSI/HPS N13.41-1997, "Criteria for Performing Multiple Dosimetry", approved December 1996. The assigned EDE is the sum of each dosimeter measurement modified by its appropriate weighting factor. EDE will be used in place of deep dose equivalent (DDE) in the calculation of total effective dose equivalent (TEDE).

This request does not seek approval to use Section 4 "Criteria for When to Use Multiple Dosimeters" or Section 5.5, "Alternatives to the Use of Multiple Dosimeters" of the Standard.

### 1.2 REGULATORY EVALUATION

The radiation protection approach and dose limits contained in 10 CFR Part 20 are based on the recommendations of the International Commission on Radiation Protection (ICRP) in its 1977 Publication No. 26 (ICRP 26). For stochastic effects, the ICRP 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 ($H_E = \Sigma W_T H_T$)."

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).

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

$$\text{TEDE} = \text{deep-dose equivalent (DDE)} + \sum W_T H_{T,50}\,(\text{CEDE})$$

The organ $W_T$ is 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. This conservative 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 NRC Regulatory Issue Summaries 2002-06, 2003-04, and 2004-01, the NRC has approved several methods for determining external EDE ($EDE_{ex}$), and has encouraged the use of $EDE_{ex}$, in place of DDE for demonstrating compliance with the TEDE requirements in 10 CFR Part 20.

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. Thus, 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 $EDE_{ex}$. Footnote 2 to the "Organ Dose Weighting Factors" table in 10 CFR 20.1003 states that "for 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." The above standard, ANSI/HPS N13.41, provides weighting factors that can be utilized when multiple dosimeters are used to measure the external dose received by an individual.

## 2.0 TECHNICAL JUSTIFICATION

### 2.1 IMPROVED ASSESSMENT OF DOSE

In uniform radiation fields, the dosimeter used to measure whole body dose is typically worn on the chest. The dosimeter measures radiation exposure using an operational dose quantity called DDE.

When the radiation field is highly non-uniform, either the chest dosimeter is moved to the part of the whole body expected to receive the highest dose or additional dosimeters are worn so that the highest whole body dose can be measured.

Difficulties arise because the annual occupational dose limit is based on the stochastic risk from whole body exposure, which is related to the dose quantity EDE. While the use of DDE as a surrogate quantity to approximate EDE works well in uniform radiation fields, in highly non-uniform radiation fields, a more accurate estimate of EDE is needed to improve the assessment of occupational dose.

## 2.2 COMPARTMENT FACTORS

ANSI/HPS N13.41 provides a method for estimating $EDE_{ex}$ based on using multiple dosimeters at specific areas of the body. The whole body is divided into seven areas called "compartments." Each compartment, or composite compartment, is monitored separately. The results of the dose measurements for each compartment are weighted with an associated "compartment factor." A compartment factor "relates the fractional risk to the organs underlying the measurement location to the total risk from uniform irradiation of the whole body." The resulting weighted doses are then summed to determine the $EDE_{ex}$ for the whole body.

ANSI/HPS N13.41, Appendix A describes how the 10 CFR 20 organ or tissue weighting factors are apportioned to each compartment based on the associated underlying organs and tissues. The resulting compartment factors used to calculate $EDE_{ex}$ are listed below:

**ANSI/HPS N13.41 COMPARTMENT FACTORS**

| Compartment Name | Compartment Factor |
|---|---|
| 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 |

## 2.3 DOSIMETER SELECTION AND PLACEMENT

NRC Inspection Procedure 71121.01, "Access Control to Radiologically Significant Areas" issue date 03/06/02, Section 03.04(c) "Dosimeter selection and placement criteria," provides suitable criteria for assuring compliance with Part 20.1201(c). These criteria provide for monitoring the part of the body expected to receive the highest dose.

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.

Consistent with Entergy's current practice, a single chest dosimeter will measure the dose to both the thorax and abdomen compartments. The combined compartments will be called the chest compartment.

National Voluntary Laboratory Accreditation Program (NVLAP) accredited dosimeters will be worn at the same whole body locations after the application is approved as they are today. Because we will continue to monitor the part of the body expected to receive the highest dose, the dosimeter orientation toward the source will not change. Therefore, there are no new challenges to the dosimeter's angular response characteristics resulting from approval of this application.

2.4 DOSE ASSIGNMENT

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.

2.5 CONCLUSION

Accurate assessment of occupational dose from external sources of radiation in highly non-uniform radiation fields requires a method for assessing EDE. Use of the proposed weighting factors will improve the accuracy of licensee assessment of occupational dose.

Entergy requests approval to assess EDE based on the consensus technical standard, ANSI/HPS N13.41. This standard was approved by the American National Standards Institute – Accredited HPS N13 Committee on 20 June 1996. At the time of balloting, the HPS N13 Committee membership included representatives from the NRC and the National Council on Radiation Protection and Measurements.

The ANSI/HPS N13.41 consensus technical standard has previously been approved for use by the NRC for evaluating occupational dose to medical personnel wearing lead aprons in Regulatory Issue Summary 2002-06, "Evaluation Occupational Dose for Individuals Exposed to NRC-Licensed Material and Medical X-Rays," dated April 16, 2002.

The use of multiple dosimeters to monitor the part of the whole body expected to receive the highest dose will utilize criteria for dosimeter selection and placement consistent with current NRC inspection procedures.

**Attachment 2**

**CNRO-2006-00030**

**List of Regulatory Commitments**

## List of Regulatory Commitments

The following table identifies those actions committed to by Entergy in this document. Any other statements in this submittal are provided for information purposes and are not considered to be 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:<br><br>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.<br><br>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 | |