Entergy

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May 1, 2001
IPN-01-041
JPN-01-008
ENGC Ltr.-1.2.01.037
CNRO-2001-000aa

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Mail Station PI-137
Washington, DC 20555

SUBJECT: Indian Point 3 Nuclear Power Plant
Docket No. 50-286
Pilgrim Nuclear Power Station
Docket No. 50-293
Arkansas Nuclear One, Units 1 & 2
Docket Nos. 50-313 & 50-368
James A. FitzPatrick Nuclear Power Plant
Docket No. 50-333
Waterford 3 Steam Electric Station
Docket No. 50-382
Grand Gulf Nuclear Station
Docket No. 50-416
River Bend Station
Docket No. 50-458
Request for Exemption from 10 CFR 20.1003 Definition of "Deep-Dose Equivalent" and Permission to Use External Whole Body "Weighting Factors" Other than 1.0

Dear Sir:

Pursuant to 10 CFR 20.2301, Entergy Operations, Inc. (EOI), Entergy Nuclear Operations, Inc. (ENOI) and Entergy Nuclear Generating Company (ENGC) *[Entergy]* request an exemption from the requirements of 10 CFR 20.1003, Definitions, for "*deep-dose equivalent*" and permission to use external whole body "*weighting factors*" other than 1.0 in calculating the "*effective dose equivalent*" for external exposures within the scope of 10 CFR 20.1202 and other applicable sections.

Entergy is proposing to use an alternate method for "weighting factors" based on Electric Power Research Institute (EPRI) research methodology that is also supported by the National Council on Radiation Protection and Measurements (NCRP). This methodology provides occupational

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dose results that more accurately reflect the effective exposure received by plant personnel. The proposed methodology for calculating occupational exposure does not impact the public or the worker's health and safety.

Attachments to this letter summarize the bases for this exemption request and permission to use other weighting factors.

Entergy plans to implement this exemption within sixty (60) days after receipt of NRC approval. No changes to the Technical Specifications are required; instead the licensees will continue compliance with 10 CFR 20 and the approved exemption by revising the applicable plant-specific radiation protection program and procedures. Entergy would like to arrange a meeting with the NRC staff to discuss this request. If you agree with this request, Entergy would be pleased to meet with you at your convenience.

Entergy requests NRC review and approval of this exemption request by December 2001.

If you have any questions, please contact Mr. J. Kelly at (914) 272-3370.

Very truly yours,

Michael R. Kansler
Senior Vice President and
Chief Operating Officer
ENOI, ENGC

Very truly yours,

Gary Taylor
Senior Vice President &
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EOI

Attachment: Request for Exemption from 10 CFR 20.1203, "Deep-Dose Equivalent" and Permission to Use External Whole Body "Weighting Factors" Other Than 1.0

cc: Next Page

cc:

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ATTACHMENT to
IPN-01-041
JPN-01-008
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CNRO-2001-000aa

REQUEST FOR EXEMPTION FROM 10 CFR 20.1003 DEFINITION OF "DEEP-DOSE EQUIVALENT" AND PERMISSION TO USE EXTERNAL WHOLE BODY "WEIGHTING FACTORS" OTHER THAN 1.0

ENTERGY OPERATIONS, INC.
ENTERGY NUCLEAR OPERATIONS, INC.
ENTERGY NUCLEAR GENERATING COMPANY

May 1, 2001

1.0 REGULATORY BACKGROUND

Commercial nuclear power plants are subject to the requirements of 10 CFR Part 20, "Standards for Protection Against Radiation." Section 20.4 of these requirements issued in 1960 (Ref. 5.1) stated that:

> For determining exposure to X or gamma rays up to 3 MeV, the dose limits specified in Section 20.101 to 20.104 inclusive, may be assumed to be equivalent to the air dose. For the purpose of this part, air dose means that the dose is measured by a properly calibrated appropriate instrument in air at or near the body surface in the region of the highest dose rate.

On May 21, 1991 (Ref. 5.2), a final rule was published in the Federal Register that amended 10 CFR Part 20 to update the NRC's "Standards for the Protection Against Radiation." The purpose of that update

> ...puts into practice recommendations from [International Commission on Radiological Protection] ICRP Publication 26 and subsequent ICRP publications. The revision conforms the Commission's regulations to the Presidential Radiation Protection Guidance to Federal Agencies for Occupational Exposures signed by the President on January 20, 1987. The ICRP recommendations and Presidential guidance were based on the concept of the effective dose equivalent.

The final rule included definitions for "*effective dose equivalent*" and "*weighting factor.*" The final rule allowed using risk-weighted organ dose "effective dose" concept for internal doses without permitting a similar approach to be employed for external doses.

The NRC noted:

> The ICRP and 1987 Federal guidance on occupational radiation exposure in principle permit the use of external weighting factors. However, none of the principal standard-setting organizations has included specific recommendations for the use of weighting factors for external dose.
>
> The application of weighting factors also entails calculation of organ doses instead of whole-body doses from external radiation. One component of this calculation is estimation of the attenuation of the radiation as a function of the depth of the organ in the body. There are practical problems in the determination of the type and energies of the radiation involved and of the orientation of the individual with respect to the source of the radiation that have to be considered in making such calculations. There, application of weighting factors for external exposures will be evaluated on a case-by-case basis until more guidance and additional weighting factors (such as for the head and the extremities) are recommended.

> *Final rule:* ...For the purpose of weighting the external whole-body dose (for adding it to the internal dose), a single weighting factor, $w_T = 1.0$, has been specified. The use of other weighting factors for external exposure may be approved on a case-by-case basis on request to the NRC.

2.0 INDUSTRY BACKGROUND

The regulations in 10 CFR Part 20 were known to be appropriately conservative and within the capability of the technology and analytical methods at the time of its publication over 40 yeas ago. Nuclear utilities, in most cases, used film badges to demonstrate compliance with these regulations in the sixties and seventies and more recently started using thermoluminescent dosimeters (TLD) to measure occupational exposure to penetrating photon radiation.

Radiation dosimetry had advanced a great deal by the time of the original publication of 10 CFR Part 20. A significant advance was summarized in the publication of the ICRP 26 in 1977 (Ref. 6.3) which introduced the concept of risk-based radiation dose limits; i.e. Effective Dose Equivalent (EDE). This concept was based on the fact that human organs and tissues differ in their susceptibility to the effects of radiation. To account for these differences, the ICRP proposed specific organ radiation exposure weighting factors. As noted above, this concept was later incorporated into the revision to 10 CFR Part 20 in 1991 for internal doses, but not for external doses. The regulations required licensees to evaluate radiation exposures in terms of the EDE using the conservative assumption that the weighting factor for external exposure is one.

In 1988 a meeting of several radiation protection managers from nuclear power plants was held in Keystone, Colorado to identify important radiation protection issues that would benefit from EPRI research support. The attendees determined that dose assessment using the effective dose equivalent for external photon radiation was a high priority item that EPRI should support. The 10 CFR Part 20 regulations allowed licensees to propose alternative methods for evaluating the external radiation component of an EDE (Ref. 5.2).

In 1989, Batelle Northwest Laboratory was contracted by EPRI to conduct this research. In 1991, this research project moved to Texas A&M with the principal investigator. The EPRI Phase I Report was published in February 1993 (Ref. 5.4).

The research approach taken was to apply a validated and verified Monte Carlo computer code to calculate photon transport throughout the human body. The research used mathematical models for the human adult male and female and for a variety of external radiation sources, calculated energy deposition in a large number of human organs and tissues for a broad range of photon energies and radiation source geometries. Finally, given the published weighting factors, the researchers calculated the EDEs for these irradiations.

The results of the research showed the mathematical models of the human body and the computer code used to calculate external photon interactions within the body functioned correctly. This allowed the researchers to determine the dose equivalent to organs and tissues, which facilitated correct weighting and summing of doses to ascertain the EDEs.

The research described how the EDE varies with photon energy for various radiation beam source and point source geometries. The research discussed the relationship between an EDE and the location of dosimeters on the body and illustrated that dosimeter response to off-normal radiation beams (i.e., those that do not strike the body straight on) will not underestimate the EDE.

A paper based on this EPRI Phase 1 report was accepted for publication in a peer-reviewed journal (Ref. 5.5).

The EPRI Phase 2 report was published in June 1995 (Ref. 5.6). This report presented calculations of photon energy fluence on the surface of the human body for a range of photon energies and source geometries. The researchers then derived algorithms from the energy fluence calculations and the Phase 1 results that can be applied to standard dosimeter readings to more accurately calculate effective dose equivalent. A comparison was then made of effective dose equivalent measurements using a physical model of the human torso with effective dose equivalent calculated by the algorithms under both laboratory and field conditions at a nuclear plant. Results from the laboratory and field trails yielded excellent agreement.

This research concluded that the widespread practice of supplementing a single front-worn dosimeter with additional dosimeters placed facing a radiation source can significantly overestimate effective dose equivalent. Using a single front-worn dosimeter is acceptable. Using the simple algorithms applied to two dosimeters (on the front and the back) yielded a more accurate and numerically lower effective dose equivalent under all radiation exposure situations.

A paper based on this EPRI Phase 2 report was accepted for publication in a peer-reviewed journal (Ref. 5.7).

EPRI subsequently published a concise summary (Ref. 5.8) of the EDE research, explaining the methodology for assessing effective dose equivalent and presenting some simple guidelines illustrating how the methodology can be implemented at nuclear power plants. Entergy is proposing to follow these guidelines at its nuclear facilities.

These EPRI Phase 1 and Phase 2 research reports address the NRC's concerns raised in the Statements of Consideration identified above.

The National Council on Radiation Protection and Measurements (NCRP) supports these EPRI results as identified in their Report No. 122 (Ref. 5.9). The NCRP provides practical recommendations on the use of personal monitors to estimate the effective dose equivalent and effective dose for occupationally exposed individuals. These recommendations are similar to the results of the EPRI research and the algorithms presented therein.

NRC Inspection Procedure 83724 (Ref. 5.10) includes criteria for the placement of personal extremity dosimeters in non-uniform radiation fields. The procedure also includes a suggested dose gradient threshold for relocating or providing additional dosimetery. Changes to this and other NRC guidance documents may be appropriate if this exemption is approved.

3.0 EXEMPTION REQUEST

10 CFR 20.1201(a)(1) defines the annual occupational dose limits for adults "...which is the more limiting of- (i) The total effective dose equivalent... or (ii) The sum of the deep-dose equivalent and the committed dose equivalent to any individual organ or tissue other than the lens of the eye..." "Total Effective Dose Equivalent (TEDE) means the sum of the deep-dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures)." Entergy is requesting the option: (1) to use the analogous basis for deep-dose equivalent, i.e., effective dose equivalent, and (2) to use the organ dose weighting factors as specified in Part 20.1003 for the external whole body dose instead of the current single weighting factor of 1.0. (Note that 10 CFR 20.1201(c) already permits other radiation measurements to be used to assess the deep-dose equivalent, lens-dose equivalent and shallow-dose equivalent if the individual monitoring device was not in the region of highest potential exposure.)

Entergy is requesting to use the EPRI methodology as an acceptable alternative approach for accomplishing the Commission's objectives as specified in Part 20.1201(a)(1). Entergy would like the option to apply this EPRI approach where there is expected to be a significant difference between the deep-dose equivalent and the effective dose equivalent as defined in Part 20.1003. An examples of this situation would be work in an area of high exposure received from a non-uniform radiation source. Individual facility procedures would specify when to use the current industry practice and when to use the alternative approach.

4.0 JUSTIFICATION FOR EXEMPTION

10 CFR 20.2301 states that the Nuclear Regulatory Commission may grant an exemption from the requirements of the regulations contained in 10 CFR Part 20 provided that:

- The exemption is authorized by law; and
- The exemption would not result in undue hazard to life and property.

The requested exemption satisfies the 10 CFR 20.2301 criteria as stated below:

A. The requested exemption is authorized by law.

   10 CFR 20.2301 authorizes the Nuclear Regulatory Commission to grant this exemption.

B. The requested exemption does not present an undue hazard to life or property.

   The requested exemption will allow use of a well-founded and more accurate means of estimating worker radiation exposure and does not impact public health and safety or present an undue hazard to life or property.

5.0 REFERENCES

5.1 Federal Register (25 FR 10914), November 17, 1960

5.2 Federal Register (56 FR 23360), May 21, 1991

5.3 ICRP Publication 26, Recommendations of the ICRP Annals of the ICRP, 1977

5.4 EPRI TR-101909, Volume 1; Assessment of the Effective Dose Equivalent for External Photon Radiation, Volume 1: Calculational Results for Beam and Point Source Geometries, Final Report, February, 1993

5.5 Reece, W. D.; Poston, J. W.; Xu, X.G. Determining the effective dose equivalent for external photon radiation: Calculational results for beam and point source geometries. Radiation Protection Dosimetry Volume 55, No. 1, 1994, pp. 5-21.

5.6 EPRI TR-101909, Volume 2; Assessment of the Effective Dose Equivalent for External Photon Radiation, Volume 2: Calculational Techniques for Estimating External Effective Dose Equivalent from Dosimeter Readings. Final Report, June 1995

5.7 Xu, X. G.; Reece, W. D.; Poston, J. W. A study of the angular dependence problem in effective dose equivalent. Health Physics Volume 68, No. 2, February 1995, pp. 214-224.

5.8 EPRI TR-109446, Criteria and Methods for Estimating External Dose Equivalent from Personnel Monitoring Results: EDE Implementation Guide, Final Report, September 1998

5.9 NCRP Report No. 122, Use of Personal Monitors to Estimate Effective Dose Equivalent and Effective Dose to Workers for External Exposure to Low-LET Radiation, December 27, 1995

5.10 NRC Inspection Manual, Inspection Procedure 83724, External Occupational Exposure Control and Personnel Dosimetery, April 17, 2000.

Enclosures to IPN-01-041, JPN-01-008, ENGC Ltr.-1.2.01.037, CNRO-2001-000aa

1. EPRI TR-101909, Volume 1; Assessment of the Effective Dose Equivalent for External Photon Radiation, Volume 1: Calculational Results for Beam and Point Source Geometries, Final Report, February, 1993

2. EPRI TR-101909, Volume 2; Assessment of the Effective Dose Equivalent for External Photon Radiation, Volume 2: Calculational Techniques for Estimating External Effective Dose Equivalent from Dosimeter Readings. Final Report, June 1995

3. EPRI TR-109446, Criteria and Methods for Estimating External Dose Equivalent from Personnel Monitoring Results: EDE Implementation Guide, Final Report, September 1998