August 23, 2007

Mr. Rick A. Muench
President and Chief Executive Officer
Wolf Creek Nuclear Operating Corporation
Post Office Box 411
Burlington, KS 66839

SUBJECT: WOLF CREEK GENERATING STATION - APPROVAL TO USE EFFECTIVE DOSE EQUIVALENT WEIGHTING FACTORS FOR EXTERNAL RADIATION EXPOSURE (TAC NO. MD5866)

Dear Mr. Muench:

By letter dated June 22, 2007 (WO 07-0013), Wolf Creek Nuclear Operating Corporation (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 Wolf Creek Generating Station (WCGS). Authority to permit the use of other weighting factors than those in the table entitled "Organ Dose Weighting Factors" in 10 CFR 20.1003 is in footnote 2 to in table.

The NRC staff has completed its review of the above request. Enclosed is the NRC staff's related safety evaluation that concludes that the 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, is acceptable for WCGS.

Sincerely,

/ra/

Jack Donohew, Senior Project Manager
Plant Licensing Branch IV
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-482

Enclosure: Safety Evaluation

cc w/encl: See next page

August 23, 2007

Mr. Rick A. Muench
President and Chief Executive Officer
Wolf Creek Nuclear Operating Corporation
Post Office Box 411
Burlington, KS 66839

SUBJECT: WOLF CREEK GENERATING STATION - APPROVAL TO USE EFFECTIVE DOSE EQUIVALENT WEIGHTING FACTORS FOR EXTERNAL RADIATION EXPOSURE (TAC NO. MD5866)

Dear Mr. Muench:

By letter dated June 22, 2007 (WO 07-0013), Wolf Creek Nuclear Operating Corporation (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 Wolf Creek Generating Station (WCGS). Authority to permit the use of other weighting factors than those in the table entitled "Organ Dose Weighting Factors" in 10 CFR 20.1003 is in footnote 2 to in table.

The NRC staff has completed its review of the above request. Enclosed is the NRC staff's related safety evaluation that concludes that the 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, is acceptable for WCGS.

Sincerely,

/ra/

Jack Donohew, Senior Project Manager
Plant Licensing Branch IV
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-482

Enclosure: Safety Evaluation

cc w/encl: See next page
DISTRIBUTION:

PUBLIC	RidsNrrDorl	RidsNrrLAJBurkhardt
LPLIV r/f	RidsNrrDorlDpr	RidsOgcRp
RidsAcrsAcnwMailCenter	RidsNrrDorlLpl4	RidsRgn4MailCenter
RidsNrrDirsIhpb	RidsNrrPMJDonohew	

ADAMS Accession No.: ML072220355

OFFICE	NRR/LPL4/PM	NRR/LPL4/LA	DIRS/IHPB/TL	OGC	NRR/LPL4/BC
NAME	JDonohew	JBurkhardt	RPedersen	MLoftus	THiltz
DATE	8/23/07	8/15/07	8/14/07	8/20/07	8/23/07

OFFICIAL RECORD COPY

cc:
Jay Silberg, Esq.
Pillsbury Winthrop Shaw Pittman LLP
2300 N Street, NW
Washington, D.C. 20037

Regional Administrator, Region IV
U.S. Nuclear Regulatory Commission
611 Ryan Plaza Drive, Suite 400
Arlington, TX 76011

Senior Resident Inspector
U.S. Nuclear Regulatory Commission
P.O. Box 311
Burlington, KS 66839

Chief Engineer, Utilities Division
Kansas Corporation Commission
1500 SW Arrowhead Road
Topeka, KS 66604-4027

Office of the Governor
State of Kansas
Topeka, KS 66612

Attorney General
120 S.W. 10th Avenue, 2nd Floor
Topeka, KS 66612-1597

County Clerk
Coffey County Courthouse
110 South 6th Street
Burlington, KS 66839

Chief, Radiation and Asbestos Control
Section
Kansas Department of Health
and Environment
Bureau of Air and Radiation
1000 SW Jackson, Suite 310
Topeka, KS 66612-1366

Vice President Operations/Plant Manager
Wolf Creek Nuclear Operating Corporation
P.O. Box 411
Burlington, KS 66839

Supervisor Licensing
Wolf Creek Nuclear Operating Corporation
P.O. Box 411
Burlington, KS 66839

U.S. Nuclear Regulatory Commission
Resident Inspectors Office/Callaway Plant
8201 NRC Road
Steedman, MO 65077-1032

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO THE APPROVAL TO USE EFFECTIVE DOSE EQUIVALENT

WEIGHTING FACTORS FOR EXTERNAL RADIATION EXPOSURE

WOLF CREEK NUCLEAR OPERATING CORPORATION

WOLF CREEK GENERATING STATION

DOCKET NO. 50-482

1.0 INTRODUCTION

By the application dated June 22, 2007 (Agencywide Documents Access and Management System Accession No. ML071790404), Wolf Creek Nuclear Operating Corporation (the licensee) requested approval by the U.S. Nuclear Regulatory Commission's (NRC) for the use of the weighting factors listed in Table 1 in the American National Standard Institute (ANSI) HPS N13.41-1997, "Criteria for Performing Multiple Dosimetry," (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* (i.e., 10 CFR Part 20) for Wolf Creek Generating Station (WCGS). The Standard was approved December 1996.

The licensee stated that accurate assessment of occupational exposure of workers from external sources of radiation in highly non-uniform radiation fields requires a method for assessing the effective dose equivalent (EDE) and the use of the proposed weighting factors will improve the accuracy of its assessment of occupational exposure. Therefore, the effect of granting this request would be to allow the licensee the option to control EDE using the weighted external exposure measurements in those cases where it is a more accurate predictor of the risk from occupational radiation exposure.

The licensee stated in its application that its request to use weighting factors listed in Table 1 of the Standard was not also a request for approval to use Section 4, "Criteria for When to use Multiple Dosimeters," or Section 5.5, "Alternatives to the Use of Multiple Dosimeters," in the Standard.

2.0 REGULATORY EVALUATION

The regulatory requirements on occupational exposure of nuclear plant workers are in 10 CFR Part 20, "Standards for Protection Against Radiation." 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 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.

The 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 (i.e., $H_E = \Sigma W_T H_T$)."

For the purposes of implementing workplace controls, and due to the differences in dosimetry, 10 CFR Part 20 breaks this EDE into the following two components: (1) the dose resulting from radioactive sources internal to the body, and (2) the dose resulting from sources external to the body. Dose limits and other requirements in 10 CFR 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), which is defined in 10 CFR 20.1003 as $\Sigma W_T H_{T,50}$.

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

$$TEDE = DDE + CEDE$$

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.

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). Guidance has been provided to licensees in the following NRC Regulatory Issue Summaries (RISs):

- RIS 2002-06, "Evaluating Occupational Dose for Individuals Exposed to NRC-Licensed Material and Medical X-rays," dated April 16, 2002 (ADAMS Accession No. ML021080436). NRC issued the RIS to inform licensees of a personnel radiation monitoring compliance issue identified during recent inspections of medical licensees and provided acceptable alternative methods for compliance with 10 CFR Part 20 for determining doses to individuals who receive exposures from medical x-ray radiation, while wearing protective apparel.

- RIS 2003-04, “Use of the Effective Dose Equivalent [EDE] in Place of the Deep Dose Equivalent [DDE] in Dose Assessments,” dated February 13, 2003 (ADAMS Accession No. ML030370122). NRC issued the RIS to provide guidance to licensees on situations in which it is permissible to use the EDE, in place of the DDE, in showing compliance with regulatory requirements.

- RIS 2004-01, “Method for Estimating Effective Dose Equivalent [EDE] From External Radiation Sources Using Two Dosimeters,” dated February 17, 2004 (ADAMS Accession No. ML040420042). NRC issued the RIS to provide licensees with guidance on an approved two-dosimeter monitoring method for estimating EDE from external radiation exposures and this EDE can be used instead of the DDE in complying with certain regulatory requirements.

As discussed in the above RISs 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 10 CFR Part 20.

Authority to permit the use of other weighting factors than those in 10 CFR 20.1003 is found in footnote 2 to the table entitled "Organ Dose Weighting Factors" in 10 CFR 20.1003, which states the following: “For the purpose of weighting the external whole body dose (for adding it 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 licensee has requested the use of other weighting factors in its application dated June 22, 2007.

3.0 TECHNICAL EVALUATION

3.1 NRC Staff Evaluation

The NRC staff has reviewed the technical approach for estimating EDE_{ex} provided in the Standard. As stated by the licensee in its application, the multiple dosimetry method of the Standard divides the whole body into the following seven separate compartments: (1) head and neck, (2) thorax above the diaphragm, (3) abdomen including the pelvis, (4) upper right arm, (5) upper left arm, (6) right thigh, and (7) left thigh.

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 multiple dosimeter method of determining EDE_{ex} in the Standard 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). This criteria is in NRC Inspection Procedure 71121, "Occupational Radiation Safety," Attachment 71121.01, "Access Control to Radiologically Significant Areas," dated March 6, 2002. In this commitment, the licensee stated that its procedure RPP 03-106, "Use of Special Dosimetry," which provides guidance on the use of multiple dosimeters to monitor the part of the whole body expected to receive the highest dose, will be revised to be consistent with the criteria for dosimeter selection and placement in this NRC inspection procedure.

The licensee also committed to revise WCGS procedure RPP 03-0405, "Exposure History Files," which provides guidance for tracking and reporting of individual's occupational radiation exposure, such that the EDE_{ex} (when used) will be reported in place of the DDE. The use of EDE in place of DDE is discussed in RIS 2004-01.

The licensee has stated also that, consistent with its current practice, a single chest dosimeter will be used to measure the dose to both the thorax and abdomen compartments. The combined compartment is to be called the chest compartment.

The licensee explained that (1) dosimeters accredited by the National Voluntary Laboratory Accreditation Program will be worn at the same whole body locations and (2), because it will continue to monitor the part of the body expected to received the highest dose, the dosimeter orientation toward the source will not be changed, after its application is approved as they are today. Therefore, the licensee concluded that there are no new challenges to the dosimeters' angular response characteristics that will result from the NRC approval of this application.

The licensee's commitments discussed above were made in the form of regulatory commitments that are addressed in the next section of this safety evaluation.

3.2 Regulatory Commitments

A table of regulatory commitments, which is attached to this safety evaluation, lists the regulatory commitments made by the licensee in Attachment II to its application. As stated in

these three regulatory commitments, within 90 days of NRC's approval of the licensee's request in the application dated June 22, 2007, the licensee will do the following:

1. Revise WCGS Procedure RPP 03-106, "Use of Special Dosimetry," to be consistent with NRC Inspection Procedure 71121.01, dated March 6, 2002. This is the plant procedure that provides guidance for determining dosimeter selection and placement.

2. Revise RPP 03-0405, "Exposure History Files," such that the EDE_{ex} (when used) will be reported in place of the DDE, as discussed in NRC RIS 2004-01. This is the plant procedure that provides guidance for tracking and reporting of individual's occupational radiation exposure.

3. The licensee 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.

By revising Procedure RPP 03-106 to be consistent with that found in NRC Inspection Procedure 71121.01, the same criteria currently used for demonstrating compliance with 10 CFR 20.1201(c) in this inspection procedure will be in the plant procedure and followed by the licensee. This demonstrates compliance with 10 CFR 20.1201(c).

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 WCGS 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," which has been endorsed by the NRC, provides reasonable guidance for the control of regulatory commitments made to the NRC staff (see RIS 2000-17, "Managing Regulatory Commitments Made by Power Reactor Licensees to the NRC Staff," dated September 21, 2000, ADAMS Accession No. ML003741774). 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

$$EDE_{ex} + CEDE < 5 \text{ rem [roentgen equivalent man]}$$

is consistent with the basis for the dose limits, and footnote 2 to the table entitled "Organ Dose Weighting Factors" in 10 CFR 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 10 CFR Part 20.

Therefore, based on the above discussion and the information provided by the licensee in its application, the NRC staff concludes that the licensee's proposed use of weighting factors provided in ANSI HPS N132.41-1997 for external radiation exposures, in its application dated June 22, 2007, meets the requirements of 10 CFR Part 20. Based on this conclusion, 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 WCGS.

Attachment: Table - List of Regulatory Commitments

Principal Contributor: Jack Donohew

Date: August 23, 2007

Table - List of Regulatory Commitments

COMMITMENT	TYPE (Check one)		SCHEDULED COMPLETION DATE (If Required)
	ONE-TIME ACTION	CONTINUING COMPLIANCE	
The licensee will monitor the part of the whole body within each compartment (and/or composite compartment) that receives the highest dose. WCGS Procedure, RPP 03-106, "Use of Special Dosimetry," provides guidance for determining dosimeter selection and placement. and will be revised consistent with that found in NRC Inspection Procedure 71121.01, issue date 03/06/02.		X	Procedure RPP 03-106 will be revised within 90 days of NRC approval.
WCGS Procedure RPP 03-0405, "Exposure History Files," provides guidance for tracking and reporting of individual's occupational radiation exposure and will be revised such that the EDE_{ex} (when used) will be reported in place of the DDE, as discussed in RIS 2004-01.		X	Procedure RPP 03-0405 will be revised within 90 days of NRC approval.
The licensee 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	Procedure RPP 03-106 will be revised within 90 days of NRC approval.

ATTACHMENT