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JUL 01 2002

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TRANSMITTAL OF REPORT ADDRESSING KEY TECHNICAL ISSUE (KTI) AGREEMENT ITEM IGNEOUS ACTIVITY (IA) 2.16

This letter transmits the report entitled *Climate Change Effects on Disruptive Events Biosphere Dose Conversion Factors,* which provides information to satisfy the subject KTI agreement item, which states:

> IA 2.16 – "Document that neglecting the effects of climate change on disruptive event BDCFs is conservative."
>
> "DOE will document that neglecting the effects of climate change on disruptive event BDCFs is conservative in a subsequent revision to the AMRs Input Parameter Values for External and Inhalation Radiation Exposure Analysis (ANL-MGR-MD-000001) and Disruptive Event Biosphere Dose Conversion Factor Analysis (ANL-MGR-MD-00003) or equivalent document. This will be available to the NRC in FY02."

Volcanic release biosphere dose conversion factors (BDCFs) provide radionuclide-specific parameters that account for the pathways associated with an eruptive volcanic scenario contributing to exposure (e.g., inhalation of contaminated ash, inhalation of resuspended ash/soil mixture, external exposure to contaminated surfaces) for the receptor. The BDCFs are used along with the release scenario-specific concentration of a given radionuclide (source term) in performance analyses to calculate dose.

The enclosed report provides the basis for neglecting climate change effects in the disruptive events BDCFs. Climate evolution results in a wetter, cooler climate. The increase in frequency, intensity, or duration of precipitation affects several processes that affect the amount of

YMP-5

ash-contaminated material available for inhalation. These processes will reduce the values of the volcanic release BDCF compared to the BDCF values for the present day climate.

This letter contains no new regulatory commitments. Please direct any questions concerning this letter and its enclosure to Eric T. Smistad at (702) 794-5073 or Timothy C. Gunter at (702) 794-1343.

Joseph D. Ziegler
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OL&RC:TCG-1369

Enclosure:
Climate Change Effects on Disruptive Events Biosphere Dose Conversion Factors

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CLIMATE CHANGE EFFECTS ON DISRUPTIVE EVENTS BIOSPHERE DOSE CONVERSION FACTORS

June 2002

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Approval:

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ENCLOSURE

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ACRONYMS AND ABBREVIATIONS

BDCF	biosphere dose conversion factor
DOE	U.S. Department of Energy
KTI	Key Technical Issue
NRC	U.S. Nuclear Regulatory Commission
TSPA	Total System Performance Assessment

Climate Change Effects on Disruptive Events Biosphere Dose Conversion Factors

This report describes the basis for resolving an agreement item (IA 2.16) associated with the consequences subissue of the igneous activity Key Technical Issue (KTI). The item is the U.S. Department of Energy (DOE)-U.S. Nuclear Regulatory Commission (NRC) agreement that DOE provide clarification of how neglect of the effects of climate change on disruptive event (volcanic release) biosphere dose conversion factors (BDCFs) is conservative.

The Analysis/Model Report, *Disruptive Event Biosphere Dose Conversion Factor Analysis* (ANL-MGR-MD-000003 Rev 01) (CRWMS M&O 2001a) documents and discusses the basis for the BDCFs used in Total System Performance Assessment (TSPA) for Site Recommendation and supplemental analyses. The effect of future climate change on the BDCFs for the disruptive event (volcanic release) is not contained in the TSPA report. The *Nominal Performance Biosphere Dose Conversion Factor Analysis* (ANL-MGR-MD-000009 Rev 01) (CRWMS M&O 2001b) describes the effect of climate change on groundwater release BDCFs. The lack of documentation of the effect of climate change on BDCFs for the volcanic release scenario is the reason for the NRC's request for clarification.

1. BACKGROUND

DOE originally agreed to document how the neglect of the anticipated climate change (to a wetter and cooler climate) on disruptive event (i.e., volcanic release) BDCFs is conservative. This was to be done in a revision to the *Disruptive Event Biosphere Dose Conversion Factor Analysis* (CRWMS M&O 2001a) or equivalent document in Fiscal Year 02. The successor analysis report will not be available in Fiscal Year 02.

1.1 NRC INITIAL COMMENTS

The NRC is concerned that, based on information presented in *Disruptive Event Biosphere Dose Conversion Factor Analysis* (CRWMS M&O 2001a) and *Nominal Performance Biosphere Dose Conversion Factor Analysis* (ANL-MGR-MD-000009 Rev 01) (CRWMS M&O 2001b), the disruptive events BDCFs are apparently not affected by climate change, whereas BDCFs for the groundwater release scenario are affected by climate change (Crump 2001).

1.2 DOE INITIAL COMMENTS

Climate change is not addressed in the *Disruptive Event Biosphere Dose Conversion Factor Analysis* (ANL-MGR-MD-000003 Rev 01) (CRWMS M&O 2001a). Because of the importance of the inhalation pathway in the disruptive event (volcanic release) BDCFs and the expected impact of increased precipitation, current climate BDCFs for the volcanic release scenario are conservative. Increased precipitation with climate evolution in the absence of soil/ash redistribution considerations will result in (more rapid) soil/ash stabilization (Crump 2001).

1.3 DEFINITION OF TECHNICAL TERMS

Biosphere Dose Conversion Factor (BDCF)–A radionuclide specific parameter that accounts for pathways contributing to exposure for a defined receptor and environment. A BDCF is a

scalar value that converts a concentration (in a valid unit, such as activity per liter or square meter) into annual dose.

Dose–The regulatory specified measure of exposure of the defined receptor to radionuclides introduced by a given release scenario into the accessible environment.

Source Term–The release scenario-specific concentration of a given radionuclide as it is introduced into the Biosphere model. For the groundwater release scenario the source term is expressed in terms of activity per unit volume of groundwater. For the volcanic release scenario the source term is expressed in units of activity per unit area.

2. APPLICABLE NUCLEAR SAFETY STANDARDS/REQUIREMENTS/GUIDANCE

2.1 APPLICABLE REQUIREMENTS

The requirement to evaluate the effects of climate change is contained in 10 CFR 63.305 (b) and (c).

> *(b) DOE should not project changes in society, the biosphere (other than climate), human biology, or increases or decreases of human knowledge or technology. In all analyses done to demonstrate compliance with this part, DOE must assume that all of those factors remain constant as they are at the time of submission of the license application.*

> *(c) DOE must vary factors related to the geology, hydrology, and climate based upon cautious, but reasonable assumptions consistent with present knowledge of factors that could affect the Yucca Mountain disposal system over the next 10,000 years.*

2.2 KTI AGREEMENT

The following KTI agreement statement is based on the Summary Highlights of the NRC/DOE Technical Exchange and Management Meeting on Igneous Activity that occurred on August 29-31, 2000 (Reamer and Williams 2000) as modified in the Summary Highlights of the NRC/DOE Technical Exchange and Management Meeting on Igneous Activity that occurred on June 21-22, 2001 (Crump 2001).

Document that neglecting the effects of climate change on the disruptive event BDCFs is conservative.

DOE will document that neglecting the effects of climate change on disruptive event BDCFs is conservative in a subsequent revision to the AMR Input Parameter Values for External and Inhalation Radiation Exposure Analysis (ANL-MGR-MD-000001) and Disruptive Event Biosphere Dose Conversion Factor Analysis (ANL-MGR-MD-000003) or equivalent document.

3. BASIS FOR REGULATORY COMPLIANCE STATEMENT

The information in section 3.1 provides background information concerning the evaluation of BDCFs to support the volcanic release scenario evaluation. Section 3.2 contains a discussion of the basis for using the present day BDCFs for future times as a conservative assumption applicable to the volcanic eruption scenario.

3.1 BACKGROUND

The analysis reported in *Disruptive Event Biosphere Dose Conversion Factor Analysis* (ANL-MGR-MD-000003 Rev 01) (CRWMS M&O 2001a) developed sets of BDCFs for use in performance assessment analyses for the volcanic release scenario. The volcanic eruption and subsequent transport of radioactive material in the ash plume are not modeled within the Biosphere BDCF but are evaluated within the TSPA-using ASHPLUME V1.4LV-dll which generates a source term (S_i in Equation 1 below) for the volcanic release scenario (BSC 2001, Section 3.3.1).

Three sets of BDCFs for three distinct temporal domains (time periods) represent an approach to analyze doses for the ash-fall phase, the transition period, and the long-term steady-state period, as documented in *Disruptive Event Biosphere Dose Conversion Factor Analysis* (ANL-MGR-MD-000003 Rev 01) (CRWMS M&O 2001a). The ash-fall period is the time period during an eruption when ash contaminated by waste is falling onto the ground after being dispersed into the atmosphere and results in elevated levels of particulate matter engulfing the receptor. The transition period is the time period after the eruption during which the ash deposited on the soil is assumed to be readily resuspended; the salient characteristic for the transition period is elevated quantities of particulate matter in the atmosphere. The steady-state period occurs later in time when the elevated quantities of particulate matter (dust levels) of the transition period have settled back to pre-eruption dust levels.

The BDCF for radionuclide i for the transition period and the steady-state period is the all pathway annual dose when the source term of that radionuclide is unit activity per unit area (i.e., one pCi/m^2), as shown by Equation 1. To provide TSPA with a capability to assess the affect of ash thickness, the transition period BDCFs were calculated for two depths of ash fall, 1 cm and 15 cm. For these sets of BDCFs it was assumed that the radionuclides were concentrated in the surface layer of the soil of either 1-cm or 15-cm thickness. For the steady-state calculation, the radionuclides were assumed to be uniformly mixed in the top 15-cm layer. The BDCFs for the transition period are greater than the steady-state values. The BDCFs for the ash fall period were for the inhalation pathway only. Unlike the BDCFs for the transition and the steady-state periods, they were designed to convert daily inhalation exposures to doses for the source given as activity concentration in the air.

The recommendation in the *Disruptive Event Biosphere Dose Conversion Factor Analysis* (ANL-MGR-MD-000003 Rev 01) (CRWMS M&O 2001a) was for TSPA to calculate expected dose for performance assessment using the transition period values for the first ten years after the eruption and use the steady-state BDCFs for later times. The BDCF, for a given source term allows TSPA to use Equation 1 to calculate dose from a known source of radionuclides.

$$Dose_i = BDCF_i \times S_i \quad \text{(Eq. 1)}$$

where:

$Dose_i$ = the dose to the defined receptor from all pathways from radionuclide i (Sv)

$BDCF_i$ = the biosphere dose conversion factor for radionuclide i in Sv per Bq/l for groundwater release and in Sv per Bq/m^2 for volcanic release

S_i = the source term for radionuclide i in Bq/l for groundwater release and in Bq/m^2 for volcanic release

Dose is determined within the TSPA code by the two components in Equation 1 and each one of these components can be affected by climate change. The first is that climate change can affect the source term (S_i) in Equation 1. For example, increased or more frequent fluvial redistribution of ash due to increased precipitation (wetter climate) could cause a change in the source term. This change represents a stochastic event affecting the TSPA model and not the biosphere model represented by the BDCFs. The approach adopted for TSPA-SR and supplemental analyses (BSC 2001, Section 3.3.1.2.5) was to postulate that a conservative assumption on wind direction during the eruption compensated for the lack of consideration of fluvial redistribution in the TSPA dose calculation. The issue of redistribution will be addressed elsewhere in response to IA 2.17. The second way climate can affect annual dose is by causing changes to the BDCFs. Section 3.2 presents a qualitative discussion of how increased precipitation is expected to affect volcanic release BDCF values.

3.2 TECHNICAL BASIS FOR IGNORING CLIMATE CHANGE ON VOLCANIC RELEASE BDCF VALUES

The increase in frequency, intensity, or duration of precipitation results in several related mechanical processes that affect the mass load of airborne particles available for inhalation. One mechanical process is that of wet deposition. Wet deposition occurs when the scouring action of rain drops removes particulate matter from the atmosphere and reduces the quantity available for inhalation. A second process is the mixing of soil and surface ash layers by mechanical impact of the raindrops. This mixing can only reduce the activity concentration in the surficial layer of contaminated material (ash and soil) available for subsequent resuspension. A third mechanism is the consolidation of wet surface to reduce the amount of dust generated. A fourth process occurs after the drying of the consolidated wet surface. The drying of the consolidated surface leaves a bonded surface layer. This bonded surface, unless mechanically disturbed by activities including farming, livestock grazing, and recreational land use, limits the amount of soil and ash that will be resuspended.

Each of these stabilizing mechanisms reduces the amount of contaminated ash present in the atmosphere compared with the current climate. These mechanical effects will result in reduced values for the volcanic release BDCFs, which depend on the airborne contaminated dust concentrations for the inhalation pathway. Therefore, the volcanic release BDCFs used for the present climate are conservative if applied to a future wetter climate.

4. REFERENCES

4.1 DOCUMENTS CITED

BSC (Bechtel SAIC Company) 2001. *FY01 Supplemental Science and Performance Analyses, Volume 2: Performance Analyses*. TDR-MGR-PA-000001 REV 00. Las Vegas, Nevada: Bechtel SAIC Company. ACC: MOL.20010724.0110.

CRWMS M&O 2001a. *Disruptive Event Biosphere Dose Conversion Factor Analysis*. ANL-MGR-MD-000003 REV 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20010125.0233.

CRWMS M&O 2001b. *Nominal Performance Biosphere Dose Conversion Factor Analysis*. ANL-MGR-MD-000009 REV 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20010123.0123.

Crump, T. 2001. "Igneous Activity TE Meeting Summary." E-mail from T. Crump to J. McNeish, June 25, 2001, with attachment and presentation. ACC: MOL.20010723.0094; MOL.20010723.0095; MOL.20010723.0103, MOL.20010723.0112.

Reamer, C.W. and Williams, D.R. 2000. Summary Highlights of NRC/DOE Technical Exchange and Management Meeting on Igneous Activity. Meeting held August 29-31, 2000, Las Vegas, Nevada, with attachments. [Washington, D.C.]: U.S. Nuclear Regulatory Commission. ACC: MOL.20001101.0106; MOL.20001101.0107; MOL.20001101.0108; MOL.20001101.0105; MOL.20001101.0109; MOL.20001101.0110; MOL.20001101.0111; MOL.20001101.0112; MOL.20001101.0113; MOL.20001101.0114; MOL.20001101.0115; MOL.20001101.0116; MOL.20001101.0117; MOL.20001101.0118; MOL.20001101.0119; MOL.20001101.0120; MOL.20001101.0121; MOL.20001101.0122; MOL.20001101.0123; MOL.20001101.0124; MOL.20001101.0125; MOL.20001101.0126; MOL.20001101.0127; MOL.20001101.0128.

4.2 CODES, STANDARDS, REGULATIONS, AND PROCEDURES

10 CFR 63. Energy: Disposal of High-level Radioactive Wastes in a Geologic Repository at Yucca Mountain, Nevada. Readily available.