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QA: N/A
Project No. WM-00011

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RESPONSE TO THE ADDITIONAL INFORMATION NEED (AIN) ASSOCIATED WITH KEY TECHNICAL ISSUE (KTI) AGREEMENT TOTAL SYSTEM PERFORMANCE ASSESSMENT AND INTEGRATION (TSPAI) 2.02 COMMENT 59

References: (1) Ltr, Kokajko to Ziegler, dtd 4/21/05 (Pre-Licensing Evaluation of KTI Agreements: TSPAI 2.01, 2.02, 2.03, 2.04, and 2.07)
(2) Ltr, Ziegler to Director, DHLWRS, dtd 8/20/04 (Transmittal of Appendix M of the *Technical Basis Document No. 5: In-Drift Chemical Environment* Addressing KTI Agreements Related to TEF 2.05 and GEN 1.01 [Comments 5 and 16])

On April 21, 2005, the U.S. Nuclear Regulatory Commission (NRC) requested additional information in regards to TSPAI 2.02 Comment 59 (Reference 1). TSPAI 2.02 Comment 59 is related to KTI Thermal Effects on Flow (TEF) 2.05; both pertain to the treatment of cold-trap effects in the performance assessment. In responding to TSPAI 2.02 Comment 59, the U.S. Department of Energy (DOE) pointed to the response sent August 20, 2004, for TEF 2.05 (Reference 2) as having additional pertinent information (i.e., Appendix M of *Technical Basis Document No. 5: In-Drift Chemical Environment*).[1] The NRC notes in TSPAI 2.02 Comment 59 AIN-1 (Reference 1) that while the additional information provided for TEF 2.05 was responsive, two supporting documents were not available: *Multiscale Thermohydrologic Model* (ANL-EBS-MD-000049, Revision 02) and *In-Drift Natural Convection and Condensation Model* (MDL-EBS-MD-000001, Revision 00). The AIN requests these documents. The portions of these contractor reports cited in this letter were reviewed by DOE and are acceptable for addressing the AINs, although the reports in their entirety were not formally reviewed and accepted by DOE. Some of the documents are being revised, and the revisions would be available when issued.

[1] BSC (Bechtel SAIC Company) 2004. "Appendix M: Cold Trap Effects." *Technical Basis Document No. 5: In-Drift Chemical Environment.* Las Vegas, Nevada: Bechtel SAIC Company.

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Since the time of the NRC review, *Multiscale Thermohydrologic Model* has been revised, and *In-Drift Natural Convection and Condensation Model* has been released and had two administrative change notices (ACN) processed. This letter transmits the current versions of both documents (Enclosures 1 and 2). Enclosure 3 is a compact disk (CD) containing the electronic files of Enclosures 1 and 2. The electronic file of Enclosure 1 is in a .pdf format containing 14,866,912 bytes, and the electronic file of Enclosure 2 is in a .pdf format containing 14,814,496 bytes. Both of these documents can be made publicly available. The remainder of this letter provides a summary response describing how the enclosed reports address TSPAI 2.02 Comment 59 AIN-1.

TSPAI 2.02 Comment 59 AIN-1

The text of TSPAI 2.02 Comment 59 AIN-1 is as follows:

> *Agreement TEF.2.05 has been evaluated, and feedback was communicated to DOE in a separate letter (Kokajko, 2005b). While information in that agreement evaluation letter pertinent to Comment 59 states that DOE documents on natural convection processes have not yet been released, the information that the DOE provided was responsive to the concerns underlying Agreement TEF.2.05, which NRC identified as closed (Kokajko, 2005b). These documents are needed to assess the rationale for condensed water remaining on and in the wallrock. Repository-scale cold traps are excluded because the condensation is stated to occur on drift walls and, therefore, does not contact the engineered barrier system; thus, the possibility of water dripping on drip shield and invert is not considered in screening arguments. Unreleased documents on natural convection (Multiscale Thermohydrologic Model, Revision 02 and In-Drift Natural Convection and Condensation Model) need to be reviewed to evaluate arguments indicating that condensed water resulting from repository-scale cold traps does not contact the drip shield nor the invert. DOE should consider providing information in any potential License Application to support repository-scale cold trap screening arguments.*

This response provides the current versions of the two documents requested by TSPAI 2.02 Comment 59 AIN-1: *Multiscale Thermohydrologic Model*, ANL-EBS-MD-000049, Revision 03 (Enclosure 1) and *In-Drift Natural Convection and Condensation Model*, MDL-EBS-MD-000001, Revision 00, ACN 02 (Enclosure 2).

The primary discussions of cold-trap effects in *Multiscale Thermohydrologic Model* appear in Sections 5.7 and 7.5. Section 5.7 documents the fact that the multiscale thermal-hydrologic model assumes that gas- and liquid-phase flow in the longitudinal direction along drifts has an insignificant effect on its calculations of thermal-hydrologic conditions in the drifts and the adjoining host rock. This assumption is tested in Section 7.5, where the multiscale thermal-hydrologic model results are compared against those of a corresponding three-dimensional monolithic thermal-hydrologic model. In the latter model, gas- and liquid-phase flow (i.e., the cold-trap effect) is allowed to occur along the emplacement drift, subject to limitations of porous media models. For the waste packages at the center of the repository, the multiscale thermal-hydrologic model calculations agree closely with those of the three-dimensional monolithic thermal-hydrologic model, with the differences between the two models being much smaller than the range of thermal-hydrologic conditions arising from parametric uncertainty. For the waste packages at the outer edge of the repository, the differences between the multiscale thermal-hydrologic model calculations and those of the corresponding three-dimensional monolithic thermal-hydrologic model are larger than at the center of the repository. These differences, however, are still smaller than the range of thermal-hydrologic conditions arising from parametric uncertainty. Thus, the comparison in Section 7.5 demonstrates that repository-scale cold trap effects do not have a significant effect on the ability of the multiscale thermal-hydrologic model to fulfill its intended purpose of calculating thermal-hydrologic conditions in the drifts and in the adjoining host rock.

In-Drift Natural Convection and Condensation Model documents the models used to evaluate heat and mass transfer within the drifts for performance assessment purposes. Section 6.3 describes the in-drift condensation model, which is a steady-state network condensation model. It incorporates axial dispersion of water vapor in an emplacement drift and implements mass and energy balance conditions. Waste packages, drip shields, invert, and emplacement drift wall are represented as nodes. The network includes unheated regions at the ends of the emplacement drifts. It is supported by a three-dimensional computational fluid dynamics in-drift convection model with associated two-dimensional studies (Sections 6.1 and 6.2). The convection model represents a drift segment and develops a dispersion coefficient for use in the network condensation model. In Section 6.4, correlations are developed to evaluate the effective thermal conductivity for the in-drift configuration and account for the increased heat transfer due to natural convection. These correlations are used by the multiscale thermal-hydrologic model. Section 7 presents model confidence-building and support efforts. The results of convection modeling are summarized in Sections 8.1 and 8.2. Section 8.3 summarizes the abstracted results from the condensation model, with details provided in Appendices H and I. The results of the effective thermal conductivity analysis are summarized in Section 8.4.

It is important to note that the screening decision of FEP 2.1.08.04.0B on repository-scale cold traps has changed from that reflected in TSPAI 2.02 Comment 59 AIN-1 and documented in Revision 2 of *Engineered Barrier System Features, Events, and Processes*.[2] With Revision 3, the screening decision changed from excluded to included, which is consistent with the two enclosed reports and the response to TEF 2.05 (Section M.3).[3, 4] As discussed above, the effects

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[2] BSC 2004a. *Engineered Barrier System Features, Events, and Processes*. ANL-WIS-PA-000002 REV 02. Las Vegas, Nevada: Bechtel SAIC Company.

of repository-scale cold traps are excluded from representation in the multiscale thermal-hydrologic model. The reason is that there is no significant impact on the calculations of thermal-hydrologic conditions (i.e., temperature and relative humidity or liquid saturation) in the drifts and the adjoining host rock (*Multiscale Thermohydrologic Model*, Section 7.5). Nonetheless, the effects of both repository- and drift-scale cold traps are included in the performance assessment by representing condensation that occurs on the drift walls. The modeling results described in Section 8.3 of *In-Drift Natural Convection and Condensation Model* specify the potential for condensation to occur at the drift wall above the drip shield and, for such locations where condensation occurs, the magnitude of the condensation. This condensation is represented in the performance assessment in the same manner as drift seepage, although with a different spatial distribution and flux rate. Thus, drift-wall condensation does contact the engineered barrier system, including the drip shield and the invert, and its effects are incorporated into the evaluation of radionuclide transport through the drift invert into the unsaturated zone below.

Based on the information presented in this letter and in the enclosed documents, pending NRC review and approval, DOE recommends that TSPAI 2.02 Comment 59 be closed.

There are no new regulatory commitments in this letter or its enclosures.

Please direct any questions concerning this letter to J. Russell Dyer at (702) 794-1301 or e-mail russ_dyer@ymp.gov, or Deborah L. Barr at (702) 794-1479 or e-mail deborah_barr@ymp.gov.

Mark H. Williams, Director
Regulatory Authority Office

RAO:WJB-0374

Enclosures:
1. *Multiscale Thermohydrologic Model*, ANL-EBS-MD-000049, Revision 03
2. *In-Drift Natural Convection and Condensation* MDL-EBS-MD-000001, Revision 00, ACN 02
3. CD of Enclosures 1 and 2

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[3] BSC 2004b. *Engineered Barrier System Features, Events, and Processes*. ANL-WIS-PA-000002 REV 03. Las Vegas, Nevada: Bechtel SAIC Company.

[4] See note 1.

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