2009 Compliance Recertification Application (CRA-2009)
Compliance Application Review Document (CARD) No. 44

Engineered Barriers

44.0 BACKGROUND

Assurance requirements were included in the disposal regulations to compensate in a qualitative manner for the inherent uncertainties in projecting the behavior of natural and engineered components of the repository for many thousands of years (50 FR 38072). Section 194.44 is one of the six assurance requirements in the Compliance Criteria. Section 194.44 implements the assurance requirement of 40 CFR 191, Section 191.14(d) to incorporate one or more engineered barriers at radioactive waste disposal facilities. The disposal regulations define a barrier as "any material or structure that prevents or substantially delays movement of water or radionuclides toward the accessible environment" (Section 191.12(d)). Section 194.44 requires the U.S. Department of Energy (DOE or Department) to conduct a study of available options for engineered barriers at the Waste Isolation Pilot Plant (WIPP) and submit this study and evidence of its use with the compliance application. Consistent with the containment requirement at Section 191.13, DOE must analyze the performance of the complete disposal system, and any engineered barrier(s) that DOE ultimately implements at the WIPP must be considered in this analysis and EPA's subsequent evaluation.

In order to fulfill this requirement, DOE proposed four different engineered barriers for EPA's consideration. These include shaft seals, panel closure system (PCS), magnesium oxide and borehole plugs. All these features were developed to contain the waste in a multiple barrier design concept. However, EPA only recognized MgO (Mgnesium Oxide) as an engineered barrier and stated that "EPA reviewed the information contained in the CCA and agreed that the emplacement of MgO in waste panels of the WIPP may be expected to substantially delay the movement of water or radionuclides. For compliance with this requirement, EPA did not evaluate panel seals, shaft seals or borehole plugs. EPA considered these items to be features of the disposal system design and evaluated them in that context."

MgO used in sacks are dry, granular and almost 91% pure. Magnesite ore is calcinated to obtain the composition of periclase. This is more suitable for the intended chemical reaction to reduce actinide solubilities.

44.1 REQUIREMENTS (194.44)

(a) "Disposal systems shall incorporate engineered barrier(s) designed to prevent or substantially delay the movement of water or radionuclides toward the accessible environment."

(b) "In selecting any engineered barrier(s) for the disposal system, DOE shall evaluate the benefit and detriment of engineered barrier alternatives, including but not limited to: cementation, shredding, supercompaction, incineration, vitrification,

improved waste canisters, grout and bentonite backfill, melting of metals, alternative configurations of waste placements in the disposal system, and alternative disposal system dimensions. The results of this evaluation shall be included in any compliance application and shall be used to justify the selection and rejection of each engineered barrier evaluated."

(c)(1) "In conducting the evaluation of engineered barrier alternatives, the following shall be considered, to the extent practicable:

(i) The ability of the engineered barrier to prevent or substantially delay the movement of water or waste toward the accessible environment;

(ii) The impact on worker exposure to radiation both during and after incorporation of engineered barriers;

(iii) The increased ease or difficulty of removing the waste from the disposal system;

(iv) The increased or reduced risk of transporting the waste to the disposal system;

(v) The increased or reduced uncertainty in compliance assessment;

(vi) Public comments requesting specific engineered barriers;

(vii) The increased or reduced total system costs;

(viii) The impact, if any, on other waste disposal programs from the incorporation of engineered barriers (e.g., the extent to which the incorporation of engineered barriers affects the volume of waste);

(ix) The effects on mitigating the consequences of human intrusion.

(2) If, after consideration of one or more of the factors in paragraph (c)(1) of this section, DOE concludes that an engineered barrier considered within the scope of the evaluation should be rejected without evaluating the remaining factors in paragraph (c)(1) of this section, then any compliance application shall provide a justification for this rejection explaining why the evaluation of the remaining factors would not alter the conclusion."

(d) “In considering the ability of engineered barriers to prevent or substantially delay the movement of water or radionuclides toward the accessible environment, the benefit and detriment of engineered barriers for existing waste already packaged, existing waste not yet packaged, existing waste in need of repackaging, and to-be-generated waste shall be considered separately and described.”

(e) “The evaluation described in paragraphs (b), (c) and (d) of this section shall consider engineered barriers alone and in combination.”

44.2 1998 CERTIFICATION DECISION

The U.S. environmental Protection Agency (EPA or Agency) expected DOE’s CCA to document its analysis of potential engineered barriers, including a comparison of the benefits and detriments of each.

In the CCA, DOE proposed multiple barriers to help guard against unexpectedly poor performance from one type of barrier. DOE’s multiple barrier approach included shaft seals, the panel closure system, magnesium oxide (MgO) and borehole plugs.

EPA evaluated the information regarding engineered barriers that was provided by DOE in the CCA, CCA Chapters 3 (pp. 3-14 to 3-45), 6 (pp. 6-105 to 6-114), and 7 (pp. 7-89 to 7-96), as well as in CCA Appendices BACK, EBS, SEAL, PCS, SOTERM.2.2, and WCA.4.1. The Agency also considered supplemental information provided in the report “Implementation of Chemical Controls through a Backfill System for the Waste Isolation Pilot Plant (WIPP)” (Docket A-93-02, Item II-I-15) and in a letter to EPA dated February 26, 1997 (Docket A-93-02, Item II-I-10, Enclosure 2g).

DOE specified the proposed method of incorporating the engineered barrier (MgO backfill) into the disposal system in the CCA, CCA Chapter 3.3.3 and CCA Appendix BACK. DOE identified MgO as the backfill material of choice, and provided the rationale for choosing the physical form of MgO to be used, the approximate grain size of the MgO to be emplaced, and the type and size of packages to be used to transport and emplace the MgO. The CCA also described how the MgO mini sacks and super sacks would be arranged around waste containers in the disposal rooms and indicated that the MgO backfill could be emplaced in the same manner and with the same equipment as the waste containers.

EPA found that DOE conducted the requisite analysis of engineered barriers and selected an engineered barrier designed to prevent or substantially delay the movement of waste or radionuclides toward the accessible environment. In the 1998 Certification Decision, EPA specified that only MgO backfill met the regulatory definition of an engineered barrier. EPA determined that DOE provided sufficient documentation to show that MgO can effectively reduce actinide solubility in the disposal system.

A complete description of EPA’s 1998 Certification Decision for Section 194.44 can be obtained from EPA Air Docket, A-93-02, Items V-A-1 and V-B-2.

44.3 CHANGES IN THE 2004 COMPLIANCE RECERTIFICATION APPLICATION (CRA-2004)

DOE did not report any significant changes to the information on which EPA based the 1998 Certification Decision. DOE did not conduct a new analysis to evaluate the benefit and detriment of engineered alternatives, as required by 194.44 (b) through (e). The 2004 CRA reflects EPA's determination that only MgO meets EPA's requirements for an engineered barrier.

44.3.1 EVALUATION OF COMPLIANCE FOR 2004 RECERTIFICATION

Based on EPA's review of the activities and conditions in and around the WIPP site, EPA did not identify any significant changes in the implementation of the requirement for engineered barriers. The 2004 CRA did not reflect any changes to the analysis of engineered barrier options. The 2004 CRA accurately reflected the 1998 Certification Decision and its conclusion that MgO is the only engineered barrier that meets EPA's requirements.

Since the 1998 Certification Decision DOE reported changes and requested EPA approval of changes to a few MgO activities. First, DOE requested EPA approval to eliminate the use of MgO mini-sacks to enhance worker safety. EPA approved this change in the MgO emplacement in January 2001. (EPA Air Docket A-98-49, II-B3-15). EPA's approval noted that the elimination of the MgO mini-sacks is insignificant to long-term repository performance since a large excess of MgO will remain, and MgO liberated from super–sacks will be available to react chemically with CO_2. At this time, EPA also noted that DOE must maintain a safety factor of at least 1.67 in the disposal facility.

Second, DOE notified EPA of a change in the vendor for MgO. DOE's evaluation indicated that the product from the new vendor meets the established criteria and has no impact on the required function of the engineered barrier.

Following EPA direction (EPA Air Docket A-98-49, II-B2-72), in 2005, DOE improved tracking of the MgO emplacement. DOE is now able to calculate the MgO safety factor for each room of the repository. Through this new system, DOE is able to demonstrate that the 1.67 safety factor is being maintained in each room. (EPA Air Docket a-98-49, II-B2-58)

EPA did not receive any public comments on DOE's continued compliance with the engineered barriers requirements of Section 194.44.

44.3.2 CRA-2004 RECERTIFICATION DECISION

Based on a review and evaluation of the 2004 CRA, Appendix AIC (1998), and supplemental information provided by DOE (FDMS Docket ID No. EPA-HQ-OAR-2004-0025, Air Docket A-98-49), EPA determines that DOE continues to comply with the requirements for Section 194.44.

44.4 CHANGES IN THE 2009 COMPLIANCE RECERTIFICATION APPLICATION (CRA-2009)

DOE did not report any significant changes to the information on which EPA based the 1998 Certification and 2004 Recertification Decisions. DOE did not conduct a new analysis to evaluate the benefit and detriment of engineered alternatives, as required by 194.44 (b) through (e). The 2009 CRA continues to reflect EPA's determination that only MgO meets EPA's requirements for an engineered barrier.

DOE documented (DOE 2009 CRA Section 44.6) four changes in the emplacement of MgO since the 2004 recertification: DOE changed the MgO vendor, modified MgO emplacement to accommodate high CPR content compressed waste, decreased the MgO excess factor to 1.2 from 1.67, and continued MgO experimental investigations (DOE 2009 CRA Section 44.6.1)

44.4.1 EVALUATION OF COMPLIANCE FOR 2009 RECERTIFICATION

Based on EPA's review of the activities and conditions in and around the WIPP site, EPA did not identify any significant changes in the requirement for engineered barriers. The 2009 CRA documentation accurately reflects the 1998 Certification and 2004 Recertification Decisions and their conclusion that MgO is the only engineered barrier that meets EPA's requirements.

Change in MgO Vendor

January 2005 DOE selected Martin Marietta Magnesia Specialties LLC (Martin) as the new MgO supplier after Premier Chemicals notified DOE that they would be unable to provide MgO. DOE determined that Martin's MgO was suitable for use at WIPP. EPA evaluated the vendor change and concurred (EPA 2010a).

Modified MgO Emplacement

March 2004 EPA approved the emplacement of super-compacted waste from the DOE Advanced Mixed Waste Treatment Project (AMWTP). This super-compacted waste contains higher CPR waste concentrations than average WIPP waste requiring emplacement of additional MgO to sustain the MgO excess factor. DOE accomplished this need by emplacing addition MgO on specially designed racks when needed (DOE 2009 CRA Section 44.6.1.2). EPA verified (2009 CARD 21) during annual inspections that DOE sustained an excess factor of 1.67 and emplaced MgO properly.

Decreased MgO Excess to 1.2

In April 2006, the DOE submitted a planned change request for EPA approval of reducing the MgO excess factor from 1.67 to 1.2 (DOE 2009 CRA Section 44.6.1.3). To justify its request, the DOE used reasoned arguments regarding health-related transportation risks to the public, the cost of emplacing MgO, and the uncertainties

inherent in predicting the extent of microbial consumption of CPR materials during the 10,000-year WIPP regulatory period.

EPA responded by requesting that the "DOE needs to address the uncertainties related to MgO effectiveness, the size of the uncertainties, and the potential impact of the uncertainties on long-term performance". In particular, EPA instructed the DOE to identify all of the uncertainties related to the calculation of the MgO excess factor, and quantify these uncertainties, if possible. The DOE responded to this request with a detailed uncertainty analysis (DOE 2009 CRA Section 44.6.1.3).

In February 2008, EPA approved the reduction of the MgO excess factor to 1.2. However, the EPA imposed two conditions in its approval letter (Reyes 2008, p. 1):

> "First, DOE must continue to calculate and track both the carbon disposed and the required MgO needed on a room-by-room basis. Second, DOE must annually verify the reactivity of MgO and ensure that it is maintained at 96% as assumed in DOE's supporting documentation. These conditions ensure that the WIPP will continue to meet the assurance requirements in our radioactive waste disposal regulations.
>
> As a result of this evaluation, it is our opinion that further reductions in the MgO safety factor are not warranted given the current state of knowledge. We believe that reducing the safety factor below 1.2, based on our current understanding of the disposal system, would not be sufficient to comply with the assurance requirement that MgO is intended to address."

Ongoing MgO Experiments

DOE continued MgO related experiments to confirm that MgO will continue to perform as expected in the WIPP (DOE 2009 CRA Section 44.6.1.4). As a result of EPA's second condition (above) DOE is required to verify the efficacy of the MgO emplaced. DOE started a program to test each batch of MgO shipped to WIPP (EPA 2010a Section 4.6). To verify DOE's MgO testing process EPA in the 2009 CRA May 21, 2009 completeness letter, comment 1-C-1, requested that DOE explain their approach (EPA 2009a). DOE responded November 19, 2009 (DOE 2009f) that, "Each lot (shipment) is tested for physical properties at the Martin-Marietta facility. A grab sample of each lot is collected at the Martin Marietta facility and sent with the shipment of MgO to the WIPP bagging facility. Once at the WIPP bagging facility, the grab sample is sent for testing using the new SNL procedure for testing the periclase plus lime content." EPA found this approach to be adequate and that MgO will perform as assumed at WIPP.

EPA did not receive any public comments on DOE's continued compliance with the engineered barriers requirements of Section 194.44.

44.4.2 2009 RECERTIFICATION DECISION

Based on a review and evaluation of the CRA-2009, CRA-2004, Appendix AIC (1998), and supplemental information provided by DOE (FDMS Docket ID No. EPA-HQ-OAR-2009-0330, Air Docket A-98-49), EPA determines that DOE continues to comply with the requirements for Section 194.44.