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APR 10 2006

Ms. Elizabeth A. Cotsworth
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, N.W.
Washington, DC 20460

Subject: Transmittal of Planned Change Request

Dear Ms. Cotsworth:

This letter provides the Department of Energy (DOE) request for Environmental Protection Agency (EPA) approval to emplace 1.2 moles of magnesium oxide (MgO) for every mole of consumable carbon contained in the transuranic waste emplaced in the Waste Isolation Pilot Plant (WIPP). This differs from the 1.67 moles of MgO currently required to be emplaced by the EPA in its correspondence dated February 3, 2005. This change request was prepared in accordance with Title 40 CFR § 194.4 and DOE believes that this is a non-significant change that does not require a rulemaking. DOE has informally briefed your staff regarding this change.

We believe that this Planned Change Request (PCR) represents a reasonable balance between transportation health-related risks to the public, the cost of emplaced MgO, and the degree of uncertainty in microbial processes. The enclosed paper provides additional information and justification for this PCR.

Sincerely,

David C Moody

David C. Moody
Manager

Enclosure

cc: w/enclosure

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MgO Planned Change Request

The U.S. Department of Energy (DOE) conducted a review of operational processes at the Waste Isolation Pilot Plant (WIPP) and determined that a reduction in public risk can be achieved by changing MgO emplacement activities at WIPP. This change is desirable because it can reduce public risks without adversely impacting repository performance. The change proposed by the DOE is to add 1.2 moles of magnesium oxide (MgO) in the WIPP repository for every mole of biodegradable organic carbon in the emplaced transuranic waste. Until such time that the degree of uncertainty in microbial processes can be reduced, DOE assumes that all of the organic carbon in the waste can be consumed by microbial processes. Thus, the proposed amount of MgO is 20% more than a conservatively derived estimate of the mass of MgO required to sequester carbon dioxide generated by microbial consumption of all of the organic carbon in the waste.

The ratio of 1.2 is referred to as the MgO loading factor in this document. The proposed loading factor represents a balance between vehicle-related health risks to the public, the cost of emplaced MgO, and a degree of uncertainty in microbial processes. DOE's proposed value also acknowledges that the WIPP Waste Information System (WWIS) now tracks the emplaced masses of MgO and cellulose/plastic/rubber materials on a room-by-room basis. The rationale for an MgO loading factor of 1.2 is described in this planned change request.

1.0 MgO is an Assurance Requirement

The U. S. Environmental Protection Agency (EPA) required the WIPP disposal system to include both natural and engineered barriers. The use of natural and engineered barriers is intended to provide additional confidence that compliance with EPA's long-term containment requirements (40 CFR § 191.13) would be achieved. The EPA's position on engineered barriers, as stated in their certification decision (EPA, 1998a, Section VIII.D.4), is that MgO was the engineered barrier that met the requirements for an assurance measure under 40 CFR § 191.14.

In 40 CFR §194.14, the EPA states that their assurance measures are intended to provide the confidence needed for long-term compliance with the containment requirements in the disposal standards. The assurance measures included in the repository design include active institutional controls, monitoring, permanent markers, and both engineered and natural barriers.

EPA defines a barrier as:

> *Barrier means any material or structure that prevents or substantially delays movement of water or radionuclides toward the accessible environment. For example, a barrier may be a geologic structure, a canister, a waste form with physical and chemical characteristics that significantly decrease the mobility of radionuclides, or a material placed over and around waste, provided that the material or structure substantially delays movement of water or radionuclides.*

In Section 3.3 of the Compliance Certification Application (CCA) (DOE, 1996), DOE stated that MgO was selected as an engineered barrier for the repository. The MgO ensures that chemical conditions favoring lower actinide solubilities are maintained in WIPP brines. The MgO maintains these conditions by sequestering the carbon dioxide produced by potential microbial consumption of cellulose, plastic and rubber (CPR) materials in the waste. During the first WIPP certification, DOE demonstrated that MgO could be placed over and around the waste and argued that it would substantially delay the movement of radionuclides toward the accessible environment. EPA agreed with DOE's position on MgO as an engineered barrier:

> *The EPA determined that MgO will be an effective barrier, based on DOE's scientific evaluation of the proposed barrier's ability to prevent or substantially delay the movement of radionuclides toward the accessible environment.* (EPA 1998a, Section VIII.D.4).

The MgO engineered barrier coupled with the natural barrier of the surrounding host rock (salt) met the assurance requirement for multiple barriers. The EPA agreed that the emplacement of MgO in waste panels of the WIPP may be expected to substantially delay the movement of water or radionuclides (EPA 1998b, CARD 44.A.3). The EPA also "*concluded that DOE's qualitative justification was sufficient to show that the emplacement of MgO backfill in the repository will help prevent or substantially delay the movement of radionuclides toward the accessible environment by helping to maintain alkaline conditions in the repository, which in turn favors lower actinide solubilities*" (EPA, 1998a, Section VIII.B.4.(c)).

2.0 Excess MgO is not a "Safety Factor"

The amount of excess MgO has been inappropriately termed a "safety factor." This calculated factor is defined as the ratio of the amount of emplaced MgO versus the amount of MgO required to sequester essentially all the carbon dioxide generated by microbial consumption. This ratio does not relate to safety, but to maintaining chemical conditions that result in reduced actinide solubilities. This calculation is based on conservative assumptions that exaggerate the amount of MgO required to maintain chemical conditions in the repository that generate reduced actinide solubilities. The term "safety factor" is therefore inappropriate because a value less than 1 does not necessarily point to an unsafe condition or failure of a mechanism, as is usually implied by the traditional engineering definition of a "safety factor". This document uses the term "loading factor" to avoid these misleading connotations.

3.0 Mass of MgO

The mass of MgO needed to obtain a specific loading factor is based on a deterministic equation (DOE, 2005). This equation determines the amount of MgO to be emplaced on a per-room basis:

$$M_{MgO} = LF(M_C + M_R + 1.7M_P)\frac{6MW_{MgO}}{MW_{Cell}} \tag{1}$$

where

M_{MgO}	is the required mass of MgO,
LF	is the MgO loading factor,
M_C	is the total emplaced mass of cellulose material in the room,
M_R	is the total emplaced mass of rubber material in the room,
M_P	is the total emplaced mass of plastic material in the room,
MW_{MgO}	is the molecular weight of MgO, 40.3 grams per mole, and
MW_{Cell}	is the molecular weight of cellulose, 162.0 grams per mole.

The factor of 6 in Equation (1) represents the fact that the chemical formula for cellulose material is taken as $C_6H_{10}O_5$, so there are 6 moles of organic carbon for each mole of cellulose material. The factor of 1.7 represents the ratio of the moles of organic carbon per unit mass of plastic material versus per unit mass of cellulose material (Wang and Brush, 1996, Appendix I.5).

4.0 Rationale for an MgO Loading Factor of 1.2

The DOE believes that it is important to maintain an appropriate amount of MgO in order to ensure its effective performance as an engineered barrier and classification as an assurance per 40 CFR §191.14. The DOE proposes to add 1.2 moles of MgO in the WIPP repository for every mole of consumable organic carbon that is present in emplaced transuranic waste. The proposed loading factor of 1.2 represents a balance between vehicle-related health risks, the cost of MgO, and uncertainty in microbial processes. Specifying an MgO loading factor greater than 1.0 increases health risks to today's population without benefit to future populations, increases the cost of repository operations, and does not provide additional assurance that the repository will perform as predicted. On the other hand, the DOE acknowledges uncertainties in long-term microbial consumption of organic carbon and the associated reactions with MgO, and proposes an MgO loading factor of 1.2 to accommodate these uncertainties. The DOE is evaluating methods to reduce this uncertainty in the future, but until this is accomplished, DOE believes 1.2 is the appropriate loading factor.

The transportation-related risks to the general population, the cost savings from an MgO loading factor of 1.2, and the ability of the WIPP Waste Information System to track emplaced inventory on a room-by-room basis are discussed in this section. A discussion of the potential impacts of an MgO loading factor of 1.2 on repository compliance and performance assessment is also included here.

4.1 Transportation-Related Risks

Bulk MgO is currently trucked to Carlsbad from Western Michigan (Manistee, MI) in 24 to 27 Ton belly dump trailers, pulled by a common tractor. No highway routes are designated for the trucks. Trucks used to haul MgO are available for other loads on the northbound, return trip. Shipment rates depend on the rate of waste disposal and may increase or decrease to accommodate fluctuations in the waste disposal rate. Bulk MgO is packaged in Carlsbad and shipped to the WIPP site in 4,100 pound "supersacks". Eight supersacks are shipped in each truckload.

Transportation related risks can be assessed in two categories: vehicle-related health risks and vehicle-related accident risks.

4.1.1 Vehicle-Related Health Risks

Vehicle-related health risks are associated with the generation of air pollutants by transport vehicles during shipment. The health endpoint assessed under routine transportation conditions is the excess latent mortality due to inhalation of vehicular emissions. These emissions consist of particulate matter in the form of diesel engine exhaust and fugitive dust raised from the road/railway by the transport vehicle, brake linings, and similar particulates.

Transportation risk factors for pollutant inhalation in terms of latent mortality were generated by Biwer and Butler (1999) and reported in (DOE, 2002). These risks are based on epidemiological data that associate mortality rates with particulate concentrations in ambient air. A value of 8.36×10^{-10} latent fatality per kilometer of truck transport is used in this analysis. This value is for heavy combination trucks (truck class VIIIB). The latent fatality risks estimated by using this value may be considered to be near an upper bound (Biwer and Butler, 1999) because of the conservatism of the assumptions made to reconcile results among independent epidemiological studies.

The risk factors in (DOE, 2002) are for an assumed population density of 1 person per square kilometer, so the one-way shipment risks are calculated by multiplying the appropriate risk factor by the average population density along the route and the route distance. The values of the population density and distance for each leg of the transportation route were generated by the TRAGIS Routing Model (Version 1.4.15) from Oak Ridge National Laboratory. The risks related to routine vehicle risks use one-way shipments on the Manistee to Carlsbad route and round-trip shipments between Carlsbad and the WIPP site. One-way mileage from Manistee to Carlsbad is 1,584 miles (2,545 km) and the round trip mileage from Carlsbad to the WIPP site is 86.4 miles (141.1 km). Population densities along the routes are lumped into rural, suburban and urban travel. Cargo-related impacts are not considered because MgO is assumed to be inert.

The resulting annual emissions and estimated annual fatalities for the Manistee, MI to Carlsbad, NM shipments of MgO are reported in Table 1. At the current rate of 208 truck shipments per year, there are 4.89 metric tons of emissions per year and a risk of approximately one fatality every 5 years from pollutant inhalation. Reducing the amount of emplaced MgO is clearly beneficial to the current population because it reduces the pollutant emissions and associated risk of fatalities.

Table 1. Vehicle-Related Impacts Associated with Shipments of Bulk MgO from Manistee, MI to Carlsbad, NM

Shipments	208[1]	400	1000
Emissions (Metric Tons)	4.89	9.36	23.4
Fatalities (Persons)	0.20	0.38	0.96

[1] Current annual shipping rate

Similar risk analyses were performed for the truck shipments between Carlsbad, NM and the WIPP site. At the current rate of 312 truck shipments per year, there are 0.43 metric tons of emissions per year and a risk of approximately 0.0018 fatalities per year. These values are significantly less than the corresponding values in Table 1 because of the low population density around the WIPP site and because the travel distance is 84.6 miles versus 1,584 miles. The benefits from decreased truck shipments of MgO are marginal along the route from Carlsbad, NM to the WIPP site in comparison to the health risks in Table 1.

4.1.2 Vehicle-Related Accident Risks

Vehicle-related accident risk refers to the potential for transportation-related accidents that could directly result in fatalities unrelated to the cargo in the shipment. State average fatality rates from Saricks and Tompkins (1999), as reported in (DOE, 2002), are used in the risk assessments. Vehicle-related accident risks are calculated by multiplying the total distance traveled by the rate for transportation-related accidents, injuries and fatalities. The vehicle-related accident risks were calculated by using one-way shipments on the Manistee to Carlsbad route and round-trip shipments between Carlsbad, NM and the WIPP site. The resulting number of accidents, injuries, and fatalities for the current annual rate of 208 shipments per year are 0.019 accidents per year, 0.016 injuries per year, and 0.0066 fatalities per year. These values are sufficiently low that reducing the required mass of MgO has only a marginal benefit for vehicle-related accident risks in comparison to vehicle-related health risks.

4.2 WIPP Waste Information System

Recent changes to the WIPP Waste Information System (WWIS) have significantly increased the reliability of DOE's estimates of the emplaced masses of CPR materials in waste and MgO in supersacks. The WWIS has recently been enhanced to: (1) track the emplaced mass of MgO, (2) track the location of CPR materials from the emplacement process, and (3) calculate and report the MgO loading factor on a per room basis, following the procedure in WPO5-WH1011, Section 5.0, CH Waste Processing. Currently, emplacement activities continue uninterrupted if the MgO loading factor is greater than its target value. If the MgO loading factor is less than its target value, then the Waste Handling Manager is notified and the following conditions are evaluated:

(a) Current emplacement location and remaining volume in the disposal room;
(b) Expected CPR content in incoming waste, based on which waste streams are being shipped to WIPP and at what rates; and
(c) The number of additional supersacks required.

Based on this information, additional MgO may be emplaced immediately or planned for a future work shift. Once the additional MgO is emplaced, the corresponding data are uploaded to the WWIS and the MgO loading factor is reevaluated. The repeated evaluations of the MgO loading factor allow repository operations to maintain optimum MgO loading with the least impact to operations.

The EPA has conducted an inspection of the WIPP waste emplacement processes and procedures (EPA, 2005c). The results of this inspection confirmed that the necessary waste emplacement procedures are in place and that the appropriate staffs of WIPP's Managing and Operating Contractor are adequately trained for waste emplacement. The EPA also observed that the WWIS adequately tracks the amount of CPR materials and MgO in the repository, and that the WWIS is able to calculate the MgO loading factor (called the MgO safety factor in EPA's letter). The data in the WWIS provide an accurate, quantitative basis for ensuring that the required mass of MgO is emplaced with the CPR materials that may produce carbon dioxide.

4.3 No Impact on Performance Assessment and Compliance

A detailed discussion of the potential impacts on performance assessment from an MgO loading factor of 1.2 is presented by Leigh et al. (2006). The key points from this memorandum are summarized here.

MgO is not explicitly modeled in performance assessment (PA), but the presence of MgO influences physical and chemical processes that are explicitly included in PA. PA assumes that there is enough MgO emplaced in the repository to sequester essentially all carbon dioxide that might be generated by microbial consumption of CPR materials. Consequently, repository pressures as calculated by BRAGFLO are lower than would be expected in the absence of MgO and the pH of repository brines is buffered to a value around 9.

Repository pressures as calculated by BRAGFLO are lower with MgO because MgO sequesters carbon dioxide produced by microbial activity, directly reducing the mass of gas and the associated gas pressure in the repository. This is an important effect because previous PA's have shown that repository pressure has a significant role in determining spallings releases, direct brine releases, and other aspects of repository performance. However, repository pressures predicted by PA are unchanged by a loading factor of 1.2 because this amount of MgO is more than sufficient to react with the carbon dioxide generated by microbial consumption of the CPR materials.

The MgO also buffers the pH in repository brines to a value around 9 (Wang, 1996), thereby creating conditions that decrease actinide solubilities relative to those expected in the absence of MgO (DOE, 2004, Appendix Barriers). Other pH-dependent quantities affecting repository performance, such as colloidal concentrations of actinides in brine and actinide matrix distribution coefficients (K_d's), are also stabilized by this buffering effect. The PA assumption that all of the carbon dioxide that might be generated by microbial consumption of CPR materials is consumed by MgO still holds as long as 1 mole of MgO will be emplaced for every mole of consumable organic carbon in CPR materials in the emplaced waste. In this situation, Wang's calculation (Wang, 1996) that the pH will be buffered around 9 remains valid.

In summary, a loading factor of 1.2 will have no impact on performance assessment and compliance, and will provide an excess of 20% above the conservative assumptions in PA.

4.4 Cost Savings

The potential cost impacts from reducing the MgO loading factor from 1.67, its current value, to the proposed value of 1.2 have been estimated using the latest inventory information for CPR materials from the Performance Assessment Baseline Calculation (PABC) (Leigh et al., 2005). The total PABC inventory of CPR materials can be calculated from the average density of CPR materials in the inventory (Leigh et al., 2005, Tables 9 through 12) and the total volume of CH-TRU and RH-TRU wastes (DOE 2004, Table 6-12). The total masses in the PABC inventory include both the emplaced waste in Panels 1, 2, and 3 and the future shipments of stored and projected waste to WIPP. However, there is no cost savings for the MgO that is already emplaced in Panels 1, 2, and 3, so the cost savings should be estimated for the future shipments alone. The total masses of CPR materials in the future shipments are calculated as the total PABC inventory minus the emplaced inventory of CPR materials. The emplaced inventory is based on WWIS data as of April 4, 2006.

The total masses of C, P, and R materials in the future shipments are calculated to be 8.80×10^6 kg, 8.36×10^6 kg, and 2.12×10^6 kg, respectively. The required mass of MgO for the future shipments can be determined from Equation (1) in Section 3. The mass of MgO is 6.26×10^7 kg for a loading factor of 1.67 and 4.50×10^7 kg for a loading factor of 1.2. The reduction in MgO mass is $(6.26\times10^7 \text{ kg} - 4.50\times10^7 \text{ kg}) = 1.76\times10^7$ kg when the loading factor is reduced from 1.67 to 1.2.

The cost of MgO, including the raw material itself, transportation, packaging in supersacks, and racks for the supersacks, is estimated to be $0.392 per emplaced pound or $0.863 per emplaced kilogram. This cost does not include the labor cost for emplacement. Transportation costs are a yearly estimate because transportation costs are higher in summer months than in winter months.

The cost savings from adopting a loading factor of 1.2 as compared to a loading factor of 1.67 is then estimated as $(\$0.863/\text{kg})(1.76\times10^7 \text{ kg}) = \$15.2$ million. There is clearly a significant cost savings from adopting the proposed loading factor of 1.2.

5.0 Conclusion

DOE proposes to add 1.2 moles of MgO in the WIPP repository for every mole of consumable organic carbon that is contained within the emplaced transuranic waste, instead of the current value of 1.67 moles of MgO. The DOE is currently required to assume that all organic carbon can be consumed by microbial processes. The proposed amount of MgO is 20% more than a conservatively derived estimate of the mass of MgO required to sequester carbon dioxide generated by microbial consumption of organic carbon in the waste.

The proposed loading factor of 1.2 represents a balance between vehicle-related health risks, the cost of MgO, and uncertainty in microbial processes. Specifying an MgO loading factor significantly greater than 1.0 increases health risks to today's population without benefit to future populations, increases the cost of repository operations, and does not provide additional assurance that the repository will perform as predicted. DOE acknowledges uncertainties in the production of carbon dioxide by microbial consumption of organic carbon in the waste, and proposes that an MgO loading factor of 1.2 is sufficient to accommodate these uncertainties.

7.0 References

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