UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

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OFFICE OF
AIR AND RADIATION

Mr. Jose R. Franco, Manager
Carlsbad Field Office
U.S. Department of Energy
P.O. Box 3090
Carlsbad, New Mexico 88221-3090

Dear Mr. Franco:

The U.S. Environmental Protection Agency is continuing with its completeness review of the U.S. Department of Energy's (DOE) 2014 Compliance Recertification Application (CRA-2014) for the Waste Isolation Pilot Plant. This letter transmits to you the second set of Agency completeness comments and questions (see Enclosure). We request that DOE respond in a timely manner. If you have any questions concerning this request, please contact Kathleen Economy at (202) 343-9844 or economy.kathleen@epa.gov.

Sincerely,

Jonathan D. Edwards
Director
Radiation Protection Division

Enclosure: Second Set of CRA 2014 Completeness Questions

cc: Electronic Distribution
George Basabilvazo, DOE/CBFO
Russ Patterson, DOE/CBFO
Frank Marcinowski, DOE/HQ
Doug Tonkay, DOE/HQ
Alton Harris, DOE/HQ
Ricardo Maestas, NMED
Nick Stone, EPA Region 6
EPA WIPP Team
EPA WIPP Docket

Second Set of EPA Completeness Comments For CRA 2014

194.23 MODELS AND COMPUTER CODES

2-23-1 ROM Salt Panel Closures Locations. Please provide the WIPP configuration layout (a plan view) used for the 2014 CRA that includes all locations where the ROM salt panel closures are to be placed. Provide text that provides the exact location, dimensions and properties for the set of panel closures that lie furthest north in the repository.

2-23-2 Provide An Update of the Derivation of the Shaft Properties at the Repository Horizon. In the BRAGFLO grid for the 2004 and 2009 CRA Performance Assessments (PAs), the modeled lower portion of the shaft included an effective permeability that incorporated both the concrete portion of the shaft (at the repository horizon level) and the furthest north panel closures located just south of the waste and exhaust shafts. The material properties of the modeled shaft (the concrete monolith segment) were combinations of the shaft properties and the Option D panel closure properties (Camphouse and Clayton 2011, ERMS 555204). Now, however, there is a new panel closure system that uses run of mine salt instead of the Option D design, and the properties of new panel closure system are different than that of the concrete portion in the lower shaft. In the CRA 2014 PA, however, it appears the material properties of the shaft at the repository horizon have not been updated to reflect the change. Please confirm this and identify how the properties would change to reflect the change in the panel closure design.

194.33 Future Drilling

2-33-1 Future Drilling Into Nitrate Waste. Please provide the probability and describe the potential consequence(s) to PA calculations of drilling into the nitrate waste.

194.43 Passive Institutional Controls

2-43-1 Changes in Passive Institutional Controls (PICs). Recent Nuclear Energy Agency and International Atomic Energy Agency reports describe changes and developments in international approaches to PICs. These are referenced in INIS-US-13-WM-13145 which states “The DOE/CBFO WIPP PIC's program in place today meets the regulatory criteria, but complete feasibility of implementation is questionable, and may not be in conformance with the international guidance being developed.” Please explain this feasibility concern. Please also provide the complete INIS-US-WM-13145 report (the Web link only provides an Abstract) and any other recent studies or reports that may impact PICs planning in the future.

Reference:

INIS-US-13-WM-13145, “The Revised WIPP Passive International Controls Program – A Conceptual Plan – 13145, Dated 2013-07-01,
Web link: http://www.osti.gov/scitech/biblio/22225507

194.44 Engineered Barriers

2-44-1 MgO Physical Segregation. In Franco (2012) DOE notified EPA that MgO emplacement has been modified by placing a 3,000 pound supersack of MgO on every other waste stack or on each waste stack in every other row. In the Franco 2012 letter the "effective diffusion penetration length of CO_2" was considered but the information on physical segregation is limited.

Please provide updated documentation to more explicitly and clearly address whether the larger lateral separation distance still allows sufficient reactions between MgO and CO_2.

References:

Franco, J.R. 2012. Letter to A. Perrin (Subject: "Planned Change Notice for Placement of MgO Supersacks," with enclosure (Analysis of an alternative placement scheme for MgO supersacks). February 14, 2012. Carlsbad, NM: U.S. Department of Energy Carlsbad Field Office.

U.S. Department of Energy (DOE). 2009. Title 40 CFR Part 191 Subparts B and C Compliance Recertification Application for the Waste Isolation Pilot Plant, Appendix MgO-2009. *Magnesium Oxide as an Engineered Barrie*r. DOE/WIPP 09-3424. Carlsbad, NM: Carlsbad Field Office.

Vugrin, E.D., M.B. Nemer, and S.W. Wagner. 2006. *Uncertainties Affecting MgO Effectiveness and Calculation of the MgO Effective Excess Factor* (Rev. 0, November 17). ERMS 544781. Carlsbad, NM: Sandia National Laboratories.

194.46 Removal of Waste

2-46-1 CCA Appendix WRAC Waste Removal Documentation Needs Updating.
The cited removal plan is basically the same as that given during the 1996 CCA and does not reflect updates and modifications to the repository design and waste characteristics. The Agency found discrepancies between what was used as the removal plan listed in 1996 CCA Appendix WRAC, "Waste Removal after Closure," with the current 2014 repository design, waste, and container characteristics. These are listed below. Please update the waste retrieval plan to address these discrepancies. Please assure that 40 CFR 194.46 requirements "Removal of Waste" still comply and are aligned with expected repository conditions at the time of closure, and that removal of waste remains feasible.

- The repository is no longer mined on one contiguous level [CCA Appendix WRAC page WRAC-7], the southern portion of the mine was moved up to the Clay Seam G level.
- The waste containers have changed. The CCA assumed two principal types of containers (55-gallon drums and standard waste boxes) [CCA Appendix WRAC, page WRAC-8] but with the introduction of large waste boxes, shielded RH-TRU containers, pipe over packs, and super-compacted waste, these assumptions are no longer valid.
- The waste characteristics have changed with the introduction of nitrate waste potentially subject to exothermic reactions.

- The run-of-mine salt panel closure replaced the original concrete-based Option D panel closure design, which can no longer be used "as markers for locating panels and drifts" [CCA Appendix WRAC, Section WRAC.6.4].
- Given the use of shielded containers CH and RH wastes no longer must be segregated in the waste panels [CCA Appendix WRAC, Sections WRAC.4.3, WRAC.6, WRAC.6.4] and can no longer be removed using separate retrieval operations where the RH shielded containers are comingled with CH waste containers.
- CCA Appendix WRAC refers to performance assessment (PA) modeling to predict future characteristics of repository waste rooms. The PA assumptions, models, parameters, and inventory have changed since the CCA. Please include these changes in the waste removal reevaluation.
- CCA Appendix WRAC, Section WRAC.4.3 takes credit for the effectiveness of active and passive controls to deter human intrusion for up to 700 years after closure. However, this credit was denied by EPA because of difficulty predicting the future. This should be removed from the waste removal reevaluation.

References:

U.S. Department of Energy (DOE). 1996. Title 40 CFR Part 191 Compliance Certification Application for the Waste Isolation Pilot Plant (October). CCA Appendix WRAC, Waste Removal After Closure". DOE/CAO-1996-2184. Carlsbad, NM: Carlsbad Area Office.

U.S. Department of Energy (DOE). 1996. Title 40 CFR Part 191 Compliance Certification Application for the Waste Isolation Pilot Plant (October). CCA Chapter 7.0, "Assurance Requirements". DOE/CAO-1996-2184. Carlsbad, NM: Carlsbad Area Office.

U.S. Department of Energy (DOE). 2004. Title 40 CFR Part 191 Compliance Recertification Application for the Waste Isolation Pilot Plant (March). CRA-2004 Chapter 7.0, "Assurance Requirements". DOE/WIPP 2004-3231. Carlsbad, NM: Carlsbad Field Office.

U.S. Department of Energy (DOE). 2009. Title 40 CFR Part 191 Compliance Recertification Application for the Waste Isolation Pilot Plant (March). CRA-2009 Section 46, "Removal of Waste" DOE 09-2434. Carlsbad, NM: Carlsbad Field Office.

194.55 Results of Compliance Assessments

2-55-1 Incorrect Reference. Appendix IGP-2014, Section IGP-2.1 makes reference to 194.55(b)(1), should this be 194.54(b)(1) "Existing boreholes…"?

Chemistry Comments

2-C-3 Data Supporting Water Balance Assumptions. The CRA-2014 PA calculations include the effects of MgO hydration, microbial degradation of CPR and iron sulfide formation on repository water balance. For PA, it is assumed that hydrogen sulfide created by CPR degradation preferentially reacts with iron hydroxide versus metallic iron (CRA-2014 Appendix MASS, page MASS-57). These hydrogen-sulfide reactions are:

$$Fe(OH)_2(s) + H_2S(g) \rightarrow FeS(s) + H_2O(l) \quad (1)$$

$$Fe(s) + H_2S(g) \rightarrow FeS(s) + H_2(g) \quad (2)$$

The assumption that hydrogen sulfide preferentially reacts with iron hydroxide increases brine production and decreases gas production compared to the assumption that all or some of the hydrogen sulfide reacts with metallic iron.

It is also assumed for PA that carbon dioxide preferentially reacts with brucite instead of unreacted MgO. The carbonation reactions are:

$$1.25\ Mg(OH)_2(s) + CO_2(g,aq) \rightarrow 0.25\ Mg_5(CO_3)_4(OH)_2 \bullet 4H_2O(s) \quad (3)$$

$$1.25\ MgO(s) + CO_2(g,aq) + 1.25\ H_2O(l) \rightarrow 0.25\ Mg_5(CO_3)_4(OH)_2 \bullet 4H_2O(s) \quad (4)$$

The assumption that carbon dioxide preferentially reacts with brucite increases brine production in the repository.

Please provide supporting data for these water-balance assumptions and evaluate the potential magnitude of the effects of these assumptions on the water balance.

2-C-4 Hydromagnesite Conversion Rate. Clayton (2013) formulated the conversion reaction from hydromagnesite to magnesite for inclusion in the BRAGFLO calculations as:

$$Mg_5(CO_3)_4(OH)_2 \bullet 4H_2O(s) \rightarrow 4\ MgCO_3(s) + Mg(OH)_2(s) + 4\ H_2O(l) \quad (5)$$

Clayton (2013) calculates a range for the hydromagnesite conversion rate based on reaction times of 100 years to 10,000 years. However, the minimum reaction time for this conversion is uncertain. SCA (2008) reviewed the available experimental and natural analogue data and concluded that hydromagnesite conversion is best represented by a range of zero conversion (only hydromagnesite remains after 10,000 years) to complete conversion (only magnesite remains after 10,000 years), with a uniform distribution across this range. Please provide an explanation as to why the specific upper and lower limits used in the PA were picked.

The effect of using zero rather than 100 years as the minimum conversion rate is likely to be less brine production in the water balance, based on equation (5). Please provide an explanation of the effects on PA if the lower limit of the hydromagnesite conversion rate is set to zero while the upper limit is decreased by a variety of plausible factors that are less than what Clayton had adopted.

References:

Clayton, D.J. 2013. Justification of Chemistry Parameters for Use in BRAGFLO for AP-164, Rev. 1. Sandia National Laboratories, ERMS 559466.

SCA (S. Cohen and Associates). 2008. Review of MgO-Related Uncertainties in the Waste Isolation Pilot Plant. Final Report prepared for the U.S. Environmental Protection Agency Office of Radiation and Indoor Air, Washington, D.C., January 24, 2008.

2-C-5 Cumulative Effects of Water Balance Assumptions on PA. The result of several water balance assumptions is to increase brine production from waste reactions in the repository. These assumptions include that hydrogen sulfide will preferentially react with iron hydroxide instead of metallic iron (Comment 2-C-3); that carbon dioxide will preferentially react with brucite instead of MgO (Comment 2-C-3); and that the minimum rate of hydromagnesite conversion to magnesite is greater than zero (Comment 2-C-4). Please provide a description of the cumulative effects of these assumptions on the water balance calculations for the CRA-2014 PA.

2-C-6 MgO Hydration Rate. MgO has been supplied for the WIPP engineered barrier by three vendors: National Magnesia Chemicals, Premier Chemicals, and, currently, from Martin Marietta Magnesia Specialties (Martin Marietta). The majority of the MgO in the repository is from Premier Chemicals and Martin Marietta. Clayton (2013) used MgO hydration rates obtained from experiments conducted with MgO supplied by Premier Chemicals to establish the hydration rates used in PA. However, Wall (2005) performed preliminary tests with the Martin Marietta MgO and concluded that it reacted to form brucite faster than Premier MgO. Given the multiple vendors that supply MgO a summary of the following information needs to be provided;

- The inundated and humid MgO hydration rates for MgO from the three vendors.
- The potential effects of the variable MgO hydration rates on repository performance.
- The amounts of National Magnesia Chemicals, Premier MgO and Martin Marietta MgO that will be present in the WIPP repository at the time of closure, and assumptions regarding the future source(s) of MgO.

References:

Clayton, D.J. 2013. Justification of Chemistry Parameters for Use in BRAGFLO for AP-164, Rev. 1. Sandia National Laboratories, ERMS 559466.

Deng, H., M. Nemer, and Y. Xiong. 2007. Experimental Study of MgO Reaction Pathways and Kinetics Rev. 1. Sandia National Laboratories TP 06-03.

Deng, H., Y. Xiong, M. Nemer and S. Johnsen. 2009. Experimental Work Conducted on MgO Long-Term Hydration. Sandia National Laboratories ERMS 551421.

Wall, N.A. 2005. Preliminary Results for the Evaluation of Potential New MgO. Sandia National Laboratories ERMS 538514.

2-C-7 MgO Hydration Rate Data File. Please provide a copy of the Microsoft Excel file “hydration kinetics Q & HY2 & HH djc 5-1-07.xls” used by Nowak and Clayton (2007) to calculate the MgO hydration rates.

References:

Nowak, E.J. and D. Clayton. 2007. Analysis of MgO Hydration Laboratory Results and Calculation of Extent of Hydration and Resulting Water Uptake versus Time under Postulated WIPP Conditions. Sandia National Laboratories ERMS 546769.

2-C-8 Iron and Lead Corrosion Rate Data. Please provide spreadsheets containing the iron and lead corrosion data listed in Appendix A, Tables A-1 and A-2 from Roselle (2013).

References:

Roselle, G.T. 2013. Determination of Corrosion Rates from Iron/Lead Corrosion Experiments to be Used for Gas Generation Calculations. Sandia National Laboratories ERMS 559077.

194.32 Scope of Performance Assessment

Since the original certification decision changes have been made to the repository, it is our observation that, for many of the features, events, and processes (FEPs) we have reviewed, DOE has not fully considered all of the relevant changes to the repository. Additionally, DOE has not fully considered updates relevant to activities within the WIPP vicinity. Table FEP-1 lists our comments on specific FEPS; immediately below we discuss general FEP screening issues that need further attention.

2-32-G1 Obsolete FEP Screening Arguments, Curtailed FEP Screening Arguments, and Completeness Considerations. The screening arguments in the CRA-2014, Appendix SCR-2014 for many FEPs have been carried forward from past baseline reviews and do not necessarily reflect changes that have occurred in the past several years. This especially applies to information on how some FEPs are accounted for in PA. Some FEPs need to be updated to reflect current repository design and new knowledge of repository behavior. These are identified in Table FEP-1.

For some FEPs, the screening argument needs to provide a more complete discussion of the FEP and how it is determined to be screened-in or screened-out. The supporting arguments, along with documents incorporated by references, need to provide a basic understanding of how the FEP is accounted for in PA calculations, where the FEP is accounted for in the repository region and surrounding geosphere, and when in the regulatory time frame the FEP is accounted for. Those FEPs with inadequate or curtailed screening arguments are provided in Table FEP-1.

For some FEPs that DOE has reported “no change”, EPA disagrees and believes that DOE should reconsider and update the FEP discussion. Table FEP-1 includes those FEPs in this category that EPA has identified, to date, as being incomplete.

FEP-1. EPA Specific Comments on Incomplete DOE CRA-2014 FEPs

FEP	DOE Reported Change	EPA Comments
H21 Drilling Fluid Flow	No Change	2-32-S1. Screening argument considers only boreholes intersecting the waste region. Please supplement the argument with a discussion of boreholes that intersect the non-waste regions and the consequence to PA calculations. Provide references and specific information as to whether boreholes penetrating non-waste regions could result in the transport of radionuclides between the waste and non-waste regions, to overlying units, or to the surface. Provide information, either directly or by reference, as to how deep boreholes penetrating the non-waste and waste regions of the repository are accounted for in the PA.
H22 Drilling Fluid Loss	No Change	2-32-S2. The screening argument considers flow into the repository from boreholes that intercept pressurized fluid in underlying formations but only for boreholes intersecting the waste region. In the current BRAGLO model gas and brine readily flow between the waste and non-waste regions. A discussion and analysis of boreholes that could intersect the non-waste regions and their impact on the PA needs to be provided.
H23 Blowouts	Updated with new value of parameter GLOBAL:PBRINE	2-32-S3. Screening argument considers only boreholes intersecting the waste region and also pressurized Castile brine. In the current BRAGLO model gas and brine readily flow between the waste and non-waste regions. Please supplement the argument with a discussion and analysis of boreholes that could intersect the non-waste regions on the PA.
H28 Enhanced Oil and Gas Production	No Change	2-32-S4. Please address whether enhanced production techniques are being used in the Delaware basin and in the vicinity of WIPP. Please also address the potential for these techniques to create a preferential pathway for radionuclide releases through a second well.
H58 Solution Mining	Updated with information regarding solution mining activities in the region	2-32-S5. This FEP is screened out partially on the basis that solution mining will not occur in low ambient temperature conditions. However, solution mining is occurring in the nearby Eddy mine under similar conditions that exist in the vicinity of WIPP. Please provide text that reconciles the basis of the screening argument and the conditions at the Eddy mine where solution mining is taking place.
W1 Disposal Geometry	Updated with new information	2-32-S6. In the screening argument please provide evidence that the modeled excavated volume is the expected mined volume of the underground workings at the time of closure.
W3 Heterogeneity	Updated to reflect the inventory data	2-32-S7 The screening argument citation of the CCA as the source of information on the

FEP	DOE Reported Change	EPA Comments
of Waste Forms	sources used for the CRA-2014 PA	heterogeneity of waste forms ignores changes that have occurred in the past 15 years, including supercompacted waste and mingling RH waste in shielded containers with CH waste. Please update the information to reflect current waste forms.
W5 Container Material Inventory	Updated to reflect the inventory data sources used for the CRA-2014 PA	2-32-S8. Please supplement the screening argument with an explanation of the implementation in PA of the material inventory of shielded containers containing RH waste.
W18 Disturbed Rock Zone (DRZ)	Updated to include new panel closure implementation	2-32-S9. The screening argument for this FEP states "This excavation-induced, host-rock fracturing is accounted for in PA calculations (the CCA, Chapter 6.0, Section 6.4.5.3)." The cited CCA text indicates that the DRZ is modeled in the same way around all repository excavations. However, the DRZ is now expected to vary spatially. Provide an updated description of the DRZ in the waste and non-waste locations of the repository.
W19 Excavation-Induced Changes in Stress	Updated to include new panel closure implementation	2-32-S10. Screening argument was combined with that for W18 *Disturbed Rock Zone (DRZ)*; please see comments for FEP W18.
W20 Salt Creep	Updated to include new panel closure implementation	2-32-S11. Please supplement the screening argument with a discussion of salt creep and consolidation specific to the ROM salt in the ROMPCS, and healing of the adjacent DRZ. Such a discussion can be found in Camphouse et al. (2012, Section 2.0. ERMS 557396). The screening argument for this FEP states that "Salt creep in the Salado is accounted for in PA calculations (the CCA, Chapter 6.0, Section 6.4.3.1)." The cited CCA section discusses these FEPs only in the context of the waste region. In addition, this is the only FEP that addresses DRZ healing, which is expected to vary spatially.
W21 Changes in the Stress	Updated to include new panel closure implementation	2-32-S12. Screening argument was combined with that for W20 *Salt Creep*; please see comments for FEP W20. Additionally, please supplement the screening argument with discussions of 1) the coupling between consolidation of the ROM salt in the ROMPCS and healing of the adjacent DRZ (DRZ healing cannot occur until the ROM salt is consolidated and applies a back stress sufficient to compress and heal the DRZ); and 2) lateral extrusion of the ROM salt when under compressive stress from drift creep closure.

FEP	DOE Reported Change	EPA Comments
W25 Disruption Due to Gas Effects	No Change	2-32-S13. Please supplement the screening argument with a discussion of the potential for high waste panel gas pressures to delay the consolidation of the ROM salt, thereby maintaining a higher permeability in the PCS for a longer period of time.
W27 Gas Explosions	No change	2-32-S14. Please update the screening argument to reflect the LANL inventory with nitrates and added organic matter that resulted in an exothermic reaction.
W28 Nuclear Explosions	Updated to reflect the inventory used for the CRA-2014 PA	2-32-S15. Please modify the screening argument to address whether, in addition to "a reduction of TRU radionuclides from previous estimates", the quantities of fissile radionuclides have also been reduced.
W40 Brine Inflow	Updated to reflect water balance implementation in PA	2-32-S16. Please supplement the screening argument with information on the impacts of changes in GLOBAL:PBRINE and the PCS on brine inflow.
W42 Fluid Flow Due to Gas Production	Updated to reflect water balance implementation in PA and new steel corrosion rates	2-32-S17. Please supplement the screening argument with information on the impacts of changes in GLOBAL:PBRINE and the PCS on the availability of brine in the waste panels.
W44 Degradation of Organic Material	Updated to reference new inventory data	2-32-S18. Please supplement the screening argument with an expanded discussion of the importance of the availability of brine on the degradation of organic material. Changes that affect the availability of brine in a waste panel, such as the water balance implementation, the revised value of GLOBAL:PBRINE, and the properties of the ROMPCS and associated DRZ, will affect this FEP.
W45 Effects of Temperature on Microbial Gas Generation	Updated to reference new inventory data	2-32-S19. Please modify the screening argument to acknowledge the reduced thermal impact of seal concrete hydration because of the elimination of additional explosion walls and the Option D monolith.

FEP	DOE Reported Change	EPA Comments
W53 Radiolysis of Cellulose	Screening argument updated with new radionuclide inventory	2-32-S20.The reported reason for the screening argument update is not consistent between Table SCR-1, where the update is due to new radionuclide inventory, and Section SCR-6.5.1.7.2 where the update is due to new cellulose inventory. The screening argument in Section SCR-6.5.1.7.3 refers only to the new radionuclide inventory. Please reconcile the information.
W72 Exothermic Reactions	No change	2-32-S21. Please supplement the screening argument with a discussion of the impact of exothermic reactions in the waste panels.
W73 Concrete Hydration	Updated to reflect the inventory used for the CRA-2014 and planned thermal experiments	2-32-S22. Please supplement the screening argument with a discussion of the impact on the PA based on a reduced concrete inventory due to DOE now not using the Option D concrete monoliths in the panel closure system. Update the analysis to include where explosion walls are or will be installed.
W110 Panel Closure Physical Properties	Updated with new information on panel closure design	2-32-S23. Please update the screening argument to provide a description of the as-emplaced properties of the ROM salt now that *in situ* testing has been completed.
W111 Panel Closure Chemical Composition	Updated with new information on panel closure design	2-32-S24. Please update the screening argument to include the chemical composition of the steel bulkheads that are part of the panel closure design.
W113 Consolidation of Panel Closures	Updated screening argument with new information regarding panel closure composition	2-32-S25. Please supplement the screening argument with information on consolidation specific to the ROM salt in the ROMPCS. Such a discussion can be found in Camphouse et al. (2012, Section 2.0. ERMS 557396).
W115 Chemical Degradation of Panel Closures	Updated screening argument with new panel closure materials	2-32-S26. The screening decision for this FEP was changed from UP (screened in) to SO-P (screened out – low probability). Please supplement the screening argument with a discussion of the chemical degradation of the steel bulkheads, which are part of the ROM salt panel closure system. Please also provide technical justification for the changed screening decision in light of the presence of the bulkheads.

References

Camphouse, R., M. Gross, C. Herrick, D. Kicker, and B. Thompson 2012b. Recommendations and Justifications of Parameter Values for the Run-of-Mine Salt Panel Closure System Design Modeled in the PCS-2012 PA. Sandia National Laboratories. Carlsbad, NM, May 3. ERMS 557396.

Kirkes, G.R. 2013. *Features, Events and Processes Assessment for the Compliance Recertification Application—2014 (Revision 0).* ERMS 560488. Carlsbad, NM: Sandia National Laboratories.