December 22, 2008

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of: U.S. DEPARTMENT OF ENERGY (High Level Waste Repository)	Docket No. 63-001

CLARK COUNTY, NEVADA'S REQUEST FOR HEARING, PETITION TO INTERVENE AND FILING OF CONTENTIONS

Pursuant to 10 CFR § 2.309 and the notice published by the Nuclear Regulatory Commission ("NRC" or "Commission") at 73 Fed. Reg. 63,029 (October 22, 2008), Clark County, Nevada ("Clark County") hereby submits this Request for Hearing, Petition to Intervene and Filing of Contentions in the captioned proceeding. This proceeding involves the Department of Energy's ("the DOE's") application before the Nuclear Regulatory Commission ("the NRC") for a license to construct a high level radioactive waste and spent fuel repository at Yucca Mountain in Nye County, Nevada.

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ATTACHMENTS

Attachment 1: Affidavit of Dr. Alvin Mushkatel

Attachment 2: Affidavit of Dr. Sheila Conway

Attachment 3: Affidavit of Eugene I. Smith

Attachment 4: Affidavit of Dennis Bley

Attachment 5: NTS, "Stockpile Stewardship Program" (2004)

Attachment 6: "National Security and Nuclear Weapons: Maintaining Deterrence in the 21st Century" (July 2008)

Attachment 7: United States Government Accountability Office, "Nuclear Waste: Action Needed to Improve Accountability and Management of DOE's Major Clean-up Projects," GAO-08-1081 (September 2008)

Attachment 8: United States Department of Energy, Office of Inspector General, "Memorandum for the Secretary" (April 23, 2001)

Attachment 9: "Going the Distance? The Safe Transport of Spent Nuclear Fuel and High-Level Radioactive Waste in the United States." Committee on Transportation of Radioactive Waste. National Research Council of the National Academies: The National Academies Press; Washington, D.C. (2006)

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Attachment 11: UER, "Sustainable Indicators Report." Prepared for the Clark County Department of Comprehensive Planning Nuclear Waste Division. (Jan 2001)

Attachment 12: UER, "Community visioning report on behalf of the town of Indian Springs, Clark County, Nevada." Prepared for the Clark County Department of Comprehensive Planning Nuclear Waste Division (Feb 2004)

Attachment 13: UER, "Clark County Monitoring Program: Community Survey." Prepared for the Clark County Department of Comprehensive Planning Nuclear Waste Division (Apr 2008)

Attachment 14: UER, "Clark County Monitoring Program: Community Survey." Prepared for the Clark County Department of Comprehensive Planning Nuclear Waste Division (May 2007)

Attachment 15: UER, "Clark County Monitoring Program: Community Survey." Prepare for the Clark County Department of Comprehensive Planning Nuclear Waste Division (Feb 2006)

Attachment 16: UER, "Clark County Monitoring Program: Community Survey." Prepared for the Clark County Department of Comprehensive Planning Nuclear Waste Division (Jul 2006)

Attachment 17: Schweer, K. UNLV Center for Business and Economic Research (2001)

I. INTRODUCTION

A. Name of Party

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C. Standing

Clark County enjoys standing as a matter of right as an Affected Unit of Local Government,[1] and is therefore deemed to have demonstrated the standing elements of 10 CFR 2.309 of the Commission's regulations.[2] Clark County herein submits 15 contentions, thus satisfying the requirements of § 2.309(d)(2).[3]

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[1] The Secretary of Energy granted Clark County's request for AULG status on April 21, 1988.

[2] 73 Fed. Reg. 63,029 at 63030 (October 22, 2008) ("Any AULG seeking party status shall be considered a party to this proceeding, provided that it files at least one admissible contention in accordance with 10 CFR 2.309. An AULG need not address the standing requirements under that section.")

[3] In the event Presiding Officer does not admit any of Clark County's contentions, Clark County respectfully requests leave to participate as an Interested Governmental Participant pursuant to 10 CFR Section 2.315(c). The County's representative for the purposes of said hearing is the Clark County Commission. The County will identify those contentions on which it wishes to participate within the time frame established by the Commission.

D. Joint Contentions

Clark County is not submitting any joint contentions at this time. However, Clark County will review the contentions raised by other parties and will evaluate whether to pursue any such contentions jointly.

II. CONTENTIONS

Clark County's contentions are as follows:

1. A brief statement of the contention

Treatment of uncertainty in the Safety Analysis Report[4] ("SAR") is neither complete, integrated, nor unbiased. Three important sources of uncertainty that impact the SAR results – data assumptions, model assumptions, and methods assumptions – appear in the SAR primarily as assumptions, screening "analyses," and claims of conservatism, presented without associated technical bases. As a result, risk could be much higher than calculated. The DOE's evaluation of risk is therefore unreliable and fails to comply with the safety requirements of 10 CFR Part 63.

2. A summary of the basis for the contention

There are many potential sources for uncertainty in the results of the SAR. Some sources are due to aleatory effects (randomness) and some are epistemic (the result of lack of knowledge). Both kinds of uncertainty must be treated properly if the results of the analysis are to be meaningful. The pre-closure safety analysis (Chapter 1 of the SAR, LSN# DEN001592183) omits justifications for many assumptions, screening analyses, and claims of conservatism, rendering the results of the analysis unreliable. Examples of improper treatment of uncertainty are provided in Section 5 of this contention, but the

[4] United States Department of Energy, Office of Civilian Radioactive Waste Management, "Yucca Mountain Repository License Application Safety Analysis Report," DOE/RW-0573, Rev.0, June 2008. LSN# DEN001592183.

omissions are so pervasive that the examples provided are merely illustrative of a systemic problem.

The Total System Performance Assessment[5] ("TSPA"), which is the basis of the post-closure safety analysis in Chapter 2 of the SAR, (LSN# DEN001592183) is a detailed and complex analysis that links together physical, chemical, and biological models of processes that could lead to eventual release and transport of radionuclides from buried wastes. The complexity and long time period of the analysis require that the uncertainties be clearly identified and more carefully executed and documented than is the case in DOE's SAR.

There are three primary ways in which these sources of uncertainty enter the SAR:

1) Data assumptions – the database, including accuracy of the data and its applicability to the problem at hand, as well as the results of expert elicitation; both should properly reflect the kind and extent of uncertainty in the data.
2) Model assumptions – models are abstractions of reality; the results of the model may diverge from reality because of randomness or because the models do not reflect the true state of the world over time. Alternative models should be considered in the uncertainty treatment.
3) Methods assumptions – methods used for developing expressions of uncertainty and for combining models and uncertainties must be theoretically correct and must be implemented appropriately.

As required by 10 CFR Part 63 paragraphs 10, 21, 101, 114, and 311, uncertainty must be thoroughly addressed qualitatively and quantitatively if the results are to be adequate to support licensing of the facility. Qualitatively, the analysis must properly characterize all

[5] Sandia National Laboratories, "Total System Performance Assessment Model/Analysis for the License Application Volume III." Prepared for: U.S. Department of Energy Office of Civilian Radioactive Waste Management Office of Repository Development, LSN# DEN001579005.

uncertainties in all aspects of the model. Quantitatively, the uncertainty must be treated in an integrated and justified way; dependencies must be addressed.

As outlined above, assumptions at every stage of the analysis are directly related to the uncertainty in the results. There are many ways in which the assumptions used in developing the analysis could be upset. Examples of the types of assumptions that often cause problems that Clark County has identified in the SAR are detailed in Section 5 of this contention, and include:

- Conservative assumptions in one area, which, while seemingly benign, can mask real problems elsewhere;
- Assumed applicability of data -- lack of thorough review of databases for accuracy, applicability, and their representation of uncertainty can introduce untracked errors;
- Errors and damage that might occur during pre-closure activities can negate assumptions about placement and condition of casks that are essential to the TSPA; and,
- Failure to evaluate alternative assumptions can mask key problems and does not allow complete treatment of uncertainty.

When uncertainty is broad, extreme high values control the mean; i.e., if some low probability, high consequence possibilities are screened, then the mean value will underestimate the risk.

3. A demonstration that the contention is within the scope of the hearing

This contention raises an issue whether the DOE has complied with the NRC requirements applicable to Yucca Mountain, and falls within the scope of the hearing as specified in section II, paragraph 1 of the Notice of Hearing. Incomplete or poorly integrated treatment of the uncertainty associated with the analysis of the Yucca

Mountain Repository, including errors in the assumptions and screening activities in the TSPA and SAR, could mean that the risk is greater than reported in the TSPA and SAR. 10 CFR Part 63 is risk-informed and performance-based. Risk of health effects to the reasonably maximally exposed individual is the basis for its performance objectives.[6] The issue of inadequate treatment of uncertainty thus lies within the scope of the proceeding, as described in the NRC's Notice of Hearing.[7]

4. A demonstration that the contention is material to the findings the NRC must make to license Yucca Mountain

Under 10 CFR § 63.31(a)(2), the NRC may authorize construction of the repository at Yucca Mountain if it determines that there is a reasonable assurance or expectation the materials described in the Application can be disposed of without unreasonable risk to the health and safety of the public. In reaching this determination, 10 CFR § 63.31(a)(3) requires that the site and design comply with Subpart E, Technical Criteria, of 10 CFR Part 63, and that the DOE's proposed operating procedures to protect health and to minimize danger to life or property are adequate.

Subpart E, 10 CFR § 63.111 requires a pre-closure safety analysis that meets the requirements of § 63.112: That the safety analysis include the technical basis for either inclusion or exclusion of specific, naturally occurring and human-induced hazards in the safety analysis; an analysis of the performance of the structures, systems, and

[6] USNRC, "Yucca Mountain Review Plan: Final Report" NUREG-1804, Rev. 2, Washington, July 2003. LSN# DEN001414954.

[7] 73 Fed. Reg. 63029 (October 22, 2008).

components to identify those that are important to safety and their performance; and evaluation of possible mitigation measures.

Subpart E, 10 CFR §§ 63.113 and 63.114 requires a post-closure performance assessment that accounts for uncertainties and variabilities in parameter values, accounts for alternative conceptual models, and provides the technical bases for all aspects of the analysis. Furthermore, 10 CFR § 63.10 requires that the information required by the Commission's regulations is complete and accurate in all material respects. Failure to properly consider uncertainty or to document the basis for its treatment can render this information materially incomplete and inaccurate.

5. A concise statement of facts or expert opinions supporting the contention, along with appropriate citations to supporting scientific or factual materials

10 CFR Part 63 establishes risk-informed and performance-based requirements for licensing that underscore the importance of proper and complete consideration of uncertainty. The report of the Independent Performance Assessment Review ("IPAR") Panel[8] states that:

> An overarching requirement is that the uncertainties associated with the future performance of the repository be understood and quantified. . .This focus on uncertainties is driven by the complexities of the processes that may lead to the release of radionuclides from the repository and the extremely long periods of time over which the repository performance is to be evaluated (10,000 and 1,000,000 years after closure).

[8] George E. Apostolakis, G.E., Chair, R.G. Ballinger, C. Fairhurst, M. Gascoyne, L. Smith, and C.G. Whipple, "Report of the Independent Performance Assessment Review (IPAR) Panel" prepared for Sandia National Laboratories Yucca Mountain Project, March 21, 2008. LSN #: DEN001598189.

Therefore, treatment of uncertainty must be held to a high standard. In an analysis that seeks to quantify all events with probabilities greater than 1 chance in 10,000 over 10,000 years (1×10^{-8} per year), uncertainty is the key to an adequate analysis; it must be thoroughly treated, allowing for the wide variety of possible futures as well as uncertainty in underlying assumptions, models, and data. This is a very high standard, and the DOE's failure to adhere to it renders the long-term results of the TSPA and SAR unreliable, which in turn fails to provide reasonable assurances of safety.

Clark County's review of the SAR and existing formal reviews identify a number of cases where the treatment of uncertainty, including the assumptions and screening criteria, are not fully justified.[9] Supporting facts for this contention are detailed in the Table below, and include a number of examples that demonstrate a systematic problem in the Application--a problem that is pervasive in the documentation and appears to be widespread in the actual analysis.

The difficulty in evaluating the DOE's assessment of risk can be demonstrated as follows: The risk assessment is made of many analyses that interact. One such analysis is the human reliability analysis ("HRA") in the pre-closure PRA. Only five pages of the entire SAR are devoted to an explanation of the HRA (SAR Section 1.7.2.5 pp 1.7-35 to 1.7-39). These pages simply describe the approach and outline two examples. There is no roadmap showing how details of the HRA are incorporated. The reference list of SAR 1.7.6 General References simply points to 14 Bechtel SAIC Company technical reports on specific aspects of the pre-closure PRA event sequence analysis. To unravel the

[9] Clark County considered whether each of the examples provided in the Table included in this contention should be entered as separate contentions and concluded that the examples illustrate a systematic problem.

analysis one must turn to one of the reports referenced in the DOE's summary; for example, the report on reliability and event sequence analysis of the canister receipt and closure facility.[10] However, in that report the DOE simply provides another brief summary and reference to another document. Following the thread to Appendix E of that document, there is a 231 page HRA report. Similar lengthy reports are associated with each aspect of the facility. There are literally thousands of pages of detailed HRA and that is only one element of the complete analysis. Thus, although this is one example, it is representative of the difficulty in unraveling the analysis throughout the Application.

The NWTRB, TSPA IPAR review, and the NRC staff apparently agree that the issue identified in this contention is relevant, legitimate and pervasive:

- In a letter to the DOE, the NWTRB observed[11] that in the area of integration of waste acceptance/transportation with repository operations, "DOE has analyzed a single scenario based on certain optimistic assumptions" and noted that different conditions than assumed could be very important. (An example of not examining alternative models.) They also suggested that there seems to be a lack of understanding of the surface facility design's technical basis and that integrated throughput analysis that considers possible off-normal events is necessary to understand uncertainty in actual performance. (Once again, lack of complete treatment of uncertainty can provide misleading or incomplete results.) Finally, they pointed out that the feasibility of unique components and operations has not been confirmed, which also portends uncertainty in actual operations. (An example of failure to consider uncertainties in model assumptions and data applicability.)
- IPAR's identification of the unsupported "conservative" treatment of SCC allowed an inappropriate screening of alternative corrosion models.
- NRC staff have identified, in a growing number of Requests for Additional Information ("RAIs"), issues where DOE has not provided a technical basis for assumptions in the analyses, alteration of methods for calculations, claims of conservatism, and apparently the use of inappropriate data. Several of these are

[10] "Design Calculation or Analysis: Canister Receipt and Closure Facility Reliability and Event Sequence Categorization Analysis," BSC 2008b. LSN#DEN001578955.

[11] Garrick, B.J, letter from US Nuclear Waste Technical Review Board to E.F. Sproat, DOE, November 5, 2008. LSN # NEN000000780.

actually included in the Table below, e.g., items in the table associated with DOE's aircraft crash analysis (1.1.2, 1.1.3, 1.1.4, 1.2.1, 1.3.2, 2.1.7, 3.2.1, and 3.2.2) are also raised in NRC RAIs[12].

The NRC staff have already begun the process of identifying specific cases in their RAIs, and from the examples cited above, there appear to be an unprecedented number of them. The NRC staff should not be forced to identify, essentially by audit, such a pervasive list of items lacking adequate analysis and documentation -- these are items that the DOE was obliged under Part 63 to present in the Application. In fact, the DOE failed to provide these items. The licensing process would be better served by directing the DOE to provide at the outset all requisite documentation and technical bases for its data, modeling, and methods assumptions which are required by 10 CFR Part 63. An analogy from quality assurance ("QA") makes the point. In *Quality is Free*[13], Philip Crosby notes that the purpose of QA is to confirm that quality is present in a product. QA cannot build quality into a defective product. The place to do it right is in the design (when it is "free" if the design process is working properly), not in the review.

Finally, the lack of transparency in the DOE's SAR makes it more difficult for interested parties to perform independent verifications and analyses, particularly when resources are thin. It is not possible for Clark County to identify all of the DOE's cases of insufficient treatment of uncertainty due to the limited resources and time to submit this contention, and because they are spread throughout the thousands of pages of

[12] USNRC, Request for Additional Information (RAI), Volume 3—Postclosure Chapter 2.2.1.2.2—Event Probabilities (Department of Energy's Safety Analysis Report Sections 2.3.6.6, 2.3.6.8.4, 2.2.2.3) LSN# NRC000029843.

[13] Crosby, P.E., *Quality is Free*, New American Library, Penguin Putnam, New York 1980.

supporting documents to the Application. However, the examples are sufficient to demonstrate the DOE's errors.

CLK-SAFETY-001, Table 1. POTENTIAL IMPACTS OF UNCERTAINTY [aleatory (randomness) & epistemic (incomplete knowledge)]

UNCERTAINTY Due to:	PROBLEMS Found in SAR[14]		
	Unjustified Assumptions	**Inappropriate Screening "Analyses"**	**Unsubstantiated Claims of Conservatism**
Data Assumptions	Generic Implications: Data collected from events that differ from the case being modeled and extrapolating data to new conditions can lead to underestimating risk. 1.1.1 Database Not Reviewed. IPAR pointed out that they had not reviewed the database used in the analysis. It is not clear that any thorough outside review of the databases used in the SAR was performed.	Generic Implications: Improper screening of data can badly distort analysis results. Censored data requires a physical and statistical basis. Both can lead to overly optimistic results. 1.2.1 Screening of Real Events. Analysis supporting SAR 1.6.3.4.1 in BSC 20007c LSN#DN2002406192 censors data for mishaps with unknown distances to crash and unknown glide ratios, without developing a suitable uncertainty approach to account for them.	Generic Implications: Even if conservative under considered condition, it is often used under other conditions elsewhere in the model, where it can underestimate risks. 1.3.1 IPAR review on SCC and Wedging. The 2008 IPAR review[15] identified a case where an improper assumption of conservatism hid important information that could mean the results do not reflect a real, physical form of corrosion. "Conservative" modeling of stress corrosion cracking (SCC) led to the assumption that SCC would occur and therefore an alternative mechanism, oxide wedging, would not have a chance to occur and need not be modeled (i.e., it could be screened from further consideration). IPAR pointed out that SCC is almost certainly precluded by conditions at the burial vault. Therefore it is improper to

[14] Numbering for reference only; represents items in each cell of the 3x3 matrix:

	Unjustified Assumptions	Inappropriate Screening	Unsubstantiated Conservatism
Data Assumptions	1.1.x	1.2.x	1.3.x
Model Assumptions	2.1.x	2.2.x	2.3.x
Methods Assumptions	3.1.x	3.2.x	3.3.x

[15] George E. Apostolakis, G.E., Chair, R.G. Ballinger, C. Fairhurst, M. Gascoyne, L. Smith, and C.G. Whipple, "Report of the Independent Performance Assessment Review (IPAR) Panel" prepared for Sandia National Laboratories Yucca Mountain Project, March 21, 2008. LSN # DEN001598189.

CLK-SAFETY-001, Table 1. POTENTIAL IMPACTS OF UNCERTAINTY [aleatory (randomness) & epistemic (incomplete knowledge)]

UNCERTAINTY Due to:	PROBLEMS Found in SAR[14]		
	Unjustified Assumptions	**Inappropriate Screening "Analyses"**	**Unsubstantiated Claims of Conservatism**
			screen out oxide wedging. The impact on risk must be determined.
Data Assumptions	1.1.2 Incomplete Basis. Analysis supporting SAR 1.6.3.4.1 (LSN # DEN001592183) in BSC 2007c (LSN#DN2002406192) cites unavailable references for an assumed exponential decay factor in the Solomon model for flights through the Beatty Corridor and fails to justify truncated range for the factor. Does data or a model support this? 1.1.3 Incomplete Basis. Analysis supporting SAR 1.6.3.4.1 (LSN # DEN001592183) in BSC 2007c (LSN#DN2002406192) provides no basis for the claim that all midair collisions and flights into terrain occur during maneuvering. No uncertainty analysis is provided. Does data or a model support this? 1.1.4 Incomplete Basis. Analysis supporting SAR 1.6.3.4.1 (LSN # DEN001592183) in BSC 2007c (LSN#DN2002406192) uses its Table 10 to support the analysis of aircraft crash, without providing a technical basis for the table. Does data or a model support this?		1.3.2 No Supporting Data. Analysis supporting SAR 1.6.3.4.1 (LSN # DEN001592183) in BSC 2007c (LSN#DN2002406192) claims that it is conservative to assume that overflights of the restricted area occur at an altitude of 14,000 feet, without providing the technical basis analysis.

CLK-SAFETY-001, Table 1. POTENTIAL IMPACTS OF UNCERTAINTY [aleatory (randomness) & epistemic (incomplete knowledge)]

UNCERTAINTY Due to:	PROBLEMS Found in SAR[14]		
	Unjustified Assumptions	**Inappropriate Screening "Analyses"**	**Unsubstantiated Claims of Conservatism**
Model Assumptions	Generic Implications: Wrong model can completely miss important phenomena that govern a physical process, potentially underestimating risk. Using one model, when epistemic uncertainty requires weighting the results from several possible models can underestimate risk.	Generic Implications: Screening of models ignores the possibility of other models being appropriate under specific conditions, which can have high risk significance	Generic Implications: The most common misuse of conservatism is in cases where an assumption that is conservative under one condition can be overly optimistic in another. Failing to consider other conditions can grossly underestimate risk. "Conservatively" assuming one mechanism occurs can mask other important mechanisms. Some claims are not conservatisms at all, but simply crude estimates of possible uncertainty; e.g., attempting to account for possible future growth.
	2.1.1 No Deliquesance. The DOE analysis assumed deliquesance would not occur. While IPAR agreed that later work made this assumption likely true, the NWTRB disagreed very strongly[16]. Furthermore, nitrate concentration is important on its own, but takes on a much greater importance if the issue of corrosion by deliquescent salts is not rejected. If one accepts the possibility of localized corrosion by deliquescent salts the importance of the drip shields is greatly diminished, as there is no need for the shields to fail before localized corrosion can be initiated. Nitrate ion concentration in the dust and or the water influences the rate of	2.2.1 See 1.3.1 IPAR review on SCC and Wedging. Wedging effectively screened from analysis.	2.3.1 See 1.3.1 IPAR review on SCC and Wedging. Claim that assuming SCC is conservative, essentially masked other effects.

[16] Minutes of the May 29, 2008 NWTRB meeting. LSN #: NEN000000714.

CLK-SAFETY-001, Table 1. POTENTIAL IMPACTS OF UNCERTAINTY [aleatory (randomness) & epistemic (incomplete knowledge)]

UNCERTAINTY Due to:	PROBLEMS Found in SAR[14]		
	Unjustified Assumptions	**Inappropriate Screening "Analyses"**	**Unsubstantiated Claims of Conservatism**
	corrosion, as the nitrate ion acts as a corrosion inhibiter. Uncertainty in the amount of nitrate present therefore adds to the overall uncertainty in localized corrosion. DOE under Section 6.3.5.2 of the TSPA states that "The temperature, pH, chloride-ion concentration, and nitrate-ion concentrations in aqueous solutions on the WP outer surface are the primary factors that determine the potential for initiating localized corrosion." In the TSPA-LA Model, only crown seepage water chemistry has the potential to fail WPs due to localized corrosion (SNL 2007 [DIRS 181267], Section 7.1.5). This stand-alone analysis is documented in Section 6.3.5.2. The temperature, pH, chloride-ion concentration, and nitrate-ion concentration in aqueous solutions on the WP outer surface are the primary factors that determine the potential for initiating localized corrosion. DOE continues to take credit for the inhibitive effects of nitrate ion concentration even though it has been known for same time that the nitrate ion concentration is decreased when exposed to elevated temperatures (Goldschmitt Conference Cologne, Germany and presentation to the NWTRB, January 2008). This would have a direct effect on the initiation of localized corrosion and makes the issue of deliquescent salt		

CLK-SAFETY-001, Table 1. POTENTIAL IMPACTS OF UNCERTAINTY [aleatory (randomness) & epistemic (incomplete knowledge)]

UNCERTAINTY Due to:	PROBLEMS Found in SAR[14]		
	Unjustified Assumptions	**Inappropriate Screening "Analyses"**	**Unsubstantiated Claims of Conservatism**
	mixtures that much more important. The possibility that corrosive salt mixtures can cause early waste package failures would be damaging to the project, but a sound basis is required to support the DOE position and an objective treatment of the uncertainty is needed.		
Model Assumptions	2.1.2 Infiltration. DOE has paid for the development of two models for the amount of infiltration to be considered in the calculation for the amount of water that would fall on the drip shields. The original one developed by the USGS (INFIL) was rejected due to some inappropriate e-mails sent by some of the investigators working on the model. (There was never any proof that the data were compromised.) The next model, developed by SADIA (MASSIF) calculated higher infiltration rates than the one developed by the USGS. DOE then used temperature data and Chlorine mass balance data to degrade the results from SANDIA to match those that were originally developed by the USGS. The report does not explain the data and model uncertainty accounted for in the final numbers for infiltration or provide a technical basis abandoning the original analysis and adjusting the second.	2.2.2 Canister Damage. Surface damage to the disposal canisters can occur during handling and the final disposal operation, which could affect corrosion. We have not found that the effects of stresses introduced during handling mishaps are considered in the SAR. It would seem that the introduction of stresses from accidental collisions would add to the uncertainty and have a possible effect on localized corrosion. All of the corrosion investigations we know about have used carefully prepared specimens.	2.3.2 Limited Range of Conservatism. SAR p. 2.1-40 states that naval SNF are conservatively modeled as commercial SNF, without demonstrating that this is always conservative.

CLK-SAFETY-001, Table 1. POTENTIAL IMPACTS OF UNCERTAINTY [aleatory (randomness) & epistemic (incomplete knowledge)]

UNCERTAINTY Due to:	PROBLEMS Found in SAR[14]		
	Unjustified Assumptions	**Inappropriate Screening "Analyses"**	**Unsubstantiated Claims of Conservatism**
	2.1.3 Operational Uncertainties. NWTRB points out additionally that other uncertainties in integrated systems operations (which affect the duration of the preclosure period and risk during that time) are not considered by DOE, when it modeled a single scenario with additional optimistic assumptions, such as an optimal waste receipt schedule and the absence of any upset conditions. They pointed out that at least the following scenarios should be addressed: • Less than 90 percent of CSNF arriving in TADs. • Seasonal variation in the receipt rate of CSNF. • Delay in receipt of DOE waste, or DOE waste not received in the order needed. • Less than 75 percent availability of the surface facilities. • Occurrence of upset conditions in any part of the system. • Provisions DOE is making to ship spent fuel that is in storage casks at utility sites. • Provisions DOE is making regarding dual-purpose spent fuel storage	2.2.3 TAD 90/10 Split. DOE has analyzed a single scenario assuming that the repository will receive 90 percent of commercial spent nuclear fuel in transportation-aging-disposal (TAD) canisters. Many factors not included in the analysis and its uncertainty could dramatically change the ratio of TAD to other shipments, e.g., delay in construction or inability to construct the Nevada rail line, delay in deployment of TADs beyond 2013, the number of utility sites without usable short-line rail connection to a main rail line, and other ways in which DOE may have underestimated shipments not in TADs[17]. If this figure is not attained then worker exposure at the surface facilities is likely to be increased.	2.3.3 Limited Range of Conservatism. SAR 2.4.2.2.1 claims that drip shield and waste package early failure mechanisms are represented by conservative assumptions, without demonstrating that specific assumptions are always conservative.

[17] For example, while the DOE's base case is 307 non-TAD containers, EPRI estimates 2,375 non-TAD containers by 2020. "Occupational Risk Consequences of the Department of Energy's Approach to Repository Design, Performance Assessment and Operation in the Yucca Mountain License Application," EPRI 1018058, Aug. 2008. LSN #: NEN000000720.

CLK-SAFETY-001, Table 1. POTENTIAL IMPACTS OF UNCERTAINTY [aleatory (randomness) & epistemic (incomplete knowledge)]

UNCERTAINTY Due to:	PROBLEMS Found in SAR[14]		
	Unjustified Assumptions	**Inappropriate Screening "Analyses"**	**Unsubstantiated Claims of Conservatism**
	systems to avoid repackaging into TADs at Yucca Mountain.		
Model Assumptions	2.1.4 Incomplete Basis. Same as 1.1.2. Analysis supporting SAR 1.6.3.4.1 (LSN # DEN001592183) in BSC 2007c (LSN#DN2002406192) cites unavailable references for an assumed exponential decay factor in the Solomon model for flights through the Beatty Corridor and fails to justify truncated range for the factor. Does data or a model support this?	2.2.4 Operational Uncertainties. Same as 2.1.3. Single point assumptions effectively screens out other real possibilities.	
	2.1.5 Incomplete Basis. Same as 1.1.3. Analysis supporting SAR 1.6.3.4.1 (LSN # DEN001592183) in BSC 2007c (LSN#DN2002406192) provides no basis for the claim that all midair collisions and flights into terrain occur during maneuvering. No uncertainty analysis is provided. Does data or a model support this?	2.2.5 Incomplete Basis. Same as 1.1.3 and 2.1.5. Lack of consideration of other cases of midair collisions effectively screens out other possibilities.	
	2.1.6 Incomplete Basis. Same as 1.1.4. Analysis supporting SAR 1.6.3.4.1 (LSN # DEN001592183) in BSC 2007c (LSN#DN2002406192) uses its Table 10 to support the analysis of aircraft crash, without providing a technical basis for the table. Does data or a model support this?		
	2.1.7 Incomplete Basis. Analysis supporting SAR 1.6.3.4.1 in BSC 20007c LSN#DN2002406192 uses an		

CLK-SAFETY-001, Table 1. POTENTIAL IMPACTS OF UNCERTAINTY [aleatory (randomness) & epistemic (incomplete knowledge)]

UNCERTAINTY Due to:	PROBLEMS Found in SAR[14]		
	Unjustified Assumptions	**Inappropriate Screening "Analyses"**	**Unsubstantiated Claims of Conservatism**
Model Assumptions	unsupported factor to reduce the chance of crash affecting the facility. NRC RAI #7 points out that glide could occur in any direction. 2.1.8 Conflicting Assumptions. Analysis supporting SAR 1.6.3.4.1 in BSC 20007c LSN#DN2002406192 appears to have conflicting assumptions with respect to independence of crashes and over-flights on number of sorties flown.		
Methods Assumptions	Generic Implications: Assumptions about the appropriate method to apply can artificially restrict the range of epistemic uncertainty, as can ignoring steps in a method that search for sources of uncertainty. This effect is all in one direction: risk will be underestimated. 3.1.1 No Uncertainty in FEP Analysis. Appendix I of TSPA Vol. 3 (LSN#: DEN001579005), which lists all of the FEPs and the reasons for their inclusion or rejection, does not consider uncertainties as promised in Chapter 1 of the SAR.	Generic Implications: Use of frequency cut-offs in logic models (e.g., event trees and fault trees) can hide important common mode failures and, in complex models, can ignore the fact that the sum of a large number of low frequency events can far exceed the cut-off frequency. Without checks, such as summing the frequencies of all cut-off scenarios, the degree of underestimating risk is unknown. 3.2.1 Optimistic Assumption. Analysis supporting SAR 1.6.3.4.1 (LSN # DEN001592183) in BSC 2007c (LSN#DN2002406192) assumes that, for flights outside the restricted zone, pilots will eject outside the zone. There is no allowance for entry into the zone as the pilot tries to control or uncertainty and no convincing technical basis.	Generic Implications: Analyses that use "conservative" screening values treat multiple events as independent; when they are dependent risk can be grossly underestimated 3.3.1. Same as 3.1.5. SAR 1.7.2.5 human reliability analysis does not discuss dependencies among human failure events that are incorporated into fault trees. Failure to identify and model dependencies among events can substantially underestimate risk from human-involved event sequences. Review of referenced detailed analysis reports, e.g., LSN# DEN001578955, do not appear to address this issue. When HRA screening values are used, as described in SAR 1.7.2.5 Step 4, this is an especially important point.

CLK-SAFETY-001, Table 1. POTENTIAL IMPACTS OF UNCERTAINTY [aleatory (randomness) & epistemic (incomplete knowledge)]

UNCERTAINTY Due to:	PROBLEMS Found in SAR[14]		
	Unjustified Assumptions	**Inappropriate Screening "Analyses"**	**Unsubstantiated Claims of Conservatism**
Methods Assumptions	3.1.2 Long Term Corrosion Testing. DOE has used saturated zone water to conduct most, if not all of their long term corrosion testing. Experiments at LLNL have found that there is a distinct difference in the composition of unsaturated zone water that is found at the level of the repository and the water that is found in the saturated zone. The effect of the uncertainty in the water composition on the long-term corrosion effects of the drip shield and the waste package is not included in the analysis. This also interfaces with the effects of the condition of the surface of the as emplaced waste packages. 3.1.3 Infiltration. See 2.1.2 New method had to be "adjusted" to fit problem. 3.1.4 Canister Testing. The environment and handling of the disposal canisters is a critical issue when looking at long-term performance. All of the testing that has been done on coupons has been performed on carefully prepared surfaces. The effects of surface damage due to mishandling and the subsequent stress fields and their effect on corrosion have not been considered in the uncertainty analysis. This is one area where stress corrosion could be an important issue.	3.2.2 No Technical Basis Provided. SAR 1.6.3.4.1 (LSN # DEN001592183) in BSC 2007c (LSN#DN2002406192) lacks justification for the technical basis for screening analysis of ordnance.	

CLK-SAFETY-001, Table 1. POTENTIAL IMPACTS OF UNCERTAINTY [aleatory (randomness) & epistemic (incomplete knowledge)]

UNCERTAINTY Due to:	PROBLEMS Found in SAR[14]		
	Unjustified Assumptions	**Inappropriate Screening "Analyses"**	**Unsubstantiated Claims of Conservatism**
Methods Assumptions	3.1.5 SAR 1.7.2.5 human reliability analysis does not discuss dependencies among human failure events that are incorporated into fault trees. Failure to identify and model dependencies among events can substantially underestimate risk from human-involved event sequences. Review of referenced detailed analysis reports, e.g., LSN#DEN001578955, do not appear to address this issue.		

6. Sufficient information to show a genuine dispute with the DOE, along with specific references to the portions of the Application being controverted

The DOE's transmittal letter alleges that the DOE prepared the Application in accordance with the requirements set forth in 10 CFR § 63.21, "Content of Application," and the guidance contained in the "Yucca Mountain Review Plan," NUREG- 1804, Revision 2, Final Report (July 2003) ("YMRP").[18] However, the Application does not comply with §§ 63.111 and 63.113, which also require compliance with § 63.114, as explained in section 5 of this contention.

Failure to adequately address uncertainty means that risks to the public and workers could exceed those calculated in the pre-closure safety analysis, an issue that will directly affect the health and safety of workers, many of whom are residents of Clark County. Likewise the post-closure TSPA could underestimate the consequences and likelihood of post-closure radioactive releases, which could have devastating economic and social impacts on Clark County and its residents.

[18] Letter from E.F. Sproat, III, Director, Office of Civilian Radioactive Waste Management, DOE, to M.F. Weber, Director Office of Nuclear Material Safety and Safeguards, USNRC, "Yucca Mountain Repository License Application (LA) for Construction Authorization," dated June 3, 2008.

1. A brief statement of the contention

The SAR improperly failed to analyze the risks to the proposed repository at Yucca Mountain associated with ground-to-ground missile testing at the Nevada Test Site ("the NTS").

2. A summary of the basis for the contention

SAR Section 1.6.3.4.1 improperly eliminated analysis of ground-to-ground missile testing at the NTS. The SAR indicates that the DOE decided to exclude such analysis solely because of a single email from M.J. Childers to R. Morissette, dated January 31, 2002, in which Childers states that "no future launches are anticipated in the near future" (BSC 2007b, as referred to in SAR Section 1.6.5 General References, LSN# DEN000328287). Although the last Army Tactical Missile System launch was conducted at Area 26 of the NTS in June of 2000, in June of 2006, the Defense Threat Reduction Agency ("DTRA") proposed a non-nuclear 700-ton fuel oil and fertilizer bomb test, known as Divine Strake, to gather data about penetrating underground bunkers that produce and store weapons of mass destruction. While the DTRA withdrew its proposal in February 2007, it is clear that future ground-to-ground missile testing at the NTS is reasonable and likely within the entire pre-closure period. Stated differently, there are no final and definitive assurances or evidence that ground-to-ground missile testing at the NTS will never again be conducted and never again pose a threat during the pre- or post-closure periods.

The DOE incorrectly extrapolates a conclusion that no missile testing will be conducted during the pre-closure phase of the proposed facility based solely on a single email that says that "no future launches are anticipated in the near future…" This is blatantly in error, and ignores, among other things, the DTRA's 2006 and 2007 proposed Divine Strake test. More recently, Secretary of Defense Robert Gates indicated the need to resume nuclear testing to ensure the safety of the United States nuclear stockpile.

Noteworthy is the fact that the DOE does not here contend that ground-to-ground missile testing would not pose a threat to the facility. Rather, the DOE failed to even analyze the threat by presuming, with virtually no basis, that missile testing will never again be conducted and that therefore there is no threat or risk to study.

3. A demonstration that the contention is within the scope of the hearing

This contention raises an issue whether the DOE has complied with the NRC requirements applicable to Yucca Mountain, and falls within the scope of the hearing as specified in the Notice of Hearing. The potential effects of a strike by an errant missile raise self-evident safety issues.

4. A demonstration that the contention is material to the findings the NRC must make to license Yucca Mountain

10 CFR § 63.31(a)(2) states that the NRC may authorize issuance of a construction authorization for Yucca Mountain if it determines that there is reasonable assurance or expectation that the materials described in the Application can be disposed of without unreasonable risk to the health and safety of the public. In reaching this determination, 10 CFR § 63.31(a)(3) requires that the Application satisfy the

requirements in 10 CFR § 63.21, and the site and design to comply with Subpart E of 10 CFR Part 63. 10 CFR § 63.21(c)(9) requires an assessment to determine the degree to which features, events and processes of the site that are expected to materially affect compliance with § 63.113 have been characterized, and paragraph (c)(15) requires adequate support for the models used to provide the information required in paragraph (c)(9). 10 CFR § 63.114 (part of Subpart E) requires a performance assessment to evaluate the ability of the engineered barrier system along with natural barriers to meet the performance objectives of § 63.113, and this performance assessment must include consideration of the probability and consequences of events and processes identified under 10 CFR § 63.21(c)(9). This contention alleges non-compliance with these regulatory provisions and therefore raises a material issue within the scope of the licensing proceeding.

The DOE recognizes that air operations pose risks requiring analysis -- section 1.6.3.4.1 of the SAR reviews Aircraft Impact and risks associated with potential aircraft hazards. The DOE nevertheless failed to address such hazards in connection with ground-to-ground missile testing, and this failure was based merely on one email that does not even itself state that there will be no more missile testing in the area.

5. Concise statement of the facts or expert opinions supporting the contention, along with appropriate citations to supporting scientific or factual materials

The NTS was established in 1951 to provide a proving ground for the nation's burgeoning nuclear weapons program. Between 1951 and 1962, over one hundred atmospheric nuclear tests were conducted at the NTS. Subsequently, the United States Government initiated a moratorium on above-ground testing, moving all testing

underground. In 1992, President Clinton commenced a moratorium on all nuclear testing, while directing the United States Department of Energy National Nuclear Security Administration ("USDOE/NNSA") to maintain the safety and reliability over the United States' nuclear arsenal. In recent years, the DOE has developed a number of programs to meet these objectives. Subcritical experiments are conducted to obtain information about nuclear weapons in the absence of nuclear testing. As part of the moratorium, President Clinton charged the USDOE/NNSA with the responsibility "to maintain a test readiness program in the event that resumption of nuclear weapons testing becomes necessary."[19]

In July of 2007, the Secretary of Energy, Secretary of Defense, and Secretary of State issued a joint statement titled "National Security and Nuclear Weapons: Maintaining Deterrence in the 21st Century." The statement notes that delays in modernizing the nuclear weapons stockpile raise "the prospect of having to return to underground nuclear testing to certify existing weapons."[20]

Further evidence is the sole email upon which the SAR relies for its failure to study missile testing. That email poses the question: "Is ground-to-ground missile testing still ongoing at the NTS?" That email then answers that question, stating in part that "no future launches are anticipated in the near future…." (LSN# DEN000328287). The statement does not say that missile testing has been permanently terminated or prohibited, nor that the NTS has been or will be shut down. Rather, it merely states that no launches are "anticipated" in the "near future." The DOE takes an unwarranted and unsupported leap of faith in using that vague and somewhat qualified phrase to be

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[19] See NTS, "Stockpile Stewardship Program," Attachment 5 hereto.

[20] Attachment 6 hereto.

tantamount to evidence that missile testing will not remain active and that study of its risks and affects on its proposed facility is unnecessary.

6. Sufficient information to show a genuine dispute with the DOE, along with specific references to the portions of the Application being controverted

This contention and the evidence summarized herein establish a genuine dispute with the DOE's claims that the proposed facility will not endanger the public health and safety, and its claim that it need not analyze the risks associated with constructing such a facility in the proximity of a missile testing site. One informal email does not alone provide sufficient basis for presuming that missile testing will not occur during the pre-closure period, even if the email actually said such a thing. Here, the sole basis for the DOE's assumption that there will be no more missile testing is an email that does not even state there will be no more testing, only that no launches are "anticipated" in the "near future."

1. A brief statement of the contention

SAR Subsections 2.2.2.2.3.1, 2.3.11.2.2 and related sections, which indicate the probability of igneous activity disrupting a repository drift, underestimates that probability, likely by two or more orders of magnitude, because it assumed incorrectly that melting to produce basaltic magma will be in the shallow lithospheric mantle and not in the deeper asthenosphere.

2. A summary of the basis for the contention

The DOE's assumption that the source of the basaltic magma is in the shallow lithosphere infers a dwindling supply of new basalt and little chance of future events. The DOE does not account for published data and interpretations that indicate that melting to produce basalt is in the asthenosphere and not in the lithosphere. Melting of asthenosphere implies a more active igneous future for Yucca Mountain and a higher probability of igneous activity disrupting repository drifts.

3. A demonstration that the contention is within the scope of the hearing

This contention raises an issue whether the DOE has complied with the NRC requirements applicable to Yucca Mountain, and falls within the scope of the hearing as specified in section II, paragraph 1 of the Notice of Hearing.

4. A demonstration that the contention is material to the findings the NRC must make to license Yucca Mountain

10 CFR § 63.31(a)(2) states that the NRC may authorize issuance of a construction authorization for Yucca Mountain if it determines that there is reasonable assurance or expectation the materials described in the Application can be disposed of without unreasonable risk to the health and safety of the public. In reaching this determination, 10 CFR § 63.31(a)(3) requires that the Application satisfy the requirements in 10 CFR § 63.21, and the site and design to comply with Subpart E of 10 CFR Part 63. 10 CFR § 63.21(c)(9) requires an assessment to determine the degree to which features, events and processes of the site that are expected to materially affect compliance with § 63.113 have been characterized, and paragraph (c)(15) requires adequate support for the models used to provide the information required in paragraph (c)(9). 10 CFR § 63.114 (part of Subpart E) requires a performance assessment to be completed to evaluate the ability of the engineered barrier system along with natural barriers to meet the performance objectives of § 63.113, and this performance assessment must include consideration of the probability and consequences of events and processes identified under 10 CFR § 63.21(c)(9). This contention alleges non-compliance with these regulatory provisions and therefore raises a material issue within the scope of the licensing proceeding.

5. A concise statement of the facts or expert opinions supporting the contention, along with appropriate citations to supporting scientific or factual materials

The SAR discusses the assumption that basaltic magmas were generated in the shallow lithospheric mantle mainly in Subsections 2.2.2.2.3.1 and 2.3.11.2.2. In SAR

Subsection 2.2.2.2.3.1 at 2.2-97, and repeated in Subsection 2.3.11.2.2.5 at 2.3.11-23, it states:

> The PVHA experts generally view volcanism in the Yucca Mountain region as a regional-scale phenomenon resulting from melting processes in the upper lithospheric mantle. . . .
>
> Analyses of magmatic processes in the Yucca Mountain region generally indicate that the magnitude of mantle melting has significantly decreased since the middle Miocene. The analyses also suggest that melts in the past few million years were generated within relatively cool ancient lithospheric mantle (compared to asthenospheric mantle), which is a factor that may contribute to the relatively small and decreasing volume of basaltic melt erupted in the Yucca Mountain region since the Miocene period (BSC 2004k, Section (6.3.3)).

These statements are contrary to published research that clearly explains that melting of lithospheric mantle to produce basalt late in an extensional event, as the DOE assumes, is difficult if not impossible. In several papers it was demonstrated that lithospheric mantle does not melt to produce basalt around Yucca Mountain.[21] Peridotite of the mantle lithosphere is too cold to melt. The only components that could melt are those with a lower solidus temperature than dry peridotite. These components were probably totally melted during previous events that produced the voluminous rhyolite ash-flow tuffs that now form Yucca Mountain.

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[21] See "Episodic Volcanism and Hot Mantle: Implications for Volcanic Hazard Studies at the Proposed Nuclear Waste Repository at Yucca Mountain, Nevada," (04/01/2002), LSN# NEV000002718 at 4-10; Smith, E.I. and Keenan, D.L. "Yucca Mountain Could Face Greater Volcanic Threat,", EOS, TRANSACTIONS OF THE AMERICAN GEOPHYSICAL UNION, Vol. 86, No. 35 (2005) at 317; and Smith, E.I., Conrad, C.P., Plank, T., Tibbetts, A., Keenan, D., "Testing Models for Basaltic Volcanism: Implications for Yucca Mountain, Nevada," AMERICAN NUCLEAR SOCIETY, PROCEEDINGS OF THE 12TH INTERNATIONAL HIGH-LEVEL RADIOACTIVE WASTE MANAGEMENT CONFERENCE (2008) at 157-164.

Calculations of melting depths indicate that basalts at Yucca Mountain were produced by melting at depths of 115-133 km within the asthenospheric mantle.[22] These calculations were done assuming a dry mantle, but even if water contents of 1-4.5 wt.% are considered, melting is still deep in the asthenosphere.[23] Depth of melting calculations used the Fe-Na[24] and Silica geobarometers[25] and were calibrated using basalt samples from the Big Pine Volcanic Field in eastern California. In the Big Pine example, both geobarometers placed melting in a zone of low-velocity (high temperature) asthenosphere at depths of 50 to 75 km.[26] These calculations place high confidence in melting depths calculated using both the Fe-Na and Silicon barometers and strongly indicate that melting to produce basaltic magma is in the deep asthenosphere and not in the lithospheric mantle.

Prior to ten million years ago, shallow melting did occur in the Great Basin area, including in the Crater Flat Volcanic Field immediately adjacent to Yucca Mountain. Harry, D.L., Sawyer, D.S., and Leeman, W.P.,[27] and Harry, D.L. and Leeman, W.P.,[28] examined the effects of extension in the Great Basin in relation to melting of lithospheric mantle (shallow melting). They determined that certain components commonly found in

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[22] See "A Mantle Melting Profile Across the Basin and Range, SW USA," (01/22/2002), LSN# NEV000004173 at ECV 5- 1 – ECV 5-21; NEV000002718 at 4-10; Smith, et al. (2008) at 157-164; and "Yucca Mountain Project Terry Plank Lamont-Doherty Earth Observatory Report on Activities from January 26, 2008 - February 26, 2008," (02/26/2008), LSN# NEV000005026 at 1-4.

[23] See NEV000005026 at 1-4; and Smith, et al. (2008) at 157-164.

[24] See NEV000004173 at ECV 5-1 through ECV 5- 21.

[25] See NEV000005026 at 1-4.

[26] See NEV000005026 at 1-4.

[27] "The Mechanics of Continental Extension in Western North America: Implications for the Magmatic and Structural Evolution of the Great Basin," EARTH AND PLANETARY SCIENCE LETTERS, Vol. 117 (1993) at 59-71.

[28] "Partial Melting of Melt Metasomatized Subcontinental Mantle and the Magma Source Potential of the Lower Lithosphere," JOURNAL OF GEOPHYSICAL RESEARCH, Vol. 100 (1995) at 10255-10269.

the lithospheric mantle (mafic veins or water rich minerals) could be melted during the initial phases of extension. This would explain the widespread silica-rich volcanism during Oligocene time (33.7-23.8 million years ago). These studies also determined that the early melting events exhausted the lower melting temperature components in the lithospheric mantle. Consequently, any volcanism after about 10 million years ago could not be from this source and must be from asthenospheric (deep) melting. Gallagher, K., and Hawkesworth, C.J., did a regional study of the Great Basin to determine the effects of the presence of water on subsurface melting.[29] Their study concluded that lithospheric mantle will only melt with the presence of water (0.5 wt. %) and that lithospheric mantle will melt before asthenospheric mantle. They also concluded that the early voluminous volcanic activity likely depleted the water component that made lithospheric mantle melting possible. In addition, the large scale extension throughout the region caused thinning of the lithospheric mantle. This allowed upwelling of the asthenospheric mantle. The resulting decrease in pressure in the asthenosphere created conditions favorable to melting of this material. The depletion of water and resulting thinning of the lithosphere due to extension led the authors to the conclusion that little if any lithospheric mantle melting could have occurred more recent than 10 million years ago. Deep melting models are a more accurate way to explain the volcanism that occurred during the last 10 million years.

The DOE uses an isotopic data set that shows that basalt near Crater Flat has higher Strontium ("Sr") and lower neodymium ("Nd") isotopic signatures than expected

[29] Gallagher, K., and Hawkesworth, C.J., "Dehydration Melting and the Generation of Continental Flood Basalts," NATURE, Vol. 358 (1992) at 57-59; See also Hawkesworth, C., Turner, S., Gallagher, K., Bradshaw, T., and Rogers, N., "Calc-Alkaline Magmatism, Lithospheric Thinning, and Extension in the Basis and Range," JOURNAL OF GEOPHYSICAL RESEARCH, Vol. 100 (1995) at 10271-10286.

for asthenospheric sources. They use this data to support the shallow melting model. This isotopic data does not establish shallow melting because it is not inconsistent with deep melting. Lee, C.T., Yin, Q., Rudnick, R.L., Chesley, H.T., and Jacobsen, S.B., "Osmium Isotopic Evidence for Mesozoic Removal of Lithospheric Mantle Beneath the Sierra Nevada, California," SCIENCE, Vol. 289 (2000) at 1912-1916 suggested that basalts with the isotopic signatures found in the Crater Flat volcanic field could be related to contamination either by lithospheric mantle or by subducted crustal material. A later study determined that Archean (>2.7 billion years old) crust may be present beneath the southern Great Basin area.[30] Melting of Archean crust or contamination from it could account for the isotopic signatures.

In recent years there have been numerous studies based on a variety of data, all of which point to the presence of deep melting in the Yucca Mountain area and throughout most of the central Great Basin.[31] Indeed, the DOE originally suggested melting of the asthenosphere to produce basalt. Perry and Crowe noticed steep rare earth element patterns, which indicate deep melting.[32] Furthermore, several geophysical studies all support hotter than normal mantle at depth in the central Nevada region and thus deep melting.[33]

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[30] See Lee, C.T., Yin, Q., Rudnick, R.L., and Jacobson, S.B., "Preservation of Ancient and Fertile Lithospheric Mantle Beneath the Western United States," NATURE, Vol. 111 (2001) at 69-73.

[31] Reported in Wang, et al. (2002) at 10 ECV 5-1 through ECV 5-21, and Smith, et al. (2008) at 157-164.

[32] "Geochemical Evidence for Waning Magmatism and Polycyclic Volcanism at Crater Flat, Nevada," (04/20/1992), LSN# DN2001597248 at 1-10,

[33] See Van der Lee, S. and Nolet, G., "Upper Mantle S Velocity Structure of North America," JOURNAL OF GEOPHYSICAL RESEARCH, Vol. 102 (1997) at 22815-22838; Savage, M.K., Lowry, A.R., Ribe, N.M., and Smith, R.B., "Dynamic Elevation of the Cordillera, Western United States," JOURNAL OF GEOPHYSICAL RESEARCH, Vol. 105 (2000) at 23371-23390; Sheehan, A.F., "Seismic Anisotrophy and Mantle Flow from the Great Basin to the Great Plains, Western United States," JOURNAL OF GEOPHYSICAL RESEARCH, Vol. 105S (2000) at 13725- 13734.

6. Sufficient information to show a genuine dispute with the DOE, along with specific references to the portions of the Application being controverted

This contention challenges SAR Subsections 2.2.2.2.3.1 and 2.3.11.2.2 and related sections, which state a major assumption that the DOE uses to derive its probability estimate for igneous events, namely that melting to produce basalt near Yucca Mountain will occur in the shallow lithospheric mantle. If the DOE were to make the correct assumption, SAR Subsections 2.2.2.2.3.1, 2.3.11.2.2 and related sections, which indicate that the probability of igneous activity disrupting a repository drift is 1.7 x 10-8 events/year, would underestimate that probability, likely by two or more orders of magnitude. The supporting reasons are given in Section 5 above and may be summarized as follows: The DOE's assumption that the source of the basaltic magma is in the shallow lithosphere infers a dwindling supply of new basalt and little chance of future events. The DOE does not account for published data and interpretations that indicate that melting to produce basalt is in the asthenosphere and not in the lithosphere. Melting of asthenosphere implies a more active igneous future for Yucca Mountain and a higher probability of igneous activity disrupting repository drifts.

1. A brief statement of the contention

SAR Subsections 2.2.2.2.3.1, 2.3.11.2.2 and related sections, which indicate the probability of igneous activity disrupting a repository drift, underestimates that probability, likely by two or more orders of magnitude, because the DOE ignored the entire 11 million year span of basaltic volcanism near Yucca Mountain.

2. A brief summary of the basis for the contention

Despite the 11 million year long record of basaltic volcanism near Yucca Mountain, the DOE considered only the past 5 million years of the geologic record and concluded both that volcanism near Yucca Mountain is decreasing in volume and number of events and that future eruptions are very unlikely. These observations fail to consider the entire history of volcanism as recorded in surface outcrops and core from borings about Yucca Mountain that define two super-episodes of volcanism. Rather than a single slowly dying igneous system, volcanism near Yucca Mountain occurred in *two* periods over the last 11 million years, each lasting 3 to 4 million years. Both super-episodes show chemical signs of a waning volcanic system toward the end of their history. The implication is that volcanism near Yucca Mountain does not record a single waning system but represents igneous activity that periodically starts and stops. Two periods of volcanic activity have already occurred at Yucca Mountain. Consideration of the complete record would support the proposition that the eruption at Lathrop Wells 78,000 years ago represents the beginning of a third super-episode.

3. A demonstration that the contention is within the scope of the hearing

This contention raises the issue of whether the DOE has complied with the NRC requirements applicable to Yucca Mountain, and falls within the scope of the hearing as specified in section II, paragraph 1 of the Notice of Hearing.

4. A demonstration that the contention is material to the findings the NRC must make to license Yucca Mountain

10 CFR § 63.31(a)(2) states that the NRC may authorize issuance of a construction authorization for Yucca Mountain if it determines that there is reasonable assurance or expectation the materials described in the Application can be disposed of without unreasonable risk to the health and safety of the public. In reaching this determination, 10 CFR § 63.31(a)(3) requires the Application to satisfy the requirements in 10 CFR § 63.21, and the site and design to comply with Subpart E of 10 CFR Part 63. 10 CFR § 63.21(c)(9) requires an assessment to determine the degree to which features, events and processes of the site that are expected to materially affect compliance with § 63.113 have been characterized, and paragraph (c)(15) requires adequate support for the models used to provide the information required in paragraph (c)(9). 10 CFR § 63.114 (part of Subpart E) requires a performance assessment to be completed to evaluate the ability of the engineered barrier system along with natural barriers to meet the performance objectives of § 63.113, and this performance assessment must include consideration of the probability and consequences of events and processes identified under 10 CFR § 63.21(c)(9). This contention alleges non-compliance with these regulatory provisions and therefore raises a material issue within the scope of the licensing proceeding.

5. A concise statement of the facts or expert opinions supporting the contention, along with appropriate citations to supporting scientific or factual materials

SAR Subsection 2.3.11.2.1.1 at 2.3.11-16, states:

> [T]he decreased eruptive volume through time, together with geochemical evidence (Perry, Crowe, et al., 1998, P. 4-8) indicates that the intensity of mantle-melting processes beneath the Yucca Mountain region has waned over the past 5 million years (Perry and Crowe 1992, p. 2359; Perry, Crowe, et al., 1998, p- 4-1). Considered in terms of total eruption volume, recurrence intervals, and duration of volcanism during the past 5 million years, the Crater Flat volcanic field, adjacent on the west to Yucca Mountain, is one of the least active basaltic volcanic fields in the western United States (BSC 2004a Section 6.1.1.1).

Although volcanism over the past 11 million years is mentioned in SAR Subsection 2.3.11.2.1.1 at 2.3.11-16, ("Small-volume basaltic volcanism has continued into the Quaternary as part of the general decline in eruption volume over the past 11 million years in the Yucca Mountain region Perry, Crowe, et al., 1998, Chapter 2)"), emphasis is placed only on activity over the past 5 million years. The study of the entire 11 million year old record tells a different story.

Yucca Mountain core provides a unique opportunity to view the volcanic history of the Yucca Mountain area back to 11 million years ago. Unlike previous work that limits analysis to post-5 million-year basalts,[34] the core provides a record from the beginning of basalt volcanism 11 million years ago. Rather than a pattern of decreasing volume and waning activity, the record from the core combined with data from surface exposures reveals two episodes of activity separated by a several million year period of relative quiet. Within each episode, volcanism occurred periodically with individual peaks of activity lasting from 500,000 to 1 million years. Each super-episode shows

[34] See Valentine, G.A. and Perry, F.V., "Tectonically Controlled, Time- Predictable Basaltic Volcanism from a Lithospheric Source," (2007), LSN# DN2002382703 at 201-216.

chemical evidence of early larger degrees of melt formation followed by a pattern of waning volcanism as revealed by higher Ce/Yb and increasing epsilon Nd values. An important question is whether the Lathrop Wells cone (ca. 78,000 years old) represents the start of a new episode of eruption or whether it represents the end of an episode. Valentine and Perry suggest that it is the lone event in its episode because of the amount of time passed since the event without another eruption.[35] However, because there was a 1 million year period of little to no activity following the eruption of the Crater Flat cones and nearly 2.5 million years of quiet between the eruption of basalt in SE Crater Flat and the 1 million year ago Crater Flat volcanoes, there is a strong possibility that the Lathrop Wells cone may herald the beginning of a new eruptive episode.

6. Sufficient information to show a genuine dispute with the DOE, along with specific references to the portions of the Application being controverted

This contention challenges SAR Subsection 2.3.11.2.1, which advocates that the volcanic system near Yucca Mountain represents a simple system that began with high volume activity and is now in a waning period. The implication of using the entire 11 million year record is that another super-episode of activity could occur, that the Lathrop Wells eruption may represent the beginning of a third super-episode, and that SAR Subsections 2.2.2.2.3.1, 2.3.11.2.2 and related sections, which indicate that the probability of igneous activity disrupting a repository drift is 1.7×10^{-8} events/year, underestimates that probability, likely by two or more orders of magnitude. Supporting reasons are given in Section 5 above and may be summarized as follows: Despite the 11 million year long record of basaltic volcanism near Yucca Mountain, the DOE uses the

[35] LSN# DN2002382703 at 214.

past 5 million years of the record to conclude both that volcanism near Yucca Mountain is decreasing in volume and number of events and that future eruptions are very unlikely. These observations do not consider the entire history of volcanism as recorded in surface outcrops and core from borings about Yucca Mountain that define two super-episodes of volcanism. Rather than a single slowly dying igneous system, volcanism near Yucca Mountain occurred in two periods over the last 11 million years, each lasting 3 to 4 million years. Both super-episodes show chemical signs of a waning volcanic system toward the end of their history. The implication is that volcanism near Yucca Mountain does not record a single waning system but represents igneous activity that periodically starts and stops. Two periods of volcanic activity have already occurred at Yucca Mountain. Consideration of the complete record would support the proposition that the eruption at Lathrop Wells at 78,000 years ago represents the beginning of a third super-episode.

1. A brief statement of the contention

SAR Subsections 2.2.2.2.3.1, 2.3.11.2.2 and related sections, which indicate the probability of igneous activity disrupting a repository drift, underestimate that probability, likely by two or more orders of magnitude, because the DOE focuses improperly on upper crustal extension patterns to explain volcano location and the timing of volcanic events.

2. A summary of the basis for the contention

Understanding the process of volcanism is critical for calculating the probability of future events. The DOE clearly lacks this understanding and instead focuses on upper crustal extension patterns to explain volcano location and the timing of volcanic events. Contrary to the DOE's arguments, the primary controls of the location of a volcanic field lie in the earth's mantle. The location of thermal anomalies, the topography at the base of the lithosphere, and patterns of mantle flow together control the location and timing of volcanism. Upper crustal structures and extension rates may be important for controlling the location of volcanoes whose magma resides for periods of time in the crust, but have less of an effect for basaltic magmas that rise quickly from their mantle source without stalling for long periods of time in the crust.

3. A demonstration that the contention is within the scope of the hearing

This contention raises an issue whether the DOE has complied with the NRC requirements applicable to Yucca Mountain, and falls within the scope of the hearing as specified in section II, paragraph 1of the Notice of Hearing.

4. A demonstration that the contention is material to the findings the NRC must make to license Yucca Mountain

10 CFR § 63.31(a)(2) states that the NRC may authorize issuance of a construction authorization for Yucca Mountain if it determines that there is reasonable assurance or expectation that the materials described in the Application can be disposed of without unreasonable risk to the health and safety of the public. In reaching this determination, 10 CFR § 63.31(a)(3) requires the Application to satisfy the requirements in 10 CFR § 63.21, and the site and design to comply with Subpart E of 10 CFR Part 63. 10 CFR § 63.21(c)(9) requires an assessment to determine the degree to which features, events and processes of the site that are expected to materially affect compliance with § 63.113 have been characterized, and paragraph (c)(15) requires adequate support for the models used to provide the information required in paragraph (c)(9). 10 CFR § 63.114 (part of Subpart E) requires a performance assessment to be completed to evaluate the ability of the engineered barrier system along with natural barriers to meet the performance objectives of § 63.113, and this performance assessment must include consideration of the probability and consequences of events and processes identified under 10 CFR § 63.21(c)(9). This contention alleges non-compliance with these regulatory provisions and therefore raises a material issue within the scope of the licensing proceeding.

5. A concise statement of the facts or expert opinions supporting the contention, along with appropriate citations to supporting scientific or factual materials

SAR Subsection 2.3.11.2.2.5 at 2.3.11-23 states that "[f]or regional volcanism, no single base-case conceptual model is appropriate because the underlying physical processes that control the precise timing and location of volcanic events within a particular region remain uncertain"[36] The DOE clearly does not understand the processes that control volcanism. Nevertheless, the DOE in SAR Subsections 2.2.2.2.3.1 at 2.2-96 through 98, 2.3.11.2.1.1 at 2.3.11-15 through 18, and 2.3.11.2.2.5 at 2.3.11-23 through 24 and related sections calls upon crustal structures and extension rates to explain the location and timing of volcanism. There is, however, considerable literature that contradicts this conclusion for basaltic volcanism and suggests that thermal anomalies, mantle flow patterns, and topography at the base of the lithosphere explain the location and timing of volcanism. The DOE ignores the role of the mantle and published geochemical and geophysical work that suggests that deep melting of asthenospheric mantle caused by upwelling associated with low-viscosity "pockets" and a step in lithospheric thickness explain the occurrence of volcanic activity near Yucca Mountain, and the episodic nature of volcanism.[37] Smith and Keenan (2005) at 317, and Smith, et al. (2008) at 157-164 cite articles that document a sharp change in the thickness of the

[36] BSC 2004a, Section 6.3.1.6.

[37] See Smith, E.I. and Keenan, D.L., "Yucca Mountain Could Face Greater Volcanic Threat," EOS, TRANSACTIONS OF THE AMERICAN GEOPHYSICAL UNION, Vol. 86, No. 35 (2005) at 317; and Smith, E.I., Conrad, C.P., Plank, T., Tibbetts, A., and Keenan, D., "Testing Models for Basaltic Volcanism: Implications for Yucca Mountain, Nevada," AMERICAN NUCLEAR SOCIETY, PROCEEDINGS OF THE 12TH INTERNATIONAL HIGH-LEVEL RADIOACTIVE WASTE MANAGEMENT CONFERENCE (2008) at 157-164). Smith, et al., "Episodic Volcanism and Hot Mantle: Implications for Volcanic Hazard Studies at the Proposed Nuclear Waste Repository at Yucca Mountain, Nevada," (04/01/2002), LSN# NEV000002718 at 4-10.

North American plate producing a west facing buttress or keel in the lithosphere. Formed by Paleozoic and Mesozoic orogeny, a lithospheric boundary (the western margin of the North American Craton) and lithospheric thinning beneath the Sierra Nevada, the buttress lies either to the west or east of the Crater Flat area. Mantle flow caused by the buttress results in eddies or rolls that stir up areas of mantle close to the melting temperature. Mantle caught in upward flow melts due to pressure reduction and produces basaltic magma. A mantle eddy travels with the lithosphere and results in long-lived, geographically restricted magmatism. The shape and spacing of areas of hot mantle control the geographic extent and episodic nature of volcanism.

Numerical modeling of mantle flow provides information about the geometry of areas of upwelling, the effects of lithospheric steps, and the role of "hot-pockets" of mantle.[38] Mantle flow beneath North America is thought to be dominated by the descent of a region of dense mantle rocks that lie about 1500 km below the Midwest and Eastern portion of the continent. This region, known as the "Farallon Slab" can be imaged seismically and was produced by subduction of dense oceanic lithosphere in the mantle interior off the western coast of North America prior to about 30 million years ago. Several studies have shown that descent of this slab produces a broad region of mantle down welling beneath the eastern portion of North America that depresses the Earth's surface and influences the westward motion of the North American plate. Numerical models of global-scale mantle flow confirm this flow pattern. Within the asthenosphere beneath the southwestern United States, these models show eastward directed flow

[38] See Smith and Keenan (2005) at 317, and Smith, et al. (2008) at 157-164.

toward the region of down welling. The rate of eastward flow at the base of the asthenosphere is up to 3 cm/yr.

Because the overlying North American plate is moving westward at rates of about 2 cm/yr, the asthenosphere beneath the southwestern United States is shearing at rates of up to about 5 cm/yr. The vigorous shear flow occurring beneath the southwestern United States occurs within a region of asthenosphere that exhibits large lateral variations in material properties; these variations can be observed seismically. In particular, variations in seismic velocity observed by van der Lee and Frederiksen,[39] at about 110 km show several trends that will influence the flow field of the asthenosphere beneath the southwestern United States. First, there is a general increase in seismic velocity moving from the southwest toward the continental interior. In general, faster seismic velocities are thought to represent denser and colder material, with lithospheric rocks featuring both. Thus, the eastward increase in seismic velocity is consistent with an increase in continental thickness moving from the Basin and Range province (with lithosphere shallower than 110 km) to the stable craton of the Midwest (with lithosphere thicker than 110 km). This increase in thickness has been observed by some authors to occur as a sharp increase in lithospheric thickness beneath the Nevada region. Second, several "pockets" of low-velocity anomalies are evident within the asthenosphere of the southwestern United States at a depth of 110 km. These "pockets" are consistent with portions of the asthenosphere that are unusually low-density, and therefore presumably hotter than the surrounding asthenosphere. These low velocity "pockets" of asthenosphere have also been observed in other tomographic studies of the western

[39] See Van der Lee, S. and A. Frederiksen, "Seismic Earth: Array Analysis of Broadband Seismograms," G. Nolet and A Levander, Eds, GEOPHYSICAL MONOGRAPH SERIES, 157 (2005) at 67-80.

United States. Thus, the flow field within asthenosphere of the southwestern United States likely encounters both a sharp increase in the thickness of the cold lithosphere, as well as several "pockets" of unusually hot asthenosphere. Because the viscosity of mantle rocks is thought to vary strongly with temperature, the cold lithosphere and hot "pockets" can be thought of as high-viscosity and low-viscosity features, respectively. Both types of lateral viscosity variations may interact with the background mantle flow field to produce asthenospheric upwelling flow.

Numerical models examine how asthenospheric shear flow interacts with the lateral viscosity variations described above. To do this, Smith and Keenan, and Smith, et al. examined flow within a two-dimensional layered structure that features a high-viscosity lithosphere and a low-viscosity asthenosphere.[40] By pinning the surface lithosphere and imposing a velocity boundary condition on the base of the asthenosphere, Smith and Keenan, and Smith, et al. generated a shear flow within asthenospheric layer that models the one occurring beneath the western United States.[41] To test the effect of varying lithospheric thickness on the flow field, Smith and Keenan, and Smith, et al. imposed lateral variations in the thickness of the lithospheric layer. To do this, Smith and Keenan, and Smith, et al. inserted a "cavity" of asthenospheric fluid into the lithospheric layer.[42] Within the "cavity" region, the lithosphere is thin; outside of it the lithosphere is thicker. Shear flow in the asthenosphere generates circulation within the lithospheric "cavity." For a relatively narrow cavity, circulation develops within the cavity with an upwelling arm on the upstream side of the shear flow. For a wider cavity (or a step

[40] Smith and Keenan ((2005) at 317), and Smith, et al. ((2008) at 157-164).

[41] Id.

[42] Id.

function increase in lithospheric thickness as expected for the southwestern United States), a small "vortex" develops in the corner of the cavity, with upwelling flow along the vertical face of the lithospheric step.

For the geometries of lithospheric variations that are expected for the southwestern United States, Smith and Keenan, and Smith, et al. found that the amplitude of upwelling may be up to about 5% of the shear flow magnitude, or about 0.25 cm/yr for the 5 cm/yr of shear flow expected for the southwestern United States.[43] Lower viscosities of the upwelling fluid, which would be expected to accompany adiabatic melting, tend to amplify this effect. In a second test, Smith and Keenan, and Smith, et al. embedded a "pocket" of low-viscosity fluid within the asthenospheric layer.[44]

If this pocket is positioned immediately below the lithospheric layer, the faster velocities that the shear flow exerts on the base of the pocket generate a circulation within the low-viscosity pocket itself. Smith and Keenan, and Smith, et al. found that this circulation develops if the viscosity of the pocket is more than about 10 times less than the viscosity of the surrounding asthenosphere.[45] If the pocket viscosity is 100 times smaller than the viscosity of the asthenosphere (which would be expected if the temperature of the pocket were about 200 degrees Celsius hotter than the asthenosphere), then Smith and Keenan, and Smith, et al. found that upwelling portion of the circulatory flow may feature upward velocities that are up to ~20% of the magnitude of asthenospheric shear.[46] Thus, for the 5 cm/yr of shear flow, up to 1 cm/yr of upwelling is

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[43] Smith and Keenan (2005) at 317, and Smith, et al. (2008) at 157-164.

[44] Id.

[45] Id.

[46] Id.

predicted within a low-viscosity "pocket" of asthenosphere. The low-densities of the hot fluid should augment this upwelling.

In summary, the vigorous shear flow that occurs beneath the western US can interact with lateral viscosity variations in both the lithospheric and asthenospheric layers to produce upwelling flow. At least two viable mechanisms associated with heterogeneity in lithospheric thickness and asthenospheric viscosity produce upwelling flow at maximum rates estimated to be ~1 cm/yr. Since both types of heterogeneity are present beneath the southwestern United States, either mechanism may produce the upwelling responsible for adiabatic melting in the asthenosphere. It is also possible that both mechanisms may be interacting to produce even more vigorous upwelling flow. These observations highlight the role of the mantle in controlling the location and timing of volcanism.

6. Sufficient information to show a genuine dispute with the DOE, along with specific references to the portions of the Application being controverted

This contention takes issue with SAR Subsections 2.2.2.2.3.1, 2.3.11.2.1.1, 2.3.11.2.2.5, and related sections, which indicate wrongly that upper crustal extension is the main control of volcano location.

Geophysical and geochemical studies indicate that the mantle strongly controls the location and timing of volcanism near Yucca Mountain, and demonstrate that the DOE does not understand the process of volcanism at Yucca Mountain. A proper understanding would indicate that SAR Subsections 2.2.2.2.3.1, 2.3.11.2.2 and related sections, which indicate that the probability of igneous activity disrupting a repository drift is 1.7×10^{-8} events/year, underestimate that probability, likely by two or more orders

of magnitude. Supporting reasons are given in Section 5 above and may be summarized as follows: Understanding the process of volcanism is critical for calculating the probability of future events. The DOE clearly lacks this understanding and instead focuses on upper crustal extension patterns to explain volcano location and the timing of volcanic events. Contrary to the DOE's arguments, the primary controls of the location of a volcanic field lie in the earth's mantle. The location of thermal anomalies, the topography at the base of the lithosphere, and patterns of mantle flow together control the location and timing of volcanism. Upper crustal structures and extension rates may be important for controlling the location of volcanoes within which magma resides for periods of time in the crust, but have less of an effect for basaltic magmas that rise quickly from their mantle source without stalling for long periods of time in the crust.

CLK-SAFETY-006
THE DOE IMPROPERLY EXCLUDES THE DEATH VALLEY VOLCANIC FIELD AND GREENWATER RANGE FROM VOLCANISM CALCULATIONS

1. A brief statement of the contention

SAR Subsections 2.2.2.2.3.1, 2.3.11.2.2 and related sections, which indicate the probability of igneous activity disrupting a repository drift, underestimate that probability, likely by two or more orders of magnitude, because the DOE does not include the Death Valley volcanic field in the Greenwater Range as part of the area to be considered for hazard calculations.

2. A summary of the basis for the contention

SAR Subsections 2.2.2.2, 2.2.2.2.3.1, 2.3.11.2.1.1, and 2.3.11.2.2.5 claim that the essential characteristics of the age and location of basaltic volcanism near Yucca Mountain were fundamentally understood when the Probabilistic Volcanic Hazard Assessment ("PVHA") was completed in 1996; however, this statement ignores volcanic activity in the Greenwater Range just 20 km south of buried basalt in Amargosa Valley. Volcanic rocks in the Greenwater Range have chemical, mineralogical and age similarities to those near Yucca Mountain and clearly represent the southern extension of the field of volcanoes about Yucca Mountain. This larger volcanic field, therefore, should be considered in any calculation of repository disruption by volcanic activity.

3. A demonstration that the contention is within the scope of the hearing

This contention raises an issue whether the DOE has complied with the NRC requirements applicable to Yucca Mountain, and falls within the scope of the hearing as specified in section II, paragraph 1 of the Notice of Hearing.

4. A demonstration that the contention is material to the findings the NRC must make to license Yucca Mountain

10 CFR § 63.31(a)(2) states that the NRC may authorize issuance of a construction authorization for Yucca Mountain if it determines that there is reasonable assurance or expectation that the materials described in the Application can be disposed of without unreasonable risk to the health and safety of the public. In reaching this determination, 10 CFR § 63.31(a)(3) requires the Application to satisfy the requirements in 10 CFR § 63.21, and the site and design to comply with Subpart E of 10 CFR Part 63. 10 CFR § 63.21(c)(9) requires an assessment to determine the degree to which features, events and processes of the site that are expected to materially affect compliance with § 63.113 have been characterized, and paragraph (c)(15) requires adequate support for the models used to provide the information required in paragraph (c)(9). 10 CFR § 63.114 (part of Subpart E) requires a performance assessment to be completed to evaluate the ability of the engineered barrier system along with natural barriers to meet the performance objectives of § 63.113, and this performance assessment must include consideration of the probability and consequences of events and processes identified under 10 CFR § 63.21(c)(9). This contention alleges non-compliance with these regulatory provisions and therefore raises a material issue within the scope of the licensing proceeding.

5. A concise statement of the facts or expert opinions supporting the contention, along with appropriate citations to supporting scientific or factual materials

The DOE asserts that the size and shape of the volcanic field about Yucca Mountain is well known and that the hazard estimates made by experts of the PVHA panel in 1996 are still valid. Even after considering buried volcanic centers discovered after 1996, the DOE claims in SAR Subsection 2.2.2.2 at 2.2-91 that "[t]he results also show that the effects of buried volcanic centers on the hazard estimate are modest (Section 2.3.11.2.2.6)**,** and the updated hazard estimate is robust and suitable for use in the license application and supporting TSPA calculations." However, the volcanic field about Yucca Mountain should be expanded to include the volcanoes of the Greenwater Range near Death Valley. The following evidence supports this contention.

First, volcanic activity in the Greenwater Range is associated with at least 17 volcanic centers and occurred after about 5 million years ago, contemporaneous with activity near Yucca Mountain.[47]

Second, basalt from Death Valley is very similar in major and trace element chemistry to basalt from Crater Flat. Trace-elements usually better characterize volcanic rocks than do major elements and are considered as fingerprints that are commonly used to correlate volcanic rocks from area to area. For comparison purposes, volcanic rocks are usually normalized to a standard rock like average ocean island basalt. Plots of trace elements versus normalized concentration show characteristic patterns that can be used to fingerprint and compare rocks from different volcanic fields. Comparing Death Valley and Crater Flat basalt on such a plot shows that they share a similar pattern. Especially

[47] See "Geologic Map of California -- Death Valley Sheet, with Index and Stratigraphic Nomenclature" (01/01/1974), LSN# DN2001741565.

characteristic is low Niobium ("Nb") and high rubidium ("Rb"), thorium ("Th") and uranium ("U").[48]

Third, Strontium ("Sr") and neodymium ("Nd") isotopes for Greenwater Range basalts[49] are identical to isotopic analyses from Crater Flat. Basalts in both areas have low epsilon Nd values (between -9.95 and -12), and high $^{87}Sr/^{86}Sr$ (0.7069-0.7073).[50]

Fourth, basalts in both the Crater Flat and Death Valley areas are similar in mineralogy and contain olivine as the major phenocrysts phase. Plagioclase is rare and usually occurs as microlites in the matrix.

In summary, the close geographic proximity to Crater Flat, similar age of eruption, similar mineralogy and major element chemistry, distinctive trace element patterns and distributions, and identical isotopic ratios demonstrate that Death Valley basalt in the Greenwater Range is closely associated with Yucca Mountain basalt. Hazard assessment for Yucca Mountain should consider the Greenwater volcanoes near Death Valley as a part of a field of volcanoes about Yucca Mountain. Calculations of repository disruption that ignore the Death Valley field underestimate the probability of repository disruption by igneous activity.

6. Sufficient information to show a genuine dispute with the DOE, along with specific references to the portions of the Application being controverted

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[48] See "Report of Research Activities in 2007 Prepared to Satisfy the Requirements of a Clark County Contract for Volcanic Hazard Assessment of the Proposed Nuclear Waste Repository at Yucca Mountain, Nevada" (07/08/2008), LSN# CLK000000071, at 10-13.

[49] See Asmerom, Y., Jacobsen, S.B., and Wernicke, B.P., "Variations in Magma Source Regions During Large Scale Continental Extension, Death Valley Region, Western United States," EARTH AND PLANETARY SCIENCE LETTERS, Vol. 125 (1994) at 235-254)

[50] See CLK000000071, at 10-13.

This contention takes issue with SAR Subsections 2.2.2.2, 2.2.2.2.3.1, 2.3.11.2.1.1, 2.3.11.2.2.5, which claim that the essential characteristics of the age and location of basaltic volcanism near Yucca Mountain were fundamentally understood when the PVHA was completed in 1996, ignoring volcanic activity in the Greenwater Range just 20 km south of buried basalt in Amargosa Valley. Had this activity been considered, then SAR Subsections 2.2.2.2.3.1, 2.3.11.2.2 and related sections, which indicate that the probability of igneous activity disrupting a repository drift is 1.7×10^{-8} events/year, would have had to be revised, as they underestimate that probability, likely by two or more orders of magnitude.

Supporting reasons are given in Section 5 above and may be summarized as follows: SAR Subsections 2.2.2.2, 2.2.2.2.3.1, 2.3.11.2.1.1, 2.3.11.2.2.5 claim that the essential characteristics of the age and location of basaltic volcanism near Yucca Mountain were fundamentally understood when the PVHA was completed in 1996. This statement ignores volcanic activity in the Greenwater Range just 20 km south of buried basalt in Amargosa Valley. Volcanic rocks in the Greenwater Range have chemical, mineralogical and age similarities to those near Yucca Mountain and clearly represent the southern extension of the field of volcanoes about Yucca Mountain. This larger volcanic field, therefore, should be considered in any calculation of repository disruption by volcanic activity.

1. A brief statement of the contention

DOE wrongly assumes in SAR Subsections 2.3.11 and 2.3.11.1 and related subsections that its approach to estimating the probability of igneous events for the first 10,000 years is applicable to the probability estimate for 1,000,000 years as well, because its approach fails to consider deep melting models or the entire period of volcanism from 11 million years to the present.

2. A summary of the basis for the contention

Despite the requirement to consider compliance periods greater than 10,000 years, DOE essentially ignores this requirement in the Application. Compliance periods greater than 10,000 years are only briefly mentioned and the DOE claims in SAR Subsections 2.3.11 that because of the overall volcanic stability of the region (in terms of recurrence rate, eruptive style, volume, and location relative to the repository) over the last 2 million years, this same estimated annual frequency of intersection is also valid for evaluations over time periods that extend beyond 10,000 years. This statement does not consider deep melting models or the entire period of volcanism from 11 million years ago to the present.

3. A demonstration that the contention is within the scope of the hearing

This contention raises an issue whether the DOE has complied with the NRC requirements applicable to Yucca Mountain, and falls within the scope of the hearing as specified in section II, paragraph 1 of the Notice of Hearing.

4. A demonstration that the contention is material to the findings the NRC must make to license Yucca Mountain

10 CFR § 63.31(a)(2) states that the NRC may authorize issuance of a construction authorization for Yucca Mountain if it determines that there is reasonable assurance or expectation that the materials described in the Application can be disposed of without unreasonable risk to the health and safety of the public. In reaching this determination, 10 CFR §63.31(a)(3) requires the Application to satisfy the requirements in 10 CFR § 63.21, and the site and design to comply with Subpart E of 10 CFR Part 63. 10 CFR § 63.21(c)(9) requires an assessment to determine the degree to which features, events and processes of the site that are expected to materially affect compliance with § 63.113 have been characterized, and paragraph (c)(15) requires adequate support for the models used to provide the information required in paragraph (c)(9). 10 CFR § 63.114 (part of Subpart E) requires a performance assessment to be completed to evaluate the ability of the engineered barrier system along with natural barriers to meet the performance objectives of § 63.113, and this performance assessment must include consideration of the probability and consequences of events and processes identified under 10 CFR § 63.21(c)(9). This contention alleges non-compliance with these regulatory provisions and therefore raises a material issue within the scope of the licensing proceeding.

5. A concise statement of the facts or expert opinions supporting the contention, along with appropriate citations to supporting scientific or factual materials

Compliance periods as long as 1,000,000 years must be considered for volcanic probability calculations. However, DOE essentially ignores this requirement. In SAR 2.3.11 and similar sections, DOE claims that calculations for the 10,000 year period also apply for longer compliance post-closure periods, but bases this conclusion on a model of shallow melting in the lithospheric mantle and observations of volcanism over the past 5 million years. This is explained in detail in contentions CLK-SAFETY-003 and CLK-SAFETY-004. In brief, a shallow melting model infers that volcanic activity will be less vigorous in the future and that the number of future events will be small and infrequent, but work by Smith, et al., and references therein, show persuasively that deep melting models are more relevant to the Yucca Mountain area.[51] Deep melting models predict a more active volcanic future with a higher probability that volcanism will become more vigorous. The deep melting model is especially important for the 1 million year compliance period because peaks of activity recorded for the Yucca Mountain area have occurred every 1-2 million years. Therefore, a new episode of activity is likely to occur during the longer post-closure compliance period. Also, considering the entire record of volcanism from 11 million years to the present demonstrates that in the Yucca Mountain

[51] "Episodic Volcanism and Hot Mantle: Implications for Volcanic Hazard Studies at the Proposed Nuclear Waste Repository at Yucca Mountain" (04/01/2002), LSN# NEV000002718 at 4-10, Smith, E.I. and Keenan, D.L., "Yucca Mountain Could Face Greater Volcanic Threat," EOS, TRANSACTIONS OF THE AMERICAN GEOPHYSICAL UNION, Vol. 86, No. 35 (2005), at 317, Smith, E.I., Conrad, C.P., Plank, T., Tibbetts, A., and Keenan, D., "Testing Models for Basaltic Volcanism: Implications for Yucca Mountain, Nevada," AMERICAN NUCLEAR SOCIETY, PROCEEDINGS OF THE 12TH INTERNATIONAL HIGH-LEVEL RADIOACTIVE WASTE MANAGEMENT CONFERENCE (2008) at 157-164.

area two super-episodes of activity occurred each lasting 3-4 million years.[52] Moreover, when considering the last 11 million years the Yucca Mountain area is far from being volcanically stable as claimed in SAR 2.3.11. The implications of using deep melting models and the entire volcanic record are that future volcanic activity could be just as intense as past activity and that a third super-episode may occur. In fact, data and analyses are consistent with the proposition that the Lathrop Wells cone that erupted 78,000 years ago after nearly 1 million years of quiescence may represent the beginning of the third super-episode.

6. Sufficient information to show a genuine dispute with the DOE, along with specific references to the portions of the Application being controverted

This contention takes issue with SAR subsections 2.3.11 and 2.3.11.1 and related sections, which wrongly assume that the DOE's approach to estimating the probability of igneous events for the first 10,000 years is applicable to the probability estimate for 1,000,000 years as well. Had the DOE not made this assumption, and considered the factors discussed above, SAR Subsections 2.2.2.2.3.1, 2.3.11.2.2 and related sections, which indicate that the probability of igneous activity disrupting a repository drift is 1.7 x 10-8 events/year, would have had to be revised, as they underestimate that probability, likely by two or more orders of magnitude.

Supporting reasons are given in Section 5 above and may be summarized as follows: The DOE essentially ignores the legal requirements to consider compliance periods greater than 10,000 years in the Application. Compliance periods greater than

[52] See "Report of Research Activities in 2007 Prepared to Satisfy the Requirements of a Clark County Contract for Volcanic Hazard Assessment of the Proposed Nuclear Waste Repository at Yucca Mountain, Nevada" (07/08/2008), LSN# CLK000000071 at 14-17.

10,000 years are only briefly mentioned and DOE claims in SAR subsections 2.3.11 at 2.3.11-1 and 2.3.11.1 at 2.3.11-9 that because of the overall volcanic stability of the region (in terms of recurrence rate, eruptive style, volume, and location relative to the repository) over the last 2 million years, this same estimated annual frequency of intersection is also valid for evaluations over time periods that extend beyond 10,000 years. This statement does not consider deep melting models or the entire period of volcanism from 11 million years to the present.

1. A brief statement of the contention

The DOE's approach to determining the frequency of future igneous events wrongly ignores the data set obtained from core, which along with surface data provides a record of volcanism back to 11 million years that requires consideration, and wrongly relies instead on the chemistry of surface basalt erupted over the past 5 million years. This approach obscures long-term trends and provides an inaccurate prediction of future events.

2. A summary of the basis for the contention

Contrary to the claim in SAR subsection 2.3.11.2.1.1 that the chemistry of buried basalt bodies is essentially the same as basalt exposed on the surface, buried basalt contains rock types not found or that are rare at the surface. Buried basalt observed in core from borings in Crater Flat, Amargosa Valley and Jackass Flat reveal compositions not found or that are rare at the surface.

Combining core with surface data reveals a geologic history back to 11 million years characterized by two super-episodes of volcanism each independently showing major and trace element signs of a developing and then dying system that may be replicated in the future. The DOE ignores the rich data set obtained from core and relies on the chemistry of surface basalt erupted over the past 5 million years to make assumptions about the frequency of future events. This approach obscures long-term trends and provides an inaccurate prediction of future events.

3. A demonstration that the contention is within the scope of the hearing

This contention raises the issue of whether the DOE has complied with the NRC requirements applicable to Yucca Mountain, and falls within the scope of the hearing as specified in section II, paragraph 1 of the Notice of Hearing.

4. A demonstration that the contention is material to the findings the NRC must make to license Yucca Mountain

10 CFR § 63.31(a)(2) states that the NRC may authorize issuance of a construction authorization for Yucca Mountain if it determines that there is reasonable assurance or expectation that the materials described in the Application can be disposed of without unreasonable risk to the health and safety of the public. In reaching this determination, 10 CFR § 63.31(a)(3) requires the Application to satisfy the requirements in 10 CFR § 63.21, and the site and design to comply with Subpart E of 10 CFR Part 63. 10 CFR § 63.21(c)(9) requires an assessment to determine the degree to which features, events and processes of the site that are expected to materially affect compliance with § 63.113 have been characterized, and paragraph (c)(15) requires adequate support for the models used to provide the information required in paragraph (c)(9). 10 CFR § 63.114 (part of Subpart E) requires a performance assessment to be completed to evaluate the ability of the engineered barrier system along with natural barriers to meet the performance objectives of § 63.113, and this performance assessment must include consideration of the probability and consequences of events and processes identified under 10 CFR § 63.21(c)(9). This contention alleges non-compliance with these regulatory provisions and therefore raises a material issue within the scope of the licensing proceeding.

5. A concise statement of the facts or expert opinions supporting the contention, along with appropriate citations to supporting scientific or factual materials

SAR Subsection 2.3.11.2.1.1 at 2.3.11-17 states: "Major-element, trace-element and isotopic data were obtained from the buried basalt bodies and indicate that all are broadly basaltic in composition with typical SiO_2 contents of 42-50%. These geochemical results are consistent with geochemical analyses of basalt samples from surface exposures near Yucca Mountain [(Perry and Bowker 1998)]." However, work by "Report of Research Activities in 2007 Prepared to Satisfy the Requirements of a Clark County Contract for Volcanic Hazard Assessment of the Proposed Nuclear Waste Repository at Yucca Mountain, Nevada," (07/08/2008), (LSN# CLK000000071) at 9-10 indicates that:

1. Basalt collected from borings in Crater Flat and the Amargosa Valley is quite different in chemistry when compared to basalt in the 1.0 million year old cinder cones in Crater Flat;

2. Basalt in core has a larger range of SiO_2 contents (43 to 52 wt. %), compared with Crater Flat (47-50 wt. %), and lower light rare-earth element concentrations; and,

3. Three rock types were observed in core but are not found at the surface:

    a. Lower silica basanites in USW-VA-1;
    b. Coarse-grained quartz diorite dikes in boring USW-VA-1 at a depth of 556.7 feet; and
    c. Basalt with 2-3 mm clinopyroxene crystals in JF-5.

Yucca Mountain core provides a unique opportunity to view the volcanic history of the Yucca Mountain area back to 11 million years ago. Unlike previous work that limits analysis to post-5 million-year basalts,[53] the core provides a record from the beginning of basalt volcanism 11 million years ago. Rather than a pattern of decreasing

[53] See "Tectonically Controlled, Time-Predictable Basaltic Volcanism From a Lithospheric Source," (02/07/2007), LSN# DN2002382703 at 1-22,

volume and waning activity, the record from the core combined with data from surface exposures reveals two episodes of activity separated by a several million year period of relative quiet. Within each episode, volcanism occurred periodically with individual peaks of activity lasting from 500,000 to 1 million years. Each super-episode shows chemical evidence of early larger degrees of melt formation followed by a pattern of waning volcanism as revealed by higher Ce/Yb and increasing epsilon Nd values. An important question is whether the Lathrop Wells cone (ca. 78,000 years old) represents the start of a new episode of eruption or whether it represents the end of an episode. Valentine and Perry[54] suggest that it is the lone event in its episode because of the amount of time passed since the event without another eruption. However, because there was a 1 million year period of little to no activity following the eruption of the Crater Flat cones and nearly 2.5 million years of quiet between the eruption of basalt in SE Crater Flat and the 1 million year old Crater Flat volcanoes, there is a strong possibility that the Lathrop Wells cone may herald the beginning of a new eruptive episode.

[54] See LSN # DN2002382703 at 19.

6. Sufficient information to show a genuine dispute with the DOE, along with specific references to the portions of the Application being controverted

This contention challenges the claim in SAR Subsection 2.3.11.2.1.1 that the chemistry of buried basalt bodies is essentially the same as basalt exposed on the surface, and the related claim that predictions of future igneous events may rely on surface data without full and careful consideration of core data. Had the DOE considered core data, which provides a record from the beginning of basalt volcanism 11 million years ago, SAR Subsections 2.2.2.2.3.1, 2.3.11.2.2 and related sections, which indicate that the probability of igneous activity disrupting a repository drift is 1.7×10^{-8} events/year, would have had to be revised as they underestimate that probability, likely by two or more orders of magnitude.

Supporting reasons are given in Section 5 above and may be summarized as follows: Contrary to the claim in SAR Subsection 2.3.11.2.1.1 that the chemistry of buried basalt bodies is essentially the same as basalt exposed on the surface, buried basalt contains rock types not found or rare at the surface. Buried basalt observed in core from borings in Crater Flat, Amargosa Valley and Jackass Flat reveal compositions not found or rare at the surface.

Combining core with surface data reveals a geologic history back to 11 million years characterized by two super-episodes of volcanism each independently showing major and trace element signs of a developing and then dying system that may be replicated in the future. The DOE ignores the rich data set obtained from core and relies on the chemistry of surface basalt erupted over the past 5 million years to make assumptions about the frequency of future events. This approach obscures long-term trends and provides an inaccurate prediction of future events.

1. A brief statement of the contention

The DOE's assessment of the frequency of igneous events does not consider appropriate alternative conceptual models that are consistent with available data and current scientific understanding, with the result that uncertainty is underestimated and not properly characterized.

2. A summary of the basis for the contention

SAR Subsection 2.2.2.3 and related subsections indicate that the Application relies on the results of the 1996 report of the Probabilistic Volcanic Hazard Assessment ("PVHA") expert panel report released in 1996 as the basis for hazard assessment. Except for new work on the tectonics of the Crater Flat area and a brief mention of buried basalt, the DOE has not updated the PVHA findings, but still bases its conclusions on this out-dated report. The PVHA panel of experts based their results on the assumption of shallow melting to produce basaltic magma.

Using this assumption results in an underestimation of the probability of repository disruption and, at the least, the alternative model whereby melting to produce basalt occurs in the asthenosphere should have been included in the total systems performance assessment.

3. A demonstration that the contention is within the scope of the hearing

This contention raises the issue of whether the DOE has complied with the NRC requirements applicable to Yucca Mountain, and falls within the scope of the hearing as specified in section II, paragraph 1 of the Notice of Hearing.

4. A demonstration that the contention is material to the findings the NRC must make to license Yucca Mountain

10 CFR § 63.31(a)(2) states that the NRC may authorize issuance of a construction authorization for Yucca Mountain if it determines that there is reasonable assurance or expectation that the materials described in the Application can be disposed of without unreasonable risk to the health and safety of the public. In reaching this determination, 10 CFR § 63.31(a)(3) requires the Application to satisfy the requirements in 10 CFR § 63.21, and the site and design to comply with Subpart E of 10 CFR Part 63. 10 CFR § 63.21(c)(9) requires an assessment to determine the degree to which features, events and processes of the site that are expected to materially affect compliance with § 63.113 have been characterized, and paragraph (c)(15) requires adequate support for the models used to provide the information required in paragraph (c)(9). 10 CFR § 63.114 (part of Subpart E) requires a performance assessment to be completed to evaluate the ability of the engineered barrier system along with natural barriers to meet the performance objectives of § 63.113, and this performance assessment must include consideration of the probability and consequences of events and processes identified under 10 CFR § 63.21(c)(9). Moreover, 10 CFR § 63.114(c) explicitly requires consideration to be given to alternative conceptual models of features and processes that are consistent with available data and current scientific understanding, and requires an

evaluation of the effects that alternative conceptual models have on the performance of the geologic repository in order that, as required by 10 CFR §§ 63.102(h) and 63.304, uncertainty is properly estimated and accounted for. This contention alleges non-compliance with these regulatory provisions and therefore raises a material issue within the scope of the licensing proceeding.

5. A concise statement of the facts or expert opinions supporting the contention, along with appropriate citations to supporting scientific or factual materials

The DOE relies heavily on the "Probabilistic Volcanic Hazard Analysis for Yucca Mountain, Nevada, BA0000000-01717-2200-00082, Revision 0," June 26, 1996, (LSN# DEN000861156 ("PVHA")) as a basis for calculations of the intersection of the repository footprint by an igneous event. The PVHA report is now out-of-date and does not reflect updated or recent data and information or consider alternative models for volcanism. Indeed, SAR Subsection 2.3.11.2.2.5 at 2.3.11-23 states that "no single base-case conceptual model is appropriate." The 1996 PVHA panel used the assumption that melting to produce basaltic magma is shallow in the lithospheric mantle. The SAR discusses the assumption that basaltic magmas were generated in the shallow lithospheric mantle mainly in SAR Subsections 2.2.2.2.3.1 and 2.3.11.2.2. In SAR Subsection 2.2.2.2.3.1 at 2.2-97, and repeated in Subsection 2.3.11.2.2.5 at 2.3.11-23, the DOE states:

> The PVHA experts generally view volcanism in the Yucca Mountain region as a regional-scale phenomenon resulting from melting processes in the upper lithospheric mantle. . . . Analyses of magmatic processes in the Yucca Mountain region generally indicate that the magnitude of mantle melting has significantly decreased since the middle Miocene. The analyses also suggest that melts in the past few million years were generated within relatively cool ancient lithospheric mantle (compared to asthenospheric mantle), which is a factor that may contribute to the

> relatively small and decreasing volume of basaltic melt erupted in the Yucca Mountain region since the Miocene period.[55]

These statements are contrary to published research that clearly points out that melting of lithospheric mantle to produce basalt late in an extensional event, as the DOE assumes, is difficult if not impossible. In several papers[56] it was demonstrated that lithospheric mantle does not melt to produce basalt about Yucca Mountain. Peridotite of the mantle lithosphere is too cold to melt. The only components that could melt are those with a lower solidus temperature than dry peridotite. These components were probably totally melted during previous events that produced the voluminous rhyolite ash-flow tuffs that now form Yucca Mountain.

Calculations of melting depths[57] indicate that basalts at Yucca Mountain were produced by melting at depths of 115-133 km within the asthenospheric mantle. These calculations were done assuming a dry mantle, but even if water contents of 1-4.5 wt. % are considered, melting is still deep in the asthenosphere.[58] Depth of melting calculations used the Fe-Na[59] and Silica geobarometers[60] and were calibrated using basalt samples

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[55] BSC 2004k, Section 6.3.3.

[56] See "Episodic Volcanism and Hot Mantle: Implications for Volcanic Hazard Studies at the Proposed Nuclear Waste Repository at Yucca Mountain," April 1, 2002, LSN# NEV000002718 at 4-10; Smith, E.I. and Keenan, D.L., "Yucca Mountain Could Face Greater Volcanic Threat," EOS, TRANSACTIONS OF THE AMERICAN GEOPHYSICAL UNION, Vol. 86, No. 35 (2005), at 317; Smith, E.I., Conrad, C.P., Plank, T., Tibbetts, A., and Keenan, D., "Testing Models for Basaltic Volcanism: Implications for Yucca Mountain, Nevada," AMERICAN NUCLEAR SOCIETY, PROCEEDINGS OF THE 12TH INTERNATIONAL HIGH-LEVEL RADIOACTIVE WASTE MANAGEMENT CONFERENCE (2008) at 157-164.

[57] See "A Mantle Melting Profile Across the Basin and Range, SW USA," January 22, 2002, LSN# NEV000004173, at ECV 5-1 through ECV 5-21; NEV000002718 at 4-10; Smith, et al. (2008) at 157-164; and "Yucca Mountain Project Terry Plank Lamont-Doherty Earth Observatory Report on Activities from January 26, 2008 - February 26, 2008," February 26, 2008, LSN# NEV000005026 at 1-4.

[58] See NEV000005026 at 1-4; and Smith, et al. (2008) at 157-164.

[59] See NEV000004173 at ECV 5-1 through ECV 5-21.

[60] Id.

from the Big Pine Volcanic Field in eastern California. In the Big Pine example, both geobarometers placed melting in a zone of low-velocity (high temperature) asthenosphere at depths of 50 to 75 km.[61] These calculations place high confidence in melting depths calculated using both the Fe-Na and Silicon barometers and strongly indicate that melting to produce basaltic magma is in the deep asthenosphere and not in the lithospheric mantle.

Prior to ten million years ago, shallow melting did occur in the Great Basin area, including in the Crater Flat Volcanic Field immediately adjacent to Yucca Mountain. Harry, D.L., Sawyer, D.S. and Leeman, W.P., examined the effects of extension in the Great Basin in relation to melting of lithospheric mantle (shallow melting).[62] They determined that certain components commonly found in the lithospheric mantle (mafic veins or water rich minerals) could be melted during the initial phases of extension. This would explain the widespread silica-rich volcanism during Oligocene time (33.7-23.8 million years ago). These studies also determined that the early melting events exhausted the lower melting temperature components in the lithospheric mantle. Consequently any volcanism after about 10 million years ago could not be from this source and must be from asthenospheric (deep) melting. Gallagher, K. and Hawkesworth, C.J., did a regional study of the Great Basin to determine the effects of the presence of water on subsurface

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[61] Id.

[62] "The Mechanics of Continental Extension in Western North America: Implications for the Magmatic and Structural Evolution of the Great Basin," EARTH AND PLANETARY SCIENCE LETTERS, Vol. 117 (1993) at 59-71, and Harry, D.L. and Leeman, W.P., "Partial Melting of Melt Metasomatized Subcontinental Mantle and the Magma Source Potential of the Lower Lithosphere," JOURNAL OF GEOPHYSICAL RESEARCH, Vol. 100 (1995) at 10255-10269.

melting.[63] Their study concluded that lithospheric mantle will only melt with the presence of water (0.5 wt. %) and that lithospheric mantle will melt before asthenospheric mantle. They also concluded that the early voluminous volcanic activity likely depleted the water component that made lithospheric mantle melting possible. In addition, the large scale extension throughout the region caused thinning of the lithospheric mantle. This allowed upwelling of the asthenospheric mantle. The resulting decrease in pressure in the asthenosphere created conditions favorable to melting of this material. The depletion of water and resulting thinning of the lithosphere due to extension led the authors to the conclusion that little if any lithospheric mantle melting could have occurred more recent than 10 million years ago. Deep melting models are a more accurate way to explain the volcanism that occurred during the last 10 million years.

The DOE uses an isotopic data set that shows that basalt near Crater Flat has higher Sr and lower Nd isotopic signatures than expected for asthenospheric sources. They use this data to support the shallow melting model. This isotopic data does not establish shallow melting because it is not inconsistent with deep melting. Lee, C.-T., Yin, Q., Rudnick, R.L., Chesley, H.T. and Jacobsen, S.B., suggested that basalts with the isotopic signatures found in the Crater Flat volcanic field could be related to contamination either by lithospheric mantle or by subducted crustal material.[64] A later study by Lee, C.T., Yin, Q,, Rudnick, R.L. and Jacobson, S.B., "Preservation of Ancient and Fertile Lithospheric Mantle Beneath the Western United States," NATURE, Vol. 111

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[63] "Dehydration Melting and the Generation of Continental Flood Basalts," NATURE, Vol. 358 (1992) at 57-59, and Hawkesworth, C., Turner, S., Gallagher, K., Bradshaw, T. and Rogers, N., "Calc-Alkaline Magmatism, Lithospheric Thinning, and Extension in the Basis and Range," JOURNAL OF GEOPHYSICAL RESEARCH, Vol. 100 (1995) at 10271-10286.

[64] "Osmium Isotopic Evidence for Mesozoic Removal of Lithospheric Mantle Beneath the Sierra Nevada, California," SCIENCE, Vol. 289 (2000), at 1912-1916.

(2001), at 69-73 determined that Archean (>2.7 billion years old) crust may be present beneath the southern Great Basin area. Melting of Archean crust or contamination from it could account for the isotopic signatures.

In recent years there have been numerous studies based on a variety of data**,** all of which point to the presence of deep melting in the Yucca Mountain area and throughout most of the central Great Basin.[65] Indeed, the DOE originally suggested melting of the asthenosphere to produce basalt. Perry and Crowe, noticed steep rare earth element patterns, which indicate deep melting.[66] Furthermore, several geophysical studies support hotter than normal mantle at depth in the central Nevada region and thus deep melting.[67]

6. Sufficient information to show a genuine dispute with the DOE, along with specific references to the portions of the Application being controverted

This contention challenges the DOE's reliance on one central conceptual model of volcanism, as described mainly in SAR Subsections 2.2.2.2.3., 2.3.11.2.2, 2.2.2.2.3.1, and 2.3.11.2.2, without including full consideration of an alternative conceptual model that is more in accord with, and is certainly consistent with, available data and current scientific understanding.

Supporting reasons are given in Section 5 above and may be summarized as follows: SAR Subsection 2.2.2.3 and related subsections state that the Application relies

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[65] See NEV000004173 at ECV 5-1 through ECV 5-21, and Smith, et al. (2008) at 157-164.

[66] "Geochemical Evidence for Waning Magmatism and Polycyclic Volcanism at Crater Flat, Nevada," April 20, 1992, LSN# DN2001597248 at 1-10.

[67] See Van der Lee, S. and Nolet, G., "Upper Mantle S Velocity Structure of North America," JOURNAL OF GEOPHYSICAL RESEARCH, Vol. 102 (1997) at 22815-22838; Savage, M.K. and Sheehan, A.F., "Seismic Anisotropy and Mantle Flow from the Great Basin to the Great Plains, Western United States," JOURNAL OF GEOPHYSICAL RESEARCH, Vol. 105 (2000), at 13725-13734; and Lowry, A.R., Ribe, N.M. and Smith, R.B., "Dynamic Elevation of the Cordillera, Western United States," JOURNAL OF GEOPHYSICAL RESEARCH, Vol. 105 (2000) at 23371-23390.

on the results of the Probabilistic Volcanic Hazard Assessment expert panel report released in 1996 ("PVHA") as the basis for hazard assessment. Except for new work on the tectonics of the Crater Flat area and a brief mention of buried basalt, the DOE has not updated the PVHA findings, but still bases its conclusions on this out-dated report. The PVHA panel of experts based their results on the assumption of shallow melting to produce basaltic magma. Using this assumption results in an underestimation of the probability of repository disruption and, at the least, the alternative model whereby melting to produce basalt occurs in the asthenosphere should have been included in the TSPA.

CLK-SAFETY-010
THE DOE IGNORES IGNEOUS EVENT DATA EVALUATED SINCE 1996 IN THE TOTAL SYSTEM PERFORMANCE ANALYSIS

1. A brief statement of the contention

DOE's assessment of the frequency of igneous events in the Application ignores information and analyses since 1996 which would, if considered, have required a significant change in the TSPA and, as a result the Application is not complete or accurate in all material respects.

2. A summary of the basis for the contention

SAR Subsection 2.2.2.3 and related sections indicate that the Application relies on the results of the Probabilistic Volcanic Hazard Assessment expert panel report released in 1996 ("PVHA") as the basis for hazard assessment. Except for new work on the tectonics of the Crater Flat area and a brief mention of buried basalt, the DOE has not updated the PVHA findings, but still bases its conclusions on this out-dated report. Much research has been done since 1996 by the DOE, the NRC, the State of Nevada and Clark County that is pertinent to hazard analysis but is not considered in the Application.

3. A demonstration that the contention is within the scope of the hearing

This contention raises the issue of whether the DOE has complied with the NRC requirements applicable to Yucca Mountain, and falls within the scope of the hearing as specified in section II, paragraph 1 of the Notice of Hearing.

4. A demonstration that the contention is material to the findings the NRC must make to license Yucca Mountain

10 CFR § 63.10 requires that the Application be complete and accurate in all material respects and include all information with known significant implications for the public health and safety. In addition, 10 CFR § 63.21(a) requires that the Application be as complete as possible in light of information reasonably available at the time of docketing. This contention alleges violations of these provisions.

5. A concise statement of the facts or expert opinions supporting the contention, along with appropriate citations to supporting scientific or factual materials

Since 1996, the DOE, the NRC, the State of Nevada and Clark County have done much work that is pertinent to volcanic hazard analysis at Yucca Mountain but is not considered in the Application. This includes:

> "Shallow Plumbing Systems for Small-Volume Basaltic Volcanoes, LA-UR-06-5978" (04/25/2007), LSN# DN2002499936;
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> "Localization of Volcanic Activity: 2 Effects of Pre-Existing Structure in Basaltic Fields" (01/31/2007) LSN# DN2002377046;
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> "Tectonically Controlled, Time-Predictable Basaltic Volcanism from a Lithospheric Source" (02/07/2007), LSN# DN2002382703;
>
> "Eruptive Styles and Inferences on Plumbing Systems at Hidden Cone and Little Black Peak Scoria Cone Volcanoes (Nevada, U.S.A.), LA-UR-06-7130" (01/16/2007), LSN# DN2002375513;
>
> "Eruptive and Geomorphic Processes at the Lathrop Wells Scoria Cone Volcano, LA-UR-06-5184" (11/30/2006), LSN# DN2002452726;
>
> "Small-Volume Basaltic Volcanoes: Eruptive Products and Processes, and Post-Eruptive Geomorphic Evolution in Crater Flat (Pleistocene), Southern Nevada" (2006), LSN# DN2002451433;
>
> "Decreasing Magmatic Footprints of Individual Volcanoes in a Waning Basaltic Field, LA-UR-06-3145" (2006), LSN# DN2002453292;
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> "Valentine, G.A., Krogh, K.E.C., 2006, "Emplacement of shallow dikes and sills beneath a small basaltic volcanic center - the role of pre-existing structure (Paiute

Ridge, southern Nevada, USA)," EARTH AND PLANETARY SCIENCE LETTERS, Vol. 246 at 217-230, doi:10.1016/j.epsl.2006.04.031;

"Early-time multiphase interactions between basaltic magma and underground openings at the proposed Yucca Mountain radioactive waste repository" (11/30/2005), LSN# DN2002318671;

"Scoria cone construction mechanisms, Lathrop Wells volcano, Southern Nevada, LA-UR-04-8750" (02/15/2005), LSN# DN2001909760; and,

"Uncovering Buried Volcanoes at Yucca Mountain" (11/22/2005), LSN# DN2002456023.

The Application also omits an important report completed by the NRC contractors that describes water contents in basaltic magma from Crater Flat and the Lathrop Wells cone. "Pre-Eruptive Magmatic Temperatures, Oxygen Fugacities, and Volatile Contents for Trachybasalts from Lathrop Wells and Red Cone, Crater Flat, Nevada, USA" (2005), LSN# NEV000005025, at 1-27.

Another major omission from the Application is the updated report from the "Probabilistic Volcanic Hazard Analysis Update ("PVHA-U") for Yucca Mountain, Nevada Rev 01" (09/02/2008), LSN# DEN001601965. This panel uses eight of the ten experts from the first panel and two additional experts. The report generated by this panel is not considered in the Application. PVHA-U provides new estimates of the probability of repository disruption taking into account the buried basalt and using more modern statistical techniques. Despite the possibility that changes in hazard assessment models and calculations are modest, it is critical that this report be included in the Application.

Omission of all the work cited above results in an underestimation of the probability of repository disruption and of the related uncertainties, which in turn leads to an erroneous TSPA.

6. Sufficient information to show a genuine dispute with the DOE, along with specific references to the portions of the Application being controverted

This contention states that the Application, especially SAR Subsection 2.2.2.3 and related sections, ignores information and analyses since 1996 that would, if considered, have required a significant change in the TSPA. Supporting reasons are given in Section 5 above and may be summarized as follows: SAR Subsection 2.2.2.3 and related subsections indicate that the Application relies on the results of the "Probabilistic Volcanic Hazard Analysis for Yucca Mountain, Nevada ("PVHA"), BA0000000-01717-2200-00082, Revision 0" (06/26/1996), LSN# DEN000861156 expert panel report released in 1996 as the basis for hazard assessment. Except for new work on the tectonics of the Crater Flat area and a brief mention of buried basalt, the DOE has not updated the PVHA findings, but still bases its conclusions on this out-dated report. Much research has been done since 1996 by the DOE, the NRC, the State of Nevada and Clark County that is pertinent to hazard analysis but is not considered in the Application.

1. A brief statement of the contention

High-quality geophysical data is necessary to answer the fundamental question as to whether volcanoes are primarily controlled by upper crustal structure or mantle. The DOE's approach to predicting the location and frequency of future eruptions, as reflected in SAR Subsection 2.2.2.2.3.1 and related subsections, relies heavily on upper crustal structures and the local stress field, but does not provide sufficient geophysical data to support this model. This is inadequate because high-quality geophysical data are necessary to confirm or rule out the proposition, supported by the currently available data, that the primary control of the location of a basaltic field near Yucca Mountain is asthenospheric mantle processes.

2. A summary of the basis for the contention

Although geophysical studies are mentioned in SAR Subsection 2.2.2.1.2 as a way to identify and characterize the orientation of faults in the subsurface, the Application lacks geophysical data to document models proposed by the DOE that use upper crustal structure and the local stress field to explain the location of volcanoes in the Yucca Mountain area. Geophysical studies are also critical for testing and comparing deep versus shallow melting models by revealing the location of low-viscosity zones (hot zones) in the crust and mantle that might contain magma or rock close to the melting temperature. Furthermore, identifying patterns of mantle circulation and the nature of the topography at the base of the lithosphere are important for describing the geometry of

volcanic source zones, which ultimately control the location and shape of volcanic fields at the surface.

3. A demonstration that the contention is within the scope of the hearing

This contention raises the issue of whether the DOE has complied with the NRC requirements applicable to Yucca Mountain, and falls within the scope of the hearing as specified in section II, paragraph 1 of the Notice of Hearing.

4. A demonstration that the contention is material to the findings the NRC must make to license Yucca Mountain

10 CFR § 63.31(a)(2) states that the NRC may authorize issuance of a construction authorization for Yucca Mountain if it determines that there is reasonable assurance or expectation that the materials described in the Application can be disposed of without unreasonable risk to the health and safety of the public. In reaching this determination, 10 CFR §63.31(a)(3) requires the Application to satisfy the requirements in 10 CFR § 63.21, and the site and design to comply with Subpart E of 10 CFR Part 63. 10 CFR § 63.21(c)(9) requires an assessment to determine the degree to which features, events and processes of the site that are expected to materially affect compliance with § 63.113 have been characterized, and paragraph (c)(15) requires adequate support for the models used to provide the information required in paragraph (c)(9). 10 CFR § 63.114 (part of Subpart E) requires a performance assessment to be completed to evaluate the ability of the engineered barrier system along with natural barriers to meet the performance objectives of § 63.113, and this performance assessment must include consideration of the probability and consequences of events and processes identified

under 10 CFR § 63.21(c)(9). This contention alleges non-compliance with these regulatory provisions and therefore raises a material issue within the scope of the licensing proceeding.

5. A concise statement of the facts or expert opinions supporting the contention, along with appropriate citations to supporting scientific or factual materials

SAR Subsection 2.2.2.2.3.1 at 2.2-97 and related subsections indicate that the DOE relies heavily on an assumption of control exerted by upper crustal structures and the local stress field to predict the location of future eruptions. For example the DOE states, The Quaternary volcanoes in the Crater Flat basin and their proximities to Yucca Mountain (Figure 2.2-24) result in the Crater Flat cluster playing a major role in assessing the potential for future volcanism at Yucca Mountain. Research on the Crater Flat structural domain, published largely since the PVHA was conducted (Fridrich 1999), provides evidence that the northeastern and southwestern portions of the basin have different extensional histories that may have influenced the location of basaltic volcanism within the basin (BSC 2004k, Section 6.4).

As noted in the next quote from SAR Subsection 2.3.11.2.1.1 at 2.3.11-17, specific predictions about the location of future volcanoes are based almost entirely on the location of upper crustal structures and extension rate: Thus, the Crater Flat volcanoes, including Lathrop Wells volcano, show that close spatial and temporal relationships exist between areas of extension and volcanism throughout the Crater Flat domain.[68] The occurrence of three episodes of post-Miocene volcanism in the more extended part of the Crater Flat domain suggests future volcanism is more likely to occur

[68] Fridrich, et al. 1999, p. 211.

in southwestern Crater Flat and less likely to occur at Yucca Mountain, which lies outside of the more extended part of the Crater Flat domain.[69] Without geophysical data to determine the subsurface geometry of faults, the thickness and geometry of the crust and lithospheric mantle, and the identification of low velocity zones (hot areas) in the crust and mantle, conclusions that relate volcano location to upper crustal structure and the local stress state are not supportable. Geophysical studies provide important information regarding prediction of the location of future volcanism. The two most important controls of volcano location are mantle source zones and crustal structures and stress fields. More evolved magmas that have a long crustal residence time (rhyolite to andesite) may have a strong upper crustal control, but mafic magmas that melt mantle and rise quickly through the crust to the surface may not be affected by either crustal structures or local stress fields. In reality it is uncommon for basalt dikes or volcanoes to locate on faults.[70] The shape of a basaltic volcanic field more strongly reflects the geometry of the melting anomaly (source zone) than weak local stress fields or shallow upper crustal faults.

Geophysical studies have been used in other volcanic fields close to Yucca Mountain to determine lithospheric thickness, locate hot zones (low velocity) in the mantle and determine whether basalt magma was generated in the lithosphere or asthenosphere. Yang, Y. and D.W. Forsyth, "Rayleigh Wave Phase Velocities, Small-Scale Convection and Azimuthal Anisotropy Beneath Southern California," JOURNAL OF GEOPHYSICAL RESEARCH, Vol. 111 (2006), B07306, doi:10.1029/2005JB004180, prepared a model of seismic shear wave velocities across California at 36.5 degrees north

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[69] BSC 2004a, Section 6.1.1.1.

[70] See "Volcanism Studies Related to the Probabilistic Volcanic Hazard at Yucca Mountain for the Period 1986-1996 (January 1997)," LSN# NEV000000704 at 1-14.

latitude across the Big Pine Volcanic Field. The study revealed a volcanic source zone (low-velocity zone) that extends from the base of the lithosphere at a depth of 50 km to 75 km. Melting depths calculated by both the Na-Fe and Silica geobarometers place melting within this zone of hot mantle.[71] The study also revealed a high-velocity zone just west of Big Pine at a depth of 75 to 175 km that may represent a fragment of the subducted Farallon Plate. Yang and Forsyth ((2006) at 1029/2005JB004180) suggest that this plate generated sufficient mantle circulation to localize volcanism at Big Pine. It is a critical omission of the DOE's research strategy and the Application that this type of information is not available for Yucca Mountain. Conrad[72] and "Technical Progress Report for November 2007,"[73] provide data critical for understanding the occurrence of volcanism in the Yucca Mountain area. Studies of mantle circulation and the effects of lithospheric topography are important for understanding why volcanoes occur where they do.

This type of study was not considered by the PVHA panel and is not included in the Application. This is another major omission and is grounds for questioning the DOE's conclusions regarding the crustal control of volcanism. In detail, Conrad has shown that the mantle beneath the Great Basin and Yucca Mountain is rapidly shearing at rates of up to 5 cm/year.[74] Moreover, mantle circulation and topography at the base of the lithosphere produce mantle upwelling (and the potential for melting) in the Yucca

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[71] See "Yucca Mountain Project Terry Plank Lamont-Doherty Earth Observatory Report on Activities from January 26, 2008 - February 26, 2008," February 26, 2008, LSN# NEV000005026, at 1-4.

[72] "Characterization of Three-Dimensional Mantle Flow Beneath Nevada: Implications for Volcanic Hazard, Technical Progress Report for May 2008," June 10, 2008, LSN# NEV000005021 at 1-19.

[73] December 3, 2007, LSN# NEV000004225 at 1-5.

[74] See LSN# NEV000005021 at 1-19; NEV000004225 at 1-5.

Mountain area. Mantle flow beneath North America is thought to be dominated by descent of a region of dense mantle rocks that lie about 1500 km below the Midwest and Eastern portion of the continent. This structure, known as the "Farallon Slab" can be imaged seismically and was produced by subduction of dense oceanic lithosphere in the mantle interior off the western coast of North America prior to about 30 million years ago.[75] Several studies have shown that descent of this slab produces a broad region of mantle downwelling beneath the eastern portion of North America that depresses the Earth's surface[76] and influences the westward motion of the North American plate.[77] Numerical models of global-scale mantle flow[78] confirm this flow pattern. Within the asthenosphere beneath the southwest United States, these models show eastward-directed flow toward the region of downwelling. The rate of eastward flow at the base of the asthenosphere can be up to 3 cm/yr. Because the overlying North American plate is moving westward with rates of about 2 cm/yr, the asthenosphere beneath the southwestern United States is shearing at rates of up to about 5 cm/yr. This basic pattern of asthenospheric shear produces a seismically fast anisotropic fabric for asthenospheric rocks with an approximately east-west orientation. This orientation is observed by SKS

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[75] See Bunge, H.-P., and Grand, S.P., "Mesozoic Plate-Motion History Below the Northeast Pacific Ocean from Seismic Images of the Subducted Farallon Slab," NATURE, Vol. 405 (2000) at 337-340.

[76] See Conrad, C.P., Lithgow-Bertelloni, C. and Louden, K.E., "Iceland, the Farallon Slab, and Dynamic Topography of the North Atlantic," GEOLOGY, Vol. 32 (2004) at 177-180.

[77] See Bokelmann, G.H.R., "Which Forces Drive North America?" GEOLOGY, Vol. 30 (2002) at 1027–1030.

[78] See Conrad, C.P., Behn, M.D. and Silver, P.G., "Global Mantle Flow and the Development of Seismic Anisotropy: Differences Between the Oceanic and Continental Upper Mantle," JOURNAL OF GEOPHYSICAL RESEARCH, Vol. 112 (2007) at B07317, doi:10.1029/2006JB004608.

splitting observations of anisotropy, thus confirming the presences of strong shear flow beneath the western United States[79]

The vigorous shear flow occurring beneath the southwestern United States occurs within a region of asthenosphere that exhibits large lateral variations in the material properties; these variations can be observed seismically. In particular, variations in seismic velocity observed by van der Lee, S. and A. Frederiksen, "Surface Wave Tomography Applied to the North America Upper Mantle, in Seismic Earth: Array Analysis of Broadband Seismograms," G. Nolet and A. Levander, Eds, GEOPHYSICAL MONOGRAPH SERIES 157 (2007) at 67-80, at about 110 km show several trends that will influence the flow field of the asthenosphere beneath the southwestern United States. First, there is a general increase in seismic velocity moving from the southwest toward the continental interior. In general, faster seismic velocities are thought to represent denser and colder material, with lithospheric rocks featuring both. Thus, the eastward increase in seismic velocity is consistent with an increase in continental thickness moving from the Basin and Range province (with lithosphere shallower than 110 km) to the stable craton of the Midwest (with lithosphere thicker than 110 km). This increase in thickness has been observed by some authors to occur as a sharp increase in lithospheric thickness beneath the Yucca Mountain region.[80] Second, several "pockets" of low-velocity anomalies are evident within the Great Basin asthenosphere at 110 km depth.

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[79] See Becker, T.W., Schulte-Pelkum, V., Blackman, D.K., Kellogg, J.B. and O'Connell, R.J., "Mantle Flow Under the Western United States from Shear Wave Splitting," EARTH AND PLANETARY SCIENCE LETTERS, Vol. 247 (2006) at 235-251.

[80] See Zandt, G., Myers, S.C., and Wallace, T.C., "Crust and Mantle Structure Across the Basin and Range-Colorado Plateau boundary at 37 N Latitude and Implications for Cenozoic Extensional Mechanism," JOURNAL OF GEOPHYSICAL RESEARCH, Vol. 100 (1995) at 10529-10548; and "A Mantle Melting Profile Across the Basin and Range, SW USA," January 22, 2002, LSN# NEV000004173 at 1-21.

These "pockets" may represent portions of the asthenosphere that are unusually low-density, and therefore presumably hotter than the surrounding asthenosphere. These low-velocity "pockets" of asthenosphere have also been observed in other tomographic studies of the western United States.[81]

Thus, the flow field within asthenosphere of the southwest United States likely encounters both a sharp increase in the thickness of the cold lithosphere, as well as several "pockets" of unusually hot asthenosphere. Because the viscosity of mantle rocks is thought to vary strongly with temperature,[82] the cold lithosphere and hot "pockets" can be thought of as high-viscosity and low-viscosity features, respectively.

Thus, the rapid asthenospheric shear flow that is present beneath the Basin and Range province is occurring in the presence of possibly large variations in lithospheric and asthenospheric viscosity. Upwelling produced by the interaction of the shear flow, low velocity "pockets" and lithospheric topography produce melting of the asthenosphere and the generation of basaltic magma. In this way, basaltic magma can be produced for long periods of time in the same geographic area. The primary control of the location of a basaltic field is therefore asthenospheric processes and not upper crustal structure or local stress fields.

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[81] See e.g., Dueker, K., Yuan, H. and Zurek, B., "Thick-Structured Proterozoic Lithosphere of the Rocky Mountain Region," GSA TODAY, Vol. 11, No. 12 (2001) at 4-9.

[82] See Kohlstedt, D.L., Evans, B. and Mackwell, S.J., "Strength of the Lithosphere: Constraints Imposed by Laboratory Experiments," JOURNAL OF GEOPHYSICAL RESEARCH, Vol. 100 (1995) at 17587-17602.

6. Sufficient information to show a genuine dispute with the DOE, along with specific references to the portions of the Application being controverted

This contention challenges SAR Subsection 2.2.2.2.3.1 and related subsections, which indicate that the DOE relies heavily on upper crustal structures and the local stress field to predict the location and frequency of future eruptions. Supporting reasons are given in Section 5 above and may be summarized as follows: Although geophysical studies are mentioned in SAR Subsection 2.2.2.1.2 as a way to identify and characterize the orientation of faults in the subsurface, the Application lacks geophysical data to document models proposed by the DOE that use upper crustal structure and the local stress field to explain the location of volcanoes in the Yucca Mountain area. Whether volcanoes are primarily controlled by upper crustal structure or mantle processes is a fundamental question, and the DOE's approach, which relies on upper crustal structures and local stress fields, is not supportable unless geophysical studies that detail the geometry of upper crustal structures, lithospheric thickness and basal topography, and circulation in the mantle are conducted to confirm or rule out the proposition, supported by the currently available data, that the primary control of the location of a basaltic field near Yucca Mountain is asthenospheric mantle processes.

1. A brief statement of the contention

The DOE lacks the requisite institutional integrity to be granted a license to construct and operate a repository in a safe and secure manner for high level radioactive waste and spent nuclear fuel at Yucca Mountain.

2. A summary of the basis for the contention

The DOE has a well-documented history, pattern, and track record of failures to meet procedural, legal, and contractual obligations. The DOE's actions demonstrate a lack of capacity and competency to effectively manage large, complex, and long-term projects in a safe manner. Taken together these failures call into question the DOE's qualifications as an NRC licensee. Clark County lacks confidence in the DOE's ability to safely and securely construct and operate the proposed repository at Yucca Mountain with the expectation of integrity and a safety conscious work environment that is required of all NRC licensees.

3. A demonstration that the contention is within the scope of the hearing

This contention raises the fundamental issue of whether the DOE has complied with the NRC requirements applicable to Yucca Mountain, and falls within the scope of the hearing as specified in Section II, paragraph 1 of the Notice of Hearing. The DOE's institutional integrity as licensee relate directly to the health and safety of the public, and

thus lies within the scope of the proceeding, as described in the NRC's Notice of Hearing.[83]

4. A demonstration that the contention is material to the findings the NRC must make to license Yucca Mountain

The NRC may authorize issuance of a construction authorization for Yucca Mountain only if it determines that there is a reasonable assurance or expectation the materials described in the Application can be disposed of without unreasonable risk to the health and safety of the public.[84] The Presiding Officer may admit contentions based on claims of poor licensee integrity on the grounds that poor integrity poses a significant safety problem.[85] The general requirement for operating licenses requires a "finding of reasonable assurance of operation without endangering the health and safety of the public."[86] This standard applies to all licensees, and the DOE should be held to no lesser standard.

The Presiding Officer may consider a variety of factors in determining "whether there is reasonable assurance that the licensee has the integrity to operate the facility in a manner consistent with the public health and safety and the NRC requirements."[87] These include "evidence of licensee behavior having a rational connection to safe operation of the facility and some reasonable relationship to licensee's candor, truthfulness, and

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[83] 73 Fed. Reg. 63029 (October 22, 2008).

[84] See 10 CFR § 63.31(a)(2).

[85] See Dominion Nuclear Connecticut, Inc. (Millstone Nuclear Power Station, Units 2 and 3), CLI-01-24, 54 NRC 349, 365 (2001).

[86] Duke Power Co. (Catawba Nuclear Station, Units 1 and 2), LBP-82-116, 16 NRC 1937, 1946 (1982).

[87] Metropolitan Edison Co. (Three Mile Island Nuclear Station, Unit 1), CLI-85-9, 21 NRC 1118, 1136-37 (1985).

willingness to abide by regulatory requirements and accept responsibility to protect the public health and safety."[88]

5. A concise statement of the facts or expert opinions supporting the contention, along with appropriate citations to supporting scientific or factual materials

There is substantial evidence demonstrating that the DOE lacks the requisite institutional integrity to be granted a license to construct and operate a waste repository at Yucca Mountain. Unfortunately, the DOE has a track record that demonstrates a patent disregard for safety and a culture of and unwillingness to abide by regulatory requirements.

One well documented example of the DOE's record is the Waste Isolation Pilot Project at Carlsbad, New Mexico ("WIPP"). WIPP involves a national shipment program of transuranic waste and is the type of waste project most similar to Yucca Mountain.[89] A cursory review of the history of WIPP reveals the DOE's track record of broken promises and the withholding of funds owed to local governments necessary to ensure public health and safety.[90] The DOE there exerted its status as a federal agency to "change the rules" well after it had achieved its objectives and obtained concessions from affected parties.[91]

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[88] Id.

[89] Urban Environmental Research, LLC, "Lessons Learned from New Mexico's Experience with the Development of a Nuclear Waste Repository", at Section 1.1 (January 2001), LSN #CLK000000013.

[90] Id. (LSN #CLK000000013) at Section 2.2.

[91] Id. (LSN #CLK000000013) at Section 2.3.1 (Interview with New Mexico Secretary of Transportation, Peter Rahn, October 4, 2000).

Historically, the DOE has withheld funds for impact assistance, including public safety activities.[92] This unimpressive track record is most evident when it comes to funding emergency response training and equipment, which seem to have been absent or grossly underestimated for WIPP.[93] As noted by the former New Mexico Secretary of Transportation, Peter Rahn, the DOE's contradictory policies indicate that the DOE makes its decisions based on what is expedient and not necessarily what is needed to adequately protect the public health and safety.[94]

There is also ample evidence that the DOE failed to effectively manage other critical projects. This ineffectiveness resulted in cost increases ranging between $139 million and nearly $9 billion[95] and schedule delays ranging between two and fifteen years,[96] not to mention the large number of projects which are never completed. This ineffectiveness reflects a culture at the DOE that fosters contradictory and unclear guidance[97] and forces key technical and budget decisions premised upon assumptions that have little to no basis in reality.[98] Moreover, specific to this proceeding is the DOE Inspector General's conclusion that certain DOE evaluation documents "suggest a premature conclusion regarding the suitability of Yucca Mountain."[99]

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[92] See id. (LSN #CLK000000013) at Sections 3.4 and 5.2.

[93] See id. (LSN #CLK000000013) at Section 3.4.2.

[94] Id. (LSN #CLK000000013) at Section 3.4.2.

[95] See United States Government Accountability Office, "Nuclear Waste: Action Needed to Improve Accountability and Management of DOE's Major Clean-up Projects," Report to the Subcommittee on Energy and Water Development, Committee on Appropriations, House of Representatives, GAO-08-1081, p.14 (September 2008) (in nine out of ten clean-up projects studied). Attachment 7 hereto.

[96] See id. (in ten out of ten clean-up projects studied).

[97] Id. at p.8.

[98] Id. at p.6.

[99] United States Department of Energy, Office of Inspector General, "Memorandum for the Secretary," p.1 (April 23, 2001); *see also id.* at p.8 ("We found several written statements in key Yucca Mountain

The DOE's lack of integrity bears directly to the issue of safety. Clark County has legitimate concerns whether the DOE can or will construct or operate the repository in a safe manner based on documented evidence of the DOE's institutional failures. These failures include, but are not limited to, the DOE's unwillingness to abide by agreements with states and local governments, even when ordered by a Court to comply with the terms of such agreements.[100]

As with WIPP in Carlsbad, New Mexico, the DOE failed to provide an effective emergency management system ("EMS") in Chapter 6 of the Application or the pertinent portions of Appendices A thru H for Yucca Mountain. DOE thus ignored the requirement to address emergency management systems and assurances of maintaining public safety. Rather than addressing such requirements, the DOE improperly relies upon the NWPA Section 180(c) (improperly alleging that the issue of safety and emergency management systems is one of post licensing funding) as justification for its failure to analyze and consider such impacts, and improperly extracted the issue as a matter to be addressed upon implementation *after* the licensing decision is made.[101] Thus, Clark County and the public are left with no assurances or safeguards to prevent the DOE from engaging in the same practices as it has done elsewhere.[102] An evaluation of the lessons learned from the DOE's behavior and actions relative to WIPP raises a legitimate

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evaluation documents that could be considered by an impartial observer to be prematurely conclusive, or inappropriately advocating a position by the Department or its contractors"). Attachment 8 hereto.

[100] See e.g., "Lessons Learned from New Mexico's Experience with the Development of a Nuclear Waste Repository" (LSN #CLK000000013) at Section 2.2.5.

[101] See CLK-NEPA-001, infra.

[102] Supra, n. 100 (LSN #CLK000000013) at Section 2.3.1.

question and concern about the DOE's willingness to abide by regulatory and contractual obligations, and the measures an AULG must take to enforce such obligations.

6. Sufficient information to show a genuine dispute with the DOE, along with specific references to the portions of the Application being controverted

By proffering its application, the DOE contends that it is properly granted a license to construct and operate the repository, and that the Application as provided is sufficient.

1. A brief statement of the contention

The DOE's Final Supplemental Environmental Impact Statement ("FSEIS") fails to provide meaningful analyses concerning the effects on emergency management and public safety impacts on Clark County associated with the siting of a high level radioactive waste and spent nuclear fuel repository, in violation of the NWPA and NEPA and their respective implementing regulations.

2. A summary of the basis for the contention

DOE has failed to undertake reasonable analyses to identify the potential impacts on Clark County emergency management and safety systems. NEPA, in conjunction with Council on Environmental Quality ("CEQ") policy, requires the lead agency for a proposed federal undertaking to provide an effective emergency management system ("EMS") inclusive of an assessment of emergency preparedness and response personnel and standards.[103] The DOE failed to provide any such assessment in Chapter 6 of the FSEIS (LSN # DEN001593557), or the pertinent portions of Appendices A thru H, and instead improperly relies upon the NWPA Section 180(c) as justification for its failure to analyze and consider such impacts, and improperly extracting the issue as a matter to be address upon implementation *after* the licensing decision is made. Insufficient identification and understanding of the demands on emergency management and preparedness endangers public safety and must be considered as part of the

[103] 10 CFR § 51.91, and 10 CFR Part 51, Subpart A, Appendix A.

Environmental Impact Statement ("EIS") in evaluating alternatives to the proposed action.

3. A demonstration that the contention is within the scope of the hearing.

This contention is within the scope of the hearing as set forth in the Commission's Notice of Hearing, wherein the Commission notified all interested parties that the NRC staff determined that it is practicable to adopt, with further supplementation, the Environmental Impact Statement ("EIS") and supplements prepared by the DOE, and that among the matters of fact and law to be considered are whether the Application satisfies the applicable requirements of NEPA and the NRC's NEPA regulations, 10 CFR Part 51.

4. A demonstration that the contention is material to the findings the NRC must make to license Yucca Mountain

10 CFR Part 51 sets forth the NRC's obligations under NEPA, and requires that an EIS or supplement thereto be filed in connection with the issuance of a construction authorization and license for disposal of high level radioactive waste in geologic repositories.[104] 10 CFR § 51.109 requires the NRC staff to present a position on whether it is practicable to adopt, without further supplementation, the EIS prepared by the DOE.[105] Here, the NRC staff has decided to adopt the EIS, as may be supplemented by the DOE. The NRC staff's decision to adopt the DOE's EIS does not cure the DOE's errors or otherwise relieve the DOE of its obligation to address items properly within the scope of the EIS.

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[104] 10 CFR § 51.20(b)(13).

[105] 10 CFR § 51.109(a)(1).

5. A concise statement of the facts or expert opinions supporting the contention, along with appropriate citations to supporting scientific or factual materials

Ensuring safety is of paramount importance to the NRC's decision to authorize the construction of Yucca Mountain; and, ensuring the safety and welfare of its citizens is of paramount importance to Clark County as a local government. There is no question that the undertaking proposed by the DOE will have an impact to Clark County's emergency management and safety system. Yet, admitting that the undertaking will have a significant impact on Clark County's emergency management and safety systems does not relieve the DOE of its duty to undertake a reasonable effort to identify and analyze what those impacts may or will be; to identify whether such impacts can be avoided, if at all; and if so, how such impacts can or will be avoided and/or mitigated.

Inadequate analysis of public safety and emergency management fails to satisfy the purpose of the NRC commission hearings, the NEPA mandated EIS process, and the Application as a whole. Evaluating response capability and all public safety needs is essential to obtaining an accurate assessment as to whether such safety *can* be provided to the public. The DOE failed to analyze impacts associated with the repository on emergency management and safety systems, instead concluding that such concerns can and should be addressed *after* a decision is made on the license Application, and when the local government seeks funding for emergency management services. The DOE's decision to "punt" on this issue to another day is inappropriate and fails to comport with safety requirements and with NEPA.

Clark County plays a critical role in regional first response and emergency management, protection of critical infrastructure (including transportation). The FSEIS

assumes that 80 percent of the onsite Yucca Mountain Repository workers would reside in Clark County (Las Vegas).[106] Furthermore, a total shipment of approximately 9,500 rail casks and 2,700 truck casks would be shipped to Yucca Mountain repository.[107] The State of Nevada estimates that 100% of the truck casks would travel through Clark County, and 8% of the rail cask shipments would traverse Clark County.[108] Clark County owns and operates the University Medical Center with the only Level One Trauma Unit, Burn Unit, and the only radiological decontamination unit in Southern Nevada. A recent study estimates that at least 95,000 residents of Clark County live within one half mile of the Union Pacific route for shipments to Yucca Mountain via Caliente, and at least 113,000 residents of Clark County live within one half mile of a highway route for truck shipments.[109]

Clark County has Memoranda of Understanding or Mutual Aid agreements with a variety of the counties and cities throughout the region that would be employed in the event of an emergency, whereby Clark County would be providing aid to numerous jurisdictions and governmental entities.[110] In short, Clark County's emergency

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[106] DOE Final Supplemental Environmental Impact Statement for a Geological Repository at Yucca Mountain, Appendix A at A-8 (2008). LSN # DEN001593557.

[107] Id. at 6-8, § 6.1.7.

[108] State of Nevada Comments on DOE's Draft Supplement Environmental Impact Statement for a Geological Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, P. 8 (January 9, 2008). LSN # DEN001583031.

[109] Halstead, Robert, "State of Nevada Perspective on the U.S. Department of Energy Yucca Mountain Transportation Program – 8154." Presented at Annual Waste Management Meetings, Phoenix, Arizona (2008). LSN# NEV000005266.

[110] Urban Environmental Research, LLC, "An Update of the Projected Impacts to Clark County and Local Governmental Public Safety Agencies Resulting from the Transportation of High-Level Nuclear Waste to Yucca Mountain." (Aug 2005). LSN# CLK000000055; Conway, Sheila, A. Mushkatel, and K.D Pijawka. "Impacts to Clark County and Local Governmental Public Safety Agencies Resulting From the Yucca Mountain Project." Prepared for the Clark County Department of Comprehensive Planning Nuclear Waste Division. (Oct 2001). LSN # CLK000000006; UER. "Impacts to Clark County Public Safety Agencies Resulting From the Yucca Mountain Project." (Feb 1999). LSN # CLK000000001.

personnel, resources and capacity will be significantly impacted by the NRC's decision. The nature and extent of incidents associated with the federal undertaking such as this, the direct and indirect impact of such incidents on emergency management and safety systems, and a reasonable effort to collect and evaluate supporting data and analyses should have been evaluated as part of a reasonable effort to identify the impacts to Clark County's emergency management and safety systems, and whether such impacts can be avoided or mitigated.

It is a fundamental error for the DOE to try to segment or separate emergency management and public safety systems from the environmental impact statements for the repository or the rail corridor. That the authorization to construct a repository and related transportation of materials to that site will impact emergency management and public safety sectors of Clark County can no longer be disputed. These impacts should have been examined in the environmental impact statements, but were not.

6. Sufficient information to show a genuine dispute with the DOE, along with specific references to the portions of the Application being controverted

The DOE contends that the Application as provided, inclusive of the relevant EIS's, is sufficient.

1. A brief statement of the contention

The DOE's evaluation of rail corridors is patently deficient in its failure to evaluate known alternatives to the Caliente Rail Corridor. The Rail EIS evaluates only two of five feasible known rail corridors, The Caliente Corridor and The Mina Rail Corridor, ultimately coining the Caliente Corridor as the "preferred alternative" to the Mina Rail Corridor. The DOE's analysis sets up a false choice between a feasible and non-feasible corridor, and to the exclusion of the consideration of three additional feasible corridors.

2. A summary of the basis for the contention

NEPA requires the lead agency and author of an EIS to provide analysis of all reasonable alternatives to a proposal.[111] Such consideration is at the heart of the environmental impact statement.[112] Not a single feasible alternative to the Caliente Rail Corridor was considered by the DOE despite the identification of at least three feasible alternatives. The EIS thus fails to comply with the applicable NEPA and NRC standards.

3. A demonstration that the contention is within the scope of the hearing

This contention is within the scope of the hearing as set forth in the Commission's Notice of Hearing, wherein the Commission notified all interested parties that the NRC

[111] 40 CFR § 1502.14.

[112] Id.

staff determined that it is practicable to adopt, with further supplementation, the EIS and supplements prepared by the DOE, and that among the matters of fact and law to be considered are whether the Application satisfies the applicable requirements of NEPA and the NRC's NEPA regulations, 10 CFR Part 51. The Application includes the Rail Alignment EIS, the Nevada Rail Corridor SEIS (LSN# DEN001598766), and FSEIS (LSN# DEN001593557). The sufficiency of each of the EIS's is a fundamental part of the Application and is intrinsically and inextricably linked to the NRC review of the overall Application.

4. Demonstration that contention is material to the findings the NRC must make to license Yucca Mountain.

10 CFR Part 51 sets forth the NRC's obligations under NEPA and requires that an EIS or supplement thereto be filed in connection with the issuance of a construction authorization and license for disposal of high level radioactive waste in geologic repositories.[113] 10 CFR § 51.109 requires the NRC staff to present a position on whether it is practicable to adopt, without further supplementation, the EIS prepared by the DOE.[114] Here, the NRC staff has adopted the EIS, as may be supplemented by the DOE, thus making this issue material to the findings the NRC must make.

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[113] 10 CFR § 51.20(b)(13).

[114] 10 CFR § 51.109(a)(1).

5. A concise statement of the facts or expert opinions supporting the contention, along with appropriate citations to supporting scientific or factual materials

Consideration of alternatives is the heart of the environmental impact statement.[115] The purpose of the EIS is to "present the environmental impacts of the proposal and the alternatives in comparative form, thus sharply defining the issues and providing a clear basis for choice among options by the decision maker and the public."[116] Applying this requirement, courts have been "especially quick to find a discussion of alternatives inadequate if it is conclusory."[117] Applied here, the DOE's failure to undertake a meaningful analysis of known transportation alternatives renders the EIS insufficient.

The NRC cannot license the site if the risks and impacts of a true reasonable and feasible alternative are not rigorously explored and examined. Such examination did not take place with regard to alternatives to the Caliente Rail Corridor. Although NEPA does not require an agency to consider every possible alternative to a proposed action, the identification of a "viable but unexamined alternative renders [the] environmental impact statement inadequate."[118] Stated another way, "[t]he range of alternatives that the agency must consider is not infinite, of course, but it does include all reasonable alternatives to

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[115] 40 CFR § 1502.14.

[116] 40 CFR § 1502.14.

[117] NEPA LAW AND LITIGATION § 10.09[1], at 10-51; Swain v. Brinegar, 517 F.2d 766, 776 (7th Cir. 1975) (stating that discussion of alternatives in selection of "corridors" for highway was inadequate); Chelsea Neighborhood Assoc. v. United States Postal Service, 516 F.2d 378, 379 (2d Cir. 1975) (holding that conclusory discussion of alternatives to parking garage were inadequate under NEPA).

[118] Muckleshoot Indian Tribe v. United States Forest Service, 177 F.3d 800, 813 (9th Cir. 1999) (quoting Citizens for a Better Henderson v. Hodel, 768 F.2d 1051, 1057 (9th Cir. 1985)).

the proposed action. The . . . reasonableness standard applies both to which alternatives the agency discusses and the extent to which it discusses them."[119]

The DOE failed to consider reasonable and viable alternatives to the Caliente Rail Corridor where there is evidence of at least three other reasonable and feasible alternatives. The Rail Alignment EIS evaluated only two rail corridors: the Caliente Rail Corridor and the Mina Rail Corridor.[120] The FSEIS does the same.[121] The DOE referred to the Caliente Corridor as the "preferred alternative" and the Mina Rail Corridor as the "non-preferred alternative."[122] However, the DOE's designation of the Mina Rail Corridor as "non-preferred" suggests that it was a feasible alternative when indeed it was not.

The Mina Rail corridor became a non-alternative upon the withdrawal of support by the Paiute Walker Tribe on April 29, 2007—greater than a year prior to the DOE's submission of the Application. The DOE acknowledged this withdrawal of support in its Application, yet continued to designate the Mina Rail Corridor as an "alternative," (albeit "non-preferred"), rail corridor.[123] Further, the DOE failed to discuss an alternative to the Mina Rail Corridor route that bypasses tribal lands or why this discussion was absent from the FSEIS.

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[119] Utahns for Better Transp. v. U.S. Dept. of Transp., 305 F.3d 1152, 1167 (10th Cir. 2002) (citing City of Grapevine v. Dept. of Transp., 17 F.3d 1502, 1506 (D.C.Cir. 1994)).

[120] See Rail Alignment EIS, at § 2.2.

[121] See FSEIS (LSN# DEN001593557) at §§ 2.1.7.3, 3.2.1.1 and 6.4.

[122] See id. (LSN# DEN001593557) at § 2.1.7.3.1.

[123] See id. (LSN# DEN001593557) at § 6.4.1.9.

There are three reasonable alternatives to the Caliente Rail Corridor: the Carlin Rail Corridor, the Jean Rail Corridor, and the Valley Modified Rail Corridor. The DOE has determined that each of these corridors have minimal land conflict complications.[124] Nevertheless, the DOE failed to examine a single one of these reasonable alternatives in the FSEIS. Instead, the DOE choses to only examine the Caliente and non-alternative Mina Rail Corridors.[125] Further, the DOE failed to provide the basis for eliminating all but the Caliente and Mina routes from its Application. Thus, the DOE's EIS's are deficient and the Application should be denied.

6. Sufficient information to show a genuine dispute with the DOE, along with specific references to the portions of the Application being controverted

The DOE contends that the Application as provided, inclusive of the relevant EIS's, is sufficient.

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[124] See Nevada Rail Corridor SEIS (LSN# DEN001598766), at §§ 5.2.1, 5.3.1 and 5.4.1.

[125] See FSEIS (LSN# DEN001593557) at §§ 2.1.7.3, 3.2.1.1 and 6.4.

1. A brief statement of the contention

The DOE ignored data and wrongly dismissed analyses of stigma related socio-economic impacts resulting from the perceived and actual risks associated with potential accidents during the course of transporting high level nuclear waste. The DOE's assertion in the EIS that the relevant impacts of the Caliente Rail Corridor as the "preferred alternative" on property values and tourism cannot be measured and thus are irreducible ignores evidence and data proffered by Clark County.

2. A summary of the basis for the contention

The DOE's failure to evaluate the impacts of alternative transportation routes to identify the resulting socio-economic impacts for each such feasible alternative route violates 10 CFR § 51.91(c) which requires an EIS to identify the alternatives proposed and evaluated, as well as whether the identified alternatives will accomplish NEPA objectives enumerated in sections 101 and 102.

3. A demonstration that the contention is within the scope of the proceeding

The NRC is responsible for evaluating the quality and conformity of the DOE's submitted Application, including the attached EIS's. The FEIS (LSN # DN2002073507) and Rail EIS (LSN # DEN001593557) included with the Application fail to sufficiently address socio-economic impacts and concerns raised by Clark County.

4. A demonstration that the contention is material to the findings the NRC must make to license Yucca Mountain

10 CFR Part 51 sets forth the NRC's obligations under NEPA and requires that an EIS or supplement thereto be filed in connection with the issuance of a construction authorization and license for disposal of high level radioactive waste in geologic repositories.[126] 10 CFR § 51.109 requires the NRC staff to present a position on whether it is practicable to adopt, without further supplementation, the EIS prepared by the DOE.[127] Here, the NRC staff has adopted the EIS, as may be supplemented by the DOE.

Moreover, "Key topics necessary to adequately evaluate potential impacts from the proposed action" must be discussed in accordance with 10 CFR § 51.91, "Final Environmental Impact Statement – Content, (LSN# DN2002073507)" and 10 CFR Part 51, Subpart A, Appendix A, "Format for Presentation of Material in Environmental Impact Statements." Thus, whether the DOE adequately satisfied the governing regulations is material to the finding the NRC must make.

5. A concise statement of the facts or expert opinions supporting the contention, along with appropriate citations to supporting scientific or factual materials

NEPA requires analysis of both direct and indirect impacts that are reasonably foreseeable. Despite NEPA's mandated analysis, the DOE knowingly fails to evaluate and assess the stigma related impacts that will result from the "reasonably foreseeable" twenty six (26) accidents identified in the Rail EIS at page S-68. Additionally, the DOE concedes that "large impacts are possible if there are accidents with releases of ionizing

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[126] 10 CFR § 51.20(b)(13).

[127] 10 CFR § 51.109(a)(1).

radiation during the transportation of spent nuclear fuel and high level radioactive waste. The social amplification and risk and stigma might become quite relevant after an accident that exposes neighborhoods to ionizing radiation." (Appendix N, FEIS pg. 23, LSN # DN2002033728).

The DOE improperly attempts to circumvent its obligation by claiming that such stigma and related property value impacts are irreducible in Section 2.4.4 of the Repository SEIS (LSN# DEN001593557). Contrary to the DOE's position, a variety of established mechanisms for measuring and mitigating stigma-related impacts resulting from the transportation of spent nuclear fuel exist. Furthermore, monitoring systems to measure and evaluate such impacts are currently utilized in assessing socio-economic impacts resulting from the transport at issue. DOE's own filings acknowledge that property values in Clark County will diminish: Appendix N of the FEIS (LSN # DN2002033728) concedes that property values will diminish by 3% even without incident.

The National Research Council Committee on Transportation of Radioactive Waste found that "the social risks for spent fuel and high level waste transportation pose important challenges to the successful implementation of programs for transporting spent fuel and high level waste in the United States. Such risks can result in lower property values along transportation routes, reductions in tourism and increased anxiety." [128] While many uncertainties exist, current research and practices demonstrate that there are many proactive steps available to reduce and manage social risks. For example, Clark County

[128] "Going the Distance? The Safe Transport of Spent Nuclear Fuel and High-Level Radioactive Waste in the United States." Committee on Transportation of Radioactive Waste. National Research Council of the National Academies: The National Academies Press; Washington, D.C. (2006). Attachment 9 hereto.

implemented a monitoring program in 2005 that allows it to measure both positive and negative effects resulting from DOE's proposed plan to ship spent nuclear fuel and high level radioactive waste to Yucca Mountain.[129] The DOE can reasonably assess and

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[129] UER. "Baseline Information and Community Perspective on Potential Repository Impacts on Clark County." Prepared for the Clark County Department of Comprehensive Planning Nuclear Waste Division. (Dec 1999). LSN# CLK000000022.

UER. "Boulder City Governmental and Fiscal Impact Report." Prepared for the Clark County Department of Comprehensive Planning Nuclear Waste Division. (Sep 2001). LSN# CLK000000066.

UER. "City of Henderson Governmental and Fiscal Impact Report." Prepared for the Clark County Department of Comprehensive Planning Nuclear Waste Division. (Jul 2001). LSN# CLK000000059.

UER. "City of Las Vegas Governmental and Fiscal Impact Report." Prepared for the Clark County Department of Comprehensive Planning Nuclear Waste Division. (Sep 2001). LSN# CLK000000060.

UER. "City of Mesquite Governmental and Fiscal Impact Report." Prepared for the Clark County Department of Comprehensive Planning Nuclear Waste Division. (Sep 2001). LSN# CLK000000065.

UER. "City of North Las Vegas Governmental and Fiscal Impact Report." Prepared for the Clark County Department of Comprehensive Planning Nuclear Waste Division. (Jul 2001). LSN# CLK000000062.

UER. "DOE and Public Trust in the Proposed Yucca Mountain Repository Program." Prepared for the Clark County Department of Comprehensive Planning Nuclear Waste Division. (Nov 2003). LSN# CLK000000028.

Navis, Irene, and Sheila Conway. "Impact Assessment and Public Outreach Strategies for Local Governments." Incorporated into Clark County's Impact Assessment Report on the Yucca Mountain Program. (Jun 2001). LSN# CLK000000052.

UER. "Impacts to Clark County Non-Public Safety Governmental Agencies Resulting from the Yucca Mountain Repository." Prepared for the Clark County Department of Comprehensive Planning Nuclear Waste Division. (Dec 2001). LSN# CLK000000032.

UER. "Moapa Band of Paiute Indians Governmental and Fiscal Impact Report." Prepared for the Clark County Department of Comprehensive Planning Nuclear Waste Division. (Jun 2001). LSN# CLK000000063.

UER. "Clark County Property Value Report on the Effects of DOE's Proposal To Ship High Level Nuclear Waste to a Repository at Yucca Mountain." Prepared for the Clark County Department of Comprehensive Planning Nuclear Waste Division. (Jun 2001). LSN# CLK000000019.

UER. "The Role of Local and State Governments in Radioactive Waste Transportation Safety." Prepared for the Clark County Department of Comprehensive Planning Nuclear Waste Division. (Feb 2003). LSN# CLK000000027.

UER. "Tribal Concerns about the Yucca Mountain Repository: An Ethnographic Investigation of the Moapa Band of Paiutes and the Las Vegas Paiute Colony." Prepared for the Clark County Department of Comprehensive Planning Nuclear Waste Division. (Oct 2002). LSN# CLK000000033.

UER. "An Update of the Projected Impacts to Clark County and Local Governmental Public Safety Agencies Resulting from the Transportation of High-Level Nuclear Waste to Yucca Mountain." (Aug 2005). LSN#: CLK000000055.

implement a similar Monitoring Program in communities across the transportation corridor alternatives permitting measurement and prevention of any stigma related property value declines for each feasible alternative.

Conway, Sheila, A. Mushkatel, and K.D Pijawka. "Impacts to Clark County and Local Governmental Public Safety Agencies Resulting From the Yucca Mountain Project." Prepared for the Clark County Department of Comprehensive Planning Nuclear Waste Division. (Oct 2001). LSN #: CLK000000006.

UER. "Impacts to Clark County Public Safety Agencies Resulting From the Yucca Mountain Project." (Feb 1999). LSN #: CLK000000001.

UER. "Lessons Learned from New Mexico's Experience with the Development of a Nuclear Waste Repository." Prepared for the Clark County Department of Comprehensive Planning Nuclear Waste Division. (Jan 2001). LSN #CLK000000013.

UER. "Gaming Industry Impacts Resulting from the DOE's Yucca Mountain Proposal." Prepared for the Clark County Department of Comprehensive Planning Nuclear Waste Division. (June 2001). LSN# CLK000000021

UER. "Yucca Mountain Impact Assessment Report, Clark County, Nevada." Prepared for the Clark County Department of Comprehensive Planning Nuclear Waste Division. (Feb 2002). Attachment 10 hereto.

UER. "Preliminary Site Suitability Evaluation for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada: Formal Response Submitted by Clark County, Nevada." Prepared for the Clark County Department of Comprehensive Planning Nuclear Waste Division. (Oct 2001). LSN #: CLK000000010.

UER. "Sustainable Indicators Report." Prepared for the Clark County Department of Comprehensive Planning Nuclear Waste Division. (Jan 2001). Attachment 11 hereto.

UER. "Community visioning report on behalf of the town of Indian Springs, Clark County, Nevada." Prepared for the Clark County Department of Comprehensive Planning Nuclear Waste Division. (Feb 2004). Attachment 12 hereto.

UER. "Clark County Monitoring Program: Community Survey." Prepared for the Clark County Department of Comprehensive Planning Nuclear Waste Division. (Apr 2008). Attachment 13 hereto.

UER. "Clark County Monitoring Program: Community Survey." Prepared for the Clark County Department of Comprehensive Planning Nuclear Waste Division. (May 2007). Attachment 14 hereto.

UER. "Clark County Monitoring Program: Community Survey." Prepared for the Clark County Department of Comprehensive Planning Nuclear Waste Division. (Feb 2006). Attachment 15 hereto.

UER. "Clark County Monitoring Program: Community Survey." Prepared for the Clark County Department of Comprehensive Planning Nuclear Waste Division. (Jul 2006). Attachment 16 hereto.

Uncertainty underground: Yucca Mountain and the nation's high-level nuclear waste. Edited by Allison M. Macfarlane and Rodney C. Ewing. Cambridge, Mass.: MIT Press, c2006. LSN #: NEV000003427.

The social amplification of risk. Edited by Nick Pidgeon, Roger E. Kasperson and Paul Slovic. Cambridge : Cambridge University Press, 2003. LSN# DN2000020283.

Gawande, K., and H. Jenkins-Smith. 2001. Nuclear waste transport and residential property values: Estimating the effects of perceived risks. Journal of Environmental Economics and Management Volume 42, Issue 2, September 2001, Pages 207-233. LSN # DEN001355690.

Schweer, K. UNLV Center for Business and Economic Research. Attachment 17 hereto.

Further, the National Research Council has recommended that the Department of Energy expand its Transportation External Coordination Working Group to obtain outside advice on social risks, including impacts and management.[130] The Council also advised that a Transportation Risk Advisory Group be convened under the Federal Advisory Committee Act to provide advice on characterizing, communicating, and mitigating the social, security, and health and safety risks that arise from the transportation of spent fuel and high level nuclear waste to Yucca Mountain.[131]

6. Sufficient information to show a genuine dispute with the DOE, along with specific references to the portions of the Application begin controverted

The DOE contends that the Application as provided, inclusive of the relevant EIS's, is sufficient. Clark County's objection to this position is stated in Section 5 to this contention.

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[130] "Going the Distance? The Safe Transport of Spent Nuclear Fuel and High-Level Radioactive Waste in the United States." Committee on Transportation of Radioactive Waste. National Research Council of the National Academies: The National Academies Press; Washington, D.C. (2006). Attachment 9 hereto.

[131] Id.

III. CONCLUSIONS

For the foregoing reasons the license application should be denied. Clark County therefore respectfully petitions the Presiding Officer to accept the contentions raised herein, set the matters for hearing, and grant Clark County party status with full rights of participation. Should the Presiding Officer find that none of Clark County's contentions are admissible, Clark County respectfully seeks leave to participate as an IGP.

Respectfully submitted,

signed electronically

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December 22, 2008

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the Matter of: U.S. DEPARTMENT OF ENERGY (High Level Waste Repository)	Docket No. 63-001

CERTIFICATE OF SERVICE

I hereby certify that on this day, December 22, 2008, the foregoing was served on all parties listed on the official service list for this proceeding as maintained by the Nuclear Regulatory Commission's Electronic Information Exchange.

Signed Electronically
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