SUMMARY OF
THE U.S. NUCLEAR REGULATORY COMMISSION/U.S. DEPARTMENT OF ENERGY
TECHNICAL EXCHANGE AND MANAGEMENT MEETING ON PRECLOSURE TOPICS
LAS VEGAS, NEVADA
NOVEMBER 7-9, 2006

INTRODUCTION

On November 7-9, 2006, the U.S. Nuclear Regulatory Commission (NRC) and the U.S. Department of Energy (DOE) held a public Technical Exchange (TE) and Management Meeting to discuss topics related to DOE's preclosure safety analysis (PCSA). This meeting was held at the Las Vegas Hearing facility in Las Vegas, Nevada. The agenda for this meeting can be found in Enclosure 2.

To support staff and stakeholder interactions, the TE and Management Meeting included video connections at NRC offices in Rockville, Maryland, and the Center for Nuclear Waste Regulatory Analyses in San Antonio, Texas. Teleconference connections were also made available for interested stakeholders. Participants included representatives of the NRC, DOE, State of Nevada, Affected Units of Local Government, Nuclear Energy Institute, other industry representatives, and members of the public. A list of attendees is provided in Enclosure 3.

The meeting agenda, list of attendees, and presentations by NRC and DOE are available with the interim meeting summary on the NRC High-Level Waste Disposal Meeting Archive web site: http://www.nrc.gov/waste/hlw-disposal/public-involvement/mtg-archive.html#KTI (NRC ADAMS ML063260131)

PURPOSE OF THE TE AND MANAGEMENT MEETING

The purpose of this meeting was to discuss topics related to DOE's PCSA. The PCSA is a systematic examination of the site, design, potential hazards, initiating events, event sequences and their potential consequences.

DISCUSSION TOPICS

NRC presented key messages on the topics related to DOE's PCSA, including: (1) aircraft hazards; (2) preclosure source terms and consequences; (3) reliability methodology; (4) human reliability analysis; (5) preclosure licensing specifications; (6) training; and (7) preclosure criticality. NRC presentations covered key messages discussed in NRC's letter to DOE dated November 2, 2006 (NRC ADAMS ML062990066). DOE presented information on the topics listed above, with the exception of preclosure criticality, and discussed license application status and requirements mapping. NRC and DOE presentations are provided in Enclosure 4. The following discussion provides highlights for each of the topics addressed in this meeting.

1. Aircraft Hazards

NRC presented key messages on aircraft crash hazards based on its understanding of DOE's approach (before receiving DOE's revised *Frequency Analysis of Aircraft Hazards for License Application* document which was transmitted to the NRC on November 3, 2006). NRC key messages focused on aircraft crash frequency and uncertainties in DOE assumptions, data, and information used, methodologies selected, and analysis techniques.

DOE's presentations outlined details of its approach for calculating aircraft crash frequencies. DOE's approach is to screen out the aircraft crash hazard by calculating the crash frequency. The crash frequency uses data from 1990 to 2005 provided by the Federal Aviation Administration, and the U.S. Air Force (USAF). Results of DOE's analysis demonstrate that the probability of such a crash is less than one in 10,000 during the preclosure period, which is assumed to be 50 years for surface operations involving spent nuclear fuel and high-level waste; thus the aircraft crash hazard is considered to be below the category 2 threshold.

NRC staff asked DOE to clarify its assumptions on: (1) future flight increases in the Beatty Corridor; (2) use of two week data, on flights in the Beatty Corridor, to extrapolate to longer periods; (3) use of crash density/year for flights in the areas outside the flight restriction area; and (4) the use of the Solomon model instead of the NUREG-0800 method, to calculate crash probability at locations away from the airway width. NRC indicated that it would be providing feedback on the revised *Frequency Analysis of Aircraft Hazards for License Application*, by the end of December 2006. On the use of the NUREG-0800 model and the Solomon model, DOE stated that both Palo Verde and San Onofre nuclear plants were licensed using the Solomon model.

DOE responded by stating that the Beatty Corridor counts based on two weeks of data were increased by 400% to account for future growth and to account for the uncertainty associated with extrapolating two weeks of data to represent an annual flight count. This increase bounded the growth rate seen by McCarran Airport in Las Vegas. DOE also stated that the annual crash density was based on historical data provided by the USAF on crashes that had occurred within the Nevada Test and Training Range (NTTR) and adjacent military operation areas over the 15.5-year period from 1990 to 2005.

Comments and questions from members of the public included:

Mr. Hugh Horstman, representing the State of Utah, stated that the flights in the NTTR have increased by 110 percent and only 20 percent of USAF aircraft mishap reports contain any information on distance traveled by the mishap aircraft after the emergency is initiated. Mr. Horstman suggested that DOE and NRC look into the details more throughly, so that the proposed repository facilities would not pose any safety risk.

Mr. Steve Frishman, of the State of Nevada, questioned DOE's rationale for using the F-16 aircraft current crash rate, when the F-22 is a newly introduced aircraft in the USAF. Mr. Frishman stated that, historically, the F-16 showed a significantly higher crash rate when introduced into service. Therefore, it is expected that F-22s will also show a higher crash rate during early years. DOE replied that there were two F-22 crashes and those crashes were included in the analysis. Additionally, the F-22, being a twin-engine aircraft, is expected to have a lower crash rate than the F-16, which is a single-engine aircraft.

Mr. Martin Malsch, representing the State of Nevada, asked whether DOE considered helicopter crash probabilities in the sensitivity analyses. Additionally, he asked if DOE had used any criterion (e.g., the largest effect on the ultimate result) in selecting the parameters for the sensitivity analyses. DOE replied that it had not considered helicopter crash probabilities in the sensitivity analyses. Crash rates are based on historical data. For the sensitivity analyses, DOE stated that it had studied parameters. Mr. Malsch also asked DOE to clarify what it meant by "...screened out, based on probability for cruise missiles." DOE replied that "screened out" means that the contribution of the specific item, such as the cruise missiles, on the overall probability, is negligible.

2. Source Terms and Consequences

NRC presented key messages on source terms and consequences, based on its current understanding of DOE's approach. NRC indicated that it would be beneficial to hear DOE's plans for developing source terms and consequence analyses in the PCSA and the radiation protection program. NRC indicated that analyses should be based on accepted engineering practices, and sound health physics principles. NRC also indicated that normal operations exposures and category 1 and 2 event sequences should be considered in consequence assessments for the PCSA. NRC also discussed the following topics related to source terms: (1) characteristics of high-level waste; (2) types of failure phenomena; and (3) release fractions. NRC indicated that the description and technical bases for confinement and radiation shielding design features should be provided in the PCSA. NRC presentations also discussed key parameters related to direct radiation exposures and airborne release consequences. NRC indicated that they intend to use one set of dosimetry weighting factors for applications of both 10 CFR Part 20 and 63. Lastly, NRC discussed elements of the radiation protection program.

DOE presented an overview of its preclosure source terms and consequence methodology. Topics covered included: (1) DOE's radiation protection program and as-low-as-reasonably-achievable (ALARA); (2) source terms; (3) consequence methodology; (4) uncertainty and sensitivity analyses; and (5) license-application-supporting-documents.

3. Reliability Methodology and Human Reliability Analysis

NRC presented key messages on reliability assessment, including: (1) technical bases; (2) approaches to reliability estimation; and (3) uncertainty. NRC also presented key messages identifying the human reliability analysis (HRA) elements that DOE should address in the PCSA, including: (1) the use of a technically appropriate HRA process; (2) treatment of errors of commission; and (3) integration of HRA into the overall PCSA. These key messages were based on previous technical exchanges and DOE's *Summary of Preclosure Safety Analysis Reliability Assessment Methodology* (ADAMS ML062420195).

DOE presented an overview of its PCSA reliability and event sequence methodology, and a presentation on its reliability methodology, which included proposed approaches to incorporating available component data, expert judgment, and uncertainty into its PCSA. DOE indicated that it is planning to use a Bayesian approach for updating the reliability information, as operational data becomes available, at the geologic repository operations area (GROA).

DOE's presentation indicated that determination of event sequence frequency is based on the use of mean values for comparison to categorization requirements. The establishment of appropriate mean values includes an assessment of uncertainty. The NRC indicated that the use of mean values is acceptable with appropriate technical bases.

DOE also presented updated information on its approach to HRA for the PCSA, and how HRA is integrated with DOE's PCSA and design and operation processes. DOE indicated that its approach would include methodology that is applicable to the operations and human activities expected at Yucca Mountain (YM). The methodology would be comprised of both qualitative and quantitative aspects. In particular, DOE contrasted nuclear power plant and YM operations from the perspective of HRA, and the implications for the choice of appropriate methods and approaches for HRA in the PCSA. In addition, DOE indicated that it plans to quantify human reliability for Category 1 or 2 event sequences that involve human actions, and that its selection

of quantification method(s) would depend on the specific human failure event(s) involved and their qualitative aspects.

DOE's HRA presentation stated that the YM facility will be first-of-a-kind, and cannot therefore utilize existing data on "...walkdowns and consultation with operators." NRC commented that although the GROA will be a first-of-a-kind facility in many ways, valuable insights may be gained from operating experience at similar facilities, and activities and the knowledge of relevant training personnel. DOE's presentation also stated that the "...current version of ATHEANA and CREAM use HEART as HEP (human error probability) quantification tool." NRC staff commented that there were applications and literature on another quantification method being developed, and not yet available for use with ATHEANA, that is based on expert elicitation [Ref. Forester, J., D. Bley, S. Cooper, E. Lois, N. Siu, A. Kolaczkowski, and J. Wreathall, 2003, "Expert elicitation approach for performing ATHEANA quantification," Reliability Engineering and System Safety, 83(2): 207-220.].

NRC indicated that it was reviewing DOE's *Summary of Preclosure Safety Analysis Reliability Assessment Methodology*, and will provide written comments to DOE on this document in December 2006.

NRC also commented that the DOE's thinking on HRA had evolved substantially since the DOE's *Summary of Preclosure Safety Analysis Reliability Assessment Methodology* document of August 2006. It is understood that HRA methodology for the PCSA was still evolving at the time of the TE.

DOE asked if NRC had any insights on margins or limits for the categorization of event sequences near category/boundary. In effect, DOE asked "How close is close?" The NRC indicated that it will not specify how close an event sequence annual frequency needs to be, in order to merit conducting additional analyses. DOE should provide adequate justification and evaluation as part of the analysis in the PCSA. DOE responded that an assessment of the judgements used in developing the mean value would be an appropriate way to investigate the robustness of the mean value, and justify categorization of the event sequence.

DOE's discussions focused on methodologies and approaches for the PCSA, because the design of GROA facilities was still under development and being finalized, at the time of this meeting. As a result, DOE did not discuss the actual implementation of the PCSA. NRC noted that it is becoming increasingly important that the implementation of these methodologies and approaches are also communicated, in order for the staff to have: (1) a clear understanding of the extent to which DOE will incorporate reliability; (2) understand the structures, systems, and components that have been identified as important to safety; and (3) understand the operations and human actions that may be relied on in the GROA facilities.

Comments and questions from members of the public included:

Ms. Judy Treichel, representing the Nevada Nuclear Waste Task Force, commented on the lack of specificity of DOE's new design. She indicated that she attended a scoping meeting and had seen presentations on the new design, and was unable to get answers to specific questions. Based on this, she questioned how DOE could be developing event sequences, discussed in this meeting, without a complete design. She also questioned how DOE was planning to submit a thorough and complete license application.

Rod McCullum, representing the Nuclear Energy Institute, expressed his agreement with NRC that, in cases where DOE's analysis showed that it was close to a category boundary or dose limit, additional focus should be applied. Specifically, that it should be up to the DOE to determine at what point (e.g., how close) to apply such additional focus. Mr. McCullum also noted that it should be up to DOE to determine what type of additional focus was warranted. In this regard, he had questions about NRC statements made earlier in the meeting that seemed to infer that NRC was requesting a consequence analysis when DOE was close to a category boundary. NRC responded by clarifying that an event sequence is screened out on the basis of frequency, and that it was not NRC's intent to require DOE to submit a consequence analysis in such cases. Additionally, NRC noted that 10 CFR Part 63 is a risk-informed performance-based rule, and as such, NRC will consider the consequences of event sequences that are close to a frequency category limit. Mr. McCullum then asked if NRC's stated interest in consequences, in cases where DOE was close to a boundary, was a reference to the possibility that staff could conduct its own independent examination of consequences in such cases. NRC responded that it was a possibility.

Mr. Ken Canavan, representing the Electric Power Research Institute, explained the rationale for the use of the mean values in risk-informed decision making, and recommended that, for the YM Preclosure facilities, mean values should be used, instead of any other values in the distributions. NRC clarified that use of the mean would be acceptable, provided DOE had appropriate technical bases.

4. Licensing Specifications and Training

NRC presented a high-level overview of licensing specifications. NRC's presentation on licensing specifications noted that licensing specifications are intended to define conditions for safe operation, and to assure that key safety controls are maintained. NRC indicated that the license application must include identification and justification for probable subjects of license specifications, based on the requirements, with special attention being given to items that have the potential to significantly influence design. NRC noted that it will impose licensing specifications based on the important design assumptions and considerations in DOE's PCSA. NRC discussed probable subjects for licensing specifications. NRC also noted that revisions to licensing specifications require an amendment to the construction authorization or a license amendment, requiring NRC approval.

NRC also provided a high-level presentation on training. Items addressed by this presentation included: (1) regulatory bases; (2) training requirements; (3) discussion on systems approach to training; and (4) other guidance.

DOE's presentation on licensing specifications discussed regulatory requirements and guidance in the *Yucca Mountain Review Plan*. DOE indicated that its proposed licensing specification format and content will be patterned after nuclear power plant and independent spent fuel storage installation guidelines. DOE's presentations also addressed technical specification bases, and provided example of licensing specifications.

DOE's presentation on training discussed its Systematic Approach to Training in which project wide groups (e.g., engineering, licensing, quality assurance, construction, and operations) are included in the development and implementation of the training program. DOE's Office of

Civilian Radioactive Waste Management (OCRWM) Director has made training the OCRWM organization (DOE and its contractors) one of his top four objectives.

5. Preclosure Criticality

NRC presented key messages on criticality safety in the context of the PCSA. NRC also discussed key regulatory requirements and existing guidance and noted that this guidance may need to be adapted for 10 CFR Part 63 requirements. NRC also stated that criticality event sequences should include credible events (e.g., fuel misloads, damaged fuel, optimum moderation) based on facility operations and analyze the most reactive credible fuel configurations. NRC stated that DOE needs to provide a technical basis for the use of a criticality safety analysis administrative margin, including the consideration of biases and uncertainties. It stated that smaller margins may require more technical justification. NRC also discussed the typical administrative margin (i.e., 0.05) used for commercial spent nuclear fuel. NRC also stated that testing requirements may need to be developed for the reliability and performance of new types of neutron-absorbing materials, if they are credited in the PCSA. NRC also noted that DOE needs to provide technical justification for burnup credit, including analyses addressing uncertainty in the data used. NRC stressed the importance of an NRC/DOE near-term interaction on DOE's preclosure burnup credit strategy.

DOE indicated that they had not planned on discussing preclosure criticality information at this meeting. However, DOE had several questions in response to the NRC presentation. DOE asked if, when referring to "potential credible events," NRC meant those event sequences that are Category 1 or 2, but not beyond Category 2. NRC agreed, and indicated that credible event sequences included Category 1 and 2 event sequences and did not include those that were beyond Category 2. DOE also asked whether it needed to provide technical justification if it used an administrative margin of 0.05 (as is commonly used elsewhere for commercial spent nuclear fuel). NRC responded that an administrative margin needs technical justification and the smaller the margin, the more justification required. DOE asked if it could use the same amount of burnup credit that was recently approved for Holtec's transportation cask. NRC responded that if DOE uses the same methodology with the same level of technical justification, then NRC has already approved it for this apporach. DOE needs to determine if it can operate using the same assumptions and controls. NRC pointed out that the data used in the Holtec application are proprietary.

Comments and questions from members of the public included:

Mr. John Kessler, of the Electric Power Research Institute, asked why NRC requires the use of an administrative margin if the bias and uncertainty are already accounted for in the calculation. NRC responded that errors have been discovered in the codes used to calculate subcriticality, and that the cross-section data used are not known better than 1-2 percent. An administrative margin accounts for these uncertainties and indicates the confidence that what is calculated as subcritical will indeed be subcritical, and as such it is necessary.

6. DOE's License Application Status and Requirements Mapping

DOE presented information on its process for license application requirements mapping. This mapping illustrates DOE's perspective on where the content of the YM License Application

outlined in 10 CFR Part 63.21 will be captured in its safety analysis report. It also provides DOE's thoughts on the relationship between the safety analysis report and the review guidance provided in the *Yucca Mountain Review Plan.*

Mr. Steve Frishman, representing the State of Nevada, stated that he had previously asked Mr. Sproat if the CD-1 design would be released for public observation and indicated that he had not received an answer to date. Mr. Frishman asked when it would be made available to the public and NRC. DOE responded that the CD-1 products were still under deliberation.

CONCLUSION

NRC indicated that the meeting allowed NRC and DOE to discuss key messages, methodologies and approaches for the broad range of PCSA-related topics discussed above. NRC also noted that it was disappointed that DOE had not planned to discuss preclosure criticality information at this meeting. NRC recognized that DOE has established a very aggressive schedule of prelicensing activities and stated that NRC needs to be a part of that schedule to ensure that it can adequately carry out its public health and safety responsibilities. NRC stated that it is important for DOE to develop a workable schedule for upcoming TEs between now and license application. NRC stated that DOE's license application must contain the requisite level of information necessary to support NRC's review. NRC also stated that upcoming meetings need to be at a sufficient level of technical detail to explain the implementation of methods and approaches discussed to date, and allow NRC to engage DOE on the design and the integration of important to safety structures, systems, and components. NRC also stated that it is important for DOE to develop a schedule identifying when key reports and documents supporting DOE's PCSA will be available for NRC's review.

ACTION ITEMS/COMMITMENTS

None.

Jack R. Davis, Deputy Director — Date 2/1/07
Technical Review Directorate
Division of High-Level Waste Repository Safety
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission

Mark H. Williams, Director — Date 1/30/07
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