Summary Highlights of NRC/DOE Technical Exchange and Management Meeting on Pre-Closure Safety

July 24-26, 2001
Las Vegas, Nevada

Introduction and Objectives

This Technical Exchange and Management Meeting on Pre-Closure Safety is one in a series of meetings related to the U.S. Nuclear Regulatory Commission (NRC) issue resolution and sufficiency review, and the U.S. Department of Energy (DOE) site recommendation decision. Consistent with NRC regulations on prelicensing consultations and a 1992 agreement with the DOE, staff-level resolution can be achieved during pre-licensing consultation. The purpose of issue resolution is to assure that sufficient information is available on an issue to enable the NRC to docket a proposed license application. Resolution at the staff level does not preclude an issue being raised and considered during the licensing proceedings, nor does it prejudge what the NRC staff evaluation of that issue will be after its licensing review. Issue resolution at the staff level, during pre-licensing, is achieved when the staff has no further questions or comments at a point in time regarding how the DOE is addressing an issue. The discussions recorded here reflect NRC's current understanding of DOE's Pre-Closure safety assessment. This understanding is based on all information available to date which includes limited, focused, risk-informed reviews of selected portions of recently provided DOE documents (e.g., system description documents and the Repository Safety Strategy).

Summary of Meeting

In its opening presentation, the NRC stated that the status of issue closure regarding the Pre-Closure Safety Area would not be discussed at this Technical Exchange and Management Meeting because: (1) a Pre-Closure Issue Resolution Status Report has not been issued, (2) the Yucca Mountain Review Plan has not been released, and (3) this is the first technical exchange and management meeting related to the Pre-Closure Safety Area where DOE/NRC agreements will be reached. The NRC stated that in a letter dated April 27, 2001, it highlighted a number of specific topics it was prepared to discuss during this meeting, but that it was not prepared to discuss every subtopic or acceptance criteria within a Pre-Closure Safety topic. Based on these discussions, the NRC and DOE reached a number of agreements on topics related to Pre-Closure Safety. The NRC/DOE agreements made at the meeting are provided in Attachment 1. The agenda and the attendance list are provided in Attachments 2 and 3, respectively. Copies of the presenters' slides are provided in Attachment 4. Highlights from the Technical Exchange and Management Meeting are summarized below.

Highlights

1) Opening Comments

In its opening comments, NRC provided a general overview of the Pre-Closure Safety topics (see "Overview of Pre-Closure Meeting" presentation given by James Andersen). In its presentation, the NRC provided the safety terms and definitions that would be used during the meeting and stated that Pre-Closure Safety is one of many NRC requirements. The NRC also

discussed its proposal to divide Pre-Closure Safety into ten topics as discussed in an NRC letter dated April 27, 2001. Under these ten topics, the NRC stated that it plans to define subtopics and/or acceptance criteria DOE would need to address in any future license application. These subtopics and/or acceptance criteria would be outlined in future Pre-Closure meetings, as well as the Yucca Mountain Review Plan. The NRC stated that it would not discuss the status of issue closure regarding any of these ten Pre-Closure Safety topics at this meeting because: (1) a Pre-Closure Issue Resolution Status Report has not been issued, (2) the Yucca Mountain Review Plan has not been released, and (3) this is the first technical exchange and management meeting related to the Pre-Closure Safety Area where DOE/NRC agreements will be reached. The NRC proposed that any agreements reached would fall under one of the ten Pre-Closure Safety topics and that each agreement identification number would take the same form as used for the Key Technical Issues. DOE agreed with this approach.

2) Development of the License Application Integrated Safety Analysis: Overview of the ISA Process and ISA Products

DOE provided a general overview of the Integrated Safety Analysis (ISA) Process and stated that the presentation would (1) describe how an ISA is developed to support a license application for a potential repository, and (2) lay the framework and context for discussion of specific ISA topics (see "Development of the Integrated Safety Analysis for a License Application" presentation given by Dennis Richardson). DOE stated that the ISA process starts with identification of all the hazards that could be present at the proposed repository. DOE then discussed how these internal and external hazards get analyzed with respect to their frequency of occurrence and consequences. The ISA process also has a feedback loop for DOE to implement an event prevention or mitigation strategy. This iterative process would then feed into the specific design criteria, site description documents, design evaluation/support, and the Q-list. The NRC had several questions on the overview. In particular, the NRC questioned why the internal and external event analysis blocks were treated separately. DOE responded that the reviews of internal and external events are not done separately, but are coupled and performed in parallel. The NRC questioned why a frequency assessment was not included in the external event analysis. DOE stated that it was being done, but was not shown in the overview slide. The NRC also questioned why the consequence analysis came before the selection of design basis events in the overview slide, but not on the slide discussing the ISA products. DOE responded that it did categorize the design basis events before performing a consequence analysis. DOE also stated that the ISA process is an iterative process. The NRC stated that in future presentations of the overview of the ISA process, it would be helpful if DOE considered implementing these comments in the revision of the block diagram. DOE stated that it would update the block diagram to better identify that (1) it will perform external event frequency assessment, (2) design basis event categorization be done before the consequence analyses, and (3) the external and internal hazards be treated in an integrated fashion.

DOE then discussed, in general, the ISA products it expected to prepare for inclusion into the license application. The NRC noted that it considered all the ISA products as part of the ISA, not just the final overall analysis. DOE agreed with this comment and referred to page 5 of the ISA presentation that illustrated the expected products that would be part of the ISA. DOE stated that it was currently developing an ISA Guide, which will describe the approach for developing an ISA, identify acceptable methods for analyzing and documenting Pre-Closure safety analysis, ensure ISA consistency with regulatory requirements, provide consistency and

uniformity in analyses, provide a basis for training, and facilitate communication between the design and licensing organizations. The NRC asked whether DOE would have one standard method or a range of quantitative and qualitative methods for analyzing and documenting Pre-Closure safety analyses. DOE stated that it would try to use a common method best suited for the proposed repository, but that it may use other methods if deemed more appropriate for a particular case (e.g., a more qualitative approach). The NRC questioned how the ISA guidance would be used in comparison to the Technical Guidance Document (TGD). DOE stated that the ISA guidance document would go into more detail than the TGD.

After additional internal discussions, the NRC asked DOE to clarify how external events were analyzed, specifically, if external event analyses would include identification and assignment of frequencies for event sequences, how external events were integrated with internal event analyses, and how external event analyses factored into design considerations. DOE stated that, in this respect, external event analyses would be treated in the same fashion as internal event analyses. DOE further stated that its process would integrate both internal and external event analyses.

3) Identification of Hazards and Initiating Events

Aircraft Crash Hazard

DOE provided responses to several NRC comments relating to aircraft hazards (see "Identification of Hazards and Initiating Events NRC Item 3(a) Aircraft Hazards" presentation given by Richard Morissette) as discussed below.

The first NRC comment was that the exclusion of aircraft crash from the list of potential human induced hazards that may affect the proposed repository is premature. DOE agreed with the NRC comment and stated that it had only completed preliminary analysis in this area, specifically to address site suitability. DOE agreed to include a more extensive evaluation in any future license application.

The next NRC comment pertained to DOE taking into account all types of aircraft flying in the vicinity of the proposed site. DOE stated that it would be developing a vicinity map with aircraft types and activities identified. DOE also stated that it would include both military and commercial aircraft, airways, and airports. The vicinity map would include commercial general aviation, DOE aircraft, and aircraft chartered by the DOE flying through airways and inside the restricted airspaces. DOE will also include the flight paths of military aircraft inside the restricted airspaces in addition to military training routes, target areas within the range, and use of airspace for different activities. DOE Yucca Mountain Project will analyze information collected by DOE/Nevada Operations on number of overflights by military aircraft through a seven mile square box centered on the Waste Handling Building and through the Nevada Test Site. NRC questioned whether the seven mile square box would include all the options currently being considered for surface facilities. DOE stated that it covers all current options.

The next NRC comment requested DOE to provide a reasonable projection into future flight activities, including the introduction of new types of aircraft and changes in military missions. DOE stated that it would work with the U.S. Air Force to obtain available information regarding future flight activities, aircraft types, and changes in military missions. DOE also stated that it

would obtain information from DOE/Nevada Operations regarding potential changes to flight activities in the DOE controlled airspace over the Nevada Test Site.

The next NRC comment pertained to the summation of probabilities from all types of aircraft from different operations taking place in the vicinity of the proposed site that has a potential to contribute a significant crash hazard. DOE stated that it would sum the annual crash frequencies from all operations that required quantitative crash frequency analysis within the vicinity.

NRC requested assessment of the flight modes of military aircraft in the vicinity of the proposed site. DOE agreed to collect this information and use it in the revised analysis. NRC questioned whether the DOE analyses would include emergency aircraft, ordnance on airplanes, and helicopters. DOE confirmed that it would appropriately account for these issues in its analyses. DOE also agreed to document the methodology used to develop the aircraft vicinity map including consideration of restricted airspace activities and nearby bombing range information. DOE indicated their intention to use a Uniform Overflight Density Model developed at Lawrence Livermore National Laboratory to assess the potential for aircraft hazards. This model takes credit for aircraft glide ratios in the event of aircraft engine failure. When asked if an agreement with the U.S. Air Force could be negotiated to control military flight activities near the Yucca Mountain site, DOE responded that it was premature to speculate on the potential for such an agreement at this time.

The next NRC comment was on consideration of air-to-ground and air-to-air combat training activities that may be carried out in the vicinity of the proposed site. DOE stated that it could collect information from the U.S. Air Force. After further discussions, the NRC and DOE reached one agreement in this area (see Enclosure 1 for details).

Tornado Missiles

DOE provided responses to several NRC comments related to tornado missiles and impact on waste package design (see "Identification of Hazards and Initiating Events NRC Item 3(e) Tornado Missile Hazards" presentation given by Douglas Orvis) as discussed below.

The first NRC comment pertained to characteristics of the missile not being commensurate with the bounding characteristics of the tornado missiles for the region. DOE stated that tornado missiles are not a hazard for disposal canisters/waste packages while they are inside the waste handling building or the subsurface facility. The necessary portions of the waste handling building would be designed to withstand credible tornado missiles. During the brief exposure time when a transporter carrying a waste package travels between the waste handling building and subsurface facilities, DOE's preliminary screening analysis indicates that none of the disposal containers will be required to withstand the characteristics of a design-basis tornado missile because it is an incredible event scenario. NRC questioned the basis for the 1E-6 frequency of the missile generating design basis tornado. NRC stated that DOE should look at the whole class of events and needs to consider lower speed missiles and their impact on the waste packages rather than screening out all tornados because the probability of the largest one is below the cutoff. After further discussions, DOE and NRC reached one agreement in this area (see Enclosure 1 for details).

NRC questioned DOE's administrative procedures for responding to tornados. DOE stated that it would have administrative procedures for actions to take when tornados were predicted in the vicinity, but that it may not take credit for them in the ISA. The procedures may be used more as defense in depth. NRC questioned if retrieval was factored into DOE's tornado analysis. DOE stated that it was not presently included, but that it would have to update the analysis to take it into account should retrieval become necessary.

4) Identification of Event Sequences

DOE provided responses to several NRC comments relating to events screened out by design and justification of probability estimates (see "Identification of Event Sequences - NRC Item 4(a) and 4(b)" presentation given by Tom Dunn) as discussed below.

Events Screened Out by Design

DOE paraphrased the NRC position concerning the elimination by design of events that may result in a release. DOE stated that it could screen Pre-Closure design basis events based on a proposed design concept. The screening could be based on design features that reduce either probability or consequences and that it was consistent with the overall risk-informed performance-based philosophy in proposed 10 CFR Part 63. DOE further stated that the screening of design basis events must be defensible and that the uncertainties must be addressed to the extent they may impact either the categorization or the consequences of a potential design basis event.

Justification of Probability Estimates

DOE provided responses to NRC comments related to justification of probability estimates as discussed below. NRC asked for clarification as to how DOE treated failure data from nuclear industry and other commercial sources. DOE stated that both types of data will be used with appropriate justification for their use. DOE stated that it agreed with the NRC position that failure probabilities must be justified sufficient to support the design basis event categorization process. DOE stated that appropriate attention will be given to event scenarios that are near thresholds. The analysis would ensure that the technical basis supports the event categorization or that the categorization is conservative (e.g., an event that is of borderline beyond design basis event may be conservatively categorized as Category 2 and a borderline Category 2 may be conservatively categorized as Category 1).

The next NRC comment pertained to the use of point estimates of frequency of failure of different components in DOE's preliminary safety analysis. DOE stated that categorization of design basis events will be defensible, including the inputs and discussions on uncertainties and sensitivities associated with any failure rates or distributions of such rates. DOE stated that mean values will be used where applicable to categorize event frequencies. NRC questioned how beyond design basis events get captured in the design basis. DOE stated that it would analyze and include the systems, structures, and components in the design basis that would be relied on to push the probability or consequences below the regulatory limit. Items that are included in the design basis will be included in the potential license application. DOE stated other analyses would be available through document control and the licensing support network.

The next NRC comment pertained to probability estimates for component failures. DOE stated that it would, as appropriate, assign probability distributions to component failure rate estimates. These distributions will be used to estimate the mean component failure rate and the variability in the estimated failure rate.

The next NRC comment stated that if DOE obtains a probability distribution for the frequency of a Pre-Closure event sequence, the mean value of that distribution can be used to categorize the event sequence, provided that the probability distributions of the component failures are valid and appropriately account for uncertainty and variability. DOE stated that they interpret this to say that the mean is acceptable for categorizing an event. The NRC agreed and noted that if it is close to the border (i.e., between Category 1 and 2, or Category 2 and beyond design basis events), the uncertainty should be subject to further scrutiny.

After further NRC discussions, the staff stated that it agreed with DOE's general methodology in this area and that it would review future documents and provide any issues at that point. No agreements were needed at this time.

5) Consequence Analysis

DOE provided responses to several NRC comments related to consequence analysis (see "Consequence Analysis - NRC Item 5(a)" presentation given by Tom Dunn) as discussed below.

NRC provided a summary of its understanding of DOE's methodology for calculating doses under Category 1 and 2 design basis events (see NRC handout included in Enclosure 4). DOE agreed with NRC's understanding as explained in the following discussion.

NRC indicated that future DOE reports must document that no single Category 1 event sequence will result in a dose that exceeds the regulatory limits. DOE responded that the sum of the doses from normal operations and annualized (i.e., frequency-weighted) dose to the public from Category 1 events will be demonstrated to be below the regulatory limit. DOE will also demonstrate that the dose from any a single Category 1 event sequence will not exceed the regulatory limit and clarified that this comparison does not include the doses from normal operations.

After further NRC discussions, the staff stated that it agreed with DOE's general methodology in this area and that it would review future documents and provide any issues at that point. No agreements were needed at this time.

6) Identification of System, Structures, and Components (SSCs) Important to Safety and Waste Isolation

DOE divided this topic into four presentations. Each presentation is discussed below.

Identification of SSCs Important to Safety, NRC Items 6(a) and 6(b)

DOE provided responses to several NRC comments related to Q-List methodology and quality level categorization (see "Identification of SSCs Important to Safety NRC Items 6(a) and 6(b)" presentation given by Dealis Gwyn) as discussed below.

The first NRC comment pertained to DOE providing adequate justification for classifying SSCs as important to safety or not. NRC also provided examples of SSCs excluded from the Q-List without appropriate justification. DOE agreed with the comment and stated that it would provide adequate justification for the classification of all SSCs once the ISA is completed. DOE stated that the examples cited are not excluded from the Q-List; they have yet to be specifically classified.

The next NRC comment pertained to whether DOE's quality level classification process was based on the ISA process. DOE agreed that the classifications that support any license application need to be based on the ISA results which are not complete at this time. DOE stated that preliminary classification work was based on engineering judgment, project strategies and related assumptions of the roles of SSCs, and preliminary calculations. DOE then provided examples of preliminary classification. NRC had questions pertaining to the subsurface ventilation example. NRC questioned if the ventilation is needed to meet 10 CFR Part 20 requirements. DOE responded that ventilation does not appear to play a role in satisfying the requirements of 10 CFR Part 20 at this point, but that worker doses in the subsurface need to be assessed further. DOE added that ventilation is used more for cooling the waste packages and may increase post-closure performance. NRC also asked whether a technical basis existed which showed that ventilation could be lost for several weeks without compromising post-closure performance. DOE stated that the current basis is described in the Science and Engineering Report.

DOE then discussed its proposed criteria for risk informed classification analysis. NRC questioned how organ dose would be considered in the classification analysis. DOE responded that its formulas took organ dose into consideration, but that the chart was simplified to display only the principal performance objectives of the proposed 10 CFR Part 63.

The next NRC comment pertained to how DOE proposed to use the aggregated annualized dose expression along with importance analysis in the quality level classification of SSCs involved in event sequences. DOE agreed that the equations should be clarified and that project documents should be updated to reflect that clarification. DOE stated that contributions from surface and subsurface normal releases are included in the annualized dose; but DOE added a separate term for surface and subsurface normal operational release into the quality level classification equation for clarity. NRC questioned the terms of the equation and the units involved. DOE clarified the terms and stated that the units were annualized dose. DOE then discussed the process whereby "take-away" analyses for each SSC involved in an event sequence are used to obtain a quality level classification. DOE stated that the classification is based on the highest quality level identified from each event sequence that includes the SSC being evaluated. In response to an NRC question, DOE clarified that "take-away" analysis does not affect the values of the frequency-weighted and normal operation dose terms in the quality level classification equation.

The next NRC comment pertained to multiple Category 1 design basis events occurring in a single year. DOE stated that it will consider combinations of Category 1 design basis events occurring in a single year when performing SSC classifications and that additional dose terms for those multiple Category 1 event sequences would be included in the quality level classification equation.

The next NRC comment pertained to classifying the SSCs required to limit onsite worker doses as Quality Level 3 items. DOE stated that it believes that classifying items that limit onsite worker dose as Quality Level 3 will ensure that worker radiological risks are appropriately addressed. DOE further stated that items required for radiation worker safety are included on the Q-List as important to safety. NRC stated that with regard to power plant licensees, certain quality levels are typically placed on particular SSCs (e.g., reading of dosimetry badges). NRC asked if doses would be calculated for workers inside the waste handling building. DOE stated it had no problem adhering to NRC nuclear power plant licensing precedents. DOE stated that it plans to incorporate nuclear radiation worker safety practices that would eventually include worker dose analyses inside the waste handling building. NRC asked if a radiation protection program would be in place for all onsite employees and if personnel located on the Nevada Test Site and Nellis Air Force Range would be treated as radiation workers or members of the public. DOE stated that this determination had not yet been made.

The next NRC comment pertained to DOE's Quality Level 2 screening criteria and its consistency with proposed 10 CFR Part 63. DOE agreed that the classification procedure can be clarified to better link with the ISA approach and processes to be used in the license application. NRC asked when Quality Assurance Procedure QAP-2-3 would be revised. DOE stated that it would be done this calendar year.

The next two NRC comments pertained to the lack of justification for certain Quality Level 2 screening criteria identified in Quality Assurance Procedure QAP-2-3 (e.g., seismic 2/1 and fire as an initiating and/or interacting event). DOE stated that SSCs classified due only to interaction concerns (i.e., seismic 2/1) have been traditionally classified as nonnuclear safety related in the commercial nuclear power industry and placed in augmented quality assurance programs. NRC noted that the need for seismic 2/1 analysis should be minimized in the design process. DOE agreed. NRC also noted that when engineering judgment is used, the basis should be technically defensible and documented as part of the quality record. DOE agreed.

The next several NRC comments were discussed in this and earlier presentations.

Identification of SSCs Important to Safety - NRC Items 6(a) and 6(b): Examples

DOE provided several conceptual examples of quality level classification for SSCs important to safety (see "Identification of SSCs Important to Safety - NRC Items 6(a) and 6(b): Examples" presentation given by Douglas Orvis). DOE stated that following the development of event trees for credible initiating events and establishing event sequence frequencies, it will calculate offsite and occupational doses, as appropriate, to demonstrate compliance with the regulations. DOE then performs a "take-away analysis" of event sequences that include the SSC. The SSC is then classified consistent with design basis event sequence frequency reduction and dose mitigation importance. NRC commented that failure rate data from high quality equipment should not be used to justify a low quality classification. DOE agreed to the NRC comment.

The NRC had a number of clarifying questions. After further NRC discussions, the staff stated that it has a general understanding of the process but that the process needs to be more transparent. DOE agreed to make the process transparent in its revised Quality Assurance Procedure QAP-2-3 and ISA Guidance document.

Identification of SSCs Important to Safety - NRC Items 6(b), Concern 6

DOE provided a response to the NRC comment related to quality level categorization and risk measures (see "Identification of SSCs Important to Safety - NRC Items 6(b), Concern 6" presentation given by Douglas Orvis). DOE stated that it believes that it is not necessary to define or apply a measure of aggregate risk for the Pre-Closure operations, and that proposed 10 CFR Part 63 does not require this. Each event sequence end-state (frequency, dose) is represented by a point in the frequency-dose domain. DOE stated that it would demonstrate regulatory compliance by providing analyses and supporting technical bases that all credible event sequences are within the frequency-consequence boundaries defined by the proposed 10 CFR Part 63. DOE stated that it considers the insights gained from event-sequence frequency-dose calculations and sensitivity analyses, coupled with engineering judgment, to provide a robust risk-informed basis for determining the appropriate classification of SSCs. Regarding Regulatory Guides 1.174 and 1.176, DOE stated that the specific technical approaches in these Regulatory Guides are not directly applicable for important to safety SSC classification for the proposed repository. NRC commented that while these Regulatory Guides are not directly applicable, they still provide valuable generic guidance.

Identification of Items Important to Waste Isolation - NRC Items 6(b), Talking Point 6

DOE provided a response to the NRC comment related to waste isolation (see "Identification of Items Important to Waste Isolation - NRC Items 6(b), Talking Point 6" presentation given by Dennis Richardson). The NRC comment pertained to whether DOE intends to categorize SSCs important to waste isolation. DOE stated that the classification procedure includes criteria for classification of SSCs important to waste isolation into Quality Level 1, 2, 3, or conventional quality. Next, DOE provided the specific classification criteria and the applicable waste isolation questions related to each criterion. DOE discussed how the total system performance assessment (TSPA) is used to classify SSCs. DOE stated that if an item is shown in TSPA to be required to meet performance objectives, the item is classified as Quality Level 1; preserving initial conditions for TSPA is designated Quality Level 2; and monitoring used to demonstrate the site is performing within licensing specifications is designated Quality Level 3. In closing, DOE then presented some conceptual design examples for Quality Levels 1 and 3 waste isolation SSCs, and provided the preliminary classification and justification.

The NRC has developed a draft position paper on an acceptable approach to risk significance categorization of important to safety SSCs and made it available for this meeting (see Enclosure 4). The paper provides draft acceptance criteria that may become part of the Yucca Mountain Review Plan that is currently under preparation at the NRC. The paper has evaluated DOE's proposed methodology for Quality Level categorization. During this meeting, DOE responded to the concerns identified. NRC mentioned that it will revise the paper taking into consideration any comments by the DOE on the draft position paper. NRC commented that this meeting covered the overall approach to Quality Level categorization, but did not go into the implementation of a graded quality assurance program nor the relative differences among

levels of quality assurance implementation for Quality Levels 1, 2, and 3 SSCs. NRC reiterated its position that the 18 criteria in 10 CFR Part 50, Appendix B, are to be applied in a graded fashion, as appropriate, to all SSCs important to safety, whether or not grading is done.

After further NRC discussions, the NRC and DOE reached two agreements in Topic 6 (see Enclosure 1 for further information).

7) Level of Design Details: Differentiated Approach to Providing Information in the License Application

DOE discussed its internal license application guidance, products list, and level of design detail approach (see "License Application Level of Detail Discussion NRC Item 7(a)" presentation given by Stephen Cereghino). DOE discussed its license application guidance and stated that it is based on the Technical Guidance Document and will be captured in a "living" database that they consider to be a project management tool. DOE stated that this database will be revised based on the final 10 CFR Part 63 and Yucca Mountain Review Plan.

DOE then discussed the license application products list and stated that it would be based on its license application guidance and identifies products required to support preparation of a license application for construction authorization. DOE described a differentiated approach, update information, and four levels of detail for the different quality level SSCs in the license application. Information would be updated, as appropriate, by periodic amendments and at the time of the application to receive and possess waste. The differentiated approach pertains to different levels of information needing to be available for the construction authorization and for the application to receive and possess waste. DOE provided a number of topics that could be updated at the application to receive and possess waste including training, maintenance, and emergency planning. DOE also discussed its level of design detail approach for the license application. Graded approach pertains to the amount of information provided for SSCs commensurate with their safety significance, as indicated by the quality level assignments discussed in previous sessions. After this discussion, DOE and NRC stated that they would like to continue the dialogue in this area. NRC commented that information provided for commercial quality SSCs should be sufficient to justify their commercial quality classification and to evaluate their interactions with Quality Level 1, 2, and 3 SSCs.

NRC stated that it is in general agreement with the concept of (1) differentiated approach for information in the license application for construction authorization and the license application to receive and possess; and (2) level of design detail for SSCs in the license application. NRC noted that DOE is preparing internal license application guidance and a strategy for license application preparation. The NRC stated that it would be interested in reviewing DOE's license application guidance and would like to discuss it after the license application guidance document is revised to reflect 10 CFR Part 63 and the Yucca Mountain Review Plan. NRC would also like to discuss examples of implementation of graded level of detail of information to be provided in the license application. After these discussions, the NRC plans to finalize its paper on this topic (Note - NRC handed out the draft version of the paper at the beginning of the presentation and it is included in Enclosure 4).

8) Pre-closure Criticality Issues / Burnup Credit

DOE provided responses to several NRC comments related to the Preliminary Pre-Closure Safety Assessment for Monitored Geologic Repository Site Recommendation (see "Burnup Credit and Pre-Closure Criticality NRC Items 2(a) and 2(b)" presentation given by Thomas Doering) as discussed below.

Regarding the NRC comment associated with the use of burn-up credit in the design of the criticality control system of the waste packages for commercial spent nuclear fuel, DOE stated that this item reflects one of the open items in the Safety Evaluation Report for Disposal Criticality Analysis Methodology Topical Report. DOE further stated that Revision 1 of the Preclosure Criticality Analysis Process Report is currently scheduled for fiscal year 2003 and would include the approach for verification of fuel assembly burnup. DOE stated that burnup credit is only being sought for commercial spent nuclear fuel and that DOE believes that burnup information for the majority of the fuel developed and available through reactor records developed under an NRC accepted quality assurance program is the best source of assembly burnup information. NRC agreed that reactor records are a more accurate source of fuel assembly burnup data than physical measurements. However, NRC stated that its current position is that measurements are needed to verify the burnup indicated by reactor records, but that it would review DOE's approach after DOE submits Revision 1 of the Preclosure Criticality Analysis Process Report.

DOE then discussed NRC comments pertaining to flooding, probability of criticality, technical basis for beyond design basis events, and misload events. In each case, DOE stated that it would document appropriate risk-informed evaluations as part of the normal criticality safety evaluations. NRC stated that it would review these evaluations when they were provided.

As a result of further NRC discussions, the NRC and DOE reached one agreement in this area (see Enclosure 1 for further information).

9) Engineered Barrier System Design and Fabrication

DOE provided responses to several NRC comments related to the engineered barrier system design and fabrication (see "Engineered Barrier System Design and Fabrication NRC Item 7(e.1), 7(e.2), and 7(e.4)" and "Engineered Barrier System Design and Fabrication NRC Item 7(e.3) presentations given by Thomas Doering and Bruce Stanley) as discussed below.

The first NRC comments pertained to waste package drop issues. NRC commented that DOE needs to demonstrate that the mesh discretizations of the finite element models used to simulate the effects of waste package drop events are sufficient to provide reasonably convergent results that can be used to assess potential failure. DOE stated that benchmarking of the finite element analyses code against pour canister drop experiments has been performed and shows acceptable fidelity with test results. NRC questioned whether the pour canister is the proper analog, citing differences in materials of construction, dimensions, strain rate effects, etc. DOE stated that the pour canister benchmark evaluation allows DOE to see if the code is working properly for waste package design analyses. DOE addressed additional comments pertaining to the boundary conditions used in the waste package drop finite element models.

DOE addressed comments pertaining to the failure criterion for the waste package drop analysis. NRC asked if the structural integrity of the spent fuel was considered when establishing allowable drop heights. DOE stated that in the event of a drop, an assessment would be made as to whether the waste form must be re-packaged, but the primary consideration when establishing drop heights is the integrity of the waste package. DOE also noted that the re-packaging requirements have not yet been established, but will be based on long-term performance needs.

DOE addressed comments pertaining to orientations for the waste package drop scenarios. DOE stated that as part of the normal design process, design basis dynamic events will be re-evaluated as the designs for both the surface and subsurface facilities matures.

NRC asked if there has been any progress in quantifying the level of waste package reliability for the purpose of ISA and TSPA assessment as defined in Subsection 1.2.1.5 of the Uncanistered Spent Nuclear Fuel Disposal Container System Description Document. DOE stated that this requirement will be clarified in future revisions of the System Description Document. NRC asked about the operational procedures in the event of a waste package breach. DOE indicated that this has not been addressed and will be addressed in the future.

The next NRC comments pertained to waste package fabrication and welding issues. DOE addressed comments pertaining to chemical composition, microstructure, and allowances for variations in parameters that could affect Pre-Closure performance. NRC questioned the range of compositions reviewed and recommended that an appropriate set of tests be conducted to evaluate and justify that the effects of these variations are properly considered. DOE stated that samples being tested are made from a number of heats of material that cover a variety of compositions and therefore provide an understanding of material throughout the range of material composition.

DOE then addressed non-destructive evaluation methods. NRC questioned whether the non-destructive evaluation methods used to inspect the alloy 22 and 316 nuclear grade materials are sufficient and capable of detecting defects that may alter waste package mechanical properties. DOE stated that its fiscal year 2001 development program includes a study to identify the minimum flaw size that can be detected in alloy 22 material. DOE noted that the ASME flaw size criteria are being used for the study.

DOE addressed contamination controls and stated that production procedures have not yet been developed in this area, however, contamination control has been demonstrated through prototype welding. NRC stated that these are expected to be addressed in operational procedures. DOE agreed. DOE then addressed filler metal selection. DOE noted that samples being tested are made from a number of heats of this wire.

DOE then addressed several issues related to welding methods, environmental restriction, weld qualification tests, and weld joint design. DOE stated that it had not developed production procedures in these areas but would follow the ASME code. DOE also noted that this issue is partially addressed in CLST agreement CLST.2.05.

DOE addressed post-weld treatment and post-weld repair issues. DOE stated that studies of the laser peening process and induction annealing tests are ongoing and the results will be

documented. NRC questioned whether DOE had any initial thoughts regarding post-weld repair. DOE stated that it had not developed a production procedure or parameters at this time.

The next NRC comments pertained to fire design criteria. DOE addressed the fire design criteria and stated that the technical basis for classifying fire as a beyond design basis event is that significant fire hazards are intended to be precluded at the repository through the design of the SSCs. DOE stated that future analysis of any off-normal waste package events will be based on the Category 1 and 2 design basis event criteria defined in proposed 10 CFR Part 63. Once sufficient information is available on the design of the repository SSCs that interface with the waste package, the technical basis for off-normal waste package events will be documented.

The last NRC comments pertained to differential thermal expansion. DOE addressed whether provisions have been made for thermal expansion in the design of the gantry crane rails. DOE stated that, although not detailed at this time, a combination of fixed and slotted anchors will accommodate expansion. DOE also stated that the invert transverse beams are anchored on one end, and feature a slotted connection on the other end, allowing for expansion. DOE noted that the design is not yet complete and the invert configuration may change for license application.

As a result of additional discussions, the NRC and DOE reached four agreements in this area (see Enclosure 1 for details). With regard to agreement PRE.07.02, DOE indicated that this agreement only applies to Pre-Closure related activities because every post-closure model must already be validated to the extent described in the agreement. NRC pointed out that the spirit of agreement PRE.07.02 should extend to all important to safety and important to waste isolation SSCs, as appropriate, regardless of whether it is considered a pre- or post-closure item.

10) Public Comments

Ms. Judy Triechel (Nevada Nuclear Task Force) commented that she was familiar with aircraft crashes, particularly in this region. She stated that the U.S. Air Force does not live up to its agreements and she was aware of numerous instances in which the U.S. Air Force did not follow the rules and procedures it agreed to. Ms. Triechel stated that she believes aircraft hazards are a site suitability issue. Furthermore, due to the potential for future work on a missile defense system and other new defense initiatives, the suitability of the proposed site for a waste repository may be questionable.

Ms. Triechel also commented on the annualized dose requirement in proposed 10 CFR Part 63. Ms. Triechel stated that frequency should not be part of the dose number and that the results of accident analysis calculations should be provided in dose, not annualized dose. Ms. Triechel commented that by using the frequency-weighted and annualized dose numbers, the results would not be understood by the public.

Ms. Triechel commented on the difference between site recommendation and license application. She noted that with some of the agreements being scheduled in fiscal year 2003, it was hard to understand how DOE could make a site recommendation in 2001. Ms. Triechel

also questioned what DOE meant by the service life of the rail system. DOE stated that the service life meant the period of time until repository closure.

C. William Reamer
Chief, High Level Waste Branch
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards
Nuclear Regulatory Commission

April V. Gil
Team Leader, Regulatory Interactions
and Policy Development
Office of Licensing & Regulatory Compliance
Department of Energy

Summary of the Resolution of Pre-Closure Safety Topics

Topic #	Topic Title	Status	NRC/DOE Agreements
3	Identification of Hazards and Initiating Events	N/A	PRE.03.01 - Provide a plan for identification and estimation of aircraft hazards for the license application. This plan should be consistent with the guidelines in NUREG-0800 and other applicable DOE standards, as appropriate, to a nuclear waste repository. Provide a map delineating the vicinity to be considered in the detailed analysis, taking into consideration available information for civilian and military aircraft, including information from federal and local agencies concerning how such activities may reasonably change. Participate in an Appendix 7 meeting to discuss the aircraft hazards plan, initial data collection and analysis, development of the vicinity map, and the appropriate level of detail for analyses to be presented in the license application assessment. DOE agrees with the request and will provide the plan and map in June 2002. DOE agrees to participate in an Appendix 7 meeting which will be scheduled after the plan and map are provided. PRE.03.02 - Provide an analysis, including (1) selection of the design basis tornado, together with the supporting technical basis; (2) selection of credible tornado missile characteristics for the waste package and other structures, systems, and components, together with the technical bases; and (3) analysis of the effects of impact of the design basis tornado missiles or justification for excluding such tornado missiles as credible hazards. DOE agrees to provide the analysis. The analysis will be available in FY03 and be documented in an update to ANL-MGR-SE-000001 and any other appropriate documents.
4	Identification of Event Sequence	N/A	None at this time.
5	Consequence Analysis	N/A	None at this time.

6	Identification of Structures, Systems, and Components Important to Safety; Safety Controls; and Measures to Ensure Availability of the Safety Systems	N/A	PRE.06.01 - Provide the update to Quality Assurance Procedure QAP 2-3. DOE agreed to provide the procedure. The procedure will be available in February 2002. PRE.06.02 - Provide the Integrated Safety Analysis Guide. DOE agreed to provide the guide. The guide will be available in February 2002.
7	Design of Structures, Systems, and Components Important to Safety and Safety Controls	N/A	PRE.07.01 - Provide an update to the Pre-Closure Criticality Analysis Process Report. DOE agreed to provide the report. The report will be available in FY03. PRE.07.02 - Provide the waste package finite element analysis based numerical simulations that represent a significant contribution to DOE's safety case. Provide documentation demonstrating that a sufficient finite element model mesh discretization has been used and the failure criterion adequately bounds the uncertainties associated with effects not explicitly considered in the analysis. These uncertainties include but are not limited to: (1) residual and differential thermal expansion stresses, (2) strain rate effects, (3) dimensional and material variability, (4) seismic effects on ground motion, (5) initial tip-over velocities, and (6) sliding and inertial effects of the waste package contents, etc. In addition, document the loads and boundary conditions used in the models and provide the technical bases and or rationale for them. DOE agreed to provide the information. The information will be available in FY03 and documented in Waste Package Design Methodology Report.

7	Design of Structures, Systems, and Components Important to Safety and Safety Controls - Cont.	N/A	PRE.07.03 - Demonstrate that the allowed microstructural and compositional variations of alloy 22 base metal and the allowed compositional variations in the weld filler metals used in the fabrication of the waste packages do not result in unacceptable waste package mechanical properties. DOE will provide justification that the ASME code case for alloy 22 results in acceptable waste package mechanical properties considering allowed microstructural and compositional variations of alloy 22 base metal and the allowed compositional variations in the weld filler metals used in the fabrication of the waste packages. DOE agrees to provide the information in FY03 and document the information in the Waste Package Design Methodology Report. PRE.07.04 - Demonstrate that the non-destructive evaluation methods used to inspect the alloy 22 and 316 nuclear grade plate material and closure welds are sufficient and are capable of detecting all defects that may alter waste package mechanical properties. DOE will provide justification that the non-destructive evaluation methods used to inspect the alloy 22 and 316 nuclear grade plate material and welds are sufficient and are capable of detecting defects that may adversely affect waste package pre-closure structural performance. DOE agrees to provide the information in FY03 and document the information in the Waste Package Operations Fabrication Process Report. PRE.07.05 - Provide justification that the mechanical properties of the disposal container fabrication and waste package closure welds are adequately represented considering the (1) range of welding methods used to construct the disposal containers, (2) post weld annealing and stress mitigation processes, and (3) post weld repairs. DOE agrees to provide the information in FY03 and document the information in the Waste Package Operations Fabrication Process Report.

AGENDA
PRECLOSURE ISSUES TECHNICAL EXCHANGE
July 24-26, 2001
Texas Station Conference Center
2101 Texas Star Lane
Las Vegas, Nevada

July 24, 2001

08:00 - 08:15 AM	Introduction and Opening Remarks – DOE
08:15 - 08:30 AM	Overview of Meeting for Observers – NRC
08:30 - 09:15 AM	Development of the LA Integrated Safety Analysis: Overview of the ISA Process and ISA Products – DOE
09:15 - 10:00 AM	Identification of Hazards and Initiating Events: Aircraft Hazards – DOE
10:00 - 10:15 AM	Break
10:15 - 11:00 AM	Identification of Hazards and Initiating Events: Tornado Missile Hazards – DOE
11:00 - 12:15 PM	Identification of Event Sequences – DOE • Events Screened Out by Design • Justification of Probability Estimations
12:15 - 1:30 PM	Lunch
1:30 - 2:45 PM	Identification of Event Sequences (Cont'd) – DOE • Events Screened Out by Design • Justification of Probability Estimations
2:45 - 3:00 PM	Break
3:00 - 3:45 PM	Consequence Analysis: Category 1 Design Basis Event Compliance Approach – DOE
3:45 - 4:15 PM	DOE/NRC Caucus
4:15 - 4:45 PM	Discussion
4:45 PM	**Adjourn Day One**

AGENDA
PRECLOSURE ISSUES TECHNICAL EXCHANGE
July 24-26, 2001
Texas Station Conference Center
2101 Texas Star Lane
Las Vegas, Nevada

July 25, 2001

08:00 - 09:45 AM	Identification of SSCs Important to Safety and Waste Isolation – DOE • Q-List Methodology • Quality Level Characterization
09:45 - 10:00 AM	Break
10:00 - 11:45 AM	Identification of SSCs Important to Safety and Waste Isolation (Cont'd) – DOE • Q-List Methodology • Quality Level Characterization
11:45 - 1:00 PM	Lunch
1:00 - 2:30 PM	Level of Design Details: Differentiated Approach to Providing Information in the License Application – DOE
2:30 - 2:45 PM	Break
2:45 - 4:15 PM	Preclosure Criticality Issues/ Burnup Credit – DOE • Burnup Credit • Flooding • Probability of Criticality for Cat 1 and 2 Events • Technical Basis for BDBEs • Misload Events
4:15 - 4:45 PM	DOE/NRC Caucus
4:45 - 5:15 PM	Discussion
5:15 PM	**Adjourn Day Two**

AGENDA
PRECLOSURE ISSUES TECHNICAL EXCHANGE
July 24-26, 2001
Texas Station Conference Center
2101 Texas Star Lane
Las Vegas, Nevada

July 26, 2000

08:00 - 10:00 AM Engineered Barrier System Design and Fabrication – DOE

- Waste Package Drop Issues
  - Waste Package Drop Finite Element Models
  - Waste Package Drop Analysis Results
  - Design Basis Waste Package Drop Scenarios
- Waste Package Fabrication/Welding Issues
  - Plate Inspections
  - Welding Procedures
  - Weld Flaws and Defects
  - Post Weld Treatments
  - Post Weld Repair

10:00 - 10:15 AM Break

10:15 - 11:00 AM Engineered Barrier System Design and Fabrication (Cont'd) – DOE

- Fire Design Criteria
- Differential Thermal Expansion
  - Gantry Crane Rails
  - Invert Structural Frame Beams Attached to Drift Wall

11:00 - 11:45 PM DOE/NRC Caucus

11:45 - 12:30 PM Discussion

12:30 - 12:35 PM Closing Remarks

12:35 PM **Adjourn Meeting**

Techical Exchange - Preclosure Issues
July 24-26, 2001
Texas Station
Las Vegas, Nevada
Sign In Sheet

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Attachment 3

Techical Exchange - Preclosure Issues
July 24-26, 2001
Texas Station
Las Vegas, Nevada
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	R.M. LATTA	US NRC	702 794-5048
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Techical Exchange - Preclosure Issues
July 24-26, 2001
Texas Station
Las Vegas, Nevada
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Techical Exchange - Preclosure Issues
July 24-26, 2001
Texas Station
Las Vegas, Nevada
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	MICHAEL VALENTINE	DOE/YMSCO	794-1314

Techical Exchange - Preclosure Issues
July 24-26, 2001
Texas Station
Las Vegas, Nevada
Sign In Sheet

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	Frank Wong	YMSCO/MTS	794-5018
	Pete Davis	Jason	307 682-2577
	Christine Linden	BSC	295-5465
	P.H. Cotter	BSC	295-5495
	Doug Smith	BSC	295-4550
	Mike Anderson	BSC	295-5499

Techical Exchange - Preclosure Issues
July 24-26, 2001
Texas Station
Las Vegas, Nevada
Sign In Sheet

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	Marty Bryan	BSC	702 295-6273
	Larry Franklin	BSC	295-4444
	Bill Culbreth	UNLV	895-3426
	Jason Viggato	UNLV	895-1331
	Guy Martin, Jr	BSC	295-0315
	Page Russell	DOE	794-1315

Attachment 4

Presenters' Slides

Overview of Pre-Closure Meeting

Las Vegas, Nevada
July 24-26, 2001

Presented by
James Andersen
U.S. Nuclear Regulatory Commission
jwa@nrc.gov (301) 415-5717

- **Meeting will address the part of the Department of Energy's (DOE) safety case related to <u>Pre-Closure Safety Analysis</u>.**

- **<u>Pre-Closure Safety Analysis</u> is**
  - **Systematic analysis of what could happen at a potential repository during its construction and operation. This means answering three questions:**
    - **what can happen?**
    - **how likely is it?**
    - **what can result?**
  - **An identification of the structures, systems, and components important to safety**
  - **One of many NRC safety requirements**

Pre-Closure safety terms and definitions

- **Scenario** - another way of saying "what can happen?"
- **Probability** - another way of saying "how likely?"
- **Consequence** - another way of saying "what can result?"
- **Important to safety** - means those engineered features of the geologic repository area whose function is
  - To provide reasonable assurance that high-level waste can be received, handled, packaged, stored, emplaced, and retrieved safely (i.e., these actions can meet a specific dose limit)
- **Geologic Repository Operations Area (GROA)** - means a high-level radioactive waste facility that is part of a geologic repository, including both surface and subsurface areas, where waste handling activities are conducted

Pre-Closure safety terms and definitions (continued)

- **Retrieval** - means the act of permanently removing radioactive waste from the underground location at which the waste had been previously emplaced for disposal

- **Initiating event** - means a natural or human induced event that causes an event sequence

- **Event sequence** - means a series of actions and/or occurrences within the natural and engineered components of a geologic repository operations area that could potentially lead to exposure of individuals to radiation

- **Design bases** - means that information that identifies the specific functions to be performed by a structure, system, or component of a facility and the specific values or ranges chosen for controlling parameters as reference bounds for the design.

- **Additional general information on the NRC and its role in the potential Yucca Mountain high-level waste repository is available**
  - **Handouts and posters on wall**
  - **NRC and Center for Nuclear Waste Regulatory Analyses staff will be glad to address your concerns, answer your questions, and discuss with you topics that remain unclear to you, during breaks in the meeting, or after the meeting**

- **Topics within the Pre-Closure Safety Area**
  - To effectively track the status and agreements reached relating to Pre-Closure Safety, the NRC believes it should to be broken into topics
  - In a letter dated April 27, 2001, the NRC staff outlined ten areas DOE should discuss in any potential license application
  - The NRC proposes to define these ten areas as Pre-Closure topics; the ten are outlined in the following two slides

- **Topics within the Pre-Closure Safety Area - Cont.**

1) Site Description as it pertains to Pre-Closure Safety Analysis

2) Description of Structures, Systems, Components, Equipment, and Operational Process Activities

3) Identification of Hazards and Initiating Events

4) Identification of Event Sequences

5) Consequence Analyses

6) Identification of Structures, Systems, and Components Important to Safety; Safety Controls; and Measures to Ensure Availability of the Safety Systems

- **Topics within the Pre-Closure Safety Area- Cont.**

7) Design of Structures, Systems, and Components Important to Safety and Safety Controls

8) Meeting the 10 CFR Part 20 as Low as is Reasonably Achievable Requirements for Normal Operations and Category 1 Event Sequences

9) Plans for Retrieval and Alternate Storage of Radioactive Wastes

10) Plans for Permanent Closure and Decontamination, or Decontamination and Dismantlement of Surface Facilities

- **Objectives of this Meeting**

  - During this meeting the NRC staff would like to reach agreement with DOE on the structure of the Pre-Closure Safety Area and discuss some issues under selected Pre-Closure Safety topics

  - The NRC staff does not plan to discuss the overall status of any of the Pre-Closure Safety topics because:

    1) A Pre-Closure Issue Resolution Status Report has not been issued

    2) The Yucca Mountain Review Plan, which would outline the applicable acceptance criteria, has not been released

    3) This is the first technical exchange and management meeting related to the Pre-Closure Safety Area

- **Objectives of this Meeting - Cont.**

  - Any agreements reached during this meeting will fall under one of the ten Pre-Closure Safety topics

  - NRC proposes that the agreements take the following identification form:

    PRE.xx.yy

    Where: PRE = Pre-Closure Safety Area
    xx = Pre-Closure Safety Topic (1-10)
    yy= Agreement Number (Sequential)

U.S. Department of Energy
Office of Civilian Radioactive Waste Management

Development of the Integrated Safety Analysis for a License Application

Presented to:
NRC/DOE Preclosure Issues Technical Exchange

Presented by:
Dennis Richardson
Manager, Integrated Safety Analysis
Bechtel SAIC Company, LLC

July 24-26, 2001

YUCCA MOUNTAIN PROJECT

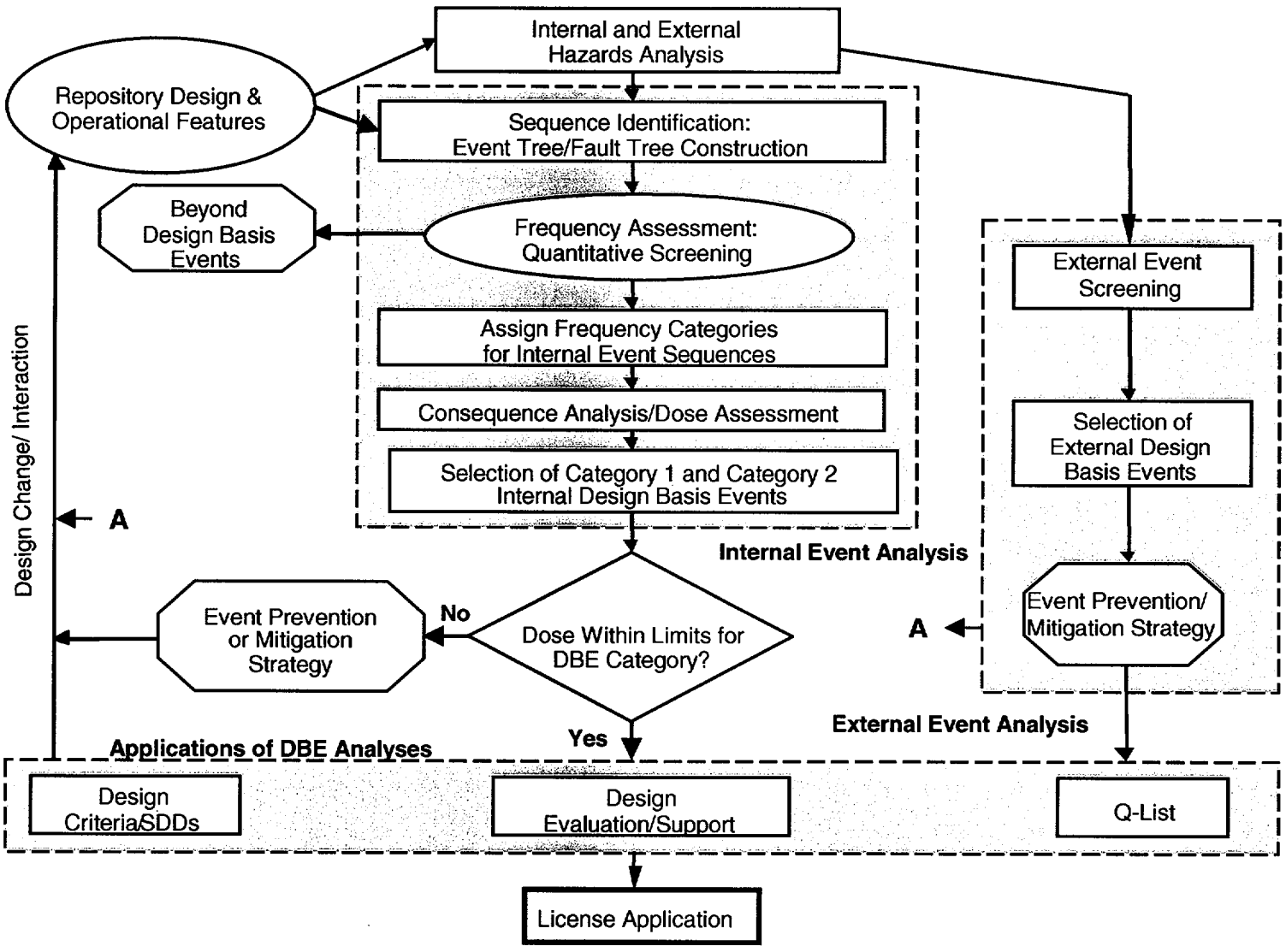
Agenda

- Objective
- Overview of Integrated Safety Analysis (ISA) Process
- ISA Products
- Summary

Objective

- Describe how an ISA is developed to support a license application for a potential repository
- Lay framework and context for discussion of specific ISA topics

Overview of the Integrated Safety Analysis Process



Integrated Safety Analysis Products

Hazards Identification → **DBE Categorization** → **Consequence Analysis** → **Identification of SSCs and Controls to Prevent and/or Mitigate** → **Integrated Safety Analysis**

Hazards Identification

MGR External Hazards (ANL-MGR-SE-000004)

MGR Internal Hazards (ANL-MGR-SE-000003)

Surface Fire Hazards Analysis

Subsurface Fire Hazards Analysis

DBE Categorization

Categorization of Design Basis Events

Aircraft Hazards (ANL-WHS-SE-000001)

Wind/Tornado (ANL-MGR-SE-000001)

Industrial/Military (ANL-WHS-SE-000004)

Rainstorm/Flooding

Seismic

DBE Fire

Loss of Offsite Power

HVAC Fault Tree Analysis

Waste Handling Fault Tree Analysis

Component Failure/Reliability Analysis

Preclosure DBEs Related to WP (ANL-MGR-MD-000012)

Preclosure Criticality Evaluations

Transporter Reliability Analysis

WP DBE Structural Analysis (Drop Height)

Shipping Cask Structural Analysis (Drop Height)

Rockfall/Handling Events

Consequence Analysis

Potential Consequences of Design Basis Events

Potential Consequences of Selected Beyond Design Basis Events

Commercial SNF Release Fractions (ANL-WHS-SE-000002)

Cat 1 DBE Worker Dose Evaluations

ALARA Evaluations

Radiation Protection Program

Atmospheric Dispersion Factors

Preclosure SNF Source Terms

Surface Normal Releases

Subsurface Normal Releases

Naval Fuel DBE Source Terms/Releases

DOE Fuel Groups/Source Terms

DOE Canister Drop Tests

Pu Can-In-Canister Structural Analysis

Identification of SSCs and Controls to Prevent and/or Mitigate

Nuclear Safety Design Basis Report

Classification Analyses

Q-List (YMP/90-55Q)

Classification Procedure QAP-2-3 (AP-2.22Q)

Grading Process/Procedure

Design Criteria Document

System Description Documents

Integrated Safety Analysis

Integrated Safety Analysis

ISA Guide

Hazards Procedure

ISA Procedure

Preclosure Safety License Application Products

07/12/2001

Hazards Identification

- External hazards analysis
  - Identify spectrum of potential external events and natural phenomena
  - Evaluate potential as credible initiating event during preclosure period
  - Provide basis for events that are screened out
  - List external events and natural phenomena that are either credible initiating events or need additional evaluation to determine credibility

Hazards Identification

- Internal hazards analysis
  - Identify potential internal hazards related to design and operation of facility
  - Systematic, robust process to evaluate facility
  - Provide basis for events that are grouped for evaluation
  - List potential internal hazards that will be evaluated as potential design basis events
- Other products/interfaces
  - Fire hazards analyses

Design Basis Event Categorization

- Categorization of Design Basis Events (DBEs)
  - Using results of hazard analyses, develop event scenarios
  - Develop event trees, as appropriate, to support scenario development
  - Categorize event scenarios as Category 1, Category 2, or Beyond DBE
  - Provide technical basis for categorization
  - Where appropriate, use and justify industry failure rates
  - Develop fault trees, as appropriate to support categorization

Design Basis Event Categorization
(Continued)

- **Categorization of DBEs** (Continued)
  - Provide basis for events that are grouped for evaluation
  - Provide basis for event categorization thresholds
  - Identify any features or controls that are required to support an event categorization

Design Basis Event Categorization

(Continued)

- **Aircraft hazards assessment**
  - Evaluate credibility of aircraft hazards at MGR
  - Use technically defensible methodology (e.g., NUREG-0800)
  - Evaluation will be based on latest flight information
  - Justify appropriateness of flight information for an operating repository
  - Identify future work, if required, to support categorization (e.g., additional flight information, consequence analysis)

Design Basis Event Categorization

(Continued)

- Wind/Tornado analysis
  - Identify wind and design basis tornado loadings in accordance with commercial nuclear industry precedent (or justify different approach)
  - Develop, as appropriate, tornado missile spectrum to be used to evaluate design
  - Identify features and/or controls that are required to protect facility from wind/tornado/tornado missiles
  - Evaluate design for wind/tornado/tornado missiles; verify design complies with ISA requirements

Design Basis Event Categorization

(Continued)

- **Industrial/Military analysis**
  - Evaluate potential industrial/military hazards for consideration in the design
  - Identify any features and/or controls required as a result of any potential credible industrial/military hazards
- **Rainstorm/Flooding analysis**
  - Determine rainstorm/flooding criteria in accordance with accepted commercial nuclear industry precedent
  - Identify any features and/or controls that are required to protect facility from rainstorm/flooding

Design Basis Event Categorization

(Continued)

- **Seismic analysis**
  - Document process for determining SSC seismic design criteria
  - Determine SSC seismic design criteria
- **Design basis fire**
  - Using facility FHAs, evaluate credible fires as potential event sequences
  - Identify features and/or controls that are required to protect the facility from fires

Design Basis Event Categorization

(Continued)

- Loss of power
  - Evaluate loss of power as initiating event
  - Demonstrate that loss of power does not result in a radiological release that exceeds regulatory limits
  - Identify features and/or controls that are required to ensure that loss of power does not result in a radiological release that exceeds regulatory limits
- HVAC system fault tree analysis
  - Determine reliability of waste handling building HVAC system for use in developing event trees that include HVAC branches

Design Basis Event Categorization

(Continued)

- High level waste handling system fault tree analysis
  - Determine reliability of handling systems for use in event trees that include handling system branches
- Other fault tree analyses, as required
  - Determine reliability of systems/components for use in developing event trees

Design Basis Event Categorization

(Continued)

- Component failure/reliability analysis database
  - Collection and analysis of industry failure rate information
  - Justification for use at MGR
  - Uncertainty analysis

Design Basis Event Categorization
(Continued)

- **Other products/interfaces**
  - Preclosure disposal container/waste package DBE analyses
  - Preclosure criticality evaluations
  - Transporter reliability analysis
  - Structural analyses

Consequence Analysis

- **Potential consequences of DBE**
  - **Determine potential radiological consequences of DBE**
  - **Identify any features and/or controls that are required to limit radiological consequences**

Consequence Analysis
(Continued)

- **Potential consequences of beyond DBE**
  - Determine potential radiological consequences of selected beyond DBEs
  - Present basis of beyond DBEs that are selected for evaluation
  - Gain risk insights into design
  - Support identification of defense-in-depth features

Consequence Analysis
(Continued)

- **Other products/interfaces**
  - Commercial spent nuclear fuel release fractions
  - Worker dose evaluations
  - ALARA evaluations
  - Radiation protection program
  - Atmospheric dispersion factors
  - Radiological source terms
  - Surface and subsurface releases from normal operations
  - DOE spent nuclear fuel groups/source terms
  - Canister drop tests
  - Structural analyses

Identification of SSCs and Controls to Prevent and/or Mitigate

- **Nuclear safety design basis**
  - Provide the nuclear safety design basis for SSCs
  - Summarize the features and controls that are required to ensure facility is within preclosure safety design basis
- **Classification analyses**
  - Determine the quality level classification based on the preclosure nuclear safety design basis

Identification of SSCs and Controls to Prevent and/or Mitigate

(Continued)

- **Q-List**
  - List of MGR SSCs and their respective quality level classification
- **Classification procedure**
  - Process and criteria for determining quality level classification of SSCs
- **Grading process/procedure**
  - Develop and document the process for how QA controls will be assigned based on quality level classification

Identification of SSCs and Controls to Prevent and/or Mitigate

(Continued)

- Other products/interfaces
  - Design criteria document
  - System Description Documents

Integrated Safety Analysis

- Integrated safety analysis
  - Demonstrate compliance with ISA regulatory requirements
  - Summarize processes and results
- Hazards procedure
  - Hazards screening criteria
  - Hazards identification in the design process
  - Relationships between project hazards analyses
- Integrated safety analysis procedure
  - Flow of integrated safety analysis in the design process

Integrated Safety Analysis
(Continued)

- **Integrated safety analysis guide**
  - Describes approach for developing an integrated safety analysis
  - Identify acceptable methods for analyzing and documenting preclosure safety analyses
  - Ensure consistency with regulatory requirements
  - Provide consistency and uniformity in analyses
  - Basis for training
  - Communication tool with design and licensing

Summary

- Approach to develop Integrated safety analysis and associated products
- Integrated safety analysis guide to support development of ISA

U.S. Department of Energy
Office of Civilian Radioactive Waste Management

Identification of Hazards and Initiating Events NRC Item 3(a) Aircraft Hazards

Presented to:
NRC/DOE Preclosure Issues Technical Exchange

Presented by:
Richard Morissette
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July 24-26, 2001

YUCCA MOUNTAIN PROJECT

Agenda

- Objective
- Responses to NRC Comments
- Path forward
- Summary

Objective

- **Objective**
  - **Respond to NRC comments related to aircraft hazards**

NRC Item 3(a)-Aircraft Hazards

- **NRC Comment**
  - **The NRC staff concludes that the exclusion of aircraft crash from the list of potential human-induced hazards that may affect the proposed repository is premature**

NRC Item 3(a)-Aircraft Hazards
(Continued)

- **DOE Response**
  - DOE agrees with comment and a more extensive evaluation is planned for License Application (LA)
  - 1999 MGR Aircraft Crash Frequency Analysis
    - Provided an understanding of the potential risks and work needed to ensure the hazard is adequately addressed for LA
    - Provided assurance that aircraft hazards do not present site suitability issues that cannot be resolved through more detailed analyses, engineered solutions, and/or administrative controls

FY99 Aircraft Crash Frequency Analysis

- **Purpose**
  - To perform a preliminary evaluation of aircraft crash as a potential external hazard
- **Approach**
  - Focus analysis on aircraft activity with high crash frequency potential
    - Identify activities with low crash frequency potential using NUREG-0800 proximity criteria
    - Evaluate remaining activities using NUREG-0800 and limited available aircraft flight information

FY99 Aircraft Crash Frequency Analysis

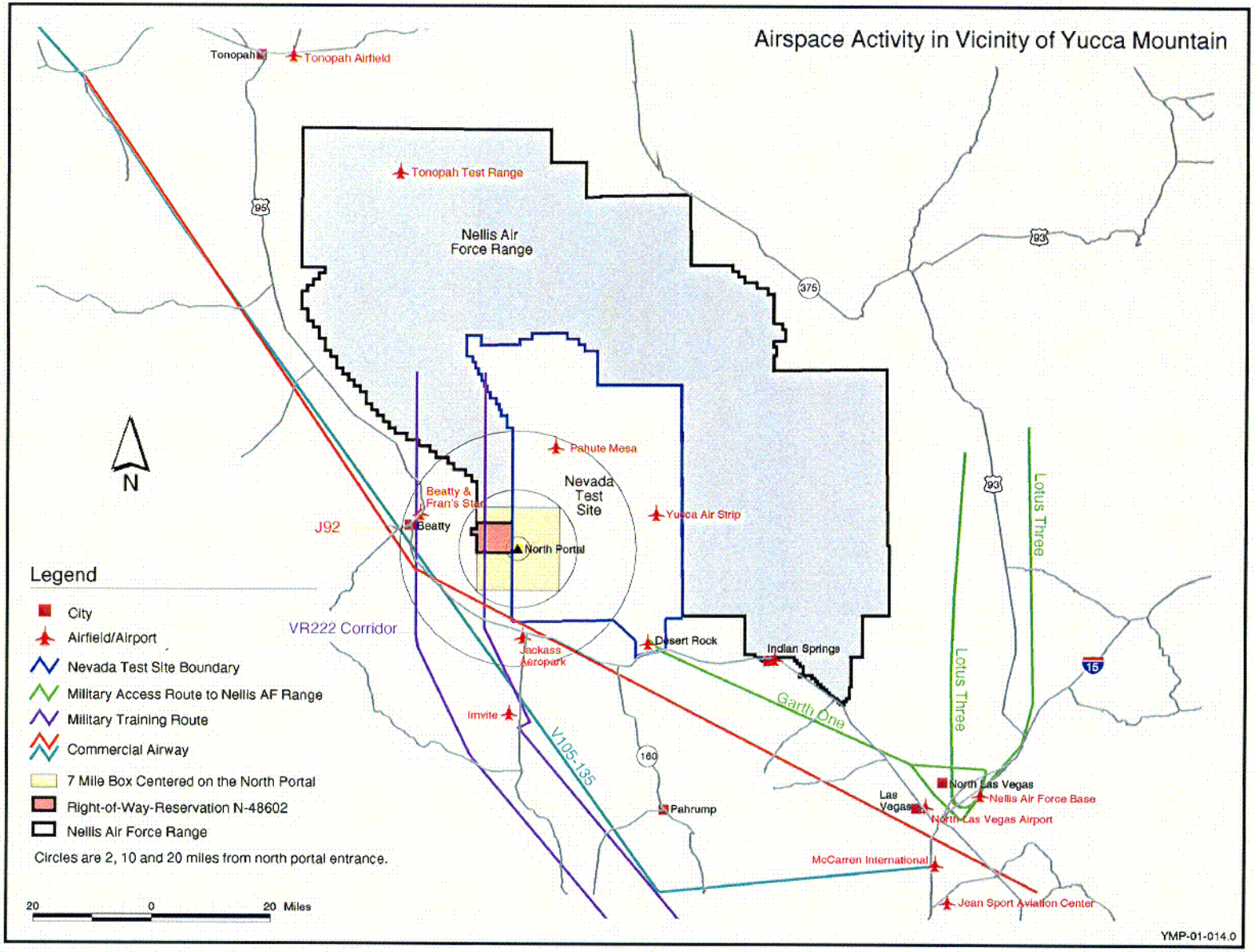
(Continued)

- **Aircraft activities with low crash frequency potential**
  - All commercial, private, DOE and military airports
  - Military training routes and Nellis Air Force Range
  - Commercial and private airways
- **Aircraft activity analyzed**
  - Military flights traversing Nevada Test Site to access Nellis Air Force Range

NRC Item 3(a)-Aircraft Hazards

- **NRC Comment**
  - The DOE should provide a detailed analysis of the aircraft crash hazards by taking into consideration all types of aircraft flying in the vicinity of the proposed site
- **DOE Response**
  - DOE agrees with comment and will develop a vicinity map with aircraft types and activities identified. An evaluation of the aircraft activities within this vicinity will determine which activities will require quantitative crash frequency analysis. DOE is defining vicinity as the area where the flight activity will have an impact on the evaluation of aircraft hazards

Preliminary Vicinity Map



Approach for Defining Vicinity

- Develop vicinity map with aircraft activities located
- Expand general information on aircraft activity to vicinity defined by map
- Select methodologies for evaluating each activity
  - Qualitative
  - Quantitative
- Develop expanded information needs
  - Military
  - Commercial

Quantitative Methodologies

- Commercial aircraft
  - Airways: NUREG-0800 airways model
  - Airports: NUREG-0800 airport model
  - Holding Patterns: As required per NUREG-0800
- Military aircraft
  - Airports: NUREG-0800 airport model
  - Military training routes: NUREG-0800 airways model

Quantitative Methodologies

(Continued)

- **Military aircraft** (Continued)
  - Air Force Range Access
    - Over Nevada Test Site: Uniform Overflight Density Model*
    - Other: NUREG-0800 airways model
  - Air Force Range: NUREG-0800 designated airspace model* as required

*With consideration of potential aircraft glide ratio

NRC Item 3(a)-Aircraft Hazards

- **NRC Comment**
  - DOE should provide a reasonable projection into future flight activities including the introduction of new type(s) of aircraft and changes in military exercises
- **DOE Response**
  - DOE will obtain available information from Nellis Air Force Base documents and staff regarding future flight activities, aircraft types, and changes in military exercises
  - DOE will obtain information from DOE/Nevada Operations regarding potential changes to flight activities in DOE controlled airspace over the Nevada Test Site
  - Using available information, types of aircraft (e.g., large twin engine, small single engine) and projected flight activities for the preclosure period will be estimated for the evaluation

Ongoing Studies

- Ongoing aircraft flight counts
  - Method
    - Computer programmed to "count" aircraft transponder codes that enter or originate within areas defined by geographic coordinates (count box)
    - Aircraft flight counts reported on quarterly basis
  - Nevada Test Site count box
    - Includes the entire test site
    - Aircraft counts started September 1998
    - Average flights/year based on 10 quarters (19,450 flights/year)

Ongoing Studies
(Continued)

- **Ongoing aircraft flight counts** (Continued)
  - Yucca Mountain count box
    - Approximate 7 miles square centered on proposed location of Waste Handling Building
    - Aircraft counts started March 1999
    - Average flights/year based on 8 quarters (1,450 flights/year)
- **Counts to continue indefinitely**

NRC Item 3(a)-Aircraft Hazards

- **NRC Comment**
  - The annual aircraft crash probability will be the summation of probabilities from all types of aircraft from different operations
- **DOE Response**
  - DOE agrees with comment and will sum the annual frequencies from all operations that required quantitative crash frequency analysis within the vicinity

Path Forward to License Application

- Prioritized approach to evaluate aircraft crashes as a potential event scenario
  - Screen out as Beyond Design Basis Event (BDBE) based on probability of occurrence
  - Demonstrate consequences are acceptable
    - No radiological releases will occur as a result of aircraft crashes, or
    - Radiological releases are within proposed 10CFR63 limits
  - Modify building design such that consequences are acceptable
  - Modify flight activities such that event is BDBE

Summary

- Preliminary evaluation showed aircraft crashes incredible
- Demonstrated need for
  - Additional flight information
  - Additional analysis
- Aircraft flight counts over Nevada Test Site are ongoing
- Path forward for license application has been established

U.S. Department of Energy
Office of Civilian Radioactive Waste Management

Identification of Hazards and Initiating Events NRC Item 3(e) Tornado Missile Hazards

Presented to:
NRC/DOE Preclosure Issues Technical Exchange

Presented by:
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July 24-26, 2001

YUCCA MOUNTAIN PROJECT

Agenda

- Objective
- Response to NRC comments
- Preliminary loaded transporter tornado missile evaluation
- Path forward
- Summary

Objective

- **Respond to NRC comments related to tornado missiles and waste package design: NRC comment 3(e)**

NRC Item 3(e)-Tornado Missile Hazards

NRC Comment:

- **The DOE has not assumed the characteristics of the missile in the Uncanistered Spent Nuclear Fuel Disposal Container System Description Document (Pettit, 2000) commensurate with the bounding characteristics of the tornado missiles for the region. No basis has been provided for the assumed alternate characteristics**

NRC Item 3(e)-Tornado Missile Hazards

(Continued)

DOE Response:

- Tornado missiles are not a hazard for disposal canisters/waste packages while they are inside the waste handling building or the subsurface facility
- Necessary portions of the waste handling building will be designed to withstand credible tornado missiles
- Tornado missiles are not a hazard for the subsurface facility

NRC Item 3(e)-Tornado Missile Hazards

(Continued)

DOE Response:

- During the brief exposure time when a transporter carrying a waste package travels between the surface and subsurface facilities, preliminary screening analysis indicates that none of the disposal containers, including the Uncanistered Spent Nuclear Fuel Disposal Container, will be required to withstand the characteristics of a design-basis tornado missile because it is an incredible event scenario (i.e., frequency < 1E-06/yr)

NRC Item 3(e)-Tornado Missile Hazards

(Continued)

DOE Response:

- **The missile criteria in the Uncanistered Spent Nuclear Fuel Disposal Container System Description Document is not related to tornado missiles and therefore does not represent "alternative characteristics" for design-basis tornado missiles**
  - **SDD criteria requires a disposal container to withstand the impact of a 0.5 kg missile (modeled as 1 cm diameter, 5 cm long valve stem) with a velocity of 5.7 meters per second without breaching**
  - **Criteria addresses a potential hazard identified in an internal events hazards analysis of the waste handling building**

Preliminary Screening Analysis for Transporter Tornado Missile

- Transporter exposure time during emplacement operations
  - Distance from waste handling building to north portal: ~122 meters
  - Transit time per waste package: ~2 minutes
  - Coupling/inspection at waste handling building: ~18 minutes
  - Open waste handling building doors, leave platform: ~7 minutes
  - Waste package exposure time, 500 waste packages per year: ~225 hours/year
  - Waste package exposure fraction: ~0.026 of yr

Preliminary Screening Analysis for Transporter Tornado Missile

(Continued)

- Screening of tornado missiles on transporter
  - Waste package exposure fraction: ~0.026 of yr
  - Frequency of missile-generating design basis tornado: 1E-06/yr
  - Effective frequency of missile-generating design basis tornado for exposed transporter: 2.6E-08/yr
- Screening analysis has not included other factors such as probability of strike, given a missile, etc

Path Forward

- **Update wind/tornado analysis to include screening of tornado missiles on waste package transporter based on maximum throughput**
  - **Uncertainty and/or sensitivity analysis will be performed, as appropriate, to justify technical screening of event sequence**

Summary

- SDD missile criteria for disposal containers are not related to tornado generated missiles
- Preliminary evaluations indicate tornado generated missiles impacting waste package transporter is an incredible event scenario
- Wind/tornado analysis to be updated to include screening evaluation

U.S. Department of Energy
Office of Civilian Radioactive Waste Management

Identification of Event Sequences - NRC Items 4(a) and 4(b)

Presented to:
NRC/DOE Preclosure Issues Technical Exchange

Presented by:
Tom D. Dunn
Integrated Safety Analysis
Bechtel SAIC Company, LLC

July 24-26, 2001

YUCCA MOUNTAIN PROJECT

Agenda

- Objective
- NRC Item 4(a) Events Screened Out By Design
- NRC Item 4(b) Justification of Probability Estimates
- DOE Response
- Path Forward
- Summary

Objective

- Discuss NRC staff comments 4(a) on Events Screened Out by Design and 4(b) on Justification of Probability Estimates

NRC 4(a)- Events Screened Out by Design

- The NRC position is paraphrased below concerning the elimination by design of events that may result in a release:
  - DOE can screen preclosure design basis events based on a proposed design concept
    - Consistent with overall risk-informed performance-based philosophy in proposed Part 63
    - Screening can be based on either:
      - » Probability, or
      - » Consequences

NRC 4(a)-Events Screened Out by Design

(Continued)

NRC Comment:

- **DOE will need to demonstrate that the particular design feature can perform its intended mitigation function over the time period of regulatory interest**
- **For supporting screening arguments, probability values for component failure or events potentially leading to the failure of the design feature, range, and distributions or relevant variables and/or boundary assumptions should be: technically defensible, and account for uncertainty and variability. Similarly, screening by consequence should be technically defensible and account for uncertainty and variability in the parameters**

NRC 4(a)-Events Screened Out by Design

(Continued)

DOE Response:

- **DOE agrees that the screening of design basis events must be defensible. One of the factors to consider is how well the screening basis is understood (e.g., failure probabilities, event sequence probabilities, consequences). Uncertainties must be addressed to the extent they may impact either the categorization or the consequences of a potential design basis event. DOE agrees that all design basis event categorizations, component failure probabilities, consequence analyses, etc will have to be technically defensible to support their use. This defense may be in terms of quantified uncertainties, "stacking of conservatism's," or a qualitative argument as to the appropriateness of the information to support the preclosure safety analysis process**

NRC 4(b)-Justification of Probability Estimates

NRC Comment:

- **DOE should justify the estimated probability of failure for the equipment and components used in surface and subsurface operations event sequence analysis. For example, the data used by DOE to determine probability of drop events for assemblies and shipping casks are based on analysis of the drop events of the cranes obtained from the industry. DOE should provide justification that:**
  - **The data used from the industry to estimate failure probability has been adequately analyzed**
  - **The data used are appropriate for use in repository operations**

NRC 4(b)-Justification of Probability Estimates

(Continued)

DOE Response:

- Similar to the discussion in 4(a), DOE agrees that failure probabilities must be justified sufficient to support the design basis event categorization process
- Appropriate attention will be given to event scenarios that are near thresholds (i.e., Category 1/Category 2, Category 2/BDBE) to either ensure that the technical basis supports the event categorization or that the categorization is conservative (e.g., an event that is borderline Category 2/BDBE may be conservatively categorized as Category 2)
- The basis for the categorization will demonstrate that the inputs used (e.g., failure rates) are correct and appropriate for its use at a potential repository

NRC 4(b)-Justification of Probability Estimates

(Continued)

NRC Comment:

- **DOE has presented ISA analyses with only point estimates of frequency of failure of different components. However, it is not clear whether the probability estimates used in these analyses represent mean, median, or some other point estimates. Frequency of component failure is highly uncertain. Consequently, the analyses presented by the DOE do not consider the uncertainty and variability associated with each frequency or probability estimate. By ignoring the uncertainty and variability associated with the event sequences using only one point estimate, there is a distinct possibility of incorrectly classifying an event or an event sequence with associated consequences. DOE should conduct sensitivity and uncertainty analyses to estimate the probability of failure during the preclosure period. Frequencies of component failures should be assigned probability distributions and mean probability of failure should be estimated**

NRC 4(b)-Justification of Probability Estimates

(Continued)

DOE Response:

- Categorization of design basis events will be defensible, which includes the inputs used. DOE will justify the correctness and appropriateness of failure rates used in preclosure safety analyses. This would include discussions on the uncertainties and sensitivities associated with any failure rates (or other inputs used in the analyses). Where applicable, mean values will be used to categorize events

NRC 4(b)-Justification of Probability Estimates

(Continued)

NRC Comment:

- **Probability Estimate of Component Failure: DOE is encouraged to consider uncertainty and variability in their probability estimate of component failure. To account for uncertainty and variability, DOE may assign distributions to component failures**

DOE Response:

- **DOE will, as appropriate, assign uncertainty distributions to failure rate estimates of component failure. These distributions will be used to estimate the mean component failure rate and the variability in the estimated failure rate**

NRC 4(b)-Justification of Probability Estimates

(Continued)

NRC Comment:

- **Events Sequence Categorization: If DOE obtains a probability distribution for the frequency of a preclosure event sequence, the mean value of that distribution can be used to categorize the event sequence, provided that the probability distributions of the component failures are valid and account appropriately for uncertainty and variability**

NRC 4(b)-Justification of Probability Estimates

(Continued)

DOE Response:

- **Probability distribution functions will be used for estimating the uncertainty in an event sequence frequency and the mean frequency, rather than a point estimate, will be used to categorize the event sequence as a Category 1, Category 2 or beyond design basis event**

Path Forward

- Program documents describing the approach for showing compliance to final 10 CFR 63 for Category 1 design basis events will be clarified
- Methods for screening event sequences will be developed in the ISA Guide based on quantified uncertainties, "stacking of conservatisms," or qualitative arguments as appropriate to the information needed to support the preclosure safety analysis process

Path Forward

(Continued)

- A database of component failure rates for SSCs used in the preclosure safety analysis will be developed to support the License Application (LA) appropriate to the level of design (these failure rates may be based on historical information or fault tree assessments of unique components)
- Methods for estimating the uncertainty in component failure rates will be developed for LA in the ISA Guide
- Methods for estimating the uncertainty in an event sequence frequency will be developed for LA such that the mean frequency can be estimated and used to categorize event sequences in the ISA Guide

Summary

- **LA path forward has been described that includes:**
  - **Developing methods and approaches for assessing, screening and categorizing event sequences using, as appropriate, uncertainty distributions on the component failure rates**
  - **Clarification of compliance to 10 CFR 63 for Category 1 design basis events**
  - **Developing a database of SSC failure rates for use in the preclosure safety assessment**

U.S. Department of Energy
Office of Civilian Radioactive Waste Management

Consequence Analysis - NRC Item 5(a)

Presented to:
NRC/DOE Preclosure Issues Technical Exchange

Presented by:
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July 24-26, 2001

YUCCA MOUNTAIN PROJECT

Agenda

- Objective
- NRC Item 5(a) – Dose Calculations for Design Basis Events
- DOE Response
- Path Forward
- Summary

Objective

- **Discuss NRC comment 5(a) on Dose Calculations for Design Basis Events and provide a path forward to LA**

NRC 5(a) - Dose Calculations for Design Basis Events

NRC Comment:

- **A frequency weighted sum of <u>all</u> Category-1 DBE doses (and in the above equation [$D=F_iD_i$]) will be added to the routine operational releases to demonstrate compliance with the regulatory dose limits**
- **In addition, the dose estimated to result from any single Category-1 event sequence would not be allowed to exceed the regulatory dose limits**
- **For the License Application Design of structures, systems and components important to safety under Category-2 DBEs, doses are calculated on a per-event-sequence basis and compared with the regulatory limit (5 rem/event sequence)**

NRC 5(a) - Dose Calculations for Design Basis Events

(Continued)

NRC Comment:

- The staff believes this approach (i.e., sum of the annualized/frequency weighted doses for Category-1 DBEs and per-event-sequence-doses for Category-2 DBEs) is acceptable because it is reasonable and technically defensible. In addition, it simplifies DOE's demonstration of compliance in the license application PCSA/ISA and NRC's review and compliance determination. It should be noted that this staff position is limited to the use of the approach discussed here and does not express any regulatory position regarding the dose estimates presented in the various DOE documents

NRC 5(a) - Dose Calculations for Design Basis Events

(Continued)

DOE Response:

- **DOE agrees with the NRC comment regarding the DOE proposed approach to demonstrate compliance for Category 1 and Category 2 Design Basis Events**

NRC 5(a) - Dose Calculations for Design Basis Events

(Continued)

NRC Comment:

- **Future revisions of the RSS and other reports must document that no single Category 1 event sequence will result in a dose that exceeds the regulatory limits**

NRC 5(a) - Dose Calculations for Design Basis Events

(Continued)

DOE Response:

- DOE will ensure that the appropriate project documents that will be used to support LA will be consistent in terminology, definitions, and equations. The process for demonstrating compliance with Category 1 limits will be clarified. DOE will demonstrate that the annual exposure to the public due to Category 1 events (frequency weighted), including normal operations is less that the regulatory limit. Also, DOE will demonstrate no single Category 1 event (which is evaluated on a per event basis) will exceed the regulatory limit

NRC 5(a) - Dose Calculations for Design Basis Events

(Continued)

NRC Comment:

- In order to facilitate the staff review and help focus the design review on the particular event sequences that might contribute higher shares of doses to the total calculated annual dose, it will be necessary for the DOE to provide a table of dose contributions from individual Category 1 event sequences in addition to the sum

DOE Response:

- DOE in future preclosure safety documents will provide a table of dose contributions from individual Category 1 event sequences in addition to the sum

NRC 5(a) - Dose Calculations for Design Basis Events

(Continued)

NRC Comment:

- The approach used by DOE for demonstrating compliance with the regulatory limits for combinations of Category 1 event sequences that could occur in a given year should be made transparent in the RSS

DOE Response:

- The DOE approach for Category 1 compliance will be described in the appropriate design documents in a clear and technically defensible manner

NRC 5(a) - Dose Calculations for Design Basis Events

(Continued)

NRC Comment:

- **The RSS should also clarify how the dose calculation approach will be used in developing the list of structures, systems and components important to safety (Q-list)**

DOE Response:

- **DOE agrees to clarify the approach that will be used to develop the list of SSCs important to safety (Q-List) in the appropriate project documents**

NRC 5(a) - Dose Calculations for Design Basis Events

(Continued)

NRC Comment:

- **The RSS should explain in clear terms how the bounding dose term (referred to in DOE's Quality Level (QL) categorization process) will be used in binning the items on the Q-list**

DOE Response:

- **DOE will clarify this point in the appropriate documents that support LA**

Path Forward

- DOE will ensure that the appropriate project documents will be consistent in terminology, definitions, and equations in stating that no single Category 1 event sequence will result in a dose that exceeds the regulatory limits
- DOE in future preclosure safety documents will develop and provide a table of dose contributions from individual Category 1 event sequences in addition to the sum of annual doses
- DOE approach for Category 1 compliance will be described in the appropriate LA design documents in a clear and technically defensible manner

Path Forward

(Continued)

- DOE will clarify the approach that will be used to develop the list of SSCs important to safety (Q-List) in the appropriate project documents for the proposed LA
- DOE will clarify how the bounding dose term for Category 1 Design Basis Events will be used in binning the items on the Q-list

Summary

- DOE agrees with the NRC comments regarding the DOE proposed approach to demonstrate compliance for Category 1 and Category 2 Design Basis Events
- Project documentation will be updated to be consistent with the approaches that have been described