

Summary Highlights of NRC/DOE Technical Exchange on DOE's Pre-Closure Safety Analysis Guide

April 25-26, 2002
Rockville, Maryland

Introduction and Objectives

This Technical Exchange to discuss Pre-Closure Safety is one in a series of meetings related to the U.S. Nuclear Regulatory Commission (NRC) and U.S. Department of Energy (DOE) issue resolution process. Consistent with NRC regulations on prelicensing interactions and a 1992 agreement with the DOE, staff-level resolution can be achieved during prelicensing interaction. 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 prelicensing, is achieved when the staff has no further questions or comments at a point in time regarding how the DOE is addressing an issue. Additional information (e.g., changes in design parameters) could raise new questions or comments regarding a previously resolved issue.

Issues are "closed" if the DOE approach and available information acceptably address staff questions such that no information beyond what is currently available will likely be required for regulatory decision making at the time of any initial license application. Issues are "closed-pending" if the NRC staff has confidence that the DOE proposed approach, together with the DOE agreement to provide the NRC with additional information (through specified testing, analysis, etc.) acceptably addresses the NRC's questions such that no information beyond that provided, or agreed to, will likely be required at the time of initial license application. Issues are "open" if the NRC has identified questions regarding the DOE approach or information, and the DOE has not yet acceptably addressed the questions or agreed to provide the necessary additional information in a potential license application.

By letter dated March 27, 2002, DOE submitted information pertaining to two NRC/DOE agreements. In response to Pre-Closure Agreement 6.01, a procedure entitled "Classification Criteria and Maintenance of the Monitored Geologic Repository Q-List" was provided. In that same letter, DOE provided its Pre-Closure Safety Analysis Guide in response to Pre-Closure Agreement 6.02. The objective of this meeting was for DOE to present an overview of the Pre-Closure Safety Analysis Guide and to discuss the NRC's initial comments on the document.

No new agreements were reached at this meeting. The agenda and the attendance list are provided as Attachments 1 and 2, respectively. Copies of the presenters' slides and the NRC's preliminary comments are provided as Attachment 3. Highlights from the Technical Exchange are discussed below.

Summary of Meeting

1) Overview of Meeting

NRC provided some general background for this topic. NRC stated that during a Technical Exchange and Management Meeting held on July 24-26, 2001, NRC and DOE discussed several pre-closure topics and reached several pre-closure agreements as a result of those discussions. As previously mentioned, DOE submitted two documents in response to Pre-Closure Agreements 6.01 and 6.02 on March 27, 2002. NRC has performed an initial review of the documents and provided its preliminary comments to DOE in preparation for this meeting. The comments are provided in the NRC handout (see Attachment 3) and were discussed during the meeting. NRC stated that it plans to complete its review of the documents in June 2002, and provide DOE with the result of that review. At that time, the NRC stated it would discuss whether the information provided in the March 27, 2002, letter and discussion during this meeting satisfies the intent of the agreement.

2) Overview of Pre-Closure Safety Analysis Guide

DOE provided an introduction to the meeting (Attachment 3) and stated that the objective of the meeting is to provide an overview of the Pre-Closure Safety Analysis Guide. DOE stated that the Pre-Closure Safety Analysis Guide is not a document subject to the DOE Quality Assurance Requirements Document controls and that it is not the procedure controlling the Q-List or the quality level classification of systems, structures, and components on the Q-List. Further, DOE stated that products which use the Pre-Closure Safety Analysis Guide methodologies will be developed and controlled in accordance with the Quality Assurance Requirements Document and will be self-contained. NRC stated that DOE needed to have procedures in place, with sufficient detail, so that qualified individuals can perform Q-List and quality level classification activities in a consistent manner. DOE stated that its intent was to have procedures in place, as required by 10 CFR Part 63 [specifically 63.142(f)]. Further, DOE stated that the documents referred to in these procedures that prescribe how to perform related activities such as calculations, analyses, independent verifications, reviews and approvals, etc., would also be subject to the Quality Assurance Requirements Document controls.

DOE stated that it may update the Pre-Closure Safety Analysis Guide based on its review of the Yucca Mountain Review Plan, interactions with other organizations, and other feedback processes. DOE stated that the intent of the Guide is to assist with the preparation of the Pre-Closure Safety Analysis and to serve as a training tool for the technical staff. DOE also stated that although the current version focuses on offsite dose, subsequent revisions will address the interfaces with worker dose analyses. NRC and DOE then discussed, in general, the information included in each of the Pre-Closure Safety Analysis Guide sections. DOE stated that, as a path forward, it intends to develop additional sections and provide additional detail on certain topics. NRC and DOE discussed the need to integrate the Pre-Closure Safety Analysis with design and present this information in the Pre-Closure Safety Analysis Guide. DOE stated that it plans to consider feedback (e.g., from the NRC) and incorporate it in subsequent revisions, as appropriate.

3) Discussion of Pre-Closure Safety Analysis Guide Sections

NRC and DOE then discussed specific sections of the Pre-Closure Safety Analysis Guide; the sections discussed are listed below.

Section 3: Strategy

DOE discussed its key pre-closure safety strategies and stated that its construction application project guideline goal is to design the facility to keep the dose limits to less than or equal to one-half of the applicable regulatory limits. NRC and DOE discussed margins and defense-in-depth and DOE stated it intends to design structures, systems, and components with a margin above what is credited for in the Pre-Closure Safety Analysis. At a later presentation, DOE indicated that the project guideline goal is intended for early stage of the pre-closure safety strategies. At the license application for construction authorization, DOE intends to demonstrate compliance with regulatory limits. NRC noted that the issue of margins and defense-in-depth will be very important in implementing 10 CFR 63.44 for changes, tests, and experiments. DOE also stated that it would use, as appropriate, nuclear industry precedent and experience. DOE noted that Section 3 provides preferred approaches, in general, such as passive over active and automatic over manual systems. Finally, NRC and DOE discussed example pre-closure safety strategies.

Section 4: Overview of Pre-Closure Safety Analysis Elements and Approaches

DOE provided an overview of the process it will use for the Pre-Closure Safety Analysis. NRC and DOE discussed the level of design detail and information base for the potential license application for construction authorization. In summary, DOE stated that the design detail will be sufficient to show that it meets the requirements of 10 CFR Part 63 as discussed during the last Technical Exchange (July 2001) where the staff provided a paper describing acceptable levels of design details. DOE stated that at the time of the license application for construction authorization, the Pre-Closure Safety Analysis will support the demonstration that the geologic operations area has been designed to preserve the option of waste retrieval. DOE also stated that if retrieval becomes necessary, DOE will submit safety analyses on retrieval design and operation for NRC review.

Section 6: Hazard Analysis

DOE presented an overview of the external hazards analysis process. NRC and DOE discussed the process DOE used to develop the generic hazards list and the method used to screen out external hazards not applicable to the proposed repository and some examples of how that process was implemented. DOE then presented an overview of the internal hazards analysis process. NRC and DOE discussed the six DOE categories for internal hazard analysis: (1) collision/crushing, (2) chemical contamination/flooding, (3) explosion/implosion, (4) fire, (5) radiation/magnetic/electrical/fissile, and (6) thermal. NRC and DOE then discussed several DOE examples of how the internal hazard analysis process was implemented. DOE and NRC discussed the need to consider three factors - radionuclide release, criticality, and reduction of shielding - in hazard identification analyses. As a result of the hazard analysis process, DOE then would develop an internal hazards event list that must be evaluated. The external and internal hazards analysis will be the basis for identifying initiating events.

Section 10.1: External - Seismic

DOE presented its approach to include seismic effects into the Pre-Closure Safety Analysis and stated that its approach is consistent with DOE's Seismic Topical Report No. 2. DOE also stated that it uses the guidance provided in the Yucca Mountain Review Plan, Commission Papers, NRC publications (i.e., NUREGs), and the requirements of 10 CFR Part 63. NRC and DOE then discussed, in more detail, several aspects of the seismic analysis for the Pre-Closure Safety Analysis and a hypothetical example of a baseline seismic event tree. NRC and DOE discussed the need to have a separate interaction regarding DOE's seismic design/fragility analyses, both for pre-closure and post-closure. As a point of clarification, DOE indicated that the design basis earthquakes for structures, systems, and components related to criticality and waste package retrieval would be determined in a manner consistent with the seismic consideration of other structures, systems, and components.

Section 7: Event Sequences

DOE discussed the methodologies used for construction and development of event tree and fault tree analysis and provided some references it is using to implement the methodology. NRC and DOE then discussed human reliability analysis and DOE stated that its approach is based on methods developed by NRC and the Electric Power Research Institute that have been applied in prior probabilistic risk assessments and individual plant examination studies. NRC and DOE discussed the DOE approach for identifying common-cause and dependent failures and DOE stated that it was using the beta-factor approach. NRC and DOE discussed how DOE plans to gather and quantify technical information that is used in the quantification of fault trees and event trees. Finally, NRC and DOE discussed how DOE defines the bases and methods for applying the results of the event tree sequence quantification to categorize credible event sequences according to the definitions of 10 CFR 63.2. DOE proposed to consider event sequences down to a frequency of 10^{-8} per year. Structure, systems, and components that mitigate or prevent event sequences may be included in the Q-List.

Section 8: Consequences

DOE discussed the methodology for calculating offsite doses for Category 1 and Category 2 event sequences. NRC and DOE discussed source terms, specifically for commercial spent nuclear fuel, crud, DOE spent nuclear fuel, vitrified high-level radioactive waste, mixed plutonium and uranium waste forms, and Navy spent fuel. DOE noted that references to the source term for Navy spent fuel, co-disposal plutonium, and MOX fuel were not discussed in the Pre-Closure Safety Analysis Guide, but will be included in future revisions, as appropriate. NRC and DOE discussed methodologies for Category 1 and 2 event sequence offsite dose calculations, Category 1 and 2 dose pathways, and commercial spent nuclear fuel release fractions. NRC noted its position that DOE should demonstrate the facility design is in compliance with the performance objectives for all pathways without the need for interdiction. DOE responded it would consider the NRC position for including the ingestion pathway in the consequence analyses for Category 2 event sequences. NRC noted the general need for the Pre-Closure Safety Analysis Guide to better address and integrate analyses for onsite workers. DOE agreed future updates to the Pre-Closure Safety Analysis Guide would address the interfaces with onsite worker dose analyses.

Section 9: Uncertainty Analysis

DOE discussed how the uncertainty/sensitivity analyses will be applied in the Pre-Closure Safety Analysis. DOE stated that Section 9 provides the methods for identifying, quantifying, propagating, and interpreting uncertainties in frequency and consequence analyses. DOE noted that other sections of the Pre-Closure Safety Analysis Guide also address facets of uncertainty analysis, and its application. NRC and DOE discussed the different types of uncertainty and how the uncertainty would be identified, treated, and propagated through the event sequence frequency and consequence analyses. Finally, NRC and DOE discussed how sensitivity studies could be used to give risk insights to specific events.

Section 13: 10 CFR 63.2 Design Basis

DOE discussed the definition of design bases and the relationship of 10 CFR 63.2 design bases to the licensing bases. DOE emphasized that analyses are based on the functions applicable to each event sequence. DOE stated that pre-closure design basis requirements will be developed from the geologic repository Category 1 and 2 event sequences identified in the Pre-Closure Safety Analysis. NRC and DOE discussed the DOE process for developing the final set of bounding 10 CFR 63.2 design bases. DOE also provided two specific examples and discussed the functional design bases, controlling parameter design bases, and supporting design information.

Section 12: Classification Process - AP-2.22Q

DOE discussed the classification methodology provided in the Pre-Closure Safety Analysis Guide and briefly discussed Procedure AP-2.22Q, "Classification Criteria and Maintenance of the Monitored Geologic Repository Q-List" and its classification process. NRC and DOE discussed the adequacy of the guidelines provided in AP-2.22Q. NRC and DOE discussed the important to safety classification criteria and the specific quality levels. NRC and DOE discussed the important to safety classification steps for classifying structures, systems, and components in Category 1 and 2 event sequences. NRC and DOE then discussed three hypothetical examples of how the classification process would be implemented. DOE stated that it would make the Q-List consistent with the classification analyses and provided an example Q-List. In addition, DOE stated that it would be periodically providing the staff with updated Q-List. As a path forward, DOE stated that it plans to include in future Pre-Closure Safety Analysis Guide revisions: (1) classification of structures, systems, and components related to criticality, (2) classification of structures, systems, and components related to radiological worker safety for Category 1 event sequences, and (3) Q-List format and maintenance. NRC commented that the Pre-Closure Safety Analyses for worker consideration and important to waste isolation designations arising from the post-closure total system performance assessment contributions to the Q-List and structures, systems, and component categorizations should be included. NRC noted that terminology related to categorization were not consistent throughout the Pre-Closure Safety Analysis Guide. DOE stated that the next revision will introduce consistent terminology.

4) Yucca Mountain Review Plan - Pre-Closure Safety Analysis Guide Comparison

DOE discussed its ongoing comparison between the draft Yucca Mountain Review Plan and the Pre-Closure Safety Analysis Guide. DOE stated that the Pre-Closure Safety Analysis Guide appears consistent with corresponding sections of the draft Yucca Mountain Review Plan, with some of the exceptions noted during the meeting. DOE stated that future revisions would be linked to the Yucca Mountain Review Plan, as appropriate, and would develop details and/or new methods sections for areas not completed in the current version (e.g., internal event floods and fires, vulnerabilities to software unreliability, and work interfaces and responsibilities). DOE also noted that it intends to develop a license application that is consistent with the format and content of the Yucca Mountain Review Plan.

5) Public Comments

None

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