U.S. NUCLEAR REGULATORY COMMISSION STAFF FEEDBACK ON U.S. DEPARTMENT OF ENERGY'S SUMMARY OF PRECLOSURE SAFETY ANALYSIS RELIABILITY METHODOLOGY REPORT

A.   GENERAL COMMENTS

U.S. Department of Energy's (DOE) *Summary of the Preclosure Safety Analysis (PCSA) Reliability Methodology Report* is consistent with the generally accepted reliability assessment approaches used in nuclear and other allied industries. Because it is a summary document, it does not contain design-specific details on how different methodologies are to be implemented in the PCSA. In the absence of implementation details we need to reiterate three key messages that were communicated to DOE in previous technical exchanges (TE), namely: (i) Sufficient technical bases to justify reliability estimates of structures, systems and components (SSCs) are necessary in the PCSA; (ii) When estimating reliability, it is acceptable to use SSC analogues at the highest possible level (typically at the system level) encompassing both hardware and software reliability issues; and (iii) Uncertainty needs to be addressed in the PCSA. In order for U.S. Nuclear Regulatory Commission (NRC) to gain confidence that 10 CFR Part 63 PCSA requirements can be met, DOE may consider presenting actual examples of how reliability methodology is implemented in the PCSA in the future.

With respect to human reliability analysis (HRA), NRC's understanding is that this document provided a snapshot of the DOE's HRA approach for the PCSA, as of August 2006. At the November 7 - 9,2006, TE and Management Meeting, DOE addressed NRC's key messages on HRA, and presented an HRA approach at a conceptual level. This HRA approach has been significantly updated since the publication of the summary document. Based on this presentation, NRC understands that the DOE's HRA approach is evolving, and may address NRC's concerns in this area, if implemented properly.

B.   SPECIFIC COMMENTS

PCSA METHODS

1.   **Initiating Event and Event Sequence Screening:** In several sections of the Reliability Methodology Report, the role of uncertainty in categorization of event sequences is not transparent. For example, in Section 2.3.2 of the Reliability Methodology Report, it is stated that "...a screening margin may be applied to ensure high confidence that the sequence is properly categorized or screened out."

      During the review of the License Application (LA), NRC plans to examine the technical bases and the role of uncertainty in the screening methods when categorizing event sequences. More regulatory attention will be paid to event sequences near the categorization boundaries.

2.   **Assumptions in Input Parameters of PCSA:** In Section 3.3, pages 14-15 of the Reliability Methodology Report, an extensive list of pertinent technical information that may be used in the reliability assessment process is provided. It is unclear from the

document how some of these items will be incorporated in the methodologies described in the absence of design details for the Geological Repository Operations Area (GROA).

During the review of the LA, NRC plans to evaluate justifications for the assumptions made in the input parameters for reliability estimation in the LA. This includes input parameters relating to generic failure data, generic fragility parameters, operator action and safety control procedures that directly affect the estimates derived for specific SSCs in the analysis.

UNCERTAINTY

1. **Distributions assigned to inputs of the PCSA:** In Section 3.4 of the Reliability Methodology Report, DOE states, in the use of Bayes Theorem, that the prior distribution is "....determined by the judgment of those who are knowledgeable" and can be estimated by using "....engineering analysis, simulation and previously developed priors".

    During the review of the LA, NRC will review the technical basis for choosing the prior distribution, in particular, if the experts disagree on the choice of a prior or if the engineering analysis, simulation or previously developed priors disagree. Additionally, NRC will review DOE's PCSA to identify cases where the choice of a prior distribution can significantly affect the categorization of a sequence frequency.

2. **Uncertainties:** In Section 3.5.1.4 of the Reliability Methodology Report, DOE states that "....both modeling and data uncertainties are addressed". Additionally, DOE states that when the mean of the sequence frequency is "....judged to be close to a categorization boundary, ...an uncertainty analysis is therefore needed ... to justify the categorization."

    While stating how data uncertainties are addressed, the Reliability Methodology Report does not describe how modeling uncertainties are addressed. Neither is there a discussion of how event sequences are to be categorized in light of uncertainty in the frequency of event sequences.

    During the review of the LA, NRC plans to review the technical basis for addressing model uncertainties, especially in cases where models could significantly affect the categorization of event sequences. NRC expects a clear delineation of: (i) the criteria used to decide when an uncertainty analysis is needed, and (ii) how the uncertainty analysis will be used to justify the categorization.

HUMAN RELIABILITY

1. **Overall Approach -** Based on the Reliability Methodology Report, NRC had concerns about the integration of the HRA with the overall PCSA, and DOE's selection of potentially inappropriate HRA methods and approaches for the PCSA. The following points, as NRC understood them, in DOE's HRA presentation at the TE and Management Meeting substantially reduced these initial concerns:

1. DOE stated that the HRA would be fully integrated with the overall PCSA and the design and operation processes, and contain both qualitative and quantitative aspects.

2. DOE indicated that it recognizes that some HRA methods, such as Techniques for Human Error Rate Prediction (THERP) and Standard Plant Analysis Risk HRA (SPAR-H), may be of no use or only limited use for application to the GROA. Furthermore, DOE indicated that its selection of quantification method(s) would depend on the specific human failure event(s) involved and their qualitative aspects.

3. DOE outlined some of the key differences in HRA applications for nuclear power plants versus the GROA, which could be instrumental in its choice of methods and approach to HRA for the PCSA.

2. **HRA Implementation -** DOE's approach was still being developed at the time of the November 2006, TE. and Management Meeting. For example, DOE indicated that there might be multiple screening values used for different types of human actions, and that the approach to screening values is still evolving. In addition, the HRA approach had not yet been implemented at the time of the TE and Management Meeting.

Although an appropriate conceptual approach and methodology are important, implementation is equally important. NRC looks forward to examples of implementation of DOE's HRA approach, including the identification of potential human failure events (including potential pre-initiator failures) for specific facility design and operations, and updates on DOE's screening value decisions.

3. **Uses of Available Operating Experience -** DOE's HRA presentation at the TE and Management Meeting stated that the Yucca Mountain Project will be a first-of-a-kind, and "....walk-downs and consultations with operators are limited."

Although the GROA will be a first-of-a-kind facility in many ways, operating experience at similar facilities and activities should not be discounted. In particular, it is likely that useful insights for qualitative aspects of the HRA can be gained, for example, by identifying past human error mechanisms and important performance-shaping and contextual factors.