January 23, 1996

Mr. C. Lance Terry
Group Vice President, Nuclear
TU Electric
Energy Plaza
1601 Bryan Street, 12th Floor
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SUBJECT: REQUEST FOR ADDITIONAL INFORMATION ON COMANCHE PEAK STEAM ELECTRIC STATION, UNITS 1 AND 2 INDIVIDUAL PLANT EXAMINATION (IPE) SUBMITTAL (TAC NOS. M74397 AND M88982)

Dear Mr. Terry:

Based on our ongoing review of the Comanche Peak Steam Electric Station, Units 1 and 2 IPE submittal and its associated documentation, we have enclosed requests for additional information (RAIs). The RAIs are related to the internal event analysis in the IPE including the accident sequence core damage frequency analysis, the human reliability analysis, and the containment performance analysis.

We request your response to our RAI within 60 days of receipt of this letter. If you have any questions, please call me at (301) 415-1038. This requirement affects nine or fewer respondents and, therefore, is not subject to the Office of Management and Budget review under P.L. 96-511.

Sincerely,
Original signed by
Timothy J. Polich, Project Manager
Project Directorate IV-1
Division of Reactor Projects III/IV
Office of Nuclear Reactor Regulation

Docket Nos. 50-445 and 50-446

Enclosure: Request for Additional Information

cc w/encl: See next page

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NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

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Comanche Peak Steam Electric Station IPE Request for Additional Information

Questions for Level 1 Review

1. This question concerns the completeness of the treatment of any twin-unit effects at the Comanche Peak Steam Electric Station (CPSES).

   The submittal represents both units of the plant (see p. 1-4). The system descriptions of several electrical systems (offsite power and switchyards, 6.9 kV EAC buses) and fluid systems (SW, CCW, and Chilled Water) indicate crossties between the units. Operational aspects of the IPE analysis also indicate the usage of the other unit (e.g., recovery actions, CCXTIE and SWXTIE on p. 3-201, -202 respectively). On the other hand, p. 3-177 of the submittal states that Unit 1 started its commercial operation in April 1990, and Unit 2 is still under construction, and consequently, sufficient plant-specific operating data cannot be available for the IPE study. (Unit 2 started its commercial operation only in 1993.) It is not clear from the submittal which systems were considered to be shared or only cross connected. Please provide a list of the cross connected and shared systems modeled for the IPE and describe the present (real) situation. (Multiunit considerations are addressed in Section 2.1.4, Guideline No. 3 of NUREG-1335.)

2. It is not clear from the submittal how the cross-tied and shared systems are treated for the unit at power if the other unit is in cold shutdown and some of the shared (or potentially cross-tied) systems are experiencing extended downtime. How do you account for the unavailability of the systems that are capable of being cross-tied or shared during the time the opposite unit is in shutdown? Please show how each shared/cross-tied system was treated in this regard and what was the impact on your results if this was not considered.

3. The initiating event analysis of the submittal is fairly detailed. However discussion of two areas is lacking: The treatment of common cause loss of AC or DC Buses as initiating events, and the possibility of dual unit initiators. Please provide the initiating frequencies and associated CDF contributions for:

   (a) Initiating events caused by common cause loss of AC or DC Buses, and

   (b) dual unit initiators.

   If any of them can be neglected, please provide the reasons.

4. The value of 0.035/year for the loss of offsite power (LOOP) initiating event frequency (for a single unit) is at the low range of typical LOOP frequency values, as provided in your data source; NSAC/166. The total CDF is dominated by this initiator (28%). Therefore, the LOOP frequency will directly influence a major portion of your results.

   Please explain how you estimated the LOOP frequency (both for single and dual units). Include in your discussion what guidelines were followed and how plant specific information and data, e.g., maintenance activity

Enclosure

in switchyards, "Type B human action failures" [see p. 3-179], anticipated frequency of disturbances from Unit 2, etc. were accounted for, including weather related events.anticipated frequency of disturbances from Unit 2, etc. were accounted for, including weather related events.

5. The CDF contribution due to SBO is an appreciable fraction (28%) of the total CDF. Unit 1 started in commercial operation in April 1990, while Unit 2 started in 1993 after the freeze date of the IPE, January 1, 1992. From the submittal, however, it is not clear whether plant changes (design or operational) due to the Station Blackout rule were credited in the IPE model or not.

   Please provide the following: (1) identify whether plant changes (e.g., procedures for load shedding, alternate AC power) made in response to the blackout rule were credited in the IPE and what are the specific plant changes that were credited; (2) if available, identify the total impact of these plant changes to the total plant core damage frequency and to the station blackout CDF; (3) if available, identify the impact of each individual plant change to the total plant core damage frequency and to the station blackout CDF (i.e., reduction in total plant CDF and station blackout CDF); (4) identify any other changes to the plant that have been implemented or are planned to be implemented that are separate from those in response to the station blackout rule that reduces the station blackout CDF; (5) identify whether the changes in #4 are implemented or planned; (6) identify whether credit was taken for the changes in #4 in the IPE; and (7) if available, identify the impact of the changes in #4 to the station blackout CDF.

6. The rupture of the steam supply line to the turbine-driven AFW pump during plant operation would be expected to result in a plant trip. At the same time, the TD AFW pump would be disabled due to exposure to steam and moisture effects. The IPE is not clear as to whether or not a break in the steam supply line to the TD AFW pump was considered as an initiating event. Please clarify the modeling of this potential initiating event. If this initiating event has not been accounted for, please provide the basis for its omission.

7. The ISLOCA is included in the study. However, there is no description about the method used to evaluate the initiating event frequencies. Provide the leak/operational testing periods of the valves involved, the potential human errors associated with the testing, and a brief summary of the calculational approach used.

8. In the submittal the link between the "functional top events" of the event trees and the "top gates" associated with the system unavailabilities and the "dynamic human actions" (listed in pp. 3-195 through 3-200) is missing. Since the front-line system success criteria are defined for the top gates (listed in Table 3.1.1-1) it is not possible to always interpret the event sequences unambiguously (in terms of these system and "dynamic" human failures).

Please provide the missing connection between the functional top events and the system unavailabilities and human actions.

9. In certain (mainly transient) event trees found in the submittal the steam release during secondary side heat removal is modeled together with the secondary feed (top event $$SGXX01S). In other event trees the multiple steam release paths were assumed to be negligible contributors (top event $$SGXX01). Please explain the criteria used to determine which modeling option was chosen for each tree.

   In addition, in some event trees (e.g., in the Loss of Service Water event tree; Figure 3.1.2-11 and in the loss of Instrument Air event tree; Figure 3.1.2-12) the top event designator $$SGXX01, which indicates only secondary feed by the AFW, is inconsistent with the associated event descriptor, which characterizes the event as "AFW with steam relief", i.e., as $$SGXX01S. Please clarify this apparent discrepancy.

10. This question concerns the modeling of DC power:

    (a) In the event tree for "Very small break LOCA" (FIG. 3.1.2.17) there is a top event with designator "EPBATTDEPL" and descriptor "TDAFWWP Runs Until Battery Depletion." This event indicates failure of the TDAFWP at 4 hours, due to loss of DC power that leads to overfill of the steam generators and failure of the TDAFWP. During this accident the chargers are operating. Explain the reason why this top event is included in the event tree.

    (b) It is not clear from the submittal whether the 4-hour battery depletion time under SBO conditions assumes load shedding. If load shedding is necessary, (i) what is the battery life without load shedding, (ii) how was load shedding modeled, and (iii) what are the HEP values for operator actions connected with load shedding?

11. On p. 3-227, the submittal discusses the approach used in the flood analysis. It states that "other (flood) hazards such as pipe whip, steam impingement, and specific liquid jet, or spray patterns were outside the scope of this analysis."

    It is not clear why the IPE team limited its consideration of flooding-related events to the relatively low energy flood sources. For example, a break in the steam supply line to the TD AFW pump could disable equipment via the effects of the spray. Similarly, the spurious actuation of the fire suppression equipment may also disable safety related system operation or damage essential system components.

    Please provide a rationale for the exclusion of flood sources involving spray and splashing.

12. The flood source selection criteria includes the following statement: "Temporary hose or tubing systems that could potentially be used for one-time maintenance or repair applications were outside the scope of this analysis."

Please discuss how other types of maintenance failures were treated in the flooding analysis. Include errors committed while in cold shutdown, which were left undiagnosed (e.g., blocked drains) during operation while the unit is at power until the flood event.

13. Section 3.4.2 of the submittal is called "Vulnerability Screening." The screening finds no vulnerabilities at the Comanche Peak units.

NUREG-1335 requests that the licensee 1) provide a list of any vulnerabilities identified by the review process, 2) a concise discussion of the criteria used by the utility to define vulnerabilities and 3) fundamental causes of each vulnerability. Please provide such information.

14. Section 3.4.3 of the submittal discusses the evaluation of the Decay Heat Removal (DHR) at the CPSES. The CDF contributions of DHR failures are presented for the leading sequences and for appropriately selected initiators. Explicit results, however, are not given for the relative CDF contributions due to failures of the systems constituting the DHR or of their support systems.

Therefore, please provide the CDF contribution for

(a) the individual systems constituting the DHR (including feed and bleed), and

(b) the individual support systems providing support to frontline systems that perform DHR.

15. RCP Seal LOCA contributes approximately 29% of the total CDF (p. 1-4). Part of the analysis is the description of the "Induced LOCA" special event tree (p. 3-56). The details of the model applied, however, are not clear.

(a) Please provide a discussion of the RCP seal LOCA model used.

(b) Provide the probability vs. leakage rate vs. time data and any specific test results.

(c) Provide a discussion of operator actions, which are proceduralized and their timing in the event of a loss of one or the other (or both) methods of seal cooling.

(d) Is seal cooling isolated in certain accidents (e.g., steam line break inside the containment), what are the operator procedures for this and how is this treated in the model?

16. The submittal in Section 6 (p. 6-1) discusses a number of plant improvements concerning emergency procedure changes and upgrading of the RCP seals in 1993 for Unit 1 and prior to initial startup for Unit 2. The IPE did not take credit for these improvements.

Please provide the following:

(a) The status of each improvement, i.e., whether the improvement has actually been implemented already, is planned (with scheduled implementation date), or is under evaluation.

(b) If available, the reduction to the CDF or the conditional containment failure probability that would be realized from each plant improvement if the improvement were to be credited in the reported CDF (or containment failure probability), or the increase in the CDF or the conditional containment failure probability if the credited improvement were to be removed from the reported CDF (or containment failure probability).

(c) The basis for each improvement, i.e., whether it addressed a vulnerability, was otherwise identified from the IPE review, was developed as part of other NRC rulemaking (e.g., as the Station Blackout Rule), etc.

17. The MGL parameters applied in the Common Cause Failure (CCF) analysis (see Section 3.3.4 of the submittal) were obtained by the Bayesian updating technique: generic CCF data had been screened (p. 3-207) to determine Comanche Peak specific "prior parameter distributions" which were then updated with CCF events ("evidences") experienced at the plant. The process resulted in proper "posterior" MGL parameters.

In the absence of plant specific events, the posterior MGL parameters are "prior dominated," i.e., strongly biased (usually downward) by the screening process. (The process seems to allow neglect of CCF events that have not yet occurred at the plant or were not identified.)

Please discuss how you ensured that no vulnerabilities were overlooked by the application of this process.

18. The sequence descriptions (p. 3-241) and the sequence classification unit's POS bins provide conflicting information, e.g., the first leading sequence #ISCM2X3 from the sequence descriptions has a frequency of 1.2E-5. In the PDS Table (Table 3.1.5-3 on p. 3-74) #ISCM2X3 has no entry. The entries are all from #ISCM2 (the entry 1.2E-5 from #ISCM2 under PDS 1H is assigned to #ISCM2X3).

An analogous case is the sequence #ISCM2TR which is described on p. 3-244. It has a frequency of 3.3E-6. There is no such entry in the PDS Table. The sequence #ISCM2 in PDS 1F has the closest frequency of 2.4E-6. This sequence may be taken as #ISCM2TR, even with the difference in value.

The description on p. 3-250 states that sequence #1WSCM5 is binned into the PDS 3SBO. However, Table 3.15-3 bins it into 4SBO and 3CB.

Please provide a corrected PDS Table or correct the sequence descriptions.

19. In the peer review it was pointed out that the actual duration of corrective maintenance was longer than that implied by the generic data used in the IPE model. Please discuss how you ensured that no vulnerabilities in this area were overlooked.

Comanche Peak Steam Electric Station IPE Request for Additional Information

Human Reliability Analysis (HRA) Questions

PRE-INITIATOR HUMAN ERRORS

1. The basis for the screening methodology used for pre-initiator human errors is unclear. On page 3-180 the submittal states that the screening methodology is a "melding of several previously published methodologies" and that "the framework and mechanics are original." It also states that "the backbone of this methodology is a event or decision tree that is based on a series of structured questions that lead an evaluator to a Human Error Probability (HEP) screening value." Please provide:

   (a) A list of the published methodologies from which your screening methodology was derived.

   (b) A discussion of how the methodology was derived.

   (c) A discussion of why the specific "questions" in Figures 3.3.3-3 and 3.3.3-4 were selected (i.e., why were these performance shaping factors (PSFs) chosen and not others?).

   (d) A discussion of the basis for how the "questions" in the decision trees presented in Figures 3.3.3-3 and 3.3.3-4 were used to estimate the non-success probability assigned to each path through the trees (i.e., how did you arrive at the number for each path through the trees?).

   (e) A discussion of how and why Figure 3.3.3-3 leads to higher failure probabilities for trains than for individual components. In other words, the basis and intent of the second decision point in the tree ("comp/train") is not clear.

2. The screening process for pre-initiators made use of the decision trees in Figures 3.3.3-3 and 3.3.3-4. It is not clear from the submittal how the screening process ensured that potentially important human events and accident sequences were not eliminated. Some outcomes provide screening values as low as 1.0E-3. Please provide:

   (a) The rationale for how the selected screening values did not eliminate (or truncate) important pre-initiator human events. (In addition, please include a list of errors initially considered but later screened.)

3. The submittal is unclear on what types of dependencies were addressed. The failure to identify and evaluate different types of dependencies that could potentially exist can result in failure to recognize vulnerabilities associated with the design, operation, maintenance or surveillance of the plant. In addressing dependencies, whether miscalibration or failure to restore, the process utilized should consider plant conditions, human engineering, performance by same crew at

same time, adequacy of training, adequacy of procedures, and interviews with training, operations and various crews. Please provide a brief discussion on what dependencies were identified and how they were identified.

4. The submittal is unclear on how dependencies were treated. It is not clear from the submittal how dependencies associated with pre-initiator human errors were addressed and treated. There are several ways dependencies can be treated. In the first example, the probability of the subsequent human events is influenced by the probability of the first event. For example, in the restoration of several valves, a bolt is require to be "tightened". It is judged that if the operator fails to "tighten" the bolt on the first valve, he will subsequently fail on the remaining valves. In this example, subsequent HEPs in the model (i.e. representing the second valve) will be adjusted to reflect this dependence. In the second example, poor lighting can result in increasing the likelihood of unrelated human events; that is, the poor lighting condition can affect different operators' abilities to properly calibrate or to properly restore a component to service, although these events are governed by different procedures and performed by different personnel. This type of dependency is typically incorporated in the HRA model by "grouping" the components so they fail simultaneously. In the third example, pressure sensor x and y may be calibrated using different procedures. However, if the procedures are poorly written such that miscalibration is likely on both sensor x and y, then each individual HEP in the model representing calibration of the pressure sensors can be adjusted individually to reflect the quality of the procedures. Please provide a concise discussion of how dependencies were addressed and treated in the pre-initiator HRA such that important accident sequences were not eliminated. If dependencies were not addressed, please justify.

5. The modification of screening HEP for pre-initiator human events unclear. On page 3-178 of the submittal it states that "If it was found that these HIs were significantly important in terms of their contribution to core damage frequency, these HIs were requantified using an expert judgement approach." The expert interview is also mentioned on page 3-187. Does this mean that the HEPs assigned to pre-initiator human events were modified? If so, please describe the expert judgment process and provide a few examples illustrating the process.

6. Some pre-initiator human events have HEPs different from those that would be derived from the decision trees. From Figures 3.3.3-3 and 3.3.3-4 of the submittal, one can see that the ranges of HEP screening values are 5E-1 to 1E-3 and 1.0 to 5E-3, respectively. In the list of latent errors given on page 3-191, event "AFCTDAFWPNX" (Both TDAFWP steam admission lines unavailable due to latent human error) has a value of 1E-4. Was this event's value determined using Figures 3.3.3-3 and 3.3.3-4, and if so, please describe the process used to determine this value. If the event's value was determined by some other process, please describe this process and explain how the value was obtained. Please list all events that were quantified with this "different" approach and provide examples illustrating how the HEPs were obtained.

7. The basis for common cause calibration errors is unclear. Page 3-187 states that "it was concluded that significant human errors could be due to the common cause error in calibration of channels within ESFAS" and that "the base calibration error rate of a single channel ..." using Figure 3.3.3-4 was 5E-3. This base calibration error rate was then "adjusted by applying two modifying factors that account for the common factors." Please provide the following:

   (a) The basis for this quantification technique.

   (b) The basis for the values used for each of the two modifying factors (0.05 and 0.01).

   (c) The list of latent errors that begins on page 3-191 contains events that appear to be common cause calibration errors (e.g., "ESCCFMISCAL"). Please describe how the values for these common cause latent errors were determined.

   (d) How were the common cause events placed in the fault trees and accounted for in the system logic? Essentially, describe how the common cause failures were incorporated and their potential impact accounted for.

POST-INITIATOR HUMAN ERRORS

8. The submittal is unclear on why non-proceduralized post-initiator actions were considered. On page 3-179 the submittal states that post-initiator human errors "may or may not be covered by procedures." Please provide a list of the human actions considered in the analysis that are not proceduralized, and justify why credit was taken for these non-proceduralized actions.

9. The basis for the screening methodology used for post-initiator immediate action (C_p) human errors is unclear. On page 3-180 the submittal states that the screening methodology is a "melding of several previously published methodologies" and that "the framework and mechanics are original." It also states that "the backbone of this methodology is an event or decision tree that is based on a series of structured questions that lead an evaluator to a Human Error Probability (HEP) screening value." Please provide:

   (a) A list of the published methodologies from which your post-initiator screening methodology was derived.

   (b) A discussion of how the methodology was derived.

   (c) A discussion of why the specific "questions" in Figure 3.3.3-2 was selected (i.e., why were these performance shaping factors chosen and not others?).

(d) A discussion of the basis for how the "questions" in the decision tree presented in Figure 3.3.3-2 were used to estimate the non-success probability assigned to each path through the trees (i.e., how did you arrive at the number used for each path through the tree?).

(e) A discussion of how the diagnosis and execution portions of operator actions are addressed with the screening methodology.

10. The screening process for the post-initiator (C_p) human errors made use of the decision tree in Figure 3.3.3-2. Several questions arise regarding the use of this tree. Since screening values as low as 0.05 can be obtained from use of the tree, it is not clear from the submittal how the screening process ensured that potentially important (C_p) human events and accident sequences were not eliminated. Furthermore, it is not clear how issues such as dependencies among human events were addressed in the screening process. Please provide:

(a) The rationale for how the selected screening values did not eliminate (or truncate) important post-initiator (C_p) human events.

(b) A discussion of what dependencies among human events were considered.

(c) A discussion of how dependencies were addressed (i.e., how did dependencies affect the HEP estimate of a human event.

(d) Several examples of the consideration of dependencies in determining HEPs for post-initiator events.

(e) A list of human actions which were initially considered, but which were later screened.

The discussion of dependencies in items (a), (b) and (c) above should address the two points below:

Human events are modeled in the fault trees as basic events such as failure to manually actuate. The probability of the operator to perform this function is dependent on the accident in progression - what symptoms are occurring, what other activities are being performed (successfully and unsuccessfully), etc. When the sequences are quantified, this basic event can appear, not only in different sequences, but in different combinations with different systems failures. In addition, the basic event can potentially be multiplied by other human events when the sequences are quantified which should be evaluated for dependent effects.

Human events are modeled in the event trees as top events. The probability of the operator to perform this function is still dependent on the accident progression. The quantification of the human events need to consider the different sequences and the other human events.

11. The modification of screening HEP for post-initiator C_P human events is unclear. On page 3-178 of the submittal it states that "If it was found that these HIs were significantly important in terms of their contribution to core damage frequency, these HIs were requantified using an expert judgement approach." Does this mean that the HEPs assigned to post-initiator C_P human events were modified? If so, please describe the expert judgment process and the extent to which HEPs would be modified. Provide an example illustrating the process.

12. Some post-initiator C_P human events appear to have HEPs other than those presented in the decision trees. From Figure 3.3.3-2 of the submittal, one can see that the range of HEP screening values is 1.0 to 5E-2. In the list of dynamic actions modeled given on page 3-195, event "&BFXXINITNY" (Operator fails to initiate feed and bleed) has a value of 1E-3. Was this event's value determined using Figures 3.3.3-2, and if so, please describe the process used to determine this value. If the event's value was determined by some other process, please describe this process and explain how the value was obtained. Which of the other human action events were quantified using methods different from the decision trees and how were they quantified?

13. The submittal is unclear on the quantitative approach used for post-initiator recovery (C_R) human events. On page 3-190 of the submittal it states that "the quantification of these recovery actions consisted of an interview of an expert with the results interpreted by decision trees. Two decision trees from SHARP1 were used in the recovery analysis. One was for detection and diagnosis (P_i) and the other was for auxiliary operator action (P_e)." Please provide a detailed description of how this approach was used to quantify post-initiator C_R human events. Please be sure to:

    (a) Describe what plant-specific performance shaping factors were used during the quantification of the human error, along with the values of the factors.

    (b) Describe how dependencies were addressed and treated in the post-initiator C_R HRA such that important accident sequences were not eliminated.

    (c) Illustrate the quantification process and treatment of dependencies with examples from the IPE.

14. It states on page 3-190 that after final quantification, additional recovery actions were identified. Please provide the following information concerning these additional recovery actions:

    (a) List and discuss the recovery actions credited in this phase.

(b) Describe how it was ensured that appropriate dependencies were considered in applying recovery actions in this phase.

(c) Discuss any sequences/cut sets to which a second recovery action was applied.

15. The submittal is not clear on how "available" time was calculated for the various post-initiator human events. Please discuss how the total available time for an action (diagnosis and execution) was generally determined, e.g., MAAP runs. Then, for several of the post-initiator human events* examined, provide:

    (a) The time estimated to be available for the operator to diagnose and perform the action and the bases for the time chosen. Please illustrate that the time at which operators would receive "cues" and indications in the control room regarding an event was taken into account. In other words, significant time can pass before operators will be alerted to certain conditions. Please illustrate that this factor was considered in determining the time operators would have available for diagnosis and performance of a task.

    (b) Examples illustrating that different times were calculated for the same task occurring in different sequences.

    * In selecting the events to be used for examples, please select actions which vary in terms of when operators would be expected to receive relevant indications that a particular situation existed.

16. The submittal is unclear on how the time required to perform particular actions was determined. For example, were times calculated from simulator exercises or from walkdowns? For each post-initiator human event examined, provide the time needed for the operator to perform the actions (in-control room and ex-control room) and the time assumed to be available for the operator to diagnose the need for the actions. Also provide the bases for the times chosen. That is, how was the time assumed to be necessary to perform the needed action determined and how was the diagnosis time determined?

17. The submittal is unclear on how the HRA was performed for the flooding analysis. Please describe the HRA process used in the flooding analysis and provide the following:

    (a) Example calculations of all types of human actions considered in the flooding analysis.

    (b) A list of the human actions modeled in the flooding analysis and their HEPs.

18. The submittal is unclear on how the HRA was performed for the Level II analysis. Please describe the HRA process used in the Level II analysis and provide the following:

(a) Example calculations of all types of human actions considered in the level II analysis.

(b) A list of the human actions modeled in the level II analysis and their HEPs.

Comanche Peak Steam Electric Station IPE Request for Additional Information

Questions for Level 2 Review

1. **RCS Depressurization** -- The RCS depressurization mechanisms considered in the IPE include stuck-open SRV, RCP seal failure after core damage, steam generator tube rupture, hot leg/surge line failure and operator action. According to the IPE submittal, RCS depressurization is dominated by operator actions. However, the values used for these mechanisms are not provided in the submittal. Please provide these values and discuss their basis.

2. **Coolant Recovery Before Vessel Breach** -- According to the IPE submittal, the issues considered in the logic tree for CET top event REC (Coolant Not Recovered In-Vessel Before Breach) include (1) the availability of coolant injection upon depressurization, and (2) recovery of electric power. The logic tree (or fault tree) is provided in Figure 4.5-3 of the IPE submittal. Please explain how the values of the various basic events regarding ac power recovery and the recovery of the various injection systems are determined in the IPE. Please also discuss the value used for basic event PRCOOLDBIV (coolable debris bed not formed in-vessel) and its basis.

3. **External Cooling of the RPV** -- The fault tree for top event VF (Vessel Failure Occurs, Figure 4.5-4) includes in-vessel recovery due to lower head cooling via ex-vessel heat removal. It is stated in the IPE submittal that "However, this external cooling was not credited for CPSES. .. This is felt to be a conservative assumption." Since this mechanism may delay, if not terminate, vessel penetration, fission product production and release paths are affected (e.g., in-vessel release from a dry debris bed versus ex-vessel release from a debris bed covered by water). The release of fission products to the environment may actually increase if the containment fails and external cooling was accounted for in the source term calculation. Please discuss the likelihood of a submerged vessel for the various PDSs (not limited to sequences that satisfy this particular CET branch where VF is questioned). Please discuss the effect of external cooling on source term definition for the various release categories. Please also discuss the effect of external vessel cooling (which results in maintaining the RCS at high temperature for a longer time) on the probability of creep rupture of RCS boundaries and steam generator tubes, and consequently, the effect on containment performance and source terms for CPSES.

4. **Containment Failure Modes** -- The following requested information pertains to the treatment of the containment failure modes.

   (a) The probabilities of containment failure size are determined in the CET by basic events PR-RUPWCFL and PR-RUPWCFE. Please provide the values, and their basis for these events.

   (b) For the quantification of the CET for PDS 1E (or PDS 1H), it is stated in the submittal (p4-183) that "For CONTAINMENT FAILURE

MODES, CFM2=5.04E-01, CFM3=5.00E-1, if the failure is early." These values do not seem to be consistent with the results of CET end state probabilities obtained from the CET quantification presented in Table 4.6-3. Substituting the values of D5-L, D5-R, D6-L, and D6-R from Table 4.6-3 into the CET end states as given in Figure 4.5-1, we obtain the value of CFM3 as 0.73. Similar substitution of the values of D3-L, D3-R, D4-L, and D4-R to the CET results in a value of CFM2 of 1.00. Please clarify these apparent inconsistencies.

5. Induced SGTR -- The following requested information pertains to induced steam generator tube rupture (ISGTR):

   (a) The frequency of induced SGTR (ISGTR), a containment bypass failure, is 1.7E-7 (p4-129). According to the IPE submittal, bypass failure is discussed separately (in Section 4.5.1) and not evaluated in the containment event trees (CETs). It is stated in the IPE submittal that "the ISGTR frequency was determined from the fraction of the non-depressurized high pressure PDS frequencies for which the SG tubes fail prior to the hot leg or the pressurizer surge line." (p4-129). The quantification of ISGTR is further discussed in Section 4.6.2.1. According to the IPE submittal, "The ISGTR frequency was calculated by subtracting the probability of depressurizing in the CET (1-(top event DP probability)) as calculated for the base case (i.e., the case where the tubes could fail, BE PRSGOK = .982) from the case where the tubes are intact (BE PRSGOK = 1.0). This difference is due to the induced failure of the tubes." It is noted that the value referred above (.982) is the same as the mean probability value for no-ISGTR used in NUREG-/CR-4551 for Surry. However, in the Surry evaluation, this is used directly for the high pressure sequences to obtain the probability of ISGTR (i.e., the conditional probability for ISGTR for sequences at high pressure is .012). The procedure used in the CPSES IPE is more complicated (e.g., in the DP fault tree, hot leg and surge line may fail after an ISGTR by event PRHLSLOK2) and yields conditional probability values much less than .012 (from 3E-4 to 5E-3, Table 4.6-18). Please discuss the data used in the IPE for ISGTR determination (i.e., all the basic events in the DP fault tree) and their basis. If NUREG/CR-4551 is the basis for ISGTR determination, then please discuss the reasons for the difference in conditional probabilities used in NUREG/CR-4551 and the values obtained and used in the IPE.

   (b) In some IPEs, the probability of induced SGTR increases as the RCP is restarted following the direction of procedures. Please discuss the probability of RCP operation and the effect of RCP operation on the probability of induced SGTR.

6. **Equipment Survivability** -- The evaluation of the general requirements for equipment survivability are discussed in the IPE submittal (p4-27 to p4-28). However, details are not provided. In NUREG-1335 it is stated that 'Documentation should be provided to support the availability and

survivability of systems and components with potentially significant impact on the CET or the radionuclide release.' Please discuss the equipment identified in the IPE as potentially having a significant effect on accident progression and discuss how its survivability under severe accident conditions is addressed in the Comanche Peak IPE.

7. **Ex-Vessel Debris Coolability** -- The probabilities of the formation of a coolable debris bed in the reactor cavity under various conditions are treated as basic events in the CET (i.e., BE PRCDB-LPSE, PRCDB-LPNS, and PRCDB-HP). The probability of basemat melt-through is determined by basic events PRMT1 and PRMT2. Please discuss the basis for the values for these basic events used in the CET quantification.

8. **Late Containment Failure** -- The following requested information pertains to the treatment of late containment failure:

   (a) In the fault trees for top event CFL (Late Containment Failure Occurs, Figures 4.5-15, 4.5-17, and 4.5-19), Event STM-FAIL (Steam Generation Fails Containment) requires the occurrence of both Event PRSTM-OCCUR (steam generation occurs) and Event DHR1 (insufficient decay heat removal). In the same fault trees, Event HR-INCONT (insufficient decay heat removal from containment) requires the occurrence of both Event DHR-ACT (decay heat rate exceeds active heat transfer to containment) and Event CDHR-PASS (decay heat rate exceeds passive heat transfer to containment). These events seem to indicate that steam may not be generated in sufficient quantity and passive heat sinks can prevent containment failure under certain conditions. Please discuss the definition of Event PRSTM-OCCUR and Event CDHR-PASS, the values used for these two basic events, and the basis for these values.

   (b) Please also discuss whether a mission time is used in the determination of the probability of late containment failure, and, if a mission time is not used, please discuss the effect the use of a mission time (e.g., 48 hours) would have on the probability of late containment failure.

9. **Isolation Failure** -- The following requested information pertains to the treatment of isolation failure:

   (a) In the Comanche Peak IPE, the probability of containment isolation failure is determined in the Level 1 analysis and not evaluated as part of the CET. However, an induced isolation failure, caused by the opening of the purge valves following the direction of the combustible gas control procedures, is included in the fault tree for the CET top events CFE (Early containment Failure Occurs). It is stated in the IPE submittal that "this issue was found negligible at CPSES," and detailed discussion is not provided in the submittal. Please provide more detailed discussion on this issue.

   (b) According to the CET, early containment failure is assumed not to occur, and thus not evaluated, if vessel failure is prevented.

Thus, induced containment isolation failure is not evaluated for cases in which core damage occurs but in-vessel recovery is successful. Since hydrogen is produced during the core damage state, combustible gas control procedures may be carried out and therefore induced isolation failure may occur even without vessel failure. Please discuss the probability of this release mode and the potential environmental release if it is not negligible.

10. **Responses to CPI Recommendations and Local Hydrogen Burns**-- The CPI recommendation for PWR dry containments is the evaluation of containment and equipment vulnerabilities to localized hydrogen combustion and the need for improvements (including accident management procedures). This issue is not specifically addressed in the IPE submittal.

    Please discuss whether plant walkdowns have been performed to determine the probable locations of hydrogen releases into the containment. Including the use of walkdowns, discuss the process used to assure that: (1) local deflagrations would not translate to detonations given an unfavorable nearby geometry, and (2) the containment boundary, including penetrations, would not be challenged by hydrogen burns.

    Please identity potential reactor hydrogen release points and vent paths. Estimates of compartment free volumes and vent path flow areas should also be provided. Please specifically address how this information is used in your assessment of hydrogen pocketing and detonation. Your discussion (including important assumptions) should cover the likelihood of local detonation and potentials for missile generation as a result of local detonation.

11. **Release Category Frequencies and Conditional Probabilities** -- In the IPE submittal, the 'absolute unconditional frequencies' and the 'relative conditional frequencies' for the release categories are provided in Tables 4.7-3 and 4.7-4, respectively. However, the values presented in these two tables are not consistent. For example, according to Table 4.7-3, Release Category VI has an absolute frequency of 2.03E-5. This is 76.03% of the total release frequency of 2.67E-5. However, the conditional frequency presented in Table 4.7-4 for this release category is 36.21%. Please clarify this inconsistency.

12. **Penetration Seal Failure** -- Regarding penetration seal failure the only information provided in the IPE submittal is in the Purge and Vent System isolation valve discussion (p4-102), where the following statement is made: "Figure 4.4-5 shows seal life as a function of time for various materials and temperatures. The materials used for pressure seals at CPSES are all silicone based. It is evident from the figure that significant purge leakage is not expected for the CPSES because silicone based seals show excellent temperature resistance (over 1000 hrs at 400°F)." Please list the seal materials for all the penetrations that are considered in the IPE for seal failure and discuss their property values.

13. **Containment Sumps** -- Table 4.1.2-2 of the IPE submittal shows that there are two containment sumps in the containment and Figure 4.1-1 shows an emergency sump. Please discuss how many sumps are in the Comanche Peak containment, their locations, and whether core debris can get into the sumps after vessel breach. Please also discuss whether there are drain lines and pump suction lines in the sump area and, if there are, the effect of core debris on the proper isolation of the drain lines and the proper operation of the suction lines.