TU ELECTRIC

Log # TXX-96495
File # 10010
10035 (GL-88-20)
Ref. # 10CFR50.54(f)

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October 24, 1996

U. S. Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555

Subject: COMANCHE PEAK STEAM ELECTRIC STATION (CPSES) - UNITS 1 AND 2
DOCKET NOS. 50-445 AND 50-446
RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION ON
CPSES INDIVIDUAL PLANT EXAMINATION FOR SEVERE ACCIDENT
VULNERABILITIES (IPE) (TAC NOS. M74397 AND M88982)

Ref:
1) NRC Generic Letter 88-20, "Individual Plant Examination For Severe Accident Vulnerabilities," dated November 23, 1988
2) NRC Generic Letter 88-20, Supplement 1, "Initiation of Individual Plant Examination For Severe Accident Vulnerabilities," dated August 29, 1989
3) TU Electric letter logged TXX-92387, from William J. Cahill, Jr., to the NRC, dated August 28, 1992
4) TU Electric letter logged TXX-92490, from William J. Cahill, Jr., to the NRC, dated October 30, 1992
5) NRC letter from Timothy J. Polich to C. Lance Terry, dated January 23, 1996
6) TU Electric letter logged TXX-96390, from C. L. Terry, to the NRC, dated June 14, 1996
7) NRC letter from Timothy J. Polich to C. Lance Terry, dated September 18, 1996

Gentlemen:

As requested by References 1 and 2, TU Electric submitted responses to NRC Generic Letter 88-20 via References 3 and 4. The NRC subsequently issued a Request for Additional Information (Reference 5) regarding TU Electric's responses (References 3 and 4). TU Electric submitted a response to Reference 5 via Reference 6. In Reference 7, the NRC staff provided to TU Electric a request for additional information.

The attachment to this letter provides responses to the NRC Request for Additional Information (Reference 7).

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Should you have any questions, please contact Carl Corbin at (817) 897-0121.

Sincerely,

C. L. Terry

By: D R Woodlan
D. R. Woodlan
Docket Licensing Manager

CBC\cc

Attachment

c - Mr. L. J. Callan, Region IV
Mr. J. I. Tapia, Region IV
Mr. T. J. Polich, NRR
Resident Inspector, CPSES

QUESTION 1a:

Many human actions were left at the screening values? What was the process/criteria for determining which human actions received detailed analysis?

RESPONSE:

The criterion used for determining which human actions received a detailed analysis was that of a potential for the accident sequence and its associated human action to be a significant risk contributor.

The determination of whether or not an accident sequence was a significant risk contributor was made using the results of the first and second rounds of preliminary quantification. The process of examination was to look at the contribution of a sequence to total Core Damage Frequency (CDF), and then review the associated human actions to decide if re-examination was required. The Fussell-Vesely importance measure was used as an additional measure. If the accident sequence was not risk-significant, the screening value for HEP was used. If it was risk significant, the human action was reviewed in more detail. This review was based primarily on expert judgement and on a limited number of simulator runs that were available.

QUESTION 1b:

A concern is that many human error probabilities (HEPs) in the dominant sequences were left at the screening values possibly causing them to be high in relation to the others where detailed analysis provided lower HEP values. How is it assured that leaving the HEPs at the screening values give the correct relative ordering of the sequences?

RESPONSE:

The screening methodology used for Type "A" and Type "C" Human Interactions (HIs) respectively was summarized in responses to HRA Questions #1 and #9 of the previous RAI.

In response to the HRA Question # 10, it was stated that one of the objectives of SHARP/SHARP 1 is "fine" screening which boils down to use of conservative but not overconservative values. "Use of the latter would raise the tail of the non-dominant sequences. Using unity as a screening value heavily increases the tail compared to use of either conservative or realistic values." Hence, use of "fine" screening minimizes distortions in the relative ordering of sequences which otherwise would have occurred had HEPs of 1.0 been assigned.

It should be pointed out that, once the re-evaluation was completed, the seqences were re-examined to see if some of the non-dominant sequences became dominant. If this was the case, the human actions were then re-evaluated again. In this way, the importance of order of the sequences

were retained. A large percentage of the HEPs in the dominant sequences were subjected to the detail evaluation, therefore, a concern should not exist.

QUESTION 2:

We noted several sequences containing multiple human actions that appear to have dependencies between these actions; yet it appears that dependence was not assumed or accounted for in the dominant sequences or cutsets. Describe the process used to assess dependencies within cutsets and give examples of how this was done using the cutsets provided in the submittal. Provide examples of those for which dependency was not assigned and describe the rational.

RESPONSE:

Please note TU Electric's response to the HRA Question #10 of the previous RAI (see attachment #1 to TXX-96390, page 61). It provided TU Electric's rationale for dealing with the issue of dependencies.

TU Electric is of the opinion that the topic of dependencies between human actions is quite complex and for which there is little or no adequate analysis method based on an experimental proof. This has lead TU Electric to adopt a conservative approach. In case of a noticeable dependency, TU Electric chose to set the subsequent dependent HEPs to 1.0. If, on the other hand, a dependency was judged to be weak use was made of conservative HEPs for the subsequent human actions. The basis for this evaluation was the experience of the TU Electric human reliability specialist with background in operations including the SRO license.

A review of the dominant sequences indicates that in practice there are only a few sequences with multiple dependent human actions. Mostly, the dominant sequences are made up of the initiating event, an equipment failure and a dynamic human action (see list of sequences in original submittal, pages 3-241 to 3-254). Associated with some of the equipment failures are latent human actions which occurred some time before an incident and are independent of the crew actions in response to the accident initiator.

A review of the sequences on pages 3-241 to 3-254 in the original submittal, shows the following:
(a) A number of sequences containing only one dynamic human action; (b) A number of sequences showing one latent human action and one dynamic action; (c) A number of cases, loss of electric power for example, in which there are some human actions, such as trying to start or recover diesels. The relevant procedure calls for two teams of auxiliary operators to be sent. This requirement lead TU Electric to conclude that the cognitive portion of the HEP is close to zero while the execution portion is independent; (d) This leaves a small number of cases in which there are multiple human actions. These were addressed on a case by case basis guided by the principles summarized in a

response to the HRA Question #10 of the previous RAI. A number of examples follow.

In case of the flood induced initiator (the third cutset on page 3-242), there are two human actions related to operation of the turbine driven auxiliary feedwater valves and loss of compressor supplying air to the unit. These were considered on closer review to be completely independent actions. Because of the loss of air, the feed flow has to be controlled locally and an auxiliary operator would be sent to undertake that operation. The supervisor would do this in response to the loss of control over feed flow from the Main Control Room. The supervisor's view is affected not so much from the loss of air, but the loss of control. Also, with alarms informing the crew of the loss of instrument air, the supervisor would send an auxiliary operator to attempt to start the compressor. The cause is the same but the diagnosis route is different.

Another case shown on page 3-243 is discussed in response to Question #5. Another example of multiple human actions is the case of loss of service water and component cooling (page 3-245). The operators fail to recover component cooling and subsequently fail to recover service water in two hours. It could be considered that these two actions are dependent, since if service water is lost then it affects component cooling. However, the indications of loss of component cooling and its consequences are different to loss of service water. The supervisor would respond to the direct effect indicated by increase in various temperature alarms and indications and then send staff to try to effect component cooling. Later, the cause would be identified and an attempt would be made to recover service water. The recovery of service water has to be within two hours, so there is also a time separation to reduce the dependency. This combination occurs in a number of scenarios (see page 3-250 of the IPE submittal).

In the case of a loss of offsite power with the failure of the diesels to operate; the supervisor would dispatch two teams of auxiliary operators to start (or restart) the diesels. This case was discussed above, but it should be pointed out that there are enough auxiliary operators to perform these tasks. These cases which feature more than one dynamic human action are seen on page 3-251, for example. These actions are failure to restart a diesel that has failed to run (seen from the control room) and one that has failed to start. Given the clear indications, the decision in the case of loss of offsite power to start both diesels is likely to be highly successful and therefore the actions to start the diesels are local independent actions. The other two examples include cases where there is no dependency as well as cases where there are dependencies.

An example of no dependency is an ATWS accident. The crews main focus is responding to reactivity issues. However, the turbine should also be tripped. These were considered to be independent. The rational being that the reactor operator and supervisor will focus on trying to insert rods into the core, whereas the balance of plant operator, seeing the

reactor trip is indicated, will trip the turbine and try to ensure the secondary side conditions are met, such as assuring that auxiliary feedwater is operational.

An example of dependency is scenarios in which secondary cooling is lost and could lead to a dependency between restoration of secondary cooling and the release of primary energy via the PORV, using Feed and Bleed. TU Electric took the opportunity to use the expertise of the instructors to estimate the effect of PORV operation in a number of scenarios. This meant that the estimated HEPs covered the effects of dependency. The values of the HEPs ranged from 0.003 to 1.0 depending on the actual context. So the approach to estimating the effects of dependency was to present the various situations to the instructors and ask them to evaluate the impact on the crews.

Of course, some of these scenarios could be more closely examined using the simulator. The crew could be faced with multiple failure scenarios and the actions taken by the crews could be observed and conclusions drawn as to their interactions. The next best approach is to rely on the insights of knowledgeable instructors.

QUESTION 3:

It appears that recovery/repair of failed systems was credited in many cases. Please provide an estimate of how the results would change (i.e., a sensitivity analysis) if this credit was not taken in the IPE.

RESPONSE:

TU Electric has made an estimate of how the results would change if all so-called NSAC Recovery values were set to 1.0. The effect on both, the internal event results and results including internal floods and Interfacing Systems LOCAs, was estimated. The increase in CDF for the two cases were found to be approximately 70% and 55% respectively. A closer examination of the results showed that the dominant sequences, namely, Loss of Off-site power and Internal flood still remained dominant. However, Loss of Off-site power contribution to overall CDF increases from 27% to approximately 50%. The second major contributor was flooding. However, its contribution dropped from about 20% to approximately 10%. All other initiators remained more or less in the same range of contribution (i.e., less then 10% for any single contributor).

The method used in the CPSES IPE HRA for the estimate of recovery actions relies on the best available data on the recovery of equipment (EPRI- NSAC Report 161, 1992). TU Electric believes that the data provided in the report is on the conservative side, since it refers to the repair and recovery process during normal operation. During emergency conditions one would expect that the staff would work faster and the requirements for return to service would be less stringent. The induced stress is expected to be motivating as experienced in a number of incidents such as Davis Besse.

It should be pointed out that the recoveries in the NSAC report were made up of two parts, one part is the ability of the operations staff to get the equipment working and the second covers those failures for which parts are not available to make the repair at the plant and have to be acquired from outside. The other EPRI report, on Modeling of Recovery Actions in PRAs EPRI RP 3206-03, 1992, would have indicated lower HEPs than those used in the CPSES IPE HRA.

The NSAC recoveries can be broken into two groups: (a) DG recoveries; and (b) Pump recoveries. For internal events (did not run results with flood and ISLOCAs) the 70% increase in CDF can be broken down to approximately 60% due to DG recoveries and 10% due to pump recoveries. The recovery from the initiating event (Loss of Off-site power) was based on restoration of off-site power given the condition of plant equipment (i.e.,the Diesel Generators (DGs) and Turbine Driven Auxiliary Feed Water (TDAFW) pump). The time allotted for restoration depends on whether the DGs/TDAFW pump failed to start or run, or whether there was additional time based on battery/accumulator depletion.

QUESTION 4:

Describe the general training provided for the new proceduralized actions implemented as a result of the IPE. Are operators explicitly trained on each of these actions and if not trained, describe the basis for the assignment of credit versus those for which training is provided?

RESPONSE:

During the normal course of training over several requalification cycles, the operators are exposed to multi-failure scenarios similar to those in the IPE that can be simulated within the training time limitations. Following these scenarios during the debriefing sessions, the instructors take the opportunity to discuss modifications to prodedures and their implications.

In addition, the Training department is developing objectives for training material which support the IPE assumptions and other IPE related issues.

QUESTION 5:

It appears that some HEPs were actually "correction or modifying factors" for other events. For example, "laterecirc" is apparently a correction to the HEP for switchover to recirc where time is available to complete the action. While this practice is not necessarily unreasonable, it is not clear how the modifying factor was determined. What is the criteria used for the assignment and magnitude of the modifying factors and which PSFs and dependencies were considered? Provide examples, describe this process and provide a list of events in

this category.

RESPONSE:

The Human Interaction (HI) with the basic event name &RCXX01, operating crew fails to realign CCPS, SIPS, and RHPS to recirculation (hot or cold), encompasses the process of taking the systems from cold leg injection to cold leg recirculation and if necessary from cold recirculation to hot leg recirculation. There are three systems involved: CVCS, SI and RHR. Inability to realign any system constitutes the failure.

The screening process yielded non-success probability of 1E-1. With this value, the event &RCXX01 was highest on the list of HIs being on a significant risk contributor roster. As such, it qualified for a detailed assessment which, in turn, employed the expert judgement method summarized in response to HRA Question #11 of the previous RAI. The outcome of this process was the value of 2E-03.

The training instructors, who served as the experts, took into account that the first portion of the task, which has some time constraints, is practiced frequently on the simulator and is addressed in great detail in the appropriate procedures. In addition, the task was deemed to be straightforward with no reluctance on the part of the operators to switch the pumps to recirculation as this act will ensure a continued source of water to the pumps. The time constraints are associated with the assumption that the containment spray pumps could be taking a suction from the Refueling Water Storage Tank (RWST) as well.

A further step was made to distinguish accident scenario specific effects, i.e. between excessive, large and medium LOCA's on one hand and small and very small LOCA's on the other. For the former, the value of 2E-3 was retained, while for the latter it was decided that the ample time factor (the injection phase lasts many hours) should be taken into account. The ample time (major PSF considered) permits the plant emergency organization to be fully staffed and the plant to be in a stabilized mode.

It was deemed that the credit should come in the form of a correction factor or a late recirculation factor. The magnitude of this factor, i.e. a factor of 0.1 was determined by the TU Electric principal HRA Analyst, a fully qualified Senior Reactor Operator (SRO), in full consultations with the plant operations staff familiar with responses to the emergencies.

TU Electric believes that it is more than reasonable to apply correction factors to HIs, whose content is essentially the same, but where ample time makes a clear distinction between one set of accident scenarios and another.

QUESTION 6:

In the licensee's response to previous RAI question 10, the treatment of dependencies is addressed on page 61. A set of rules addressing dependency between multiple human actions is provided. However, immediately following, on page 62, it is stated that "because of the nature of cutset sorting, sequences with multiple human actions (and equipment unavailabilities) quickly disappear from the list of sequences making noticeable contribution to the CDF." Does this statement imply that dependencies were only considered for sequences surviving screening? Please describe what dependencies were considered during quantification and how potential dependencies were numerically considered.

RESPONSE:

The point that TU Electric was trying to make previously was that the contribution of cutsets to the overall core damage frequency (CDF) quickly diminishes and, therefore, TU Electric did not consider it worthwhile to pursue any further sequences for which the dependent HIs were set to unity, beyond those cutsets which gave a large contribution to the CDF.

The answer to Question 2 indicated the approach for modifying the dependencies based on the detailed review of the situations, including staff assignments, Main Control Room indications, procedures and alarms. The HEPs were estimated by the TU Electric human reliability specialist based on discussions with plant staff experts.

QUESTION 7:

The value for failure of the operator to trip the RCP pump in 1 minute upon loss of cooling to the pump seals is not identified in the submittal. Was the HEP a guaranteed failure? If not, please provide the value used.

RESPONSE:

TU Electric postulated that the operators would fail to trip the Reactor Coolant pumps (RCPs) within one minute, as stated in ABN-101, "Reactor Coolant Pump Trip/Malfunction." Hence, the HEP was a guaranteed failure. This was considered to be a very conservative view, since the cause of conditions leading to a seal failure are likely to give clear indications of problems long before the need to trip the RCPs.

QUESTION 8:

Flooding of the Auxiliary Building from the RWST is a significant contributor to the core damage frequency for Comanche Peak. Is this flood capable of compromising both units through common building connections? If so, please address the frequency of core damage due to this dual unit event.

RESPONSE:

A flood induced from various pipes taking suction from RWST is a significant contributor to total CDF. More specifically, flood initiation zone AA011A2, which is located in the 790' elevation of the Auxiliary Building, is the only significant contributor. This flood could physically propagate to Unit 2 portion of Auxiliary Building and Unit 2 Safeguard Building due to the physical configuration of the buildings. However, the internal flooding analysis was performed based on individual flood zones. Each flood zone was separated based on the physical plant configuration, density of piping and possibility of flood propagation in each zone.

In response to the NRC staff question, an attempt was made to estimate the CDF due to dual unit flooding events. That is, the likelihood of an internal flooding event that could result in core damage on both units at the same time was estimated. The core damage frequency due to this dual unit event was estimated to be less than 5.0E-7 per year. This estimation was based on the assumption that the plant operators would not isolate/terminate the pipe break throughout the flooding event for flooding zone AA021A2 which was the only dominant contributor to total CDF due to flooding events.

QUESTION 9

In the submittal, the common cause parameter values were identified as assigned to a class of equipment such as "standby" or "operating". It is noted that the values provided for common cause failure of standby pumps to start were low relative (0.036) compared to fail to start values for HPI pumps (0.21) and RHR pumps (0.15) provided in NUREG/CR-4550. Similarly for diesel generators (0.014 in the submittal and 0.038 in NUREG/CR-4550). In the approach used, Comanche Peak has eliminated events from the data base judged not to be applicable to their plant. Has Comanche Peak performed a sensitivity analysis to determine if the core damage frequency is sensitive to the choice of common cause parameters due to the approach used and the uncertain character of common cause failure analysis?

RESPONSE:

No, CPSES did not perform any sensitivity analysis to determine whether or not the CDF is sensitive to different CCF parameters. However, in response to this question, a sensitivity calculation was done to estimate the change in the CDF due to higher CCF values. In this calculation, the mean CCF values were all replaced by the 95th percentile values which, in all cases, were higher than the mean values. In some cases, the new values were higher by one order of magnitude. As a result, the total CDF increased by less than 2%.

The common cause failure analysis in the CPSES IPE study was based on the PLG-0500 generic common cause failure database which has been

recognized as one of the most comprehensive and complete databases available. As mentioned in the study, the Multiple Greek Letter methodology was utilized for CCF analysis. The β and γ parameters were estimated and then placed at the component level in each system fault tree model. As a result, the total contribution of the CCF to each system unavailability was thoroughly examined and was estimated to be relatively significant. The overall contribution of the CCF events to total CDF was also found to be reasonable. The specific examples of the CCF contributions to the most dominant cutsets in the CPSES IPE study are:

- Page 3-241 of the CPSES IPE submittal:
  - EPXD66EE00NX, CCF of both diesel generators due to latent human error
  - EPCCFT, CCF of safety-related buses 1EA1 and 1EA2
- Page 3-247 of the CPSES IPE submittal, cutsets #2 and #4, and page 3-250 cutset #1:
  - EPCCFT, CCF of safety-related buses 1EA1 and 1EA2
- Page 3-252 of the CPSES IPE submittal, all five cutsets:
  - ESSSBCCF01C2, CCF of the reactor trip breaker
- Page 3-253 of the CPSES IPE submittal, cutset #1:
  - EPCCFT, CCF of safety-related buses 1EA1 and 1EA2

In addition, there are more CCF contributions in the remainder of the cutsets that were not included in the CPSES IPE study.

Consistent with the recommended industry guidelines, the generic CCF events were reviewed in order to include those CCF events that were applicable to CPSES. However, the final values of CCF parameters used in the CPSES IPE study were, in most cases, identical to the generic values. In some cases, they were even greater than the generic CCF values due to the adjustment in system size, and in a few cases, they were smaller than the generic CCF values. These values are presented under prior distribution and posterior distribution columns in Table 3.3.4.4 on pages 3-220 and 3-221 of the IPE submittal.