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Mike Barrett
Mail Code: EC08I

May 11, 1995

Ms. Stacey Rosenberg
Office of Nuclear Reactor Regulation
Mail Stop: O10E4
United States Nuclear Regulatory Commission
Washington D.C. 20555

Dear Stacey:

Attached are our responses to the comments on the Keowee Reliability Assessment you forwarded to us in your April 4, 1995, letter. The responses are in tabular format with the comment number identified in the left hand column.

Several of the comments identified oversights in the analysis or areas for improvement in the report. We have identified in the response where changes are to be incorporated. Many of the comments identified other approaches that could have been pursued in the course of the analysis. We recognize that various approaches to the analysis were possible, each with its own strengths and weaknesses. However, we find no compelling reason to change our approach to the analysis.

If you have any questions on our responses, please call me at (704) 382-6754 or e-mail at mjb1635@xsaa.dukepower.com.

Sincerely,

Mike Barrett

Michael J. Barrett
Senior Engineer
Severe Accident Analysis Section
Nuclear Engineering Division

Comment #	Duke Response
1	The Keowee failure probability reported in the base case analysis is a result that does not consider the effects of the specific initiator. However, the potential to lose the overhead power path for some LOOP initiating events is accounted for in the subsequent analysis that calculated the ac power reliability for Oconee. Further the Keowee reliability under the different events is readily discernible from the tables included. For an initiator that does not result in the loss of the overhead path, the Keowee failure probability is the result reported. For those events in which the overhead path is lost as a result of the initiator, the reliability of Keowee is the value for gate UNDER0 in table 7.5-1.
2	It is recognized that the failure probability of Keowee to supply power to Oconee is not a static value, but changes as the Keowee configuration changes. The same is true for a nuclear plant as systems are taken in and out of service or placed in different operating configurations. We have reported the average annual failure probability for Keowee, just as we report the average annual core melt frequency in the PRAs for the nuclear plants. We feel this is appropriate. We believe we obtain an understanding of the failure contributors to the various operating configurations of Keowee by solving for and reviewing the cut sets for various intermediate gates in our integrated fault tree. These gates are reported in Table 7.5-1 of the report. Cut set listings have not been included in the report for all of these gates, however, the cut sets have been captured in the solution process. The value for Keowee in standby in the comment, 97.6%, is not a value used anywhere in our analysis. Keowee is in standby when not in maintenance and not generating to the grid. All Keowee operating modes are considered in the model either directly or through a symmetrical configuration. The contribution to the annual average Keowee failure probability for infrequent operating conditions are not "artificially low". It is true that the conditional failure probability is higher in some configurations than it is in others. If an operating configuration is infrequent, regardless of whether that configuration has a high or low conditional failure probability, the contribution to the annual average failure probability must be weighted by the probability of that configuration. This is how nuclear plant system reliability models (e.g., auxiliary feedwater system) are produced solved and applied. The respective position of all ACBs have been correctly incorporated into the solution for the various operating configurations.
3	All reliability estimates are for the base case solution unless otherwise stated.
4	The boundaries considered in the analysis are described in Section 4.2 of the report. It is unnecessary to repeat all those words here.
* Check again 5	Failure of the RCPs to trip is most likely to result in a delay in the availability of the overhead path, rather than a failure of the path. We are continuing to investigate whether or not this could result in failure of the path.
6	Spurious actuation of the generator CO_2 system is included as a generator failure.
7	In the analysis' assumed configuration of Unit 1 aligned to the underground and unit 2 aligned to the overhead, ACBs 6 and 7 are closed and ACBs 5 and 8 are open for all

Comment #	Duke Response
7 (contd.)	conditions unless some failure occurs. Unit 2 (the overhead unit) supplies the 2X switchgear from the main step-up transformer (via ACB-6) whether the unit is generating to the grid or is in standby.
8	The generator ACB air system is not required for the immediate operation of the ACBs. Failure of the system could prevent re-positioning of ACBs 1 through 4 in the long term. This was not expected to be a major contributor to Keowee failure and the effort for a detailed model did not seem justified. The quantification of this event is discussed in Appendix A.4, Air Circuit Breakers.
9	By procedure the Keowee units are swapped between the overhead and underground alignments at least monthly. The time dependent failures are assumed to occur midway between challenges. Therefore, those components challenged by the monthly swap and test are assigned an exposure time of 15 days. The unit aligned to the overhead path is available for generation to the Duke system. The operational data indicates that the unit is started frequently. Often 2 or more times per day as well as seeing some periods of several days between starts. We consider 24 hours to be a reasonable estimate of the time between starts, recognizing that this underestimates the exposure in some situations and overestimates the exposure for others.
10	The Keowee PRA does not model a "fixed" configuration. One Keowee is aligned to the underground path and one is aligned to the overhead path. The designation of Unit 1 to the underground and Unit 2 to the overhead is a modeling convenience that has no bearing on the final result. Various operating modes (maintenance and generation) are included in the model. Failure probabilities for various operating conditions are calculated in the tree and these failure probabilities are conditioned by the probability of being in the configuration.
They should cite this in the text 11	The Keowee auxiliary ac power model (refer to appendix A.8) models the CX supply back to the Oconee 1 main feeder buses. The circular logic was broken by providing a failure probability for loss of power on the main feeder buses due to the hardware failures within the Oconee plant.
12	The rule file simply identifies which recovery to apply to a particular failure. Is this an adequate response?
13	The LER will be included in the list of references.
14	When peaking power is required, one or both units may placed into service. Peaking power is required on a frequent basis. As a simple example, if each unit was run for 45 minutes every day at 5 pm they would be started every 24 hours and run ~3% of the time.
15	The review of the Jocassee operating data identified no new failure modes that might have been required in the Keowee analysis.
16	Duke has restricted Keowee to the use of one generator since October 1992.
17	We disagree. We believe that the emergency and normal starts are so similar that it is appropriate to consider all starts in the data.
18	The number of hot starts was subtracted from the number of all starts on Unit 1 and Unit 2 in estimating the governor and turbine cold start failures. (App. A.10)
19	The start data provided as a follow-up to the PRA report used a different source for counting the start demands. In the 1989 time frame some maintenance surveillance tests were not included in this record. The data source for the Keowee PRA used a computer point which counts all starts of the unit and is a more complete record. By 1993 the

Comment #	Duke Response
19 (contd.)	maintenance starts are also included in the log book and the data in the follow-up tables are consistent with the start data for the PRA.
20	Not all component failure rates in the PRA are Bayesian updated. Those failure events included in the model as DEX events are based on plant specific information only. The 1 failure in twice the demands calculations have only been used on components where Bayesian updating is not being applied. When Bayesian updating generic failure rates, zero failures is input into the updating process. An alternative method for calculating these failure rates has been identified and is to be used in the final report calculations. This method is taken from EPRI, NP-6780-L, Rev. 4 Vol. 2, App. A, PRA Key Assumptions And Groundrules, April, 1992. A chi-squared distribution is used and for the median failure probability produces a result of 0.455/2T when no failures have been observed.
21 Make sure they change this in final report	The report states: "As seen from this table, most of the plant-specific failure rates are lower than their generic counter parts." This is not intended to imply " plant-specific failure rates are substantially lower than the generic failure rates". In most cases the plant-specific failure rates are not substantially lower than the generic values, while in a few cases the results are quite different. Only a small number of components show a significant difference, therefore, when the entire component population is considered the results are considered to be comparable.
22	The column heading will be corrected.
23	The method for the Bayesian updating is the same algorithm that has been employed in the EPRI Component Reliability Parameter System (CRPS). The results of our spreadsheet used for the updating calculations has been compared to the CRPS and the results are the same. The CRPS software is available from EPRI TR-103514, Maintenance Effectiveness Evaluation Database Tools. The technique employed in the CRPS (and our spreadsheet) is a simplified approach that assumes that the distribution can be represented as lognormal. The generic distribution is converted to a gamma or beta prior distribution. The plant specific information is incorporated and the resulting distribution is converted back to a lognormal. For the case of no plant specific failures the algorithm produces a new variance that is related to the old variance by the square of the ratio of the new mean to the old mean, however, the error factor remains unchanged.
24	Each component was considered individually for determination of the appropriate number of demands or hours to be applied in the plant specific failure rate calculation.
25 Check on this in final report	In the draft report there are 10 "PCB-x Fails To Open" (CHO type code) events and 2 "PCB-x Fails To Close "(CHC type code) events. Therefore, the number of demands considered in the fails to open mode was 5 times more than the fail to close mode. However, a more appropriate method of data collection would be to treat all of the PCBs in the model as a single population and include open and close data on all of them. This will be done for the final report.
26	The value printed in Table 5.3-1 is incorrect. The value presented in Table A.2-5 is the correct value and is the value in the database used during the solution process.
27	The "random failure probability" refers to the independent failure probability for the analyzed component. For some of the Keowee components, the independent failure probability is a single value that represents the potential failure of any sub-part or piece of the component. An example would be the WL Flow Control Valves whose individual failures to open on demand are represented by event FK1WL11AVO and FK2WL11AVO. The probability of CCF of these valves to open on demand is simply

Comment #	Duke Response
27 (contd.)	Beta times the probability of the AVO type code. However, due to the detailed level of component modeling performed for the Keowee PRA, other components (such as the ACBs or excitation breakers) do not have a single basic event which represents all failure causes for the component. In this case, the independent failure probability used to calculate the common cause basic event probability is found by solving the system fault tree at an intermediate gate. An example would be gate FLDCLOSE2 ("Unit 2 Field Breaker Fails to Close"). Solving the logic at this intermediate gate (excluding all transfers) produces a list of failure events whose sum represents the failure probability of the breaker as a whole. The common cause basic event is then found by multiplying this gate probability by the common cause multiplier.
28	Daily system generation with the Keowee overhead unit reduces the time that multiple components (and thus both units) could be in a failed state simultaneously. This strategy, which could be referred to as "Frequent Testing," does not prevent the sources of common cause failure, but reduces the chance that both units would be in a failed state when an emergency demand occurred. Similar to a staggered testing strategy, the "frequent testing" strategy does not require that both units be tested in order to achieve a reduction in exposure time to common cause failure modes. Credit for this defense was only applied to system components that are fully challenged during normal operation. The sensitivity study using generic data (Section 5.3 and 7.5.1) used the same MGL parameters as used for the base case common cause probabilities. However, the generic component failure rates were substituted for the Bayesian updated independent failure rates to show the effect of using the generic data source.
29 I don't know about this Get this NUREG for Honeycutt	In addition to Section 5.4, further discussion of generic MGL parameters was provided in Appendix C.2 (Section C.2.2.5.2). Because common cause data was not available for many of the Keowee systems and components, it was necessary to estimate their common cause parameters based on engineering judgment. A set of generic MGL parameters was taken from NUREG/CR-5801 and provided in Table C.2-6. These parameter values are considered to be conservative but reasonable estimates for generic or "average" components. However, as a result of the qualitative common cause analysis of the Keowee plant, several important defensive mechanisms were identified which are believed to make certain Keowee systems and components "better defended" against common cause failures than "average" components. As discussed above in the response to Comment #28, the frequent use of the Keowee overhead unit for system generation provides a strong defense against common cause failure for systems which are fully challenged or demanded during a normal start. The additional design margin provided for higher system generating loads is another important defense mechanism for the generator and generator cooling water systems. To account for this qualitative difference, the "Beta-factors" from Table C.2-6 were multiplied by 0.5 and the resulting set of modified MGL parameters were placed into Table C.2-7. The general basis for the 0.5 value is NUREG/CR-5801 Section 5.5.1.4.1. In this section for Impact Vector Analysis, the author describes a process to account for qualitative differences between a "target system" and an "average system."

Comment #	Duke Response
29 (contd.)	The author suggests an applicability factor of 0.1 for cases where the strength of target plant defenses are superior to an average plant and 0.5 for cases where the strength is only moderately better. Since these applicability factors were intended for analysis of specific common cause event reports, it is not possible to apply a low applicability factor to all generic causes. However, a more modest 0.5 applicability factor is assumed for these "well defended" systems being at least moderately better than an average plant. This assumption is equivalent to assuming that 1/2 of the "generic" CCF causes either do not apply to Keowee or would have been detected prior to an emergency demand. A quick sensitivity study was performed to examine the effect of this assumption. By "doubling" the event probabilities which used Table C.2-7, the new results showed an increase in overall Keowee unavailability of less than 2 percent.
30	The purpose of this sensitivity study was to compare results for the component-level modeling approach with a system-level common cause analysis approach. For the system-level approach the independent failure rate was the overall start and run reliability experience over the ten year data period. The start failure probability (0.0045) from Figure 7.2-2 and run failure probability (0.012) from Table 7.2-6 were multiplied by system-level "Beta-factors." For the case of generic Beta-factors, a value of 0.1 was used for the CCF to start probability and 0.05 used for the CCF to run probability. For the Keowee specific Beta-factors, the actual common-cause events which appeared in the operating history were analyzed using CCDAT to calculate run and start Beta-factors for the Keowee units. The value for the Beta-factor for failure to start was calculated to be 0.009 and the value for the run common cause failure was 0.246. Comparing the results of the Keowee specific Beta-factor with the sum of the unrecovered common cause basic event cut sets shows good agreement between the component-level and system-level modeling approaches. Comparing the Generic Beta-factor results with the other approaches illustrates the value of performing a plant-specific common cause data analysis. As seen in Table 5.4-1, using Keowee specific common cause data does make an important impact on the common cause results.
31	The number of demands was not adjusted in all cases. This oversight will be corrected in the final report.
32	Event AB61432LHE, "Manual/Auto Switch 143/2 Left in Manual" is evaluated as not being tested functionally, but being checked daily. This switch is functionally tested during test OP/0/A/2000/049, Keowee Hydro Station Auxiliary Power Transfer Test, however, one of the last steps in the test is to place the switch in auto. A swap of breakers is not observed after this last repositioning, therefore, no credit was taken for the functional test in the human error quantification. This switch is checked on the Keowee Shift Turnover and Rounds sheet (OP/0/A/2000/43). This check consists of a step to "Verify Auxiliaries Auto/Manual Transfer Switches are in AUTO" followed by an initialing of this step in the procedure.

Check on this w/mike

Check this in final report

Comment #	Duke Response
33	We continue to feel that the overall reliability number provided is the most appropriate method for reporting the Keowee reliability. Insights into the performance of Keowee for various initiators is available from results of the intermediate gates. See the response to question 1. Table 7.3-2 presents information on the influence of various events on the ac power failure probability, including the three types of LOOP events.
34	The SSF is self sufficient in its support systems. There is no dependency on the unit related systems. SSF support system failures are considered, explicitly as seen in the cut set results.
35	This statement is correct in its reference to the reliability of the back-up emergency power source (CT5). Starting Lee and energizing the CT5 precludes the Lee start failure mode, thus improving the reliability of this back-up supply.
36 A Honeycutt todo this we need to compare ours to theirs	The long exposure time for the underground unit does make the start and run failure probabilities for the generator and its support systems higher than they are for the overhead unit which has a much shorter exposure time. The extra actions required to establish the overhead path, ACB and PCB operations, make that path less reliable than the essentially passive underground path. The net effect of these two situations leads to the failure probabilities for the two pathways to be similar when the impact of the overhead maintenance is ignored. The sensitivity of the results to a generic database (including circuit breakers and relays) is included in the report. Table 7.5-1
37	We would not characterize a 0.058 failure probability as more reliable than a 0.059 failure probability. They are essentially the same. The explanation for the similarity is given in the response to question 36.
38	All importance measures are based on the base case model. As has been pointed out the overall results are dominated by the standby mode as this is the most prevalent situation. The underground unit results are similar.
39	No list is provided. Figure 7.2-1 shows the most important failure events.
40	The failure of Lee to provide power has contributions from the human errors to close breakers, and Lee start or run failures as appropriate. The historical start and run data for the three unit Lee steam station are consistent with the reliability values applied in this analysis. We believe the current values for the Lee events are appropriate.
41 ?	In order to evaluate the probability of a loss of emergency power at Oconee for the two maintenance cases, the Risk Achievement Worth (Ach Wrth in the table) is the importance measure that is meaningful. In is seen in Table 7.3-2 that the RAW for the two unit maintenance event is about a factor of 7 higher than the single unit event. Thus with both units in maintenance the conditional probability of losing all ac power is about 7 times higher than when one unit is in maintenance.
42	The composition of these sources/paths will be better described.
43	What is intended with this statement is that the more the gate is dominated by the DEX events, which are plant specific data only, the less the impact when the generic data is used. This is because the values of the DEX events do not change when the generic and Bayesian updated databases are interchanged.
44	ACB2 should open as a means to separate Keowee from the yellow bus. However, PCB9 performs a redundant function by opening as well. The failure of both is required in order to generate an overhead path failure. These cut sets don't exist in the solution

do?

both are required for yellow bus isolation for the isolation to be complete → Talk to Mike about this

Resolved under comm #2

Comment #	Duke Response
44 (contd.)	but are too small to make the table.
45 Ask them to mention this in their PRA	No statistical data has been collected to verify that the grid-cycled unit is more reliable than the standby unit. The analysis indicates that the shorter exposure times for the grid-cycled unit make the generator start and run failure probabilities smaller. The analysis does indicate that a unit generating to the grid at the time a start signal is received has a slightly higher failure probability to provide power to Oconee than a unit in standby for equivalent exposure times. This is due to the breaker operations required.
46 We need to mention this in our report under the phrases grid & generation	The start failure is dominated by the excitation system, including failures of the excitation breakers. Other breakers, such as the generator output breakers, do contribute but their role is small compared to that of the excitation system components. Considering that there are three excitation breakers to maneuver on the cold starts and only one output breaker this seems to make sense. The slightly smaller failure probability observed for the hot start condition is largely do to the fact that the excitation system breakers are already in the required positions.
47	Our analysis indicates that a unit that is used for regular grid generation is more reliable than a unit that is in standby and started less frequently. The SCIENTECH conclusion, page A-12, that "A hot start ... relies on circuit breakers more than a cold start does." is not correct. The cold start requires that all three excitation breakers move to the desired position, the hot start places no such demand on these breakers. The qualifiers recognize the reality that the overhead unit is not run every single day. Overall, we consider the assumption of 24 hours between demands reasonable since on many occasions the unit is started 2 or more times in a single day. In these cases the assumption of a 24 hour exposure is conservative.
48	The potential for a fault on one unit to impact another should be negligibly small. Failure of the standby bus is explicitly modelled irrespective of the source of the fault (within the standby bus or an unisolated fault from an interconnected bus). Failure of a switchgear on another unit would fail the standby bus only if the protective relaying failed to isolate the fault. Since the fault rate for the switchgear is the same as for the standby bus, the contribution from another unit would be the same bus failure rate times the probability of failure of the protective relaying. This would be negligible compared to the standby bus failure rate.
49	Redundant portions of the logic are tested independently.
50	We believe the update method selected gives appropriate results for the new failure rate. See response to question 23.
51	See attachment.
52	We continue to believe that the use of nuclear plant reliability data for the generic database is a reasonable selection and provides appropriate data for use in this analysis.

Attachment

Responses to the Comments on the HRA part of the Keowee PRA Study

The Appendix C comments have been paraphrased here.

Comment:

Please clarify if any data obtained from the review was used in the process of quantification of human error probabilities.

Particularly, Keowee-specific data for latent human errors such as FK1GBHXLHE (see Table 7.2-4) and EK2BASELHE (see Table 7.2-5) which are among the top five significant contributions to the unreliability of the underground and overhead units, respectively, are essential for their quantification.

Response

Only a limited amount of Keowee experience was found that corresponded to the type of events modelled for the Keowee Reliability Assessment Human Reliability Analysis. This experience is described in section C.3.3.2 of Appendix C of the Keowee human reliability assessment.

Events EK1BASELHE and EK2BASELHE which model the Keowee voltage regulator base adjust being left in an incorrect setting are represented by one actual occurrence of this type which was discovered in the review of Keowee operational history. The modelling of these events in the fault trees is based on this operational history, however, the quantification of these events is not based on operational history. Because of the infrequent opportunity for these events, there is not an extensive history of demands with successes or errors upon which to quantify them. Instead, these events were quantified based on defenses (such as procedures and independent verification) using the same model as was used for the other latent human error events.

It should be noted that changes to Keowee setpoint documentation should make the reoccurrence of an incorrect voltage regulator base adjust setting less likely.

The Keowee operational history is also represented by the modelling of errors of commission for a sensitivity study to examine the effects of post-1992 modifications to Keowee.

Other than the events mentioned above, no events were discovered in the review of Keowee operational history which resemble human error events modelled in the Keowee reliability assessment.

Additionally, it is noted that event FK1GBHXLHE is being removed from Rev. 1 of the Keowee Reliability Assessment. This component has been determined to not be required for successful operation of the unit, and has been deleted from the model.

Comment:

In the process of quantification of the latent human errors for Unit 1 and Unit 2, sometimes credit is given to operability tests for Unit 2. This assumption is not consistently applied to all latent human errors.

Response

That is true. No credit for an operability test is applied to equipment associated with Unit 2 that is not challenged during the daily grid generation function.

Comment:

Because there is no established procedure for the voltage regulator base adjust setting (modeled by events EK1BASELHE and EK2BASELHE) it is questionable that these events should have been quantified using credit for proceduralized action. Furthermore, the quantification numbers assume training on the use of procedures. Because a special procedure would be written for the base adjustment the justification for assuming that they are trained on is not clear.

Response:

The adjustment of the Keowee voltage regulator base adjust setting was described by Keowee personnel as a one time operation. Thus, there is no standing procedure to perform this. However, the interview with Keowee personnel also indicated that if this evolution were performed, a procedure to perform it would be written. It seems reasonable to expect that the personnel performing this task would be trained on the procedure they were using.

As noted above in the response to the first comment, the missetting of the voltage regulator base adjust led to improved documentation at Keowee that would make the reoccurrence of this event less likely.

Comment:

Did the HRA team consider the time sensitivity of all the recovery actions molded in the Keowee PRA? In particular, what are the time available and the time taken to identify and execute the recovery actions ABEOPRCREC and ABPOPRCREC?

For recovery actions FK0FISHREC and GK0BRGVREC it is stated that there is ample time available to complete the actions. What are the available times and response times for these recovery actions.

Response:

The HRA team did consider the time sensitivity of all human reliability actions, however, actions which were quantified using the decision tree model in EPRI-TR-100259 were not judged to be "time critical".

The Duke Severe Accident Analysis group typically assumes that there are 90 minutes available for restoration of power via events such as ABEOPRCREC and ABPOPRCREC. This is based on time to avoid core damage (given such factors as steam generator boil-off).

These events are well proceduralized as (as described in Appendix C of the Keowee Reliability Assessment). They were not judged to be time critical.

Events for restoring cooling water (FK0FISHREC and GK0BRGVREC) were not judged to be time critical. The interview with the Keowee on call operator indicated that these events were not time critical. Additionally, experience in previous PRAs (McGuire and Catawba) indicates that loss of cooling water source events are, for the most part, not time critical.

Event FKOFISHSREC is a recovery of the main WL strainer clogging. Normally, the low flow trip on this system would take 15 minutes to occur (this trip is bypassed on an emergency start). During emergency operation, the load on the Keowee generators is reduced such that the overhead unit is loaded to about 25% and the underground is loaded to 9%. Because of this light load, it is estimated that heat load on the cooling system is also reduced and cooling water flow is not an immediate concern.

This action is judged to require additional personnel who are expected to arrive at Keowee in 10 to 15 minutes. As described in the Keowee Reliability Assessment (Appendix C) the initial swap of the cooling water strainer is a proceduralized response to the Generator Cooler Water Flow alarm (1SA2/28). This event is also discussed in the response to comments below.

Event GK0BRGVREC is a recovery of cooling to the Keowee generator thrust bearing. This action is also not judged to be time critical. The discussion above for event FKOFISHREC also applies to this event except that it is recognized that running Keowee lightly loaded may put additional stress on the generator bearings (this is described in Appendix C of the Keowee reliability assessment). Normally, generator bearings are a relatively small part of the Keowee cooling water system heat load. It is judged based on operator interviews that the additional stress on the bearings during an emergency start would not make the recovery of cooling flow time critical.

When asked to rank all of the Keowee Reliability Assessment recoveries from most likely to be accomplished to least likely to be accomplished, the Keowee operator interviewed ranked the recovery of individual cooling water paths as most likely and the recovery of the main cooling water path as second most likely. This result adds confidence that these actions are not time critical and are not quantified with values that are too low.

Comment:

The action phase was assumed to be a negligible contributor for events which were performed in the control room. Did the HRA team consider the validity of this assumption for all the control room based recovery actions modeled in the Keowee PRA? In particular, the 9.00E-03 estimate for recovery actions ABEOPRCREC and ABPOPRCREC seem to be low. Are these events simple, proceduralized, and well trained on by the control room operators?

Response:

Action ABEOPRCREC is a failure to close the overhead aligned breaker to the overhead unit from Keowee. This event is simple, proceduralized (in AP/0/A/2000/002) and well trained on. The particular features of checking indications and communication associated with this event are considered in the quantification using EPRI-TR-100259 decision trees.

Action ABPOPRCREC is a failure to close the underground breaker to the overhead unit from the Oconee control room if this is the only way to restore power to the Oconee main feeder bus. As described in Appendix C of the Keowee Reliability assessment, this action requires recognition that CT-4 is not energized and communication with Keowee to transfer breaker control to Oconee. All of the appropriate cautions and communications for this actions are proceduralized in the Oconee loss of power procedure (AP/1/A/1700/11). This action is therefore judged to be simple, proceduralized and well trained on. The particular features (such as communication and reading of indications) associated with this event are considered in the quantification using EPRI-TR-100259 decision trees.

Comment:

A single value of 0.05 has been used for the action phase of the recovery actions to be performed from outside the control room. This value can be an underestimate depending on the nature of the task to be performed. the overall HEP for the action phase depends on the number of actions to be performed, their complexity, the quality of the procedure (if any), and the level of practice/training of the personnel. For complex recovery actions, human reliability event trees (NUREG/CR-1278 and NUREG/CR-4772) or human reliability fault trees (EPRI-TR-100259) are usually used to model the action phase.

Are all the modeled recovery actions simple from the execution point of view, proceduralized, and trained on so that a single value of 0.005 can be used in every case? Please justify the rationale behind using 0.005 for the recovery action FK0FISHREC.

Response:

Some of the actions which were judged to be not so well proceduralized, practiced or simple from an execution point of view were assigned higher values based on engineering judgment. This is described in the Keowee PRA Appendix C (see events AB0SWGRREC, XD0KBATREC and Y0STARTREC).

The remaining actions are judged to be better proceduralized and better understood. It is noted that, for most events the decision trees of EPRI-TR-100259 were used in addition to the 0.05 number for the action phase. These decision trees account for some aspects of the action such as communication and misinterpretation of procedures.

In the particular case of FK0FISHREC (recovery of the main cooling water strainer) the initial swap of cooling water strainer is proceduralized. However, this event is assumed to involve multiple swaps of the strainer and cleaning of the strainer baskets. The Keowee operator is assumed to be familiar with Keowee maintenance, and thus with the procedure to clean the strainers. The overall value of 6.3E-02 assigned to the event is justified based an interview with the Keowee on call operator who stated that there was ample time for this event and that it was reliable (as discussed in the responses above and in the description for this event in Appendix C of the Keowee reliability analysis). Thus the value of 0.05 for the action phase is also justified.