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2-050-04

Director of Nuclear Reactor Regulation
ATTN: Mr. R. W. Reid, Chief
Operating Reactor Branch #4
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

SUBJECT: Arkansas Nuclear One - Unit 2
Docket No. 50-368
License No. NPF-6
CPC/CEAC Software Modifications
(File: 2-1510)

Gentlemen:

Our letter of January 31, 1980, (Mr. D. C. Trimble to Mr. R. W. Reid) transmitted a description of the proposed MOD 2B/3 revision to the CPC Software. Fifteen individual software modifications or changes that comprise the MOD 2B/3 revision were described in the attachment to that letter. The MOD 2B/3 revision to the CPC system software is intended to improve the ANO-2 unit availability by reducing the probability of unnecessary trips without affecting the ability of the CPC system to perform its design basis function. Additionally, the revision is intended to improve the overall operation of the CPC/CEAC system by enhancing the processing logic and adding additional diagnostic capability. However, three months after submittal of that information, we are still awaiting a response and/or comments from the staff.

At this time our internal review and safety evaluation of the MOD 2B/3 revision with respect to 10 CFR 50.59 is complete and we have determined that the revision does not constitute an unreviewed safety question. Attachment 1 provides our justification of that conclusion for each of the fifteen modifications.

Whereas we have concluded that there is no unreviewed safety question involved with the software changes, and that we have received no comments

from the Commission, we are therefore informing you that the MOD 2B/3 revision to the CPC software will be implemented at ANO-2 on May 17, 1980.

Very truly yours,

David C. Trimble

David C. Trimble
Manager, Licensing

DCT/WBM/lp

Attachment

ATTACHMENT 1

SAFETY EVALUATION OF CPC MOD 2B/3 SOFTWARE CHANGES

A. General Safety Evaluation

10CFR50.59 Section (A) (1) states:

> "The holder of a license authorizing operation of a production or utilization facility may (i) make changes in the facility as described in the safety analysis report, (ii) make changes in the procedures as described in the safety analysis report, and (iii) conduct tests or experiments not described in the safety analysis report, without prior Commission approval, unless the proposed change, test or experiment involves a change in the technical specifications incorporated in the license or an unreviewed safety question."

The MOD 2B/3 software modifications will not require changes in the ANO-2 Technical Specifications. However, the MOD 3 portion does allow a Technical Specification change to the PPS low steam generator level trip setpoint. Therefore, the following discussion is limited to an evaluation of the software modifications with respect to whether or not they constitute an unreviewed safety question.

The CPC/CEAC System provides low DNBR and High Local Power Density trips to (1) assure that the specified acceptable fuel design limits on departure from nucleate boiling and centerline fuel melting are not exceeded during Anticipated Operational Occurrences (AOO s), and (2) assist the Engineered Safety Features System in limiting the consequences of certain postulated accidents. The AOO s and accidents used to define current CPC/CEAC design requirements are listed below:

ANTICIPATED OPERATIONAL OCCURRENCES

A. Uncontrolled Axial Xenon Oscillations
B. Insertion or Withdrawal of Full-Length or Part-Length CEA Groups
C. Insertion or Withdrawal of Full-Length CEA Subgroups
D. Insertion or Withdrawal of Single Full-Length or Part-Length CEA's
E. Excess Heat Removal Due to Secondary System Malfunctions
F. Loss of Forced Reactor Coolant Flow
G. Inadvertent Depressurization
H. Decrease in Heat Transfer Capability Between the Secondary and Reactor Coolant Systems
I. Complete Loss of AC Power to Station Auxiliaries
J. Uncontrolled Boron Dilution

POSTULATED ACCIDENTS

A. Reactor Coolant Pump Shaft Seizure
B. Steam Generator Tube Rupture

All software modifications made to the ANO-2 CPC/CEAC software will be quality assured to insure that the design bases and design requirements of the original software are not adversely impacted.

Section (A)(2) of 10CFR50.59 states:

> "A proposed change, test, or experiment shall be deemed to involve an unreviewed safety question (i) if the probability of occurrence or the consequences of an accident or malfunction of equipment important to safety previously evaluated in the safety analysis report may be increased; or (ii) if a possibility for an accident or malfunction of a different type than any evaluated previously in the safety analysis report may be created; or (iii) if the margin of safety as defined in the basis for any technical specification is reduced."

This paragraph may be summarized as follows: A change involves an unreviewed safety question if:

(1) the probability of occurrence of an accident previously evaluated is increased,

(2) the consequences of an accident previously evaluated are increased,

(3) the probability of occurrence of malfunction of equipment important to safety is increased,

(4) the consequences of malfunction of equipment important to safety is increased,

(5) the possibility for an accident of a different type than any evaluated previously may be created,

(6) the possibility for malfunction of equipment important to safety of a different type than any evaluated previously may be created, or

(7) the margin of safety as defined in the basis for any technical specifications is reduced.

Items (1) and (5) are not affected by any software modification to the CPC/CEAC System. The safety system responds to accidents but does not initiate them.

With respect to items (2), (3), (4), and (6), the only malfunction that could occur due to a software modification (and therefore increase the consequences of an accident) would be if the CPC/CEAC System did not produce a trip signal when required for the AOO's and accidents listed previously. All software modifications will be designed, reviewed, and quality assured with respect to the same design bases and design requirements as the original software, so that the modified system will have the same confidence level as the initial system in the performance of its intended function. Since the confidence level in the modified system is maintained equal to that of the initial system, items (2), (3), (4) and (6) do not result in a unreviewed safety question. The quality of the modified software is maintained by adherence to the Software Change Procedure CEN-39(A), Rev. 2.

The third portion of 10CFR50.59 Section (A)(2), i.e., Item 7, requries that there be no reduction in the margin of safety as defined in the basis for any technical specification. The bases portion of the ANO-2

Technical Specifications state that the Core Protection Calculators will provide a Low DNBR trip at 1.3 and a High Local Power Density trip at 20.3, thus assuring that the specified acceptable fuel design limits will not be violated during normal operation and anticipated operational occurrences and that the CPC's will assist the Engineered Safety Features Actuation System in limiting the consequences of accidents. Maintenance of the specified acceptable fuel design limits (SAFDLs) provides a high confidence level that fuel damage will not occur. The margin of safety provided by the SAFDLs is maintained with the CPC/CEAC software modifications. Since the SAFDLs are not changed and since the CPC/CEAC System is qualified to assure that these limits are not violated, the margin of safety is not reduced.

The NRC Staff provided additional bases with respect to the Core Protection Calculators and margin to safety. Section B.2.2.1 of the ANO-2 Technical Specifications states:

> "To maintain the margins of safety assumed in the safety analyses, the calculations of the trip variables for the DNBR - Low and Local Power Density - High trips include the measurement, calculational and processor uncertainties and dynamic allowances as defined in CEN-44(A)P, "Core Protection Calculator Functional Description," January 7, 1977, Supplement 1P, May 13, 1977, Supplement 2P, May 19, 1977, Supplement 3P, September 2, 1977; CEN-45(A)P, "Control Element Assembly Calculator Functional Description," January 7, 1977; CEN-53(A)P, "ANO-2 Cycle 1 CPC and CEAC Data Base Document," May 20, 1977, Amendment 1P, June 28, 1977, Supplement 2P, September 2, 1977."

This section of the ANO-2 Technical Specifications states that the margins of safety (assumed in the safety analysis) are maintained by the inclusion of measurement, calculational and processor uncertainties and dynamic allowances that are defined by the CPC Functional Description, CEAC Functional Description, and the CPC/CEAC Data Base. The CPC/CEAC Functional Descriptions and Data Base Document do not explicity define the aforementioned uncertainties and allowances. In fact, many of the uncertainties and allowances are components of addressable constants whose values may change depending on plant tests and measurements. The changing of such constants in accordance with approved procedures does not reduce the margin of safety but rather assures it is maintained.

The most meaningful interpretation of Technical Specification bases Section B.2.2.1 is that the measurement, calculational and processor uncertainties, and dynamic allowances must be developed and included in the system design consistent with the implemented hardware/software system. The proposed software modifications will affect these uncertainty components in the following manner:

i. Measurement uncertainties are the effect on the CPC response due to sensor and measurement channel characteristics. The proposed software modifications do not impact the sensor and associated hardware; therefore, the measurement uncertainty will not change.

ii. The calculational uncertainties (algorithm modeling and algorithm constants) address the accuracy with which the "static" CPC algorithms replicate the results of "best estimate" measurements and/or calculations, and the accuracy of the measurements and/or calculations used in obtaining the constants employed by the "static" CPC algorithms. These algorithms are core average power, core mass flow rate, hot pin and hot channel power distribution, local power density calculation and static DNBR. The proposed software modifications do not increase the uncertainties associated with these calculations; therefore, the calculational uncertainties will not change.

iii. The processing uncertainty addresses the effect of scaling, round-off, and bit manipulation of the CPC computer results. Any software modification will, in all probability, change the value of processing uncertainity. However, the new value of processing uncertainty is determined during Input Sweep Testing and is factored into the appropriate terms in the data base such that there will be no decrease in the margin to safety.

iv. The dynamic allowances are applied to the results of the dynamic algorithms and constants. The proposed software modifications do not require change to the original dynamic allowances.

Based on the facts, item (7) does not result in an unreviewed safety question.

All software modifications will be made in accordance with CEN-39(A), Rev. 2 and CEN-39(A), Supplement 1, Rev. 1. These documents have been reviewed and approved by NRC. All modifications will be designed such that the CPC/CEAC System will automatically intiate shutdown of the reactor to assure that specified acceptable fuel design limits are not exceeded as a result of anticipated operational occurrences and to assist the Engineered Safety Features in limiting the consequences of certain postulated accidents. The comprehensive software modifications testing program will assure that the modified CPC/CEAC System has been implemented in accordance with the specified functional design.

The software modifications of MOD 2B/3 have been evaluated by C-E with respect to 10CFR50.59. This evaluation has shown that these modifications do not constitute an unreviewed safety question, nor do they require a change to the ANO-2 Technical Specifications.

B. Specific Safety Evaluations

The 15 changes described in AP&L Letter 2-010-25 which constitute the MOD 2B/3 software changes are described and evaluated below:

1. Modification of the CPC DNBR update logic to include cold leg temperature difference bias algorithm for asymmetric steam generator transients to enhance CPC response to NSS Transients.

This change (the MOD 3 portion) is not considered to constitute an unreviewed safety question because it does not change the CPC acceptance criteria for protection limits and in fact makes the CPC more responsive to asymmetric transients which cause cold leg temperature differences. An associated Technical Specification change to the Reactor Protection System trip on low Steam Generator level must be made in order to make the CPC system the leading trip on asymmetric steam generator transients. Until the low steam generator level trip setpoint is changed, it will remain the leading trip for asymmetric transients and this software modification will have no impact.

2. Modification of 16-bit penalty factor word to include the DNBR and LPD penalty factors and related operating flags which will improve the transfer of information between the CEACs and CPCs.

   This change (part of the MOD 2B portion) simply adds more information to the penalty factor word in order to support the changes to penalty factor scaling, additional sensor status information and the use of DNBR as well as LPD penalty factors described in item 13. Since this does not alter the design basis protection capability, this change does not constitute an unreviewed safety question.

3. Addition of a pre-set LPD penalty factor to be used in the calculation of the LPD total CEA deviation penalty factor in the event both CEACs are flagged inoperable.

   Since the MOD 2B portion of this software change adds separate CEA deviation peanalty factors for LPD and for DNBR rather than the single worst case penalty factor used previously, the penalty factor for the CEAC inoperable case required modification. The addition of a pre-set LPD penalty factor for this case maintains the design basis protection limits and thus does not constitute an unreviewed safety question.

4. Calculation of an average of the hot channel power distribution for use in computing the integrated one pin radial peak which will improve computer efficiency.

   This portion of the MOD 2B change is made only to reduce the number of repetitive calculations done to determine one pin peaks. Elimination of the additional summations is done for efficiency only and has no effect on the calculated results. Therefore, this change does not constitute an unreviewed safety question.

5. Application of the CEA deviation penalty factor to the core average heat flux rather than to the one pin radial peak to reduce the probability of spurious channel trips and increase reactor availability.

   This portion of the MOD 2B change has two major features. The first, which involves changing the point of application of the CEA deviation penalty factor is done to remove over conservatism because of the method of application previously used. Since the same penalty factor value is applied before and after the software change and the CPC protection limits are preserved, the change does not constitute an unreviewed safety question. The second feature of this change is to calculate separate CEA deviation penalty factors which are applied

the LPD margin and DNBR margin calculations respectively. This change simply removes the over conservatism of applying the same penalty factor to both calculations and does not affect the required margin of safety to protection limits. Consequently, this change does not constitute an unreviewed safety question.

6. Calculation of the integrated one pin peak, hot pin heat flux distribution, hot pin axial shape index, and integrated hot pin heat flux during the STATIC DNBR program.

   This portion of the MOD 2B change revises the order of calculations in the STATIC program for the purpose of conserving storage space and reducing the time skewing of data to ensure the most up-to-date values are used. This change has no impact upon the calculated results and does not affect the protection criteria of the CPCS and thus does not constitute an unreviewed safety question.

7. Addition of a deadband at the low end of the excore detector signal range to reduce the sensitivity of the low end out-of-range alarm to signal noise.

   This portion of the MOD 2B change is made to eliminate the spurious sensor failure alarms which occur when the reactor is shutdown or at or very near zero power, which causes confusion in the diagnosis of real sensor failures. This change has not effect on the protection capability of the CPCS and thus does not constitute an unreviewed safety question.

8. Modification of the shape annealing correction logic to include checks and corrections to top and bottom detector responses.

   This portion of the MOD 2B software change is made to improve the software consistency. The change adjusts the shape annealing correction logic to ensure both the upper and lower detector responses are checked. At present if the upper detector response is less than 3%, the lower detector response is not checked because it is inconceivable that both the upper and lower segments could have less than 3% power. This change is only made to make the software completely consistent and does not involve an unreviewed safety question.

9. Addition of CPC and CEAC sensors out-of-range status arrays and accessibility of this information via the operator's module and a teletype.

   This portion of the MOD 2B change adds logging of data to aid in diagnosis of intermittent sensor failures. Although the change is very important in diagnosing causes of CPC channel trips, it has no impact upon the CPCS protection capability and thus does not constitute an unreviewed safety question.

10. Provision for a "snapshot" of CPC variables at the time of a CPC channel trip.

    This portion of the MOD 2B change adds diagnostic information which is very important to the diagnosis of causes of channel trips. It has no impact upon the protection capability provided by the CPCs and thus does not constitute an unreviewed safety question.

11. Modification of logic to indicate which CEAC has failed to increase the availability of the operable CEAC to continue to provide computed deviation penalty factors and CEA positions.

    This portion of the MOD 2B change allows the flexibility of flagging either one or both of the CEACs as inoperable as opposed to the present software which can only flag both or neither as inoperable. The present software requires that an inoperable CEAC be powered down or disconnected from the CPCs to mark it as inoperable. The change provides operating flexibility and had no impact upon the protection capability of the CPCs, thus does not constitute an unreviewed safety question.

12. Modification of the core average heat flux filter algorithm to reduce the sensitivity of the heat flux calculation to noise.

    This portion of the MOD 2B software change requires careful examination with respect to the 10CFR50.59 criteria. As previously discussed in the general safety evaluation section, CPC/CEAC software changes, by their nature, do not increase the probability of occurrence or consequences of an accident. Nor do they add the possibility of new types of accident. However, this specific change requires review with respect to its effect upon the margin of safety as defined in the basis of the Technical Specifications.

Section B.2.2.1 of the ANO-2 Technical Specification states:

"To maintain the margins of safety assumed in the safety analyses, the calculations of the trip variables for the DNBR - Low and Local Power Density - High trips include the measurement, calculational and processor uncertainties and dynamic allowances as defined in CEN-44(A)P, "Core Protection Calculator Functional Description," January 7, 1977, Supplement 1P, May 13, 1977, Supplement 2P, May 19, 1977, Supplement 3P, September 2, 1977; CEN-45(A)P, "Control Element Assembly Calculator Functional Description," January 7, 1977; CEN-53(A)P, "ANO-2 Cycle 1 CPC and CEAC Data Base Document," May 20, 1977, Amendment 1P, June 28, 1977, Supplement 2P, Sepetember 2, 1977.

On the surface this change might appear to affect the dynamic allowances used in the CPC design basis. However, the CPC/CEAC functional descriptions and data base document do not explicitly define the uncertainties and allowances and the proposed change does not reduce the dynamic allowance of the CPC design basis. Dynamic allowances are applied to the results of the CPC dynamic algorithms and constants.

The proposed software change is designed to reduce the CPC sensitivity to high frequency signal noise and not reduce its ability to respond to the actual process variables. The change does not alter the original dynamic allowance in the design basis. For this reason, the change is not considered to constitute an unreviewed safety question.

13. Modification of CEAC logic to compute both a DNBR and a LPD penalty factor to enhance the capabilities of the CPCs, to make the penalty factors subgroup-dependent, and to add flags to the 16-bit penalty factor word for CEAC failure and for multiple CEA deviations within a subgroup and large penalty factors.

    This portion of the MOD 2B change provides several features which provide greater flexibility for diagnosing failures and reducing unnecessary conservatism. First, to avoid excessive conservatism caused by applying the same CEA deviation penalty factor to both the DNBR and LPD margin calculations, separate CEA deviation penalty factors for DNBR and LPD are calculated. Since the design basis protection criteria of the CPC are not altered, this change does not constitute an unreviewed safety question. Second, to avoid excessive conservatism due to the assumption that Xenon redistribution is instantaneous rather than dependent on length of time with a CEA deviation, the Xenon redistribution portion is made a function of time. Since this change does not alter the design basis protection criteria, but merely causes the CPC/CEAC system to more realistically model reality, this does not constitute an unreviewed safety question. Third, the addition of diagnostic capability to detect failed CEA position sensors, remove these from the penalty factor calculation and display failed sensor status to the operator does not affect the design basis of the CPC/CEAC System and thus does not involve an unreviewed safety question. Finally, the additional diagnostic and display capability which this change provides for expanded information to the operator for multiple subgroup deviations has no effect on the CPC/CEAC design basis protection capability and is thus not considered to involve an unreviewed safety question.

14. Provisions for a "snapshot" of CEAC variables at the time of a CEAC penalty factor greater than one or when the large PF flag is set.

    This portion of the MOD 2B change is added purely for diagnostic purposes to aid in determining the cause of generation of large CEAC penalty factors. It has no impact on the CPC protection capability and thus does not constitute an unreviewed safety question.

15. Modification to CPCs to include a DNBR correction factor for rod deviation events.

    This portion of the MOD 2B change is made to reduce unnecessary conservatism by taking credit for available over power margin. This change does not alter the design criteria for CPC protection and thus does not constitute an unreviewed safety question.