Docket No. 50-368

CEN-288(A)-NP

CPC Methodology Changes
for
Arkansas Nuclear One Unit 2
Cycle 5

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LEGAL NOTICE

1. SUMMARY

Combustion Engineering on behalf of Arkansas Power & Light Company (AP&L) will implement a number of CPC algorithm and constant changes for Arkansas Nuclear One Unit 2 (ANO-2) Cycle 5. A brief review of each CPC change is provided here. All of the changes are evolutionary in nature and represent small differences in the algorithms themselves. These changes are presently being implemented for San Onofre Unit 2 Cycle 2 (Reference 3.1). A schedule for implementation of the changes at ANO-2 is provided in Table 1.

Detailed algorithm descriptions in the form of functional specifications and discussions of methodology changes are provided in Reference 3.2.

TABLE 1

ANO-2 CYCLE 5 MILESTONES

DATE	MILESTONE ACTIVITY
10/31/84	Submit CPC Software Change Document to NRC
2/1/85	Submit Reload License Amendment Request to NRC (including the Reload Analysis Report)
3/1/85	End of Cycle 4
3/15/85	Submit CPC Phase I/Phase II Test Reports to NRC
5/1/85	Startup of Cycle 5

2. SUMMARY OF CPC ALGORITHM AND CONSTANT CHANGES

2.1 Corrected LPD Penalty Factor

The Cycle 5 algorithms include correct implementation of the Local Power Density (LPD) Penalty Factor which AP&L committed to implement for Cycle 5 in their letter of October 18, 1983 (2CAN108307). The correction consists of modification of the CPC software to be consistent with the functional specification. This correction was first implemented in the Palo Verde Nuclear Generating Station Unit 1 (PVNGS-1) Cycle 1 software (Reference 3.3) and has been reviewed and approved by the NRC.

2.2 Hot Pin to Hot Channel Conversion

Presently, POWER provides a hot pin power distribution in the form of an axial power distribution and appropriate radial peaking factors. This information is used in STATIC as if it were a hot channel power distribution. CETOP-D (the design code) makes the conversion from hot pin to hot channel power directly and thus comparisons between CETOP-D and STATIC (the CPC calculation) in the CPC uncertainty analysis implicitly account for the difference.

For Cycle 5, constants will be inserted into the heat flux equations in STATIC to convert from hot pin to hot channel heat flux distribution explicitly in CPC. This change will provide a more physical approach to the DNBR calculation. It involves minor algorithm adjustments in the CPC software and updates to the functional specification. The explicit conversion from hot pin to hot channel power was first implemented in the PVNGS-1 Cycle 1 software (Reference 3.3) and has been reviewed and approved by the NRC.

2.3 Non-Uniform Heating (F_k) Correction Factor Modification

Presently, the calculation of the non-uniform heating correction factor (F_k) in the CE-1 correlation in UPDATE does not differentiate between small changes about steady state and larger changes during transients. This results in a larger DNBR penalty than necessary during steady state operation.

For Cycle 5, the F_k algorithm will be modified to provide variable F_k factor adjustments [ ]. As a result, more accurate calculations of F_k will be made for small changes in operating conditions (i.e., near steady state) while calculating more conservative values of F_k for large changes in operating conditions (i.e., transients). This change was first implemented in the PVNGS-1 Cycle 1 software (Reference 3.3) and has been reviewed and approved by the NRC.

2.4 PFMLTD and PFMLTL Range Limits

The positive range limit on the CEAC penalty factor multipliers, [ ], will be shifted from [ ] to [ ]. This change is in anticipation of the need for a different range of values in the future and has no impact on the calculational logic. This change was first implemented in the PVNGS-1 Cycle 1 software (Reference 3.3) and has been reviewed and approved by the NRC.

2.5 Reactor Coolant Pump Pressure Rise Calculation

The calculation of pressure rise across the reactor coolant pump in the FLOW algorithm will be modified to account for forward flow through the pump when the pump rotor is locked at or near zero RPM. This change was first implemented in the PVNGS-1 Cycle 1 software (Reference 3.3) and has been reviewed and approved by the NRC.

2.6 Reactor Power Cutback

Algorithms will be added to the CPC and CEAC (Control Element Assembly Calculator) for detecting the actuation of a Reactor Power Cutback (RPC) event, for using off-line calculated RPC penalty factors, and for allowing the CPC calculation to more closely model core conditions without generating an inadvertent trip in the event of a RPC. Since ANO-2 does not have a RPC system, the effect of these algorithms will be nullified through the appropriate data base constants. Addressable constants were also added to the CPC and CEAC to define the duration that the RPC flags can remain set. For ANO-2 these addressable constants will be set to zero.

The RPC algorithm change was implemented in the PVNGS-1 Cycle 1 software (Reference 3.3) and has been reviewed and approved by the NRC.

2.7 Modification of Heat Flux Distribution Extrapolation in STATIC

For certain CEA configurations, radial peaking factor assignments, and/or radial peaking factor multipliers, it is possible [ ] This [ ], which results in a CPC channel trip.

Experience has shown that this condition occurs only at low power with a partially rodded core. This change [ ] in the top of the core.

[ ] A check is performed for [ ]. If any are detected, [ ]. This change will result in a reduction in the probability of unnecessary reactor trips. This change is being implemented in the San Onofre Nuclear Generating Station Unit 2 (SONGS-2) Cycle 2 software (Reference 3.2) and is currently being reviewed by the NRC.

2.8 UPDATE Algorithm Improvement

The UPDATE algorithm of CPC provides rapid and conservative recalculation of DNBR based upon the detailed DNBR calculation contained in the STATIC algorithm, updated state parameter measurements, and derivatives of the DNBR. As part of the overall CPC uncertainty analysis, comparisons of UPDATE and STATIC-predicted DNBRs based on [ ] are used to quantify this conservatism. Presently, the UPDATE algorithm of CPC applies a penalty to the updated DNBR at all times.

An algorithm change will be implemented in Cycle 5 which will [

]. In essence, this change minimizes excess conservatisms at normal operating conditions, but retains these conservatisms during transient operation.

The CPC UPDATE algorithm is based on [

]

The new method uses [

]

For planned changes in plant operating conditions the change in state parameters will be relatively slow, thus causing [

].

For this type of operation [ ] to the UPDATE algorithm which will ensure the conservatism of the calculated DNBR.

[

]

This penalty factor along with the rest of the CPC calculations and penalty factors ensures that the DNBRs calculated during transients and accidents will generate a trip signal when needed.

The UPDATE penalty factor modification therefore ensures that the safety margin of the CPCs is maintained for all modes of operation. It will increase the steady state operating margin [

] which will reduce the possibility of spurious trips and increase plant operational flexibility. This change is being implemented in the SONGS-2 Cycle 2 software (Reference 3.2) and is currently being reviewed by the NRC.

2.9 Power Uncertainty As a Function of Core Power Level

Addressable penalty bias constants are used to adjust the thermal power and neutron-flux power level in the CPCs. Present methodology implements [ ] values of these penalty biases to bound the power level range set by CPC design requirements.

For Cycle 5, [

] This change is being implemented in the SONGS-2 Cycle 2 software (Reference 3.2) and is currently being reviewed by the NRC.

2.10 Temperature Shadowing Factor Modification

The temperature shadowing factor (TSF) is used to correct the CPC neutron flux power for decalibration effects resulting from changes in coolant density. A multiplier is applied to the neutron flux power calculation to correct ex-core detector response for inlet moderator temperature changes. In the current algorithm, the TSF is a [ ] of moderator temperature change which is measured at start-up. The uncertainty in the measurement of the TSF is accommodated in the overall uncertainty term [ ].

[ ]the TSF on moderator temperature using a [ ]temperature will be implemented for Cycle 5. The ex-core detector calibration procedures will be modified accordingly.

[

] This change will allow the TSF uncertainty to be included directly in the factor itself. This ensures a conservative correction to TSF at temperatures different from the calibration temperature without requiring unnecessary uncertainty allowance near the calibration temperature (which should be near nominal conditions). This change is being implemented in the SONGS-2 Cycle 2 software (Reference 3.2) and is currently being reviewed by the NRC.

3. REFERENCES

3.1 CEN-284(S)-P, "Safety Analysis and CPC Methodology Changes for San Onofre Nuclear Generating Station Units No. 2 and 3," Dockets 50-361 and 50-362, June 1984.

3.2 CEN-281(S)-P, "CPC/CEAC Software Modifications for San Onofre Nuclear Generating Station Units 2 and 3," June 1984.

3.3 Enclosure 1-P to LD-82-039, "CPC/CEAC Software Modification for System 80," March 1982.

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