UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

SUPPORTING AMENDMENT NO. 104 TO FACILITY OPERATING LICENSE NO. DPR-30

COMMONWEALTH EDISON COMPANY

AND

IOWA-ILLINOIS GAS AND ELECTRIC COMPANY

QUAD CITIES NUCLEAR POWER STATION, UNIT 2

DOCKET NO. 265

1.0 INTRODUCTION

By letter from J. A. Silady, Commonwealth Edison Company (CECo), to USNRC, dated March 28, 1988 (Ref. 1), Technical Specification changes were proposed for the operation of Quad Cities Station Unit 2 for Cycle 10 (QC2C10) with a reload using General Electric (GE) manufactured fuel assemblies and GE analyses and methodologies. Enclosed were the requested Technical Specification (TS) changes and reports (including Reference 2 through 4) discussing the reload and analysis done to support and justify Cycle 10 operation including an increased flow region, equipment out of service and single loop operation.

The reload for Cycle 10 is generally a normal reload with no unusual core features or characteristics. Proposed TS changes relate to Maximum Average Planar Linear Heat Generation Rate (MAPLHGR) and Linear Heat Generation Rate (LHGR) limits for the new fuel, MAPLHGR and Minimum Critical Power Ratio (MCPR) limits for all of the fuel using Cycle 10 core and transient parameters, extended operating regions and conditions, and new approved analytical methods. The new fuel is the extended burnup type which has been approved for use in several recent GE reloads.

The submittal proposes an extension of the current allowable operating region on the reactor power-flow map via an increased core flow (ICF) extension. Extended Load Line Limit Analysis (ELLA) and associated TS have also been proposed for Quad Cities Unit 2.

Also proposed for the cycle and supported with GE analyses is operation with "equipment-out-of-service" extended operating modes including feedwater heaters out of service (FWHOOS), final feedwater temperature reduction (FFWTR), relief valve out of service (RVOOS) and single loop operation (SLO). TS MCPR limits bounding analyzed combinations of these conditions have been proposed.

2.0 EVALUATION

2.1 Reload Description

The QC2C10 will retain 8 P8DGB263L and 24 P8DGB298 GE fuel assemblies from Cycle 6, 200 BP8DRB265H GE fuel assemblies from Cycle 7, 72 BP8DRB282 and 104 BP8DRB283H GE fuel assemblies from Cycle 8, 64 BP8DRB299 and 68 BP8DRB299L GE fuel assemblies from a previous cycle, and add 92 BD300C and 72 BD316A new GE8x8EB fuel assemblies. The reload is based on a previous end of cycle core nominal average exposure of 21,666 MWd/MT and Cycle 10 end of cycle exposure of 22,754 MWd/MT. The loading will be a conventional scatter pattern with low reactivity fuel on the periphery.

2.2 Fuel Design

The new fuel for Cycle 10 is the GE extended burnup fuel GE8x8EB. The fuel designations are BD300C and BD316A. This fuel type has been approved in the Safety Evaluation Report for Amendment 10 to GESTAR II (Refs. 5 & 6). The specific description of this fuel has been accepted and the fuel description is also presented for QC2C10 in Reference 4. This fuel description is acceptable.

LOCA analyses have been done for the retained and reload fuel using the improved SAFER/GESTR-LOCA methods approved by the staff. The initial condition MAPLHGR values used in these analyses are less restrictive than those used in the fuel mechanical integrity design analyses. Thus the multi-axial region MAPLHGR TS used in some other recent reload applications of extended burnup fuel are unnecessary, and only a single set of burnup dependent values, for each fuel type, as determined by the mechanical design are required. The MAPLHGR values for both the reload and retained fuel have been calculated with approved methodology (GESTAR II, Reference 6, Section 2 of Vol. 1) and are acceptable.

The proposed LHGR limit for the GE8x8EB fuel is 14.4 KW/ft (rather than the 13.4 for other GE fuel). The LHGR has been reviewed and accepted for this fuel in the GE extended burnup fuel review (Ref. 5). This LHGR is acceptable for the GE fuel in QC2C10.

2.3 Nuclear Design

The nuclear design for QC2C10 has been performed by GE with the approved methodology described in GESTAR II (Ref. 6). The results of these analyses are given in the GE reload report (Ref. 2) in standard GESTAR II format. The results are within the range of those usually encountered for BWR reloads. In particular, the shutdown margin is 4.2% delta-k at the beginning of cycle and 1.2% delta-k at the minimum conditions, thus fully meeting the required 0.38% delta-k shutdown margin. The standby liquid control system also meets shutdown requirement with a reasonable shutdown margin of 4.3% delta-k. Since these and other QC2C10 nuclear design parameters have been obtained with previously approved methods, and fall within expected ranges, the nuclear design is acceptable.

2.4 Thermal-Hydraulic Design

The thermal-hydraulic design for QC2C10 has been performed by GE with the approved methodology described in GESTAR II (Ref. 6) and the results are given in the GE reload report (Ref. 2). The GEMINI/ODYN transient analysis methodology (Ref. 6) was used for relevant transient analysis.

The Operating Limit MCPR (OLMCPR) values are determined by the limiting transients, which, for standard conditions, are usually Rod Withdrawal Error (RWE), Feedwater Controller Failure (FWCF), Turbine Trip Without Bypass (TTNBP) and Load Rejection Without Bypass (LRNBP). The analyses of these events for QC2C10, using the standard approved GEMINI/ODYN Option A and B approach for pressurization transients in standard and extended operating regions and with analyzed equipment out of service combinations, provide new Cycle 10 TS values of OLMCPR as a function of average scram time. For all standard operating conditions TTNBP is controlling at both Option A and B limits, giving OLMCPR values of 1.31 and 1.27, respectively. However, to accommodate the extended and equipment out-of-service conditions the OLMCPR has been analyzed (Ref. 3) for those conditions also. This has resulted in an increase to 1.35 for Option A and 1.30 for Option B associated with the feedwater heater out-of-service (FWHOOS) analyses. Approved methods (Ref. 6) were used to analyze these events; analyses and results are acceptable, and fall within expected ranges.

GE has calculated the core stability decay ratio at the point of minimum stability (the intersection of the natural circulation line and the extended APRM block line) for QC2C10. The calculated value of reactor core stability decay ratio is 0.58. This indicates a stable core since there is substantial margin to the acceptable value of 0.8 (for approved GE methods). However, due to the LaSalle 2 instability event which demonstrated that the decay ratio acceptance criteria do not provide assurance of core stability, the licensee will be informed of any remedial action to be taken upon the completion of our review of generic implications of the LaSalle event.

2.5 Transient and Accident Analysis

The transient and accident analysis methodologies used for QC2C10 are described and NRC approval indicated in GESTAR II (Ref. 6). The GEMINI/ODYN method was used for the core wide transient analysis which includes load rejection without bypass (LRNBP), loss of feedwater heating and feedwater controller failure. The local rod withdrawal error (RWE) was analyzed on a plant and cycle specific basis and a rod block setpoint of 108% was selected to provide an OLMCPR of 1.24 for all fuel types. This is less than the core wide events. The limiting MCPR events for QC2C10 are indicated in Section 2.4. The core wide and local transient analysis methodologies and results are acceptable and fall within expected ranges.

The limiting pressurization event, the main steam isolation valve closure with flux scram, analyzed with standard GESTAR II methods, gave results for peak steam dome and vessel pressures for standard and extended operating regions and equipment out-of-service conditions well under required limits. These are acceptable methodologies and results.

Banked position withdrawal sequence and rod patterns are used for Quad Cities 2. For plants using this system the Rod Drop Accident (RDA) event has been statistically analyzed generically and it was found that with a high degree of confidence the peak fuel enthalpy would not approach the NRC limit of 280 cal/gm for this event. This approach and analysis has been approved by NRC (Ref. 6). This approach is acceptable for QC2C10.

The LOCA analyses for QC2C10 were performed using the SAFER/GESTR-LOCA methodology. This methodology (Refs. 6 & 7) has been approved by the staff and used and approved in several recent reload applications. The licensee has reported the results of these analyses (Ref. 4) which are required to meet the necessary conditions (Ref. 7). Specifically, the analyses include break sizes from 0.05 ft^2 to the maximum DBA recirculation suction line break (4.26 ft^2). Seven different break sizes were analyzed (for either nominal input or Appendix K values) in conjunction with ECCS failure combinations. A total of 14 cases were evaluated to establish the trend of PCT curves (nominal and Appendix K) versus break size.

The input parameters for both the nominal and Appendix K cases are within those used in the approved generic analyses. The ECCS configuration of Quad Cities 2 (4 Low Pressure Coolant Injection, 2 Low Pressure Core Spray, High Pressure Coolant Injection, Automatic Depressurization System) is consistent with the ECCS configuration of a generic BWR-3/4. The results show that the DBA recirculation suction line break with battery failure is the limiting case. The plant-specific Appendix K calculation demonstrate that the DG/HPCI failure is limiting for the P8x8R fuel, which is the limiting fuel type. The calculated PCT is 828°F when nominal input values are used and 1382°F when Appendix K input values (plus adder) are used. Because the accident analyses have been performed using approved methods, and the results meet the staff's acceptance criteria, we conclude that these analyses are acceptable.

LOCA sensitivity studies or specific calculations were examined to consider the effect of extended or equipment out-of-service operation (Refs. 3 & 4). This included the full range discussed in Section 2.6. The changes to peak cladding temperature were generally small (or the condition was included in the base calculations, e.g., RWOOS) compared to the large margins available, so that no modifications to MAPLHGR limits are required for these conditions. These results are reasonable and acceptable. The results indicate that the TS MAPLHGR limits are not set by the LOCA calculations but by the thermal-mechanical design calculations.

2.6 Operating Extensions and Equipment out-of-Service

The QC2C10 reload submittal proposes extensions to standard operating regions and equipment out-of-service in the GESTAR II standard category of "Operating Flexibility or Margin Improvement Options." The selected options are ICF, FFWTR, FWHOOS, RVOOS and SLO. These have become commonly selected and approved options for a number of reactors in recent years. These options and associated analyses, including relevant transients and accidents, are described and discussed in Reference 3. Included in the analysis and discussion is the application for operation beyond nominal end of cycle with ICF (or decreased flow) and FFWTR, and coastdown to lower power levels (as low as 20 percent is assumed). The coastdown power and feedwater temperature reduction and the SLO analysis are intended to provide a basis for the removal of Quad Cities 2 license restrictions and for SLO TS additions.

For ICF the analyses are performed at the bounding condition of 108% of rated core flow (Ref. 3). The proposed operating region is bounded by the 108% APRM rod block line (0.58 W + 50%), the rated power line and the rated rod line. The region of operation above the rated rod line is known as the Extended Load Line Limit Analysis (ELLLA) region. The Safety Evaluation for this operating region includes operation beyond normal end-of-cycle, up to 100°F FFWTR (with ICF or reduced flow) and power coastdown (20 percent assumed in the analysis). Conservative power profiles were assumed. The transient analyses were used to determine OLMCPR values for these operating conditions. As discussed in Section 2.4, OLMCPR for QC2C10 is determined by the analysis of FWHOOS. The LOCA examination concluded that the effects on MAPLHGR were insignificant compared to the large margin available. The core stability is addressed in Section 2.4. The effects of ICF and FFWTR related loads, vibration, and fatigue on various reactor internals, and the impact on containment LOCA response, was examined and were found to be within allowable design limits except for (as is usually the case) a possible need for a slightly reduced feedwater nozzle refurbishment interval (based on seal leakage). Throughout these analyses the transients and accident examined, the methodologies and the results were completely similar to those reviewed on previous approved ICF-FFWTR applications for other reactors. The analyses and results and operation in this extended region are acceptable for Quad Cities 2.

The FWHOOS was analyzed in a similar manner. It is similar to FFWTR except for potential duration and time of occurrence in cycle which can affect core parameters to a greater extent. As indicated in Section 2.4, the extreme conditions used for analysis resulted in setting the OLMCPR for QC2C10. The increased limit is caused primarily by changes in axial power distribution and resulting effectiveness of scram action. This review concludes that operation with FWHOOS is acceptable for QC2C10.

For RVOOS the limiting pressurization event was analyzed and evaluated with the lowest setpoint safety relief valve OOS. The impact on MCPR is negligible. Standard sensitivity studies also show the effect on overpressure is small and results in adequate margin. The effect of a relief valve out of service was included in the LOCA analyses. It is concluded that operation with one RVOOS is acceptable.

Single loop operation (SLO) analysis was previously reviewed and approved by USNRC. Previous SLO analysis demonstrated that, within the normal operating domain and without equipment out-of-service, the consequences of abnormal operation transients from one-loop operation will be considerably less severe than those analyzed for a two-loop operation mode. MAPLHGR changes for QC2 are not necessary here since, as previously indicated (Section 2.4), the LOCA analysis for SLO (using the new methodology) provides peak cladding temperature well below limits. The stability issue for QC2 core (GE8x8EB fuel) should follow the staff position stated in Section 2.4 of this SER.

2.7 Technical Specification

The following TS changes have been proposed for Quad Cities 2 to implement the reload analyses and operation changes which have been discussed. The reason or bases for the changes have been for the most part already discussed and approved and the changes will only be briefly described as follows:

1. License Restriction 3.C

   Remove restrictions on coastdown operation and off-normal feedwater heating. These including coastdown to 20% and coastdown with off-normal FW heating have been analyzed by GE using approved methods to determine the operating restrictions (MCPR, MAPLHGR) which are bounded by the previous cycle. Therefore, the proposed change is acceptable.

2. TS 1.1.A on Page 1.1/2.1-1

   Reduction of the MCPR fuel cladding safety limit from 1.07 to 1.04 as generically approved by the NRC for the GE8x8EB fuel. This is acceptable since Quad Cities 2 is a D-lattice plant with Cycle 10 being the third successive reload core with high bundle R-factor ($\geq$ 1.04) fuel design (based on an improved analysis described in the approved Amendment 14 to NEDE-24011-PA).

3. Basis 1.1.A on page 1 1/2.1-4 and TS 3.5.J. on page 3.5/4.5-10

   Delete 7x7 discussion since it is no longer in use for this Cycle 10 reload and include the new LHGR limit of 14.4 KW/ft for new addition of the GE8x8EB fuel types. This is acceptable.

4. Basis 2.1 on page 1.1/2.1-7

Change analyzed conditions from "up to the rated thermal power condition of 2511 MWt" to "in accordance with Regulatory Guide 1.49" which states that transients must be analyzed up to 102% rated core thermal power. This is acceptable.

5. Figure 2.1-3

Add operating region as defined by the increased core flow analysis which is evaluated in Section 2.6 of this SER. This is acceptable.

6. Table 3.2-3

The Technical Specification for RBM upscale trip level setting change from 0.65 Wd + 42 to 0.65 Wd + 43 so that at 100% drive flow the rod block setting is equal to 108% core flow which is equal to 98×10^6 lb/hr. This is acceptable.

7. TS 3.3.C.5 on page 3.3/4.3-5, TS 3.5.K on Page 3.5/4.5-10, and TS Bases on page 3.5/4.5-14a

The 20 percent scram insertion time is changed to 0.68 seconds corresponding to the ODYN B analysis. MCPR limits are revised in accordance with analysis results from approved GEMINI/ODYN methodology.

8. TS 3.5.D.2 and 4.5.D.4 on page 3.5/4.5-5, and TS Bases on page 3.5/4.5-12

The limiting conditions for operation and surveillance requirements and for operation basis for the automatic pressure relief subsystem are changed to reflect the analysis for continued operation with one relief valve out of service (RVOOS). It allows extended operation with one RVOOS and limited operation (7 days) with two RVOOS provided HPCI is demonstrated to be operable. Also, change the word "or" to "and" for clarification because automatic pressure relief valves enable both core spray and LPCI mode of RHR during a small pipe break in the event of HPCI failure. This is acceptable.

9. TS Bases on pages 3.5/4.5-14 and 3.5/4.5-14b

Delete Ref. 5 from the Bases since it is no longer applicable. Also, Reference 1 is changed to incorporate the new loss of coolant accident model (SAFER/GESTR-LOCA).

10. Figure 3.5-1

Add new MAPLHGR curves for new fuel types BD300C and BD316A and delete MAPLHGR curves for fuel types no longer in use. This is acceptable.

11. Figure 3.5-2
Add the statement "For flows greater than 100%, K_f = 1.0" to the figure to address the operating region defined by the ICF analysis. This is acceptable.

12. TS 3.6.H.3 on page 3.6/4.6-5a and TS Bases on page 3.6/4.6-13a

Delete the MAPLHGR reduction factor during single loop operation based on the SAFER/GESTR-LOCA analysis. This is acceptable since an approved method was used. Revise RBM upscale limit due to new RBM setpoint. Reduce the allowed duration of unrestricted SLO to 12 hours.

3.0 ENVIRONMENTAL CONSIDERATION

This amendment involves changes to license requirements with respect to the installation and use of facility components located within the restricted area as defined in 10 CFR Part 20. The staff has determined that the amendment involves no significant increase in the amounts, and no significant change in the types, of any effluents that may be released offsite and there is no significant increase in individual or cumulative occupational radiation exposure. The Commission previously issued a proposed finding that this amendment involves no significant hazards consideration and there has been no public comment on such finding. Accordingly, this amendment meet the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b) no environmental impact statement nor environmental assessment need be prepared in connection with the issuance of this amendment.

4.0 CONCLUSIONS

We have reviewed the reports submitted for Quad Cities Unit 2 Cycle 10 operation with extended operating regions and equipment out-of-service. Based on this review we conclude that appropriate material was submitted and that the fuel design, nuclear design, thermal-hydraulic design, and transient and accident analyses are acceptable. The Technical Specification and License Condition changes submitted for this reload suitably reflect the necessary modifications for operation during this cycle.

Furthermore, the staff concluded, based upon considerations discussed above, that: (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, and (2) such activities will be conducted in compliance with the Commission's regulations and the issuance of this amendment will not be inimical to the common defense and security nor to the health and safety of the public.

5.0 REFERENCES

1. Letter from J. A. Silady (CECo) to USNRC, dated March 28, 1988, "Quad Cities Station Unit 2 Proposed Technical Specification Amendment - Unit 2 Cycle 10 Reload NRC Docket No. 50-265."

2. GE document 23A5846, Revision 0, January 1988, "Supplemental Reload Licensing Submittal for Quad Cities Nuclear Power Station Unit 2, Reload 9, Cycle 10.

3. NEDC-31449, July 1987, "Extended Operating Domain and Equipment Out-of-Service for Quad Cities Nuclear Power Station Units 1 and 2."

4. NEDC-31345P, Revision 1, January 1988, "Quad Cities Nuclear Power Station Units 1 and 2 SAFER/GESTR-LOCA Loss-of-Coolant Accident Analysis." (Proprietary information. Not available in PDR)

5. Letter (and attachments) from C. Thomas (NRC) to J. Charnley (GE) dated May 28, 1985, "Acceptance for Referencing of Licensing Topical Report NEDE-24011-P-A-6, Amendment 10."

6. GESTAR II, NEDE-24011, Revision 8, "General Electric Standard Application for Reactor Fuel."

7. NEDE-23785-1-PA, "The GESTR-LOCA and SAFER models for the Evaluation of the Loss-of-Coolant Accident" Volume I, II, and III, General Electric Company, June 1984.

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