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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION
SUPPORTING AMENDMENT NO. 50 TO FACILITY OPERATING LICENSE NO. DPR-50

METROPOLITAN EDISON COMPANY
JERSEY CENTRAL POWER AND LIGHT COMPANY
PENNSYLVANIA ELECTRIC COMPANY
THREE MILE ISLAND NUCLEAR STATION, UNIT NO. 1
DOCKET NO. 50-289

1.0 Introduction

By letter dated December 28, 1979, as supplemented March 1, 1979 (References 1 and 2), Metropolitan Edison Company (Met Ed or the licensee) requested amendment of Appendix A to Facility Operating License No. DPR-50 for Three Mile Island Nuclear Station, Unit No. 1 (TMI-1). Section 5 summarizes the proposed changes of this amendment.

The Met Ed submittal of December 28, 1978, was presented to support operation for a full operating cycle (Cycle 5) following the refueling performed at the end of Cycle 4. As such, the analysis presented in the submittal was based on the intended exposure for Cycle 5 as 265±15 effective full power days (EFPD). Information submitted describes the fuel system design, nuclear design, thermal-hydraulic design, accident analyses, and startup test program.

The refueling of TMI-1 for Cycle 5 will result in a core loading consisting of 52 fresh Mark B4 assemblies, 52 once-burned assemblies, 48 twice-burned assemblies and 25 thrice-burned fuel assemblies. Removal of the remaining orifice rod assemblies (ORA), and installation of retainers to the two regenerative neutron source clusters, are the only other physical modifications associated with the refueling.

The evaluation of the proposed modifications to the Technical Specifications of TMI-1 is presented in the following sections. Met Ed has proposed Technical Specifications which are more restrictive than would be required based solely on the Cycle 5 analysis. Met Ed hopes that this action will preclude the need for changes to the Technical Specifications to accommodate future cycles. Current NRC staff review has only considered the applicability of the Technical Specification changes to Cycle 5 operation. Applicability to future cycles must be determined by the licensee on a cycle by cycle basis.

We are also adding Technical Specifications governing the operability and surveillance of fire barrier penetration seals. The background and safety evaluation for this change are given in paragraph 6.

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2.0 Evaluation of Modifications to Core Design

2.1 Fuel System Design

The 52 Mark B4 fuel assemblies for Cycle 5 are mechanically identical to previously approved and utilized fuel assemblies at TMI-1 and other Babcock & Wilcox supplied nuclear stream supply systems, NSSS. The mechanical design of the fresh fuel was not reevaluated by the NRC staff for Cycle 5. Twenty five batch 4 Mark 4 assemblies, which were originally loaded in Cycle 2 and are now thrice-burned assemblies, will be utilized in Cycle 5. The average burnup of these assemblies at end of Cycle 5 (EOC5) is predicted to be 31,380 MWD/MTU, and the estimated effective residence time is 26,402 effective full power hours (EFPH) at EOC5. While utilization of an extensive number of fuel assemblies for four fuel cycles is atypical, the predicted exposure values are not. Furthermore, a limited number of PWR assemblies have been previously used for four operating cycles by all PWR NSSS vendors.

2.1.1 Cladding Creep Collapse

Fuel rod cladding creep collapse analyses have been performed for the most limiting (i.e., most highly exposed batch 4 fuel assembly) fuel assembly to be used in Cycle 5. The analyses were performed according to the methods and assumptions described in Reference 3 and approved by the NRC staff. These analyses predict that the time to fuel rod cladding collapse will be in excess of 30,000 EFPH. Because no Mark B assembly is predicted to reach a total exposure as high as 30,000 EFPH during Cycle 5 (Table 4-1 of Reference 1), we conclude that cladding creep collapse has been suitably considered.

2.1.2 Cladding Stress and Strain

Stress calculations have been performed for a generic fuel rod model and strain calculations for a generic pellet model. These models and calculations have been approved for prior TMI-1 reloads. The licensee has asserted that Cycle 5 parameters are enveloped by these generic models. The licensee's calculations show that in no case does the stress exceed the yield. We conclude that the clad stress under Cycle 5 operation does not exceed the yield of the clad material and clad failure is not expected.

2.1.3 Fuel Thermal Design

Analysis was performed for fuel batches 6 and 7 using TAFY (Reference 5) and TACO (Reference 6). Fuel batches 4 and 5 were analyzed using TAFY.

The licensee stated that linear heat rate (LHR) capabilities, based on centerline melt, are based on TAFY calculations and that TACO calculations for batches 6 and 7 predict higher LHR capability. TACO is the preferred code. Since fuel batches 6 and 7, rather than 4 and 5, are anticipated to be limiting during Cycle 5, these code applications are acceptable.

2.2 Nuclear Design

Figure 3-1 of Reference 1 indicates the core loading arrangement for TMI-1 Cycle 5; the initial enrichments and burnup distributions are given in Figure 3-2. A conventional out-in fuel management scheme has been utilized.

Reactivity control and power distribution control will be maintained by control rods, axial power shaping rods (APSR) and soluble boron concentration control. The rod locations are given in Figure 3-3 of Reference 1. The core will be operated with control rods essentially withdrawn at power and the APSR deeply inserted.

The projected Cycle 5 length is 265 EFPD with a cycle burnup of 8,650 MWD/MTU.

Cycle 5 nuclear parameters including critical boron concentrations, control rod worths, Doppler coefficients, moderator coefficients, xenon worth and effective delayed neutron fractions have been calculated using the approved PDQ07 code (Reference 7) hese are presented in Table 5-1 of Reference 1 and compared to the Cycle 4 values. The Cycle 5 design does not differ significantly from earlier cycles and the nuclear parameters are within the range of values expected for a plant approaching an equilibrium cycle.

Shutdown margins have been calculated for beginning of cycle (BOC) and EOC (Table 5-2 of Reference 1). The calculated minimum shutdown margin during Cycle 5 is 2.10% ΔK/K which is larger than the value of 1% ΔK/K assumed in cooldown accident analyses by an adequate margin.

2.3 Thermal Hydraulic Design

The thermal-hydraulic design conditions for TMI-1 Cycle 5 are included in Table 6-1 of Reference 1. Only the reference design radial-local power peaking factor and anticipated minimum departure from nucleate boiling ratio (DNBR) at steady state differ from the Cycle 4 values. The first of these differences is discussed below, and the second is reasonable and acceptable in that it represents an increased margin to the safety limit DNBR at steady state conditions (112% overpower).

2.3.1 Removal of Orifice Rod Assemblies

The most significant difference between the thermal hydraulic design for Cycle 5 and that for Cycle 4 is the removal of the ORA. This will leave a total of 106 vacant fuel assemblies and will result in an increase in bypass flow from 8.34% for Cycle 4 to 10.4% for Cycle 5. The increased bypass flow results in a decreased flow to fuel assemblies. Met Ed has reevaluated the effect of this modification on the reactor core DNBR. The reevaluation indicated that a decrease in the reference design radial-local peaking factor ($F_{\Delta H}$) from 1.78 to 1.71 compensates for the larger bypass flow. Analysis was performed using the BAW-2 critical heat flux correlation (Reference 8). Based on the sensitivity of the heat flux correlations, such as BAW-2, for small changes in flow, we have concluded that the 4% reduction of the limits for peak enthalpy rise is adequate to offset the approximately 2% reduction in core flow.

2.3.2 Effect of Rod Bow on Thermal Design

The potential effect of fuel rod bow has been reviewed generically in Reference 9. Based on the rod bow model approved by the NRC staff, TMI-1 has applied a DNBR penalty of 11.2% for fuel rod bow to all analyses that define plant operating limits and to design transients (Reference 1).

A thermal margin credit equivalent to 1% DNBR units to offset the rod bow penalty has been taken by the licensee based on a flow area reduction factor which has been included in the pre-bow phenomena thermal-hydraulic analyses. The bow penalty is based on an assumed burnup of 33,000 MWD/MTU and, therefore, bounds the predicted Cycle 5 peak burnup.

3.0 Evaluation of Accidents and Transients

General:

The licensee has stated that each accident analyzed in the Final Safety Analysis Report (FSAR) has been examined and has been found to be bounded by the FSAR and/or the Fuel Densification Report and/or subsequent cycle analyses. We have concluded that the consequences of hypothesized events are no worse than that stated in the FSAR or previous submittals; that is, Part 20 and Part 100 dose rate limits will not be exceeded in the event of an anticipated operating occurrence (AOO) or accident respectively.

With respect to radiation doses, Met Ed reported that because of improved fuel utilization and improved calculational methods, they now estimate they are achieving a higher plutonium-to-uranium fission ratio. Because plutonium has a higher iodine fission yield than uranium, more iodine will be produced. Met Ed estimates that the increased iodine production will increase the 2-hour thyroid doses given in the FSAR by 6 to 19%. We have reviewed the effects of this increase and conclude that the consequences of all accidents remain well within the acceptable limits.

The removal of the ORA and corresponding decreased core flow has been compensated by a decrease in the permitted peak enthalpy rise. These two effects result in an increased minimum DNBR at steady state conditions (1.02% overpower) from 2.24 to 2.33 DNBR units. The licensee has assumed that the transient DNBR degradation during an AOO or accident has not been substantially altered by these changes. Hence, the FSAR analyses are bounding. This approximation is considered acceptable.

Specific analyses:

The conclusion presented in the FSAR is that, in the event of a steam line break (SLB) accident, a small fraction of the 10 CFR 100 dose rate would be reached. The supporting analysis assumed a 1% $\Delta\rho$ safeguards allowance (shutdown margin). The predicted minimum shutdown margin during Cycle 5 is 2.10% $\Delta\rho$. On these bases the consequences of a hypothesized SLB are considered acceptable for Cycle 5 operation.

The one pump coastdown AOO was reanalyzed by the licensee using a revised flux/flow setpoint and an assumed initial peak enthalpy rise, $F_{\Delta H}$, of 1.71. The minimum predicted DNBR was calculated by the licensee to be 1.74. This leaves 20% margin to the minimum DNBR safety limit for Cycle 5 of 1.43. This limit includes an 11.2% rod bow penalty.

The licensee has stated (Reference 1) that the generic B&W ECCS analysis (Reference 10) is applicable to TMI-1, Cycle 5. Based on our review of the minimal core changes for Cycle 5 this assertion is acceptable.

Despite the foregoing, in light of our Modification of Conditions of Exemption dated May 19, 1978, we cannot conclude that operation of TMI-1 in Cycle 5 as presently configured would be wholly in conformance with the requirements of 10 CFR 50.46 relative to the performance of the ECCS. This is because until modifications proposed by the licensee and approved by the NRC staff have been implemented at the facility, the licensee must rely upon prompt operator action to assure acceptable mitigation of the consequences of a small break loss of coolant accident (LOCA). To address this concern in the interim, the licensee has defined certain operator actions to be completed within a specified time frame and has provided an acceptable analysis demonstrating that if these actions are taken upon occurrence of a small break LOCA, there is a very substantial safety margin relative to the acceptance criteria for such events. The licensee has also trained operating personnel to execute the required procedures and verified that they are capable of completion within the required time frame. In addition, the Commission's Office of Inspection and Enforcement has verified that the procedures have been implemented. Based on these considerations, and consideration of the public interest, we are granting pursuant to 10 CFR 50.12, concurrent with issuance of this amendment, a further Modification of Conditions of Exemption from the provisions of 10 CFR 50.46 such as to authorize operation of TMI-1 in Cycle 5. In granting this Modification, we are continuing the license condition relating to observance of procedures for operator action and adding a condition requiring timely implementation of modifications which eliminate reliance on prompt operator action.

4.0 Startup Tests

Startup tests are described in Reference 1. These tests are consistent with the startup tests performed in association with other recent B&W reloads. We have reviewed the tests in terms of their intended purpose and consider them acceptable. Met Ed has agreed to provide a startup test report (Reference 2).

5.0 Evaluation of Technical Specification Changes

Proposed modifications to the TMI-1 Technical Specifications are described below.

(1) Reduction in $F\Delta H$ from 1.78 to 1.71

The reduction of the peak enthalpy rise $F\Delta H^N$, compensates for increased bypass flow due to removal of ORA. This change makes the Technical Specifications consistent with the supporting accident analyses. The peak linear heat rate, Fq^n, which is the product of $F\Delta_H^N$ and the axial peak, Fz, has been correspondingly reduced for consistency.

(2) Revision of List of Figures

These changes are strictly editorial corrections and do not affect the safe operation of the plant.

(3) Modification to Core Protection Safety Limits

The cycle specific designation has been deleted. Values shown in this figure have been shown by the licensee to be more restrictive (and conservative with respect to the safety analysis) than required for Cycle 5. The licensee has chosen to adopt these more restrictive values (more restrictive with respect to operating flexibility) to preclude future Technical Specification changes. We concur that these values are applicable for Cycle 5 but have not considered the applicability for future cycles. This determination must be made by the licensee on a cycle by cycle bases.

(4) Reduction of the Permissible Quadrant Power Tilt Limits

The proposed change reduces the permissible quadrant tilt and hence is considered a conservative change. The core has been designed with quadrant symmetry and is not expected to exhibit a substantial quadrant tilt.

(5) Revision of Boron Acid Storage Volumes

The increased boric acid storage volumes are required to compensate for the reduction of the differential boron worth associated with the core reaching a near equilibrium cycle. The increased levels are required to maintain the 1% $\Delta\rho$ shutdown margin.

(6) Revision of Thermal Limits

The licensee has revised the maximum thermal power for three pump operation from 87.1 to 87.2% of rated power, and the flow during two pump operation at which the trip will occur from 49.1% to 49.2% of rated flow. This change is a result of recalculations performed with greater numerical precision.

(7) Deletion of Specific Cycle Reference on Several Figures

The affected figures are Figure 2.1-1, Core Protection Safety Limit, Figure 2.1-3, Core Protection Safety Bases, Figure 2.3-2, Protection System Maximum Allowable Setpoints for Reactor Power Imbalance, and Figure 3.5-2G, Limited Maximum Allowable Linear Heat Rate. In these figures, the cycle specific designation has been deleted. This change is editorial in nature, does not alter the safety limits for Cycle 5, and will facilitate enveloping future cycle reloads under 10 CFR 50.59.

(8) Revision to Power Imbalance Envelope

The licensee has selected a single limiting imbalance envelope rather than two envelopes each applicable for roughly half the cycle. Credit will not be taken for the typical broadening of the imbalance limits with core burnup, due to decreasing radial power peaking with increasing core burnup. This potential reduction in operating flexibility has been elected by the licensee to facilitate enveloping future cycle reloads under 10 CFR 50.59.

(9) Revision of APSR Position Limits for Operation

The revision of APSR limits will not have an affect during Cycle 5, but continued use of the APSR deeply inserted in the core will ultimately result in rod exposure approaching the design limit. This constraint should be checked by the licensee for future cycles.

(10) Revision of Rod Position Limits

These revised figures have been shown to be conservative relative to Cycle 5 specific analyses.

6.0 Fire Protection Technical Specifications

By letter dated November 30, 1977, as amended by letter dated December 16, 1977, the Commission issued Amendment No. 32 to the operating license for TMI-1. This amendment added Technical Specifications for existing fire protection equipment and fire protection administrative controls. The amendment did not include Technical Specifications for fire barrier penetration seals because seals of a defined fire resistance rating were not utilized in the plant at that time.

As a result of our fire protection review (See Amendment No. 44, dated September 19, 1978) and other NRC actions, Met Ed has been installing fire barrier penetration seals of an acceptable design in fire barriers protecting safety related areas. This installation has been in substantial conformance with the schedule set forth in Table 3.1 of the TMI-1 Fire Protection Safety Evaluation Report dated September 19, 1978, and supplements thereto.

Therefore, inasmuch as the installation of these penetration seals will be complete in the near future, we have determined that it is appropriate to add, at this time, Technical Specifications governing the operability and surveillance of the seals. The addition of these specifications has also been discussed with and agreed to by Met Ed. Therefore, we are adding such specifications, which are in conformance with those issued for other facilities and which we find acceptable.

7.0 Environmental Consideration

We have determined that the amendment does not authorize a change in effluent types or total amounts nor an increase in power level and will not result in any significant environmental impact. Having made this determination, we have further concluded that the amendment involves an action which is insignificant from the standpoint of environmental impact and, pursuant to 10 CFR §51.5(d)(4), that an environmental impact statement, or negative declaration and environmental impact appraisal need not be prepared in connection with the issuance of this amendment.

8.0 Conclusion

We have concluded, based on the considerations discussed above, that: (1) because the amendment does not involve a significant increase in the probability or consequences of accidents previously considered and does not involve a significant decrease in a safety margin, the amendment does not involve a significant hazards consideration, (2) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, and (3) 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 or to the health and safety of the public.

Dated: March 16, 1979