2. SAFETY LIMITS AND LIMITING SAFETY SYSTEM SETTINGS

2.1 SAFETY LIMITS, REACTOR CORE

Applicability

Applies to reactor thermal power, axial power imbalance, reactor coolant system pressure, coolant temperature, and coolant flow during power operation of the plant.

Objective

To maintain the integrity of the fuel cladding.

Specification

2.1.1 The combination of the reactor system pressure and coolant temperature shall not exceed the safety limit as defined by the locus of points established in Figure 2.1-1. If the actual pressure/temperature point is below and to the right of the line, the safety limit is exceeded.

2.1.2 The combination of reactor thermal power and axial power imbalance (power in the top half of core minus the power in the bottom half of the core expressed as a percentage of the rated power) shall not exceed the protective limit as defined by the locus of points (solid line) for the specified flow set forth in the Axial Power Imbalance Protective Limits given in the Core Operating Limits Report (COLR). If the actual-reactor-thermal-power/axial-power-imbalance point is above the line for the specified flow, the protective limit is exceeded.

Bases

To maintain the integrity of the fuel cladding and to prevent fission product release, it is necessary to prevent overheating of the cladding under normal operating conditions. This is accomplished by operating within the nucleate boiling regime of heat transfer, wherein the heat transfer coefficient is large enough so that the clad surface temperature is only slightly greater than the coolant temperature. The upper boundary of the nucleate boiling regime is termed, departure from nucleate boiling (DNB). At this point there is a sharp reduction of the heat transfer coefficient, which could result in excessive cladding temperature and the possibility of cladding failure. Although DNB is not an observable parameter during reactor operation, the observable parameters of neutron power, reactor coolant flow, temperature, and pressure can be related to DNB through the use of a critical heat flux (CHF) correlation. The BAW-2 (Reference 1) and BWC (Reference 2) correlations have been developed to predict DNB and the location of DNB for axially uniform and non-uniform heat flux distributions. The BAW-2 correlation applies to Mark-B fuel with inconel intermediate spacer grids and the BWC correlation applies to Mark-B fuel with zircaloy or M5 intermediate spacer grids (non-mixing vane). The local DNB ratio (DNBR), defined as the ratio of the heat flux that would cause DNB at a particular core location to the actual heat flux, is indicative of the margin to DNB. The minimum value of the DNBR, during steady-state operation, normal

5.3 REACTOR

Applicability

Applies to the design features of the reactor core and reactor coolant system.

Objective

To define the significant design features of the reactor core and reactor coolant system.

Specification

5.3.1 REACTOR CORE

5.3.1.1 A fuel assembly normally contains 208 fuel rods arranged in a 15 by 15 lattice. The reactor shall contain 177 fuel assemblies. Fuel rods shall be clad with zircaloy, ZIRLO, or zirconium-based M5 alloy materials and contain an initial composition of natural or slightly enriched uranium dioxide as fuel material. Limited substitutions of zirconium alloy or stainless steel filler rods for fuel rods, in accordance with NRC-approved applications of fuel rod configurations, may be used. Fuel assemblies shall be limited to those fuel designs that have been analyzed with applicable NRC staff-approved codes and methods, and shown by tests or analyses to comply with all fuel safety design bases. A limited number of lead test assemblies that have not completed representative testing may be placed in non-limiting core regions. The details of the fuel assembly design are described in TMI-1 UFSAR Chapter 3.

5.3.1.2 The reactor core shall approximate a right circular cylinder with an equivalent diameter of 128.9 inches. The active fuel height is defined in TMI-1 UFSAR Chapter 3.

5.3.1.3 The core average and individual batch enrichments for the present cycle are described in TMI-1 UFSAR Chapter 3.

5.3.1.4 The control rod assemblies (CRA) and axial power shaping rod assemblies (APSRA) are distributed in the reactor core as shown in TMI-1 FSAR Chapter 3. The CRA and APSRA design data are also described in the UFSAR.

5.3.1.5 The TMI-1 core may contain burnable poison rod assemblies (BPRA) and gadolinia-urania integral burnable poison fuel pellets as described in TMI-1 UFSAR Chapter 3.

5.3.1.6 Reload fuel assemblies and rods shall conform to design and evaluation data described in the UFSAR. Enrichment shall not exceed a nominal 5.0 weight percent of U_{235}.

5.3.2 REACTOR COOLANT SYSTEM

5.3.2.1 The reactor coolant system shall be designed and constructed in accordance with code requirements. (Refer to UFSAR Chapter 4 for details of design and operation.)

6.9.5 CORE OPERATING LIMITS REPORT

6.9.5.1 The core operating limits addressed by the individual Technical Specifications shall be established and documented in the CORE OPERATING LIMITS REPORT prior to each reload cycle or prior to any remaining part of a reload cycle.

6.9.5.2 The analytical methods used to determine the core operating limits addressed by the individual Technical Specifications shall be those previously reviewed and approved by the NRC for use at TMI-1, specifically:

(1) BAW-10179 P-A, "Safety and Methodology for Acceptable Cycle Reload Analyses." The current revision level shall be specified in the COLR.

(2) TR-078-A, "TMI-1 Transient Analyses Using the RETRAN Computer Code", Revision 0. NRC SER dated 2/10/97.

(3) TR-087-A, "TMI-1 Core Thermal-Hydraulic Methodology Using the VIPRE-01 Computer Code", Revision 0. NRC SER dated 12/19/96.

(4) TR-091-A, "Steady State Reactor Physics Methodology for TMI-1", Revision 0. NRC SER dated 2/21/96.

(5) TR-092P-A, "TMI-1 Reload Design and Setpoint Methodology", Revision 0. NRC SER dated 4/22/97.

(6) BAW-10227P-A, "Evaluation of Advanced Cladding and Structural Material (M5) in PWR Reactor Fuel", NRC SER dated February 4, 2000.

6.9.5.3 The core operating limits shall be determined so that all applicable limits (e.g., fuel thermal-mechanical limits, core thermal-hydraulic limits, ECCS limits, nuclear limits such as shutdown margin, and transient/accident analysis limits) of the safety analysis are met.

6.9.5.4 The CORE OPERATING LIMITS REPORT, including any mid-cycle revisions or supplements thereto, shall be provided upon issuance for each reload cycle to the NRC Document Control Desk with copies to the Regional Administrator and Resident Inspector.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NO. 233 TO FACILITY OPERATING LICENSE NO. DPR-50

AMERGEN ENERGY COMPANY, LLC

THREE MILE ISLAND NUCLEAR STATION, UNIT 1

DOCKET NO. 50-289

1.0 INTRODUCTION

By letter dated December 20, 2000, as supplemented March 14, 2001, AmerGen Energy Company, LLC (the licensee), submitted a request for approval of changes to the Three Mile Island Nuclear Station, Unit 1 (TMI-1), Technical Specifications (TSs). The March 14, 2001, letter provided additional clarifying information which did not change the initial proposed no significant hazards consideration determination or expand the amendment beyond the scope of the original notice. A March 23, 2001, letter provided a camera-ready copy of the revised TS pages.

The requested changes would permit the expanded use of the Framatome Cogema Fuels (FCF) M5 alloy for fuel rod cladding and fuel assembly spacer grids. A related Bases change is included with the licensee's application. Limited use of the M5 alloy in demonstration assemblies had been previously approved for TMI-1 in Amendment No. 194, dated July 24, 1995.

2.0 BACKGROUND

The licensee requested to operate TMI-1 with a batch reload of M5 alloy fuel beginning with the TMI-1 14th operating cycle and additional reloads of M5 alloy fuel in subsequent operating cycles until the TMI-1 core is fully loaded with M5 alloy fuel. The licensee's letter also indicates that the M5 alloy will also be used for fuel end plugs, and fuel assembly guide tubes and instrument tubes. A related exemption from the requirements of Title 10 of the *Code of Federal Regulations* (10 CFR) Sections 50.46, 50.44, and 10 CFR Part 50, Appendix K, to allow the expanded use of the M5 alloy has been issued on May 8, 2001.

3.0 EVALUATION

In its December 20, 2000, submittal, the licensee referenced Topical Report BAW-10227P-A, "Evaluation of Advanced Cladding and Structural Material (M5) in PWR [pressurized water reactor] Reactor Fuel," which had been approved by the Nuclear Regulatory Commission (NRC) staff on February 4, 2000, to justify its technical basis for using M5 fuel. BAW-10227P-A is an FCF generic topical report which describes the M5 alloy, its properties, and compares them with those of Zircaloy (Zr_4), the Zirconium alloy specified in 10 CFR 50.46(b) which it will

replace. Zircaloy is currently the most commonly used alloy in light water reactor core applications.

The NRC staff review of BAW-10227P-A found that M5 was sufficiently like Zr_4, and that it could replace Zr_4 in core designs. The staff also concluded that, when the two alloys were co-resident in the same core and had like geometry, a mixed core penalty would not have to be assessed to compensate for the material differences. The M5 fuel to be used at TMI-1 has very slight geometric differences from the resident Zr_4 alloy fuel. In evaluating the mixed-core penalty due to M5 fuel co-resident with Zr_4 fuel, the licensee determined that the penalty is negligible because the slight geometric differences have virtually no thermal-hydraulic effect. The staff, therefore, has determined that current licensing analyses will not be affected by the use of the M5 fuel at TMI-1.

In its March 14, 2001, letter, the licensee showed that BAW-10227P-A and the FCF loss-of-coolant accident (LOCA) analysis methodologies apply specifically to TMI-1 by stating that AmerGen and FCF have ongoing processes which assure that LOCA analysis input values for peak cladding temperature-sensitive parameters bound the as-operated plant values for those parameters. The licensee also described ongoing AmerGen and FCF processes which determine mixed-core penalties as needed. Since BAW-10227P-A also discusses other FCF methodologies and correlations such as those for fuel performance (swelling, hydriding, growth, etc.) and departure from nucleate boiling, these would also specifically apply to TMI-1 when operated with mixed and full-core loadings of M5-clad fuel and other M5 core structures.

The staff concludes that safe TMI-1 operation with M5 fuel can be assured when operated within the bounds of analyses performed with the methodologies found to apply specifically to TMI-1 as stated in this safety evaluation and as specified in the licensee's licensing basis documentation. The staff also concludes that, other than performing comparative analyses to determine which type of fuel is more limiting, which the licensee would document in the Core Operating Limits Report (COLR), licensing analyses will not be affected by the use of the M5 fuel at TMI-1.

The December 20, 2000, letter, Enclosure 2, contained proposed changes to the Bases of TMI-1 TS 2.1, "SAFETY LIMITS, REACTOR CORE" to specify which FCF critical heat flux correlations apply to Mark-B fuel with intermediate spacer grids made of either inconel, Zr_4, or M5. A change was also proposed to TS 5.3.1.1, "REACTOR CORE," to add M5 to the list of allowed reactor core materials. The TS additions are acceptable because they are consistent with the proposed use of M-5 fuel discussed above and meet the terms given in Topical Report BAW-10227P-A.

In the March 14, 2001, letter, the licensee proposed to change TMI-1 TS 6.9.5.2 by adding Topical Report BAW-10227P-A to the list of TMI-1 COLR references in response to the NRC staff's request. The NRC staff had requested this change to document and clarify the applicability of Topical Report BAW-10227P-A to TMI-1.

These changes correctly provide conditions of operation for the plant, are technically supported as discussed above, and are acceptable.

The staff has determined that it is acceptable to operate TMI-1 with the M-5 fuel, spacer grids, guide tubes, and instrument tubes as proposed because it is technically justified, and because

appropriate TS control is provided. This safety evaluation, in combination with an exemption issued on May 8, 2001, to 10 CFR 50.46, 10 CFR 50.44, and 10 CFR 50 Appendix K, provides adequate basis for operation of TMI-1 with its core partially or fully loaded with M-5 fuel assemblies. The staff also concludes that spacer grids, guide tubes, and instrument tubes made of M-5 are acceptable for TMI-1 operation.

4.0 STATE CONSULTATION

In accordance with the Commission's regulations, the Pennsylvania State official was notified of the proposed issuance of the amendment. The State official had no comments.

5.0 ENVIRONMENTAL CONSIDERATION

The amendment changes a requirement with respect to installation or use of a facility component located within the restricted area as defined in 10 CFR Part 20. The NRC 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 that there is no significant increase in individual or cumulative occupational radiation exposure. The Commission has previously issued a proposed finding that the amendment involves no significant hazards consideration, and there has been no public comment on such finding (66 FR 9379). Accordingly, the amendment meets 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 or environmental assessment need be prepared in connection with the issuance of the amendment.

6.0 CONCLUSION

The Commission has concluded, based on the 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, (2) such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendment will not be inimical to the common defense and security or to the health and safety of the public.

Principal Contributor: F. Orr

Date: May 10, 2001