May 4, 2001

Mr. Michael A. Balduzzi
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185 Old Ferry Road
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SUBJECT: VERMONT YANKEE NUCLEAR POWER STATION - ISSUANCE OF AMENDMENT RE: P/T LIMIT CURVES (TAC NO. MB0764)

Dear Mr. Balduzzi:

The Commission has issued the enclosed Amendment No. 203 to Facility Operating License DPR-28 for the Vermont Yankee Nuclear Power Station, in response to your application dated December 19, 2000 as supplemented on February 13 and 23, and March 29, 2001.

The amendment revises the Technical Specification (TS) by changing the reactor vessel pressure/temperature limit curves specified in TS 3.6.A.1, “Reactor Coolant Systems - Pressure and Temperature Limitations,” as graphically represented in Figure 3.6.1, “Hydrostatic Pressure and Leak Tests, Core Not Critical,” Figure 3.6.2, “Normal Operation, Core Not Critical,” and Figure 3.6.3, “Normal Operation, Core Critical.”

A copy of the related Safety Evaluation is also enclosed. Notice of Issuance will be included in the Commission’s biweekly Federal Register notice.

Sincerely,

/RA/

Robert M. Pulsifer, Project Manager, Section 2
Project Directorate I
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-271

Enclosures: 1. Amendment No. 203 to License No. DPR-28
2. Safety Evaluation

cc w/encls: See next page

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A copy of the related Safety Evaluation is also enclosed. Notice of Issuance will be included in the Commission's biweekly Federal Register notice.

Sincerely,
/RA/

Robert M. Pulsifer, Project Manager, Section 2
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Division of Licensing Project Management
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Docket No. 50-271

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VERMONT YANKEE NUCLEAR POWER CORPORATION

DOCKET NO. 50-271

VERMONT YANKEE NUCLEAR POWER STATION

AMENDMENT TO FACILITY OPERATING LICENSE

Amendment No. 203
License No. DPR-28

1. The Nuclear Regulatory Commission (the Commission) has found that:

   A. The application for amendment filed by the Vermont Yankee Nuclear Power Corporation (the licensee) dated December 19, 2000, as supplemented on February 13 and 23, and March 29, 2001, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations set forth in 10 CFR Chapter I;

   B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;

   C. There is reasonable assurance: (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;

   D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and

   E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

2. Accordingly, the license is amended by changes to the Technical Specifications as indicated in the attachment to this license amendment, and paragraph 3.B of Facility Operating License No. DPR-28 is hereby amended to read as follows:

   (B) Technical Specifications

   The Technical Specifications contained in Appendix A, as revised through Amendment No. 203, are hereby incorporated in the license. The licensee shall operate the facility in accordance with the Technical Specifications.

3. This license amendment is effective as of its date of issuance and shall be implemented within 60 days.

FOR THE NUCLEAR REGULATORY COMMISSION

/RA/ Victor Nerses for

James W. Clifford, Chief, Section 2
Project Directorate I
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Attachment: Changes to the Technical Specifications

Date of Issuance: May 4, 2001

ATTACHMENT TO LICENSE AMENDMENT NO. 203

FACILITY OPERATING LICENSE NO. DPR-28

DOCKET NO. 50-271

Replace the following pages of the Appendix A Technical Specifications with the attached revised pages. The revised pages are identified by amendment number and contain marginal lines indicating the areas of change.

Remove	Insert
115	115
116	116
135	135
136	136
137	137
138	138
139	139
140	140

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NO. 203 TO FACILITY OPERATING LICENSE NO. DPR-28

VERMONT YANKEE NUCLEAR POWER CORPORATION

VERMONT YANKEE NUCLEAR POWER STATION

DOCKET NO. 50-271

1.0 INTRODUCTION

By letter dated December 19, 2000, as supplemented on February 13 and 23, and March 29, 2001, the Vermont Yankee Nuclear Power Corporation (VYNPC, the licensee) submitted a request to amend the Vermont Yankee Nuclear Power Station (Vermont Yankee) Technical Specifications (TSs). The amendment revises the TSs by changing the reactor vessel pressure/temperature (P/T) limit curves specified in TS 3.6.A.1, "Reactor Coolant Systems - Pressure and Temperature Limitations," as graphically represented in Figures 3.6.1, "Hydrostatic Pressure and Leak Tests, Core Not Critical," Figure 3.6.2, "Normal Operation, Core Not Critical," and Figure 3.6.3, "Normal Operation, Core Critical."

The February 13 and 23, and March 29, 2001 supplements provided clarifying information that did not expand the scope of the application as published in the Federal Register or change the U.S. Nuclear Regulatory Commission (NRC) staff's proposed no significant hazards consideration determination.

2.0 BACKGROUND

2.1 Requirements for Generating Pressure-Temperature (P/T) Limits for Nuclear Power Generation Facilities

The NRC has established requirements in Appendix G to Part 50 of Title 10 of the *Code of Federal Regulations* (10 CFR Part 50, Appendix G), to protect the integrity of the reactor coolant pressure boundary in nuclear power plants. Appendix G to Part 50 requires the P/T limits for an operating plant to be at least as conservative as those that would be generated if the methods of Appendix G to Section XI of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Code) were applied. The methodology of Appendix G to the Code postulates the existence of a sharp surface flaw in the reactor pressure vessel (RPV) that is normal to the direction of the maximum applied stress. For materials in the beltline and upper and lower head regions of the RPV, the maximum flaw size is postulated to have a depth that is equal to 1/4 of the thickness and a length equal to 1.5 times the thickness. For the case of evaluating RPV nozzles, the surface flaw is postulated to propagate parallel to the axis of the nozzle's corner radius. The basic parameter in Appendix G to the Code for calculating P/T limit curves is the stress intensity factor, K_{Ia}, which is a function of the stress state and flaw configuration. The methodology requires that licensees determine the reference

stress intensity (K_{Ia}) factors, which vary as a function of temperature, from the reactor coolant system (RCS) operating temperatures, and from the adjusted reference temperatures (ARTs) for the limiting materials in the RPV. Thus, the critical locations in the RPV beltline and head regions are the 1/4-thickness (1/4T) and 3/4-thickness (3/4T) locations, which correspond to the points of the crack tips if the flaws are initiated and grown from the inside and outside surfaces of the vessel, respectively. Regulatory Guide (RG) 1.99, Revision 2, provides an acceptable method of calculating ARTs for ferritic RPV materials; the methods of RG 1.99, Revision 2, include methods for adjusting the ARTs of materials in the beltline region of the RPV, where the effects of neutron irradiation may induce an increased level of embrittlement in the materials.

The methodology of Appendix G requires that P/T curves must satisfy a safety factor of 2.0 on stress intensities arising from primary membrane and bending stresses during normal plant operations (including heatups, cooldowns, and transient operating conditions) and a safety factor of 1.5 on stress intensities arising from primary membrane and bending stresses when leak rate or hydrostatic pressure tests are performed on the RCS. Table 1 to 10 CFR Part 50, Appendix G provides the staff's criteria for meeting the P/T limit requirements of Appendix G to the Code and the minimum temperature requirements of the rule for bolting up the vessel during normal and pressure testing operations.

2.2 VYNPC Application

By letter dated December 19, 2000 (Ref. 1) as supplemented by letters dated February 13 and 23, and March 29, 2001 (Refs. 2, 3, and 4 respectively), VYNPC submitted a license amendment request to update the P/T limit curves for Vermont Yankee. The request changes the P/T limit curves effective to the end of the current operating license. On April 16, 2001 (Ref. 5), pursuant to 10 CFR 50.12, the NRC granted an exemption to allow VYNPC to deviate from the requirements of 10 CFR Part 50, Appendix G, and to use Code Case N-640 as the part of the bases for generating the Vermont Yankee P/T limit curves for normal operations effective to 32 EFPY.(1) The staff's evaluation of the proposed P/T limit curves is, in part, based on this exemption, and on the staff's evaluation of the RPV fast neutron fluence.

The estimate of the fluence, used by the licensee for the analysis presented in the submittal, originates from a 1984 surveillance capsule dosimetry analysis reported by Battelle Columbus Laboratories (Battelle) (Ref. 6). The cross sections and computational methods used to calculate the vessel fluence in this report do not conform to the regulatory guidance of RG 1.190 (DG 1053). Further, since the publication of this report, the licensee has not revised the report so as to comply with RG 1.190. The licensee's analyses to demonstrate the conservatism of the proposed P/T curves to the end-of-life are all predicated on the validity of the 1984 Battelle estimate of the fluence and have not been updated to reflect better data computational improvements. The licensee amended its request to limit the proposed P/T curves to the end of operating Cycle 23.

---

(1) Approval to use Code Case N-640 allows licensees to use the lower bound static initiation fracture toughness value equation (K_{Ic} equation) as the basis for establishing the P/T limits in lieu of using the lower bound crack arrest fracture toughness value equation (K_{Ia} equation), which is the method invoked by Appendix G to the Code. The staff's bases for approving use of Code Case N-640 is given in the SE dated April 16, 2001 (Ref. 5).

3.0 EVALUATION

3.1 Assessment of Neutron Fluence Levels

The staff has examined the licensee's proposal against Appendices G and H of 10 CFR Part 50; RG 1.99, Rev. 2; and RG 1.190 (to be published/DG 1053).

In general, the estimate of the neutron fluence enters the computation of the P/T curves through the transition temperature shift term (ΔRT_{NDT}) which accounts for neutron irradiation effects in the relation for the allowable stress intensity factor (Ref. 1, Attachment 6).

On March 4, 1983, after 7.54 effective full power years (EFPY) of irradiation, the surveillance capsule marked 117C 4084 G1 was removed after shutdown from the Vermont Yankee reactor. Based on three iron, three copper, and three nickel neutron monitor wires, the maximum fast flux (E > 1 MeV) at the surface of the vessel was estimated to be 2.18×10^8 n/cm^2-sec. This result gives a peak fast fluence of 5.19×10^{16} n/cm^2 at the time of the removal of the surveillance capsule. Furthermore, extrapolated to the time of the current submittal (22.11 EFPY), gives a value of 1.52×10^{17} n/cm^2, and a peak end-of-life (32 EFPY) fast fluence of 2.2×10^{17} n/cm^2 (Ref. 1).

Appendices G and H to 10 CFR Part 50 specify the fracture toughness requirements for ferritic materials of pressure-retaining components of the RCP boundary of light water reactor nuclear power reactors. In particular, Appendix H specifies the material surveillance program required to monitor changes in the reactor toughness properties of ferritic materials in the reactor vessel beltline region of light water nuclear power reactors that result from the exposure of these materials to neutron irradiation. In the context of the license amendment request (Ref. 1), there are two applicable surveillance criteria specified in 10 CFR Part 50, Appendix H.

A. No material surveillance program is required if by appropriate analytical methods it can be conservatively demonstrated that the peak neutron fluence at the end of the design life of the vessel will not exceed 10^{17} n/cm^2 (E > 1MeV).

B. If the above condition is not met, the reactor vessel must have the beltline materials monitored by a surveillance program.

The peak end-of-life fluence, extrapolated from the 1983 estimate of the peak fast flux, exceeds 10^{17} n/cm^2 (E > 1MeV). Moreover, the estimate was calculated with computer codes and methodologies that have not been reviewed or approved by the NRC for licensing applications. Thus, to fulfill the requirements of 10 CFR Part 50, Appendix H, the licensee has a surveillance program in place as described in the Vermont Yankee TSs. To date, the surveillance capsule withdrawal schedule has produced only one set of data (i.e., that of March 1983).

The licensee's amendment request is for a TS change to the P/T curves effective to the end of the current license. The staff finds that the licensee's computation of the effect of irradiation on the ductile-to-brittle temperature is dependent on the fast flux estimate from Ref. 1; and, therefore, does not conform to the requirement of credibility in 10 CFR Part 50, Appendix H, and RG 1.99, Rev 2. The validity of that estimate, without a fluence calculation based on NRC

reviewed and accepted computers codes and methodologies, or more surveillance data, is indefensible to the end of life; it brings into question the validity of the associated P/T curves to the end of life.

The licensee has subsequently amended its submittal (Ref. 4); and requested that the revision to the reactor vessel P/T limit curves specified in Ref. 1 be effective only through the end of Cycle 23. The staff finds this request acceptable. This conclusion is based on the following technical considerations:

a. Cycle 23 ends well before the end of the current license. The fast fluence is a monotonic function of time and would be at its maximum at the end of the license. Therefore, the fluence at the end of Cycle 23 is much less than expected at the end of the licensed life.

b. Vermont Yankee instituted low-leakage-core fuel management (placing low energy three or four times burned fuel bundles on the core periphery) shortly after the first set of surveillance capsules were removed. Thus, the reactor has operated this way for about 14 EFPY. Low-leakage fuel management is generally a significant contributor to the reduction of the fast fluence at the pressure vessel.

c. The licensee reassessed the initial reference temperature (RT_{NDT}) for beltline materials according to Branch Technical Position MTEB 5-2. The reassessment showed a reduction of the RT_{NDT} by about 25 percent from the earlier assessment.

   The reassessment demonstrated that for the same P/T conditions, the transition temperature shift term (ΔRT_{NDT}) retains its current value.

d. The licensee has assessed the instrumentation used to monitor the vessel P/T conditions and has conservatively estimated instrument uncertainty as +/- 10 ^{o}F for temperature readings and +/- 30 psig for pressure readings. These are taken into account and shift the P/T curves conservatively to the right by 10 ^{o}F.

These factors show that the expected fast fluence will be within acceptable fluence levels and that the P/T curves will be acceptable to the end of Cycle 23 as proposed in Ref. 4.

In summary, the estimate of the fluence used by the licensee for the analysis presented in the submittal originates from a 1984 Battelle report (Ref. 6). This report is unacceptable for present licensing applications, since it contains cross sections and computational methods used to calculate the vessel fluence which are not acceptable to the NRC. Moreover, since the publication of this report in 1984, the licensee has not performed sufficiently rigorous analyses to justify the continued use of that estimate of the fluence, or produced a new estimate. The analyses presented by the licensee in the amendment request that demonstrated the conservatism of the proposed P/T curves, are all predicated on the validity of the 1984 Battelle estimate of the fluence. Thus, the staff finds the P/T curves, as proposed, indefensible for application to the end of the operating license.

The staff, however, feels that for operation to the end of Cycle 23, as proposed in the March 29, 2001, letter there is reasonable assurance that the P/T curves presented by the licensee in the original amendment request (Ref 1.) will ensure that the facility will operate

within the acceptance criteria of the Updated Final Safety Analysis Report (UFSAR) and the health and safety of the public will not be endangered.

Based on these considerations, the staff concludes there is reasonable assurance of safety and finds the proposed P/T curves acceptable for use until end of Cycle 23.

3.2 P/T Limit Curve Assessment

For the normal operating conditions with the core not critical, and for pressure testing condition curves, individual P/T curves were proposed for the lower head in addition to the composite curves proposed for the beltline, nozzles, and upper vessel regions of the RPV. To test the validity of Vermont Yankee's proposed curves, the staff performed an independent assessment of the licensee's submittal. The staff applied the methodologies of the 1995 Edition of Appendix G to the Code and 10 CFR Part 50, Appendix G, as modified by the methodology of ASME Code Case N-640, as the bases for its independent assessment. For the evaluation of the RPV nozzles, the staff also modified the methods of Appendix G to the Code by the nozzle evaluation methods proposed in Appendix 5 of Welding Research Council Bulletin WRC-175, "PVRC Recommendations on Toughness Requirements for Ferritic Materials" (August 1972). This is consistent with the methods in the 1995 Edition of Appendix G to Section XI of the ASME Code.

The staff's assessment also included an independent calculation of the ART values for both the 1/4T and 3/4T locations of Vermont Yankee RPV beltline regions based on the neutron fluence specified in the submittal for Vermont Yankee effective to 32 EFPY. For the evaluation of the limiting beltline materials, the staff confirmed that the ARTs and P/T limit curves were based on the methodology of RG 1.99, Revision 2. For the evaluation of the limiting material in the limiting nozzle and lower head evaluations, the staff applied the plant-specific design basis data provided by the licensee.

The staff determined that Vermont Yankee's P/T limit generation methods were based on conservative assumptions that made the proposed P/T limit curves as conservative or slightly more conservative than the P/T limit curves generated by the staff. The staff also confirmed that Vermont Yankee's P/T limit curves included appropriate minimum temperature requirements that were at least as conservative as those required in Table 1 of 10 CFR Part 50, Appendix G, as exempted and modified by the methods of Code Case N-640.

4.0 STAFF EVALUATION RESULTS

Based on the staff's review and evaluation of VYNPC's proposed P/T limit curves for Vermont Yankee, the staff has determined that the proposed P/T limit curves are consistent with the alternate assessment criteria and methods of ASME Code Case N-640, and satisfy the requirements of 10 CFR 50.60(a), "Acceptance Criteria for Fracture Prevention Measures for Lightwater Nuclear Power Reactors for Normal Operation;" Appendix G to 10 CFR Part 50, "Fracture Toughness Requirements;" and Appendix G to the 1995 Edition of Section XI of the ASME Code, as exempted by the methods of analyses in the code case. The staff concludes that the updated P/T limit curves proposed by VYNPC for operation through Cycle 23, will continue to provide an acceptable level of margin and safety, and will provide sufficient assurance that the Vermont Yankee reactor will be operated in a manner that will protect the

RPV against brittle fracture. The proposed curves (Figures 3.6.1, 3.6.2, and 3.6.3) are, therefore, acceptable for incorporation into the Vermont Yankee TSs and for use until the end of Cycle 23, which is currently estimated by VYNPC to be April 2004. The proposed changes to TSs 3.6.A.1 and 4.6.5, reflecting the use of these curves as provided in the TS are also acceptable. For operation beyond Cycle 23, the licensee must submit for review and approval, an amendment request justifying the use of the curves beyond Cycle 23 which satisfies the guidance of RG 1.190. VYNPC has made changes to the Bases to reflect these new P/T curves and the staff has no objections.

5.0 STATE CONSULTATION

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

6.0 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 and changes surveillance requirements. The NRC staff has determined that the amendment involves no significant increase in 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 7687). 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.

7.0 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.

8.0 REFERENCES

1. Letter from M. A. Balduzzi, Vice President - Operations, Vermont Yankee Nuclear Power Corporation, to the U.S. Nuclear Regulatory Commission Document Control Desk, "Vermont Yankee Nuclear Power Station, . . . Technical Specification Proposed Change No. 244, Revised P/T Curves and Exemption of use Code Cases N-588 and N-640," December 19, 2000.

2. Letter from D. M. Leach, Vice President - Engineering, Vermont Yankee Nuclear Power Corporation, to the U.S. Nuclear Regulatory Commission Document Control Desk, "Vermont Yankee Nuclear Power Station, . . . Supplement to Technical Specification Proposed Change No. 244, "Withdrawal of Exemption of Use Code Cases N-588," February 13, 2001.

3. Letter from M. A. Balduzzi, Vice President - Operations, Vermont Yankee Nuclear Power Corporation, to the U.S. Nuclear Regulatory Commission Document Control Desk, “Vermont Yankee Nuclear Power Station, . . . Technical Specification Proposed Change No. 244, Response to Request for Additional Information,” February 23, 2001.

4. Letter from D. M. Leach, Vice President - Engineering, Vermont Yankee Nuclear Power Corporation, to the U.S. Nuclear Regulatory Commission Document Control Desk, “Vermont Yankee Nuclear Power Station, . . . Supplement to Technical Specification Proposed Change No. 244," March 29, 2001

5. Letter from R. M. Pulsifer, Project Manager, Nuclear Regulatory Commission, to M. A. Balduzzi, Vice President, Operations, Vermont Yankee Nuclear Power Corporation, "Vermont Yankee Nuclear Power Station - Exemption From the Requirements of 10 CFR Part 50, Appendix G (TAC NO. MB0763),” April 16, 2001.

6. Battelle Columbia Laboratories report BCL-585-84-3, “Examination, Testing and Evaluation of Irradiated Pressure Vessel Surveillance Specimens from the Vermont Yankee Nuclear Power Station,” May 15, 1984.

Principal Contributors: J. Medoff
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Date: May 4, 2001