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BVY 94-36

United States Nuclear Regulatory Commission
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Washington, D.C. 20555

References:
(a) License No. DPR-28 (Docket No. 50-271).
(b) Letter, USNRC to L.A. England (BWROG), Acceptance for Referencing of Topical Reports NEDO-31960 and NEDO-31960 Supplement 1, "BWR Owner's Group Long-Term Stability Solutions Licensing Methodology"(TAC NO. M75928), July 12, 1993.
(c) Licensing Topical Report, BWR Owner's Group Long-Term Stability Solutions Licensing Methodology, NEDO-31960, General Electric Nuclear Energy, June 1991.
(d) Licensing Topical Report, BWR Owner's Group Long-Term Solutions Licensing Methodology (Supplement 1), NEDO-31960 Supplement 1, General Electric Nuclear Energy, March 1992.
(e) Licensing Topical Report, Application of the "Regional Exclusion with Flow Based Scram APRM Neutron Flux Scram" Stability Solution (Option 1-D) to the Vermont Yankee Nuclear Power Plant, GENE-637-018-0793., General Electric Nuclear Energy, July 1993.
(f) NRC Bulletin 88-07, Supplement 1, NVY 88-267, December 30, 1988.

Subject: Proposed Change No. 173, BWR Thermal Hydraulic Stability and Plant-Information Requirements for BWROG Option 1-D Long Term Stability Solution

In July 1993, NRC issued, via Reference (b), a Safety Evaluation Report (SER) for the BWR Owner's Group Long-Term Stability Solution Licensing Methodology [References (c) and (d)]. The SER and the attached Technical Evaluation Report (TER) contained specific limitations for acceptance of each of the long term solutions options for a given plant. Prior to the issuance of the SER, a plant specific evaluation of the applicability of Vermont Yankee to long term solution Option 1-D was performed and the results submitted as a licensing topical report [Reference (e)]. The purpose of this letter and attachments is to supplement the previous submittal with specific information requested in the TER on the application of Option 1-D to Vermont Yankee.

The information submitted in this letter and attachment includes:

- Specific information requested on pages 26 and 27 of the TER.
- The Proposed Change package required to implement Option 1-D.
- The Core Operating Limits Reports (COLR) changes to add the fuel cycle dependent stability power and flow limits (exclusion region).

The information contained in the answers to the TER questions provide the details of administrative controls used with the power and flow exclusion region including reference to the use of power distribution controls. Power distribution controls will be administratively implemented to assure that plant operation is maintained within the safety analysis basis from which the power/flow limits were derived. The COLR changes contain power and flow limits based on the Cycle 15 analyses contained in Reference (e) and are for example only. Vermont Yankee is currently operating in Cycle 17 and plans to implement the proposed change during Cycle 18. The stability limits for Cycle 18 will be submitted separately as a modification to the COLR.

The remainder of this letter contains the information needed to support the proposed change to Vermont Yankee's Operating License pursuant to Section 50.90 of the Commission's Rules and Regulations. Attachment A contains the information requested via the TER, the proposed changes and the example COLR changes.

Proposed Change

The proposed change modifies the requirements for avoidance and protection from thermal hydraulic instabilities to be consistent with BWROG long term solution Option 1-D described in References (b) and (c). The proposed changes are:

1. Page 14, Section 2.1.A.1.a. Revises the basis for the APRM Flux Scram Setting in Run Mode. Current basis states the 120% flux scram setpoint protects from all abnormal operational occurrences (AOOs). Analysis of AOOs resulting in an instability requires the use of the flow biased portion of the APRM flux scram to ensure the safety limit is not exceeded. The text of this section is modified to indicate that analysis of the flow biased scram has been carried out over its range from 120% to 54% and protection is provided from all AOOs, including those that may result in an instability.

2. Pages 110, 110a, and 110b, Section 3.6.G.1.b. Removes requirements for neutron flux monitoring when entering stability exclusion regions. Normal operation is not allowed within the exclusion region in single loop operation per new analysis based requirements. Therefore a statement is added to this section to identify that the exclusion region is to be avoided during single loop operation and will be immediately exited should inadvertent entry occur. The

exclusion region is to be defined in the Core Operating Limits Report by reference in Technical Specification 3.6.J.

3. Page 110, Section 4.6.F.3. Removes requirement to obtain baseline neutron flux noise data. This information is required for operating within defined exclusion regions and is not necessary; if the exclusion region is entered, the first action is to exit.

4. Pages 110c and 110d, Section 3.6.H. Eliminates requirement to monitor APRM and LPRM neutron noise flux levels in the exclusion region. Renumbers LCO 3.6.H.2 to 3.6.H.1. Renumbers LCO 3.6.H.3 to 3.6.H.2 and eliminates reference to exclusion region.

5. Page 110j, Section 3.6.J. Revise entire section. The requirements for operation are defined in this section. Normal plant operation is not allowed in the analytically defined exclusion region. The exclusion region is described in the Core Operating Limits Report since it may be dependent upon the fuel cycle characteristics. Immediate exit is required for any inadvertent region entry.

6. Page 111c, Figure 3.6.4. This page contains the previous stability exclusion regions. It is being deleted since the exclusion region will be identified in the Core Operating Limits Report.

7. Page 124a, Section 3.6.G, 4.6 G Bases. The Basis for single loop operation is modified to delete reference to thermal hydraulic stability. Analysis supporting the exclusion region boundary and flow biased neutron flux scram for stability are bounding for all modes of operation. Thus, explicit reference to the thermal hydraulic stability exclusion region for the single loop mode is not necessary.

8. Page 124b, Section 3.6.H, 4.6.H. Bases. The Basis for the recirculation system is modified to remove reference to thermal hydraulic stability. Bases of stability operating restrictions are identified in Section 3.6.J Bases.

9. Page 125 and 125a, Section 3.6.J, 4.6.J Bases. The Bases for thermal hydraulic stability is revised to reflect the current approach for avoiding and protecting the fuel from thermal hydraulic instabilities.

10. Page 209 and 209d, Section 6.7.A.4. Add approved methods to this section.

<u>Reason for Change:</u>

The BWROG has pursued resolution to NRC concerns over reactor fuel performance during instability events since the 1988 LaSalle incident. The NRC concerns have centered on compliance with General Design Criteria (GDC) 10 and

12. Several solutions to ensure compliance with the GDCs have been developed and approved by the NRC in Reference (b).

This Proposed Change modifies the facility requirements for thermal hydraulic stability avoidance and protection to be consistent with the NRC approved Owner's Group solution options. Vermont Yankee has participated in the development of each option and has chosen to pursue Option 1-D by obtaining a plant-specific assessment for suitability of this solution. Option 1-D requires use of the flow-biased Average Power Range Monitor high neutron flux scram and a power/flow map exclusion region while adhering to certain power distribution limitations. The Proposed Change consists of the required operational restrictions associated with the exclusion region and modifies the bases of the Technical Specifications to describe this option. The implementation of these changes will ensure Vermont Yankee has addressed all concerns associated with GDC 10 and 12 compliance required by NRC.

Basis for Change:

Modification to the conditions of operation for avoidance and protection from thermal hydraulic oscillations is required to resolve generic issues associated with compliance to General Design Criteria 10 and 12. The modifications are based on a Vermont Yankee specific engineering assessment of oscillations using NRC approved BWROG methodologies [Reference (b)] for long-term solution Option 1-D. The assessment consisted of a two part calculation to derive the necessary plant operating restrictions.

The calculation consisted of:

1. Determination of power and flow operating limits based on conditions potentially leading to an instability.

2. Simulation of fuel performance during an anticipated operational occurrence resulting in an instability with the flow-biased APRM neutron flux scram system used to automatically suppress the oscillation.

The analyses has determined that the flow biased scram will function to suppress oscillations prior to exceeding the fuel safety limit of Minimum Critical Power Ratio (MCPR). Although the flow biased scram provides automatic fuel protection, Option 1-D also includes the use of a power/flow map exclusion region to prevent the occurrence of an oscillation during normal operation. The exclusion region, which is to be defined in the Core Operating Limits Report (COLR), provides the boundary for normal operation or operator actions. Normal operation occurs outside of the exclusion region. Inadvertent entries into the region by flow decreases and/or power increases require immediate action to exit by flow increase and/or control rod insertion.

Safety Considerations

The APRM flow biased scram system at Vermont Yankee has a design which prevents exceeding the MCPR fuel safety limit during an oscillation event. This scram system has been analyzed in Reference (e) and will automatically suppress the oscillation. This analysis addressed all abnormal operational occurrences and operating conditions which may result in an instability and challenge the flow biased scram and fuel safety limit.

Operation outside the power and flow exclusion region provides a high level of confidence that an instability will not occur. The exclusion region has been determined with a plant specific application, using Cycle 15 parameters, of the approved BWROG methods in Reference (e). Directions to exit the exclusion region for an inadvertent entry provide additional assurance of safe operation.

This Proposed Change has been reviewed by Vermont Yankee Plant Operations Review Committee and the Vermont Yankee Nuclear Safety Audit and Review Committee.

Significant Hazards Consideration

The standards used to determine that a request for amendment involves no significant hazards are included in the Commission's regulations (10CFR50.92). These standards state that the operation of the facility in accordance with the proposed amendment will not: (1) involve a significant increase in the probability or consequences of an accident previously evaluated, (2) create the possibility of a new or different kind of accident from an accident previously evaluated, or (3) involve a significant reduction in a margin of safety.

The discussion below addresses each of these criteria and demonstrates that the proposed amendment involves no significant hazards consideration.

1. The proposed amendment will not involve a significant increase in the probability or consequences of an accident previously evaluated. The implementation of BWR Owner's Group long term stability solution Option 1-D at Vermont Yankee does not modify the assumptions contained in the existing accident analysis. The use of an exclusion region and the operator actions required to avoid and minimize operation inside the region do not increase the possibility of an accident. Conditions of operation outside of the exclusion region are within the analytical envelope of the existing safety analysis. The operator action requirement to exit the exclusion region upon entry minimizes the possibility of an oscillation occurring. The actions to drive control rods and/or to increase recirculation flow to exit the region are maneuvers within the envelope of normal plant evolutions. The flow biased scram has been analyzed and will provide automatic fuel protection in the event of an instability. Thus, each proposed operating requirement provides defense in depth for protection from an instability event while maintaining the existing assumptions of the accident analysis.

2. The proposed amendment will not create the possibility of a new or different kind of accident from an accident previously evaluated.

As stated in 1), the proposed operating requirements either mandate operation within the envelope of existing plant operating conditions or force specific operating maneuvers within those carried out in normal operation. Since operation of the plant with all of the proposed requirements are within the existing operating basis, an unanalyzed accident will not be created through implementation of the proposed change.

3. The proposed amendment will not involve a significant reduction in a margin of safety. Each of the proposed requirements for plant thermal hydraulic stability provides a means for fuel protection. The combination of avoiding possible unstable conditions and the automatic flow biased reactor scram provides an in depth means for fuel protection. Therefore, the individual or combination of means to avoid and suppress an instability supplements the margin of safety.

Based on the above discussion, we have determined that this change does not constitute a significant hazard as defined in 10CFR50.92(c).

We trust that the information in this letter, the proposed changes and the attached responses to the TER support our request for approval of Option 1-D as a means to long term resolution of the stability issues at Vermont Yankee. Should you have any questions, please contact us. Vermont Yankee is prepared to meet and discuss this submittal at your convenience.

Sincerely,

Vermont Yankee Nuclear Power Corporation

Donald A. Reid
Vice President - Operations

cc: USNRC Project Manager - VYNPS
USNRC Region I Administrator
USNRC Resident Inspector - VYNPS

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STATE OF VERMONT)
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WINDHAM COUNTY)

Then personally appeared before me, Donald A. Reid, who, being duly sworn, did state that he is Vice President of Vermont Yankee Nuclear Power Corporation, that he is duly authorized to execute and file the foregoing document in the name and on behalf of the Vermont Yankee Nuclear Power Corporation and that the statements therein are true to the best of the his knowledge and belief.

Sally A. Sandstrum

Sally A. Sandstrum, Notary Public
My Commission Expires February 10, 1995

SALLY A. SANDSTRUM NOTARY PUBLIC WINDHAM COUNTY, VERMONT

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ATTACHMENT A

Vermont Yankee Responses to NRC TER Option 1-D Questions

The following contain responses to the NRC information requirements contained on page 25 and 26 of the Reference (b) Technical Evaluation Report.

1.0 Describe how the exclusion region for administrative control actions will be calculated and defined.

All exclusion region calculations will be carried out with the approved BWROG methodology (References (c) and (d)). Calculations of the region for Vermont Yankee Cycle 15 have been performed and previously submitted Reference (e). Subsequent reload cycles will assess whether the Cycle 15 exclusion region is bounding or new limits are needed. Either way, the calculations will be carried out with approved methodology.

Definition of the exclusion region will occur in the Core Operating Limits Report (COLR) as defined by Technical Specification 3.6.J. The proposed Technical Specifications in Appendix 1 to this attachment, contain specific reference to the COLR, where a figure (2.4-1) defining the power/flow map and the stability exclusion region are to be included. Modifications of the Vermont Yankee COLR to include thermal hydraulic stability based operating limits are contained in Appendix 2. In addition, power distribution controls will ensure that the analysis assumptions on which the exclusion region is based are maintained during plant operation.

2.0 Describe in detail the proposed administrative control actions if the reactor enters the exclusion region.

Sections A.3.4 - A.3.6 of Reference (c) describe the intended approach for implementation of Option 1-D via Technical Specifications, administrative limits and operating procedures. Vermont Yankee's implementation will be consistent with this approach. The proposed Technical Specifications changes (Appendix 1) include a Limiting Condition for Operation (LCO) for the exclusion region. The exclusion region will be identified on a power/flow map as in Appendix 2 (Figure 2.4-1), the proposed COLR modifications. Action statements requiring control rod insertion and/or flow increase for an unplanned entry are included in the Technical Specifications and operating procedures. An unplanned but necessary entry may occur as the result of an abnormal event such as a single pump trip. To protect plant equipment such as a recirculation pump, it may be necessary to enter the exclusion region before control rod insertion can begin to drive the reactor out of the exclusion region. The operator is directed via procedure to manually scram the plant upon recognition of an instability. These action statements are designed to prevent or suppress the occurrence of an instability, even though the flow biased APRM scram will automatically scram the plant to protect the fuel safety limit.

3.0 Describe any hardware or administrative control rod block functions that will be associated with the exclusion region. Specifically, describe how these functions are calculated and defined and what type of automated or operator action is required.

There are no planned automatic control rod block functions associated with the boundaries of the exclusion region. The exclusion region is to be avoided and will not be intentionally entered under normal operating circumstances. As defined in the proposed Technical Specifications, the operator, upon recognition of entry into the power flow exclusion region, will insert control rods and/or increase recirculation flow to exit. The insertion of control rods will be in reverse sequence of the startup path, a pre-planned sequence, or as guided by the reactor engineering staff. Operating procedures and training currently contain such directions as a result of the Interim Corrective Action guidance (Reference (f)). Upon implementation of Option 1-D, procedures and training will be consistent with information described above and further explained in Sections A.3.4 - A.3.6 of Reference (c). Plant procedures may require operator actions that result in entry into the exclusion region to protect plant equipment. These circumstances are not considered part of normal operation.

4.0 Describe in detail the information that the operator relies on to provide these administrative controls. In particular, describe how the information is presented to the operator and its "safety classification" (i.e. Class 1-E or not). Explain why this safety classification is adequate.

The operator will rely on existing instrumentation in the control room to maintain the plant outside the excluded region, control power distribution and identify an instability. These include the core flow instrumentation, the Average Power Range Monitors, and the plant process computer output terminals. The instrument signals reaching the control room used to monitor and control the plant within its operating limits are commercial grade. The classification of this equipment is consistent with other instruments by which plant limits are monitored.

During a series of thermal hydraulic stability tests performed at Vermont Yankee in 1981, the plant was maneuvered into and out of a limit cycle oscillation which was readily detectable on the control room instruments. No unusual behavior or equipment damage occurred. Following the test series, the plant was returned to rated power without incident.

While the instrumentation is essential for monitoring the plant operating state, administrative controls for stability including startup and shutdown sequence plans, operational procedures and operator training are also provided. These controls ensure that the operators will be able to maintain the plant within power and flow limits and power distributions. The start up and shutdown plans and procedures are currently designed to avoid operation within the exclusion region and will continue to do so.

The current operating procedure for stability contains each of the proposed stability operating restrictions, required actions and methods for recognition of an instability. Training ensures that operators are qualified to administrate the controls for stability. In addition, the training provides information regarding thermal hydraulic stability phenomena and alternate methods of recognizing an instability.

5.0 Describe what indications the operator would have in the control room if a power oscillation (either in phase or out of phase) were to develop. Describe the operator actions required under these circumstances.

The operators will rely on APRM instrument readings to identify an oscillation and scram the plant. In addition, operator training will also include other means for confirmation of an oscillation. The procedure will provide direction for the operator to confirm an oscillation by a 10% peak to peak APRM reading. The 10% limit is based on analysis of background noise and APRM flow biased scram performance during an oscillation. A lower setpoint may result in an unnecessary plant scram while a higher value reduces confidence in the ability of the operator to scram the plant before the flow biased scram. Training of the operators includes guidance for other means of recognizing an oscillation. These include:

1. APRM and/or LPRM Upscale or Downscale alarms
2. LPRM readings
3. Periodicity of the APRM or LPRM signal
4. Pressure or Level Swings

The operators will be directed to scram the plant upon confirmation of an oscillation, even though the APRM flow-biased scram will automatically perform the same function prior to exceeding safety limits.

6.0 Provide analyses showing the area inside the exclusion region where the flow-biased scram does not provide protection for out-of-phase instabilities. These calculations determine the non-protection line, which is defined as the line in the power-flow map below which the flow-biased scram does not provide automatic protection. Two lines must be defined:

6.1 The non-protection line at the 95% probability level with the initial CPR at technical specification limits.

The BWROG Detect and Suppress Methodology has been used to calculate Final MCPR values for out-of-phase oscillations initiating at different rodlines along the Natural Circulation Line. The methodology and inputs are consistent with those presented in the previous Vermont Yankee submittal (Reference (e)). The non-protection line is determined as the initiating state point at which the Final MCPR is equal to the Safety Limit MCPR for a given core flow rate.

With the initial MCPR at technical specification limits and the high statistical factor applied, the out-of-phase oscillations cannot grow very large before the Safety Limit MCPR is reached. This corresponds to a small change in core power level before the flow-biased scram is reached. The 95% probability level out-of-phase oscillation non-protection line was found to be approximately 2% of rated core power below the flow-biased scram line for any given core flow rate. At natural circulation, this corresponds to the 110% rodline.

6.2 The non-protection line at the 50% probability level with the expected initial CPR.

Similar analysis has been performed to determine the out-of-phase nonprotection line at the 50% probability level with the initial MCPR at a nominal, cycle average value consistent with the analysis presented in the previous submittal (Reference (e)). The initial MCPR is assumed to increase at lower rodlines. 3-D BWR Simulator calculations were performed to estimate this increase in CPR.

With the initial MCPR at a nominal value and nominal statistics used, the out-of-phase oscillations can grow larger than in the analysis above before the Safety Limit MCPR is reached. This corresponds to a larger change in core power level before the flow-biased scram is reached. The 50% probability level out-of-phase oscillation nonprotection line was found to be approximately 10% of rated core power below the flow-biased scram line for any given core flow rate. At natural circulation, this corresponds to the 90% rodline.

7.0 Provide reasonably bounding analyses showing that oscillations in the out-of-phase mode are highly unlikely in Solution I-D plants operating below the 50%-level nonprotection line. These calculations must be performed along the 50%-level nonprotection line and include at least the following cases:

7.1 Calculation of core and hot-channel decay ratios using the standard BWROG procedures for exclusion region calculations (NEDO 31960). These calculations must show that the core decay ratio is significantly larger than the hot-channel decay ratio so that the predicted mode of oscillation for these conditions is in-phase. Provide documentation of the radial power distribution (in particular the hot-channel peaking factor) used in these calculations, and justify why the chosen peaking factors are conservative.

Core and hot-channel decay ratios at the 50% level out-of-phase nonprotection line using the BWROG Regional Exclusion Methodology were obtained by interpolation of the data in the previous submittal (Reference (e)). The decay ratios were computed at natural circulation to yield the most conservative analysis. The data is shown below.

Parameter	Value
Core Power (% of Rated)	43.2
Core Flow Rate (% of Rated)	30.0
Rodline (% of Rated)	90.0
Radial Peaking Factor	1.42
Core Average Axial Peaking	1.53n3
Hot Channel Axial Peaking	1.80n3
Core Decay Ratio	1.06
Hot Channel Decay Ratio	0.44

The core decay ratio is significantly larger than the hot-channel decay ratio at the out-of-phase nonprotection line. Therefore, the predicted mode of oscillation for these conditions is in-phase using the BWROG procedure. The radial power distribution used in the procedure is the Haling distribution. Although this radial peaking is not bounding with respect to stability, the procedure uses a combination of inputs which together yield a conservative analysis. In addition, radial peaking in the Vermont Yankee reactor core cannot become significantly larger than the Haling when using normal rod patterns due to its small size.

7.2 Calculations of core and hot-channel decay ratios using conservatively defined bottom-peaked power shapes that are more representative of startup conditions than the standard BWROG procedure. These calculations must include axial and radial power shapes representative of (1) normal startup and (2) operation with failed feedwater heaters. Document the actual power shapes used and justify their conservatism.

Core and hot-channel decay ratios have been calculated at the 50% level out-of-phase nonprotection line (90% rodline at natural circulation) using realistic 3-D power shapes for several cases. Critical rod patterns were developed with the 3-D BWR Simulator and the power shapes were input into FABLE/BYPSS. The BWROG procedure is used with the exception of the power shapes.

The cases that were run include: a normal startup rod pattern at end-of-cycle, operation with failed feedwater heaters at end-of-cycle, and high radial peaking rod patterns at beginning- and end-of-cycle. The high radial peaking is obtained by fully withdrawing the center control rod while the other rods in that sequence are deeply inserted. It is conservatively assumed in each case that there is no Xenon in the core. The results of the analysis are shown below.

The core decay ratio is significantly larger than the channel decay ratio for normal startup, failed feedwater heaters, and high radial peaking at end-of-cycle. For these conditions, the predicted mode of oscillation is in-phase. The power shapes used in these cases are relatively conservative, although not limiting.

Case	Normal Startup	Failed Feedwater Heaters	High Radial Peaking	
Exposure	EOC	EOC	EOC	BOC
Radial Peaking Factor	1.40	1.42	1.61	1.35
Core Average Axial Peaking	1.37n3	1.49n3	1.47n3	2.84n3
Hot Channel Axial Peaking	1.66n3	1.79n3	1.40n3	2.62n3
Core DR	0.92	1.01	1.03	0.46
Channel DR	0.39	0.43	0.44	0.50

The power shape used in the high radial peaking at beginning-of-cycle case is very extreme and is not representative of operating conditions at Vermont Yankee. Note that the radial peaking factor calculated by the BWR Simulator for these conditions is relatively low, even with the center control rod completely withdrawn. The core decay ratio is much smaller for the beginning-of-cycle case than for the end-of-cycle case because less power is produced in the highly voided region in the top of the core. The channel decay ratio is higher for the beginning-of-cycle case because more power is produced in the bottom of the hot channel. The stability criterion is met for this case even with an extreme power shape.