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March 24, 2005

Docket No. 50-271
BVY 05-030
TAC No. MC0761

ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Subject: **Vermont Yankee Nuclear Power Station**
Technical Specification Proposed Change No. 263 – Supplement No. 25
Extended Power Uprate – Station Blackout and Appendix R Analyses

References: 1) Entergy letter to U.S. Nuclear Regulatory Commission, "Vermont Yankee Nuclear Power Station, License No. DPR-28 (Docket No. 50-271), Technical Specification Proposed Change No. 263, Extended Power Uprate," BVY 03-80, September 10, 2003

2) U.S. Nuclear Regulatory Commission (Richard B. Ennis) letter to Entergy Nuclear Operations, Inc. (Michael Kansler), "Request for Additional Information – Extended Power Uprate, Vermont Yankee Nuclear Power Station (TAC No. MC0761)," December 21, 2004

This letter provides additional information in support of the application by Entergy Nuclear Vermont Yankee, LLC and Entergy Nuclear Operations, Inc. (Entergy) for a license amendment (Reference 1) to increase the maximum authorized power level of the Vermont Yankee Nuclear Power Station (VYNPS) from 1593 megawatts thermal (MWt) to 1912 MWt. Based on new and revised analyses regarding station blackout (SBO) and 10CFR50, Appendix R fire events, the following conclusions can be drawn:

1. Containment overpressure credit is not required to ensure adequate net positive suction head (NPSH) is available to low-pressure ECCS pumps during SBO and 10CFR50, Appendix R fire events occurring during extended power uprate operations:

The NPSH requirements for the residual heat removal (RHR) and core spray pumps were re-evaluated for the extended power uprate (EPU) long-term suppression pool temperature response during SBO and 10CFR50, Appendix R fire events assuming the use of two RHR service water pumps. The results of this re-evaluation demonstrate that no containment overpressure is required to ensure NPSH is available to these pumps during these events under EPU conditions.

A001

2. <u>VYNPS has the ability to withstand a SBO until alternate power is available</u>:

   The coping analysis included with this submittal demonstrates that VYNPS has the capability to withstand a station blackout until the alternate AC power source and required shutdown equipment are started and lined up to operate.

In addition, this submittal responds to the one remaining request for additional information from NRC's letter of December 21, 2004 (Reference 2).

Attachment 1 provides a discussion of these topics in greater detail. Attachment 2 is a copy of the SBO coping analysis report, which is applicable for EPU conditions.

There are no new regulatory commitments contained in this submittal.

This supplement to the license amendment request provides additional information to clarify Entergy's application for a license amendment and does not change the scope or conclusions in the original application, nor does it change Entergy's determination of no significant hazards consideration.

If you have any questions or require additional information, please contact Mr. James DeVincentis at (802) 258-4236.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on March 24, 2005.

Sincerely,

Jay K. Thayer

Jay K. Thayer
Site Vice President
Vermont Yankee Nuclear Power Station

Attachments (2)

cc: (see next page)

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BVY 05-030
Docket No. 50-271

Attachment 1

Vermont Yankee Nuclear Power Station

Proposed Technical Specification Change No. 263 – Supplement No. 25

Extended Power Uprate

Station Blackout and Appendix R Analyses

Discussion of Changes

Total number of pages in Attachment 1 (excluding this cover sheet) is 10.

STATION BLACKOUT AND APPENDIX R ANALYSES DISCUSSION OF CHANGES

I. Containment overpressure credit is not required to ensure adequate net positive suction head (NPSH) is available to low-pressure ECCS pumps during SBO and 10CFR50, Appendix R fire events occurring during extended power uprate operations.

Adequate Net Positive Suction Head Without Crediting Containment Overpressure for SBO and Appendix R Events

The net positive suction head (NPSH) requirements for the residual heat removal (RHR) and core spray emergency core cooling system (ECCS) pumps were re-evaluated for the extended power uprate (EPU) long-term suppression pool temperature response assuming the use of two RHR service water (RHRSW) pumps. This re-evaluation demonstrates that adequate NPSH is available for the long term station blackout (SBO) and Appendix R events without crediting containment overpressure (COP). The most limiting cases for NPSH occur at the peak suppression pool temperature of 182.2°F for the SBO event and 182.8°F for the Appendix R event with two RHRSW pumps. The peak long-term suppression pool temperatures for the SBO and Appendix R events both occur at approximately 5.5 hours into the events. The results of this re-evaluation establish that no COP is required to ensure NPSH is available to the low-pressure ECCS pumps during SBO and 10CFR50, Appendix R fire events under EPU conditions.

Initial analyses of the limiting SBO and Appendix R scenarios under EPU conditions conservatively concluded that a degree of COP would be necessary to ensure adequate NPSH for certain low-pressure ECCS pumps. PUSAR section 4.2.6, "ECCS Net Positive Suction Head," discusses NPSH requirements for core spray and residual heat removal pumps under postulated design basis and non-design basis events. COP for non-LOCA events was documented and provided to the NRC staff in calculation VYC-2314, "Minimum Containment Overpressure for Non-LOCA Events," by Entergy letter dated July 2, 2004[1]. VYC-2314 was later updated and resubmitted to NRC by letter of July 27, 2004[2].

Since completing these initial analyses, Entergy has performed new analyses that assume two RHRSW pumps are used to respond to the SBO and Appendix R events. By using two pumps, instead of one pump as was initially proposed, suppression pool temperature can be maintained at a lower temperature—such that NPSH is adequate without any COP. The analyses in which two of the four RHRSW pumps (with one RHR heat exchanger) are used during SBO and Appendix R scenarios show that COP is not needed to ensure adequate NPSH for ECCS pumps at EPU conditions. The use of two RHRSW pumps is credited during these events because Technical Specification 3.5.C requires a full complement of RHRSW equipment during normal power operation and a postulated loss of an emergency bus would still ensure the

[1] Entergy letter to U.S. Nuclear Regulatory Commission, "Vermont Yankee Nuclear Power Station, Technical Specification Proposed Change No. 263 – Supplement No. 8, Extended Power Uprate – Response to Request for Additional Information," BVY 04-058, July 2, 2004

[2] Entergy letter to U.S. Nuclear Regulatory Commission, "Vermont Yankee Nuclear Power Station, Technical Specification Proposed Change No. 263 – Supplement No. 9, Extended Power Uprate – Revised Containment Overpressure Envelope," BVY 04-071, July 27, 2004

availability of two RHRSW pumps. Therefore, calculation VYC-2314 is no longer pertinent to demonstrate adequate NPSH and accomplish containment isolation needed to ensure COP.

Appendix R Fire Event

PUSAR section 6.7.1, "10 CFR 50 Appendix R Fire Event," presents the results of an Appendix R evaluation for EPU in Table 6-5, including the peak suppression pool bulk temperature. For the revised evaluation, assuming two RHRSW pumps, the peak suppression pool temperature is calculated to be 182.8°F. At this temperature, NPSH for the core spray and RHR pumps is sufficient without requiring any COP. Thus, Note 6 to Table 6-5 is no longer applicable.

Operator Actions for SBO and Appendix R Events

PUSAR section 10.5, "Individual Plant Evaluation," provided estimates of risks for a spectrum of events, including Appendix R and SBO. It was stated in this section of the PUSAR that a new operator action would be required to satisfy certain aspects of Appendix R and SBO evaluations. This operator action to close a normally open suppression chamber (i.e., torus) vent line would have been necessary to maintain COP under the initial analyses. Section 10.6 of the PUSAR, "Operator Training and Human Factors," also makes note of this action. Because COP is no longer needed for meeting NPSH requirements for these events, it is unnecessary to isolate the torus vent line. Consequently, this proposed operator action is not required.

The revised SBO and Appendix R evaluations result in minor, additional operator actions. These actions would occur in the control room and do not involve complex actions for which operators are not already trained. Adequate NPSH without the need to credit COP can be assured at EPU conditions by requiring operators to start two, rather than one, RHRSW pump per RHR loop. Starting two RHRSW pumps from the control room panel can be accomplished in a matter of seconds, and the additional action to start two, instead of one RHRSW pump, is negligible. Additionally, cooldown of the reactor to the torus via safety/relief valve operation must commence and proceed at a prescribed rate, depending upon service water temperature.

Operator action to start a second RHRSW pump to mitigate torus heatup during SBO and Appendix R events under EPU is included as new operator actions. (Note: It is current practice for operators to verify operation of service water (SW) pumps and SW header pressure before starting RHRSW pumps. To operate two RHRSW pumps at capacity, operation of the two corresponding SW pumps is required.)

Revised operator action under EPU is included to initiate cooldown of the reactor within prescribed times from the onset of SBO and Appendix R events and to control the depressurization rate depending upon service water temperature. For SBO the cooldown is assumed to begin at one hour into the event. For the Appendix R event, cooldown is assumed to commence at 30 minutes into the event. The depressurization rate for both events is $\geq$ 80°F/hr when service water temperature exceeds 75°F. This constraint does not exist when service water temperature is $\leq$ 75°F.

Summary of License Amendment Request Changes

The changes identified in the preceding discussion are summarized below. (Replacement pages to the PUSAR are not being provided.)

- Calculation VYC-2314 is unnecessary and no longer applicable. Therefore, this calculation is hereby withdrawn from this application for a license amendment.

- PUSAR section 4.2.6 is amended to state that the NPSH evaluation of peak suppression pool temperature for SBO and Appendix R events shows that COP is not required to satisfy NPSH requirements.

- PUSAR section 6.7.1 is amended to revise the peak suppression pool temperature.

- PUSAR sections 10.5 and 10.6 are amended to delete the proposed operator action associated with closing the torus vent line. In lieu of this action, and to preclude the need for COP to ensure adequate NPSH under certain scenarios, a second RHRSW pump is now required for EPU operation for the mitigation of SBO and Appendix R events. In addition, after starting the two RHRSW pumps in the control room the operator will initiate reactor cooldown and control the rate of depressurization in accordance with revised limits.

II. Station blackout coping analysis and demonstration of the availability of the alternate power source

Conformance to SBO Rule

VYNPS' compliance to the SBO rule (10CFR50.63) was established in a series of docketed communications with the NRC staff commencing in April 1989. The NRC issued a safety evaluation report (since supplemented) on the VYNPS response to the SBO rule by letter dated June 5, 1991[3]. VYNPS is categorized as an eight-hour duration plant and uses the adjacent Vernon Hydroelectric Station (Vernon Station) as its alternate AC (AAC) source to satisfy the requirements of 10CFR50.63.

Availability of AC Power from the Alternate AC Source

VYNPS uses an AAC source approach for coping with a SBO in accordance with Regulatory Guide 1.155[4]. Under this approach, VYNPS relies on the physically-adjacent Vernon Hydroelectric Station (Vernon Station) to provide power to an emergency bus until offsite or onsite AC power is available.

In NRC's inspection report of December 2, 2004[5], the NRC staff documented a finding that was characterized as being of very low safety significance regarding the need to complete a coping analysis for the period of time the AAC source would be unavailable and demonstrate by test the time required to make the alternate source available following a SBO. Because the AAC source for VYNPS was originally available to power the shutdown buses within 10 minutes of the onset of a SBO, no coping analysis was required or docketed as part of the licensing basis. It was found that due to changed circumstances the AAC source may not be available within 10 minutes. Therefore, it was found necessary to complete a coping analysis for the period of time the AAC source would be unavailable following a total electric grid collapse resulting in a station blackout at VYNPS. It was also identified that the time required to make the alternate source available had not been demonstrated by test. A preliminary coping analysis was prepared and made available to the NRC inspection team during the inspection. Subsequent to the inspection a coping analysis was completed to demonstrate the degree to which the plant support systems will sustain a station blackout under EPU conditions.

NRC EPU Request for Additional Information (RAI) SPSB-C-36 on SBO

The NRC staff issued a set of RAIs by letter dated December 21, 2004[6], regarding the application for EPU. Entergy has responded to all but one of the RAIs. The remaining RAI asked:

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[3] U.S. Nuclear Regulatory Commission letter to Vermont Yankee Nuclear Power Corporation, "Vermont Yankee Station Blackout Analysis (TAC No. 68620)," June 5, 1991

[4] U.S. Nuclear Regulatory Commission, Regulatory Guide 1.155, "Station Blackout," Revision 0, August 1988

[5] U. S. Nuclear Regulatory Commission (Wayne D. Lanning) letter to Entergy Nuclear Operations, Inc. (Jay K. Thayer), "Vermont Yankee Nuclear Power Station – NRC Inspection Report 05000271/2004008," December 2, 2004

[6] U.S. Nuclear Regulatory Commission (Richard B. Ennis) letter to Entergy Nuclear Operations, Inc. (Michael Kansler), "Request for Additional Information – Extended Power Uprate, Vermont Yankee Nuclear Power Station (TAC No. MC0761)," December 21, 2004

"What is the coping period for station blackout (SBO)? Is the NPSH analysis for SBO consistent with this?"

For EPU the duration for which VYNPS must cope until the alternate AC source is available is two hours. Secondly, the revised analysis of suppression pool temperature heatup during a SBO event shows that COP is not needed to ensure adequate ECCS pump NPSH for the duration of the event. Therefore, adequate NPSH is available for ECCS pump operation throughout the SBO event.

SBO Coping Analysis

Attachment 2 provides the results of the coping analysis demonstrating the ability of VYNPS to withstand a SBO. The coping analysis for VYNPS shows that the plant is able to safely cope with a total loss of AC power for a minimum of 120 minutes from the onset of the station blackout to the restoration of offsite AC power to a 4160 volt emergency bus. A two-hour coping time is sufficient to envelope the time required to start and align an AAC source. No plant modifications are required to attain this capability. The coping analysis was prepared using the guidance contained in NRC Regulatory Guide 1.155 and NUMARC 87-00 Rev. 1[7].

Certain procedure changes have been identified which relate to the assumptions used in the EPU analyses (e.g., use of two RHRSW pumps, specified cooldown rate, and administrative control of the condensate storage tank level). These procedure changes are considered minor.

Impact of EPU on SBO Coping Capability

Based on the results presented in Attachment 2, the planned EPU can be adequately accommodated with a two-hour coping duration. No changes are needed to the systems and equipment required to respond to an SBO event. The use of two of RHRSW pumps with one RHR heat exchanger has been shown by calculation to provide sufficient suppression pool cooling to ensure adequate NPSH is available to ECCS pumps without crediting containment overpressure. Technical Specification 3.5.C requires that the four RHRSW pumps be operable during normal plant operation. Therefore, the current plant design is adequate for responding to an SBO.

Designation and Capacity of the Vernon Station

The Vernon Station normally operates continuously year-round, and its reliability was previously reviewed as part of NRC's SBO safety evaluation[8].

Following a SBO event, the contiguously located Vernon Station, through a tie line, would have sufficient capacity to supply the required safe shutdown loads within sufficient time to ensure that the plant is capable of maintaining core cooling and appropriate containment integrity.

[7] Nuclear Management and Resources Council (NUMARC), "Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors," NUMARC 87-00, Revision 1, August 1991

[8] For example, it was documented in Vermont Yankee's letter to NRC dated April 12, 1989, "Response to Station Blackout Rule 10CFR50.63," that the hydrostation had only two unplanned outages (a total of less than three hours) since 1965.

The Vernon Station is VYNPS' AAC source for complying with the requirements of 10CFR50.63 regarding SBO and is also a 10CFR50, Appendix R alternative shutdown AC power source.

The Vernon Station is designated as a "black start" facility under arrangements with the regional grid operator. This designation requires that the facility be capable of being black-started within 90 minutes after the operator is notified.

The Vernon Station is connected to a 69 kV offsite transmission system, which is not directly connected to VYNPS' normal offsite power sources. The majority of the lines emanating from the Vernon Station are routed in completely different directions from the lines supplying offsite power to VYNPS. Because of this independence, a SBO at VYNPS would not necessarily mean that the Vernon Station is not generating power.

Vernon Tie

The Vernon Tie is a highly reliable tie line that connects the Vernon Station to either of the two VYNPS 4160 volt emergency buses and is capable of supplying required power loads under postulated SBO conditions. The Vernon Tie consists of a 13.2 kV circuit from the Vernon Station switchyard to a 13.2 kV / 4.16 kV transformer located in the VYNPS owner controlled area to a 4160 volt circuit breaker in the VYNPS switchgear room. The Vernon Tie is physically and electrically independent of other sources of power to the plant's emergency buses, including the normal offsite power circuits. The load carrying capability of the Vernon Tie is approximately equal to one emergency diesel generator.

The cable from VYNPS to the Vernon switchyard is buried and about 4,000 feet in length. This circuit has been analyzed to be able to withstand severe weather that might lead to or contribute to an electrical grid collapse. Because the Vernon Station's bus system is energized from its 69 kV switchyard, whether or not the Vernon Station's generators are operating, the Vernon Tie can be available when the VYNPS normal offsite power sources are not. (For additional details, see UFSAR section 8.5.5.)

Energization of a VYNPS 4160 volt emergency bus from the Vernon Tie requires the closure of two circuit breakers (breaker 3V4 and either breaker 3V or breaker 4V) from the VYNPS control room. Once energized, it takes very little time to align loads from the control room. There is no time restriction on the application of load after the closure of the Vernon Tie line. Loss of the Vernon Tie is annunciated and its voltage is monitored in the VYNPS control room. (See UFSAR section 8.3.3 for additional details.)

The capabilities of the Vernon Station and the Vernon Tie have previously been reviewed by the NRC staff and documented in a safety evaluation report and supplements pertaining to SBO.

Testing of the AAC Source

Surveillance testing of the Vernon Tie is performed every operating cycle in accordance with VYNPS procedure OP-4142, "Vernon Tie and Delayed Access Power Source Backfeed Surveillance." Performance of this procedure demonstrates the ability to energize an emergency bus and supply required SBO loads from the Vernon Tie in less than 10 minutes.

In addition, the SBO scenario is periodically practiced in simulator training of the NRC-licensed control room operators.

Demonstration of Black Start Capability of the Vernon Station

The Vernon Station is capable of providing transmission system restoration service and is designated and operated as a black start unit under New England Power Pool (NEPOOL) tariff. Under multi-party agreements, the owner/operator of the Vernon Station has agreed to supply energy from the Vernon Station to VYNPS during SBO and other events. The Vernon Tie is considered by NEPOOL to be a priority load.

Following loss of offsite power, the restoration of power to VYNPS would be managed from a local control center (i.e., Rhode Island, Eastern Massachusetts, Vermont Energy Control (REMVEC)) with ISO-New England being responsible for the overall regional restoration process.

As a designated black start facility, the Vernon Station is required under ISO New England operating procedure OP-11, "Black Start Capability Testing Requirements," to annually demonstrate this capability. Generating stations equipped with black start capability perform an actual black start of the unit without dependency on the interconnected system or other unrelated unit support. The results of the black start test are documented in a report to ISO-New England. ISO-New England reviews and verifies that the unit passed its black start test.

The combination of the periodic (i.e., annually) testing of the AAC source together with the energization test of the emergency bus that is conducted every operating cycle encompass the condition of the SBO event, and therefore meets the requirement of 10CFR50.63. Acceptable compliance with this requirement has been documented in NRC correspondence[9].

It is the ISO New England system operating goal that units designated as having black start capability should achieve a return to service in the fastest start time possible within a two-hour time frame. As a result, the units are expected to be staffed and prepared to commence generation within ninety (90) minutes of receiving instructions to initiate black start operations.

Timeline for restoration of the AAC source

Restoration of the bulk power system is of high importance following a regional blackout, and an emergency condition at VYNPS would receive top priority by REMVEC and National Grid Operators who control regional grid operations. This is evident in ISO New England operating procedure OP-6, "System Restoration," which states that a high priority must be given to the restoration of offsite AC power to nuclear units and that they are the most critical during the restoration of power after a blackout. Further recognition of the importance of the Vernon Tie and the Vernon Station as an AAC source to VYNPS is provided in ISO New England Master/Satellite Procedure #1, "Nuclear Plant Transmission Operations."

[9] For example, see NRC's letter of September 1, 1992, "Supplemental Safety Evaluation of Vermont Yankee Nuclear Power Station, Station Blackout Rule (10 CFR 50.63) (TAC No. M68620)" and NRC Inspection Report 95-13, "Station Blackout Inspection, Inspection Report No. 50-271/95-13," dated July 12, 1995.

Because a black start generating unit is required to be ready for restart within 90 minutes of notification, additional front-end time for identification, assessment, and notification plus back-end time to actually restart a unit and make breaker alignments, in the aggregate, can be completed within the two-hour SBO coping period.

If the Vernon Tie is de-energized an alarm is annunciated in the VYNPS control room. Per operational transient procedure OT-3122, if a SBO occurs and the Vernon Tie is de-energized due to a regional grid blackout, the VYNPS control room operator will immediately contact the REMVEC control center to black start the Vernon Station and re-energize the Vernon Tie in accordance with REMVEC operating procedures. Once the Vernon Tie is energized, a source of power is available to either of two VYNPS emergency buses, and equipment can be powered and operated in accordance with procedure OT-3122. Table 1 below provides a realistically conservative timeline for restoration of the AAC source during a postulated regional blackout scenario. For illustrative purposes, completion times associated with restoration steps are indicated. However, the steps are not necessarily sequential; consequently, completion times will most likely be shorter.

Table 1
TIMELINE FOR AAC SOURCE STARTUP AND ALIGNMENT

Step	Event/activity	Incremental time[10]	Timeline Total duration
1	SBO condition entry: loss of all offsite AC power and onsite emergency diesel generators at VYNPS	0	0
2	Notification / identification of event at Wilder control center (same owner/operator as Vernon Station)	$\leq$ 10 minutes	10 minutes
3	Vernon Station personnel notified, staff the Vernon Station and prepare for restart; REMVEC aligns the Vernon Station's 69 kV switchyard breakers in preparation for a black start	$\leq$ 90 minutes	1 hour, 40 minutes
4	Personnel staff Vernon Station for restart (black start) and/or align a hydro turbine-generator	$\leq$ 10 minutes	1 hour, 50 minutes
5	Vernon Station 13 kV switchyard breaker alignments and energization of Vernon Tie	$\leq$ 10 minutes	2 hours
6	VYNPS control room operators energize an emergency bus and start required shutdown equipment	immediate	2 hours

Bases and discussion of steps:

1. SBO event initiation at time zero. It is conservatively assumed that the SBO at VYNPS occurs concurrent with a regional blackout, including the tripping of operating units at the Vernon Station.

2. Assuming the owner/operator of the Vernon Station does not have personnel onsite at the Vernon Station, the blackout condition will be identified at its Wilder control center. Operation of the Vernon Station is monitored 24/7 by the owner/operator's staff located at the Wilder control center. Loss of the Vernon Station would be immediately indicated at the Wilder center.

   In addition, as confirmation, immediately upon losing all AC power, the control room operators at VYNPS will notify the regional grid operator (REMVEC), who will also immediately contact the Wilder control center to initiate Vernon Station black start procedures. Regardless of a call from VYNPS, actions will be taken at the onset of a grid collapse by the grid operator. Therefore, recognition of the condition within ten minutes is considered realistically conservative.

   REMVEC's and ISO-New England's continuing assessment of a blackout condition would follow the notification stage and would continue through restart of generating units and system restoration.

[10] Incremental times are approximate for information purposes and are not necessarily sequential or additive.

3. The operator of the Vernon Station is required to achieve the fastest start time possible and to have the unit ready for restart within 90 minutes from the time of notification.

   During the blackout and recovery interval, REMVEC/National Grid would remotely open the 69 kV breakers at the Vernon Station switchyard in preparation for restart. (Control of the 69 kV switchyard breakers is also available locally at the Vernon Station.) Breaker control would be available during a regional blackout because the required control/operate power is supplied from the station's 125 VDC bus and battery bank. In accordance with ISO-New England Operating Procedure OP-11, designated black start units (such as the Vernon Station) have 90 minutes from the time of receiving instructions to initiate black start operations to have the units available for restart.

4. Ten minutes is a reasonable time allotment for restarting one turbine-generator at the Vernon Station. The Vernon Station is substantially automated for black starting capability, including a 125 kW diesel generator that automatically starts on a loss of power at the station. The diesel generator supplies power to an automatic transfer switch that re-energizes essential 480 volt loads within ten seconds of event initiation.

   Restarting includes energizing the Vernon Station's 2.4 kV and 13 kV buses in accordance with the station's black start procedure.

5. "Town of Vernon" feeder breaker is opened to shed loads. The Vernon Station's output breakers are closed, thus energizing its switchyard. Final breaker alignments are required to energize the Vernon Tie line.

6. It is reasonable to expect that the VYNPS control room operators will immediately take these actions after waiting nearly two hours for the return of electrical service. Operator actions include closing two breakers (3V4 and either 3V or 4V). These actions can be completed in a matter of seconds.

BVY 05-030
Docket No. 50-271

Attachment 2

Vermont Yankee Nuclear Power Station

Proposed Technical Specification Change No. 263 – Supplement No. 25

Extended Power Uprate

Station Blackout and Appendix R Analyses

VYNPS EPU SBO Coping Analysis Report

Total number of pages in Attachment 2 (excluding this cover sheet) is 14.

Engineering Report No. VY-RPT-05-00004 Rev. 0

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Engineering Report Cover Sheet

Engineering Report Title:

VYNPS EPU SBO Coping Analysis Report

Engineering Report Type:

New ☒ Revision ☐ Cancelled ☐ Superceded ☐

Applicable Site(s)

IP1 ☐ IP2 ☐ IP3 ☐ JAF ☐ PNPS ☐ VY ☒

Quality-Related: ☒ Yes ☐ No

Prepared by:	Paul A. Rainey Paul A. Rainey Responsible Engineer (Print Name/Sign)	Date: 3/17/05
Verified/ Reviewed by:	William Lynch WL Lynch Design Verifier/Reviewer (Print Name/Sign)	Date: 3/17/05
*Reviewed by:	N/A Authorized Nuclear In-service Inspector (ANII)	Date: N/A
Approved by:	James G. Rogers Supervisor (Print Name/Sign)	Date: 3-21-05

Multiple Site Review

Site	Design Verifier/Reviewer (Print Name/Sign)	Supervisor (Print Name/Sign)	Date

*: For ASME Section XI Code Program plans per ENN-DC-120, if required.

RECORD OF REVISIONS

Engineering Report No: VY-RPT-05-00004 VYNPS EPU SBO Coping Analysis Report

Revision No.	Description of Change	Reason For Change
0	Original report	NA

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LIST OF ATTACHMENTS

EXECUTIVE SUMMARY

The VYNPS EPU, Station Blackout (SBO) Coping Analysis has been revised in accordance with the guidelines provided in RG 1.155 Rev 0 (Reference 10) and NUMARC 87-00 Rev 1 (Reference 9) for assessment of its compliance with the requirements of the 10CFR 50.63, Loss of all Alternating Current Power (Reference 8). This regulation requires that each light water cooled nuclear power plant licensed to operate must be able to withstand for a specified duration and recover from a station blackout. The revised SBO Coping Analysis shows that VY can cope with a SBO for a 2 hour duration at which time AC power is restored via the Alternate AC (AAC) power source, the Vernon hydroelectric power plant. The results provide adequate assurance that VYNPS shall be able to withstand and recover from a SBO for a coping duration of two hours.

SECTION 1
PURPOSE

A revised VYNPS EPU SBO Coping Analysis has been performed in accordance with the guidelines provided in RG 1.155, Rev 0 and NUMARC 87-00, Rev 1 for assessment of its compliance with the requirements of 10CFR50.63.

VYNPS was licensed as an alternate AC (AAC) plant. Based on the premise that the AAC source was available from the control room within 10 minutes, no coping analysis was required. Recently, it was determined that during a SBO involving a grid collapse scenario that the AAC source, the Vernon hydro, may not be available within the required 10 minutes; therefore, a coping analysis is required (Reference 11). The analyses were based on a 2 hour (i.e., 120 minutes) coping requirement. This report compiles the results of the required analyses.

SECTION 2
EVALUATION

As discussed below the analysis established that:

1) adequate condensate inventory will be available for decay heat removal,

2) the plant 125 Vdc station batteries have adequate capacity to supply all SBO DC loads for two hours with no manual load stripping,

3) the SBO equipment operability will be maintained at elevated room temperatures caused by loss of ventilation,

4) containment isolation capability will be maintained, as required, to ensure containment integrity,

5) the plant compressed air system is not essential to cope with the SBO and

6) the resultant torus temperature satisfies the net positive suction head (NPSH) requirements of the RHR and CS pumps without the need for containment overpressure.

2.1 Condensate Inventory

VYC-2398 (Reference 1) is a VY specific analysis that shows that injecting 75,000 gallons of condensate storage tank (CST) inventory is sufficient to remove decay heat, provide leakage makeup, and depressurize the reactor to 100 psia. A leakage rate of 61 gpm is used which is comprised of recirculation pump leakage of 18 gpm per pump (36 gpm total (Reference 9)) and the TS reactor coolant system leakage limit of 25 gpm. The leakage rate is maintained at 61 gpm during depressurization.

VY also determined condensate inventory using the NUMARC 87-00 Section 7.2.1 Methodology for determining condensate inventory for the 2 hour coping duration as follows:

The 2 hour coping period condensate inventory requirement (B) is calculated as follows:

B = A (13.14 Gal/MWT) x 1.02 + C

Where,

A = The plant thermal rating at EPU which is 1912 MWT

Note A 1.02 Factor is included for power uncertainty

C = Inventory required for depressurization which is 14,214 gallons (VYC-886 Reference 3)

Therefore,

B = 1912 (13.14) x 1.02 + 14,214

= 39,841 gallons

An additional term is introduced to incorporate Technical Specification limits for reactor coolant system leakage (25 gpm) and recirculation pump seal leakage (18 gpm per pump). Assuming a constant leakage rate of 61 gpm, this term is equivalent to 7320 gals. Therefore, the total condensate inventory requirement is 47,161 gallons.

VY has also applied the NUMARC 87-00 Section 7.2.1 methodology for determining condensate inventory out to the time period where the reactor is depressurized to 100 psia where low pressure CS pumps can provide injection with the torus as a water source. Per Reference 1, this is approximately 5 hours.

The 5 hour condensate inventory requirement (B) is calculated as follows:

B	=	A (22.12 Gal/MWT) x 1.02 x 5/4+ C
Where,		
A	=	The plant thermal rating at EPU which is 1912 MWT
Note		A 1.02 Factor is included for power uncertainty. A 5/4 factor is included to conservatively ratio the four hour decay heat factor to five hours.
C	=	Inventory required for depressurization which is 14,214 gallons (VYC-886 Reference 3)
Therefore,		
B	=	1912 (22.12) x 1.02 x 1.25+14,214
	=	68,139 gallons

An additional term is introduced to incorporate Technical Specification limits for reactor coolant system leakage (25 gpm) and recirculation pump seal leakage (18 gpm per pump). Assuming a constant leakage rate of 61 gpm, this term is equivalent to 18,300 gals during the 5 hour period. Therefore, the total condensate inventory requirement is 86,439 gallons.

To ensure that at least 100,000 gallons of usable CST inventory is available for 5 hours injection during a SBO (Reference 2), the minimum administrative limit for CST level identified in procedure OP 0150 (Reference 15) will be increased. This administrative limit accounts for required instrument uncertainty.

The ability to maintain adequate reactor coolant system inventory to ensure that the core is cooled has been assessed for the required coping duration by plant specific analysis and the NUMARC methodology.

The expected rates of reactor coolant inventory loss under SBO conditions do not result in core uncovery in a SBO of the required 2 hour coping duration. Therefore, makeup systems available under SBO conditions are adequate to maintain core cooling.

Additionally, the torus remains available to supplement the CST for low pressure systems once the reactor is depressurized.

2.2 Battery Capacity

NUMARC 87-00, Section 7.2.2 states that the SBO loads on the battery can be estimated from design basis accident loads since they are generally a subset of these loads. Calculation VYC-2154 (Reference 4) shows that the worst case battery scenario occurs when DC Buses DC-1 and DC-2 are cross-tied and the SBO occurs just after the largest DC MOV (V23-19) is started for testing. A separate scenario has been added to the calculation to show that the battery has the capacity to handle these loads for the full 2 hours (see MCC 4 to Reference 4).

The calculations for battery capacity use the lowest electrolyte temperature (60°F) anticipated, design margin of 1.1 and aging factor of 1.25 as recommended by IEEE Standard 485 and as required by NUMARC 87-00. In addition to calculating the battery capacity, battery terminal voltage profile corresponding to the duty cycle is also calculated to verify that the minimum voltages reached during the duty cycle are higher than the minimum voltages required for operation of the DC loads.

The plant 125 vdc station batteries have adequate capacity to supply all SBO DC loads for two hours with no manual load stripping.

2.3 Loss of Ventilation

The RCIC and HPCI rooms were previously evaluated for heat up during a SBO in VYC-886 (Reference 3). Since the heat loads in the RCIC and HPCI rooms do not change for EPU this analysis remains valid. The steady state temperature in both the RCIC and HPCI rooms is less than 150°F. RCIC and HPCI operability at this steady state temperature has been evaluated per the NUMARC 87-00 Appendix F methodologies and the equipment is operable for the required duration.

VYC-1347 (Reference 6) provides a plant specific heat up analysis of the Main Steam Tunnel following a loss of ventilation for the current power level. The analysis concludes that automatic isolation of RCIC or HPCI due to room heatup would occur approximately 18 hours after a loss of ventilation occurs. Thus automatic isolation will not occur during a SBO event.

VYC-2279 (Reference 13) provides an analysis for the impact of EPU on main steam tunnel ambient temperature. The impact is less than 1°F. The increase in steam tunnel heat load which is due to higher feedwater temperature is only approximately 2.4%. This higher heat load will result in a slightly quicker isolation which is still hours after the required SBO coping duration. The plant is depressurized using HPCI/SRVs to the point where low pressure systems provide required makeup/cooling long before isolation would occur. No manual operator actions are required in the Main Steam Tunnel.

VYC-1502 (Reference 7) provides a plant specific heat up of the control room following an Appendix R fire which causes loss of control room ventilation. The Appendix R heat load bounds the SBO heat load. The analysis shows that the control room could reach approximately 120°F at four hours given the Appendix R control room heat load. This analysis is based on removing acoustic ceiling tiles which is in OP-2192 (Reference 16). Normal control room HVAC is available when the AAC source becomes available at 2 hours. Other actions such as opening panel doors, opening the control room doors and providing temporary ventilation can also be used to reduce control room temperature and these actions are in OP-2192.

There is no heat load in the RHR/CS pump rooms until AC power is restored. The room coolers which provide the required cooling are also powered from the AAC source.

The drywell temperature was evaluated and it remains below the EQ limit and the drywell liner temperature remains below its design value for the duration of the SBO (Reference 12).

2.4 Containment Isolation

A 2 hour duration station blackout will not result in core uncovery and therefore there is no core damage (Reference 1). Per NUMARC 87-00 Rev 1 Appendix I "Responses to questions raised at the NUMARC 87-00 seminars" question #102, containment integrity is only required to be established if core damage is imminent.

VY evaluated containment isolation capability in accordance with Section 7.2.5 of NUMARC 87-00. A SBO will result in air operated containment isolation valves closing. Air operated containment isolation valves fail in their required position on loss of air or power. Motor operated valves will fail as is on loss of power.

UFSAR Table 5.2.2 (Reference 17) provides a list of primary containment penetrations and associated containment isolation valves. The table below lists those penetrations that contain MOVs:

Penetration No.	Description	Valve No.
X-8	Main Steam Drains	V2-74, V2-77
X-224A, B	Residual Heat Removal Torus Suction	V10-13A/B/C/D, V10-15A/B/C/D
X-12	Shutdown Cooling Suction	V10-18, V10-17
X-13A, B	Residual Heat Removal	V10-27A/B,V10-66
X-210, 211 A&B	Residual Heat Removal Torus	V10-39A/B,V10-34A/B, V10-38A/B
X-39A, B	Residual Heat Removal Drywell Spray	V10-31A/B,V10-26A/B
X-14	Reactor Water Cleanup	V12-15,V12-18
X-10	Reactor Core Isolation Cooling	V13-15,V13-16
X-227	Reactor Core Isolation Cooling	V13-41
X-16A, B	Core Spray	V14-12A/B

Penetration No.	Description	Valve No.
X-210A, B	Core Spray	V14-26A/B
X-25; 218	Containment Atmosphere Dilution	VG-22A/B
X-226A, B	Core Spray	V14-7A/B
X-11	High Pressure Coolant Injection	V23-15, V23-16
X-225	High Pressure Core Injection	V23-58
X-24	Reactor Building Component Cooling Water	V70-117

Penetration X-25 & X-218

The 1" CAD MOVs (VG-22A/B) at penetrations X-25 & X-218 are excluded per NUMARC 87-00 Section 7.2.5 because the valves are less than 3" diameter (Reference 18).

Penetration X-24

RBCCW valve V70-117 at penetration X-24 is excluded per NUMARC 87-00 Section 7.2.5 exclusion because this valve is in a non-radioactive line that is not expected to be breached.

PENETRATIONS X-8, X-12, X-14, X-10, X-11 and X-13A/B

The following penetrations have an AC MOV and a DC MOV in series to provide isolation:

Penetration No.	Description	Valve No.
X-8	Main Steam Drains	V2-77(DC); V2-74(AC)
X-12	Shutdown Cooling	V10-17(DC); V10-18(AC)
X-14	Reactor Water Cleanup	V12-18(DC); V12-15(AC)
X-10	Reactor Core Isolation Cooling	V13-16(DC); V13-15(AC)
X-11	High Pressure Coolant Injection	V13-16(DC); V23-15(AC)
X-13 A/B	Residual Heat Removal	V10—57(DC); V10-66(AC)

All of the above AC valves can be excluded since the DC counter part valves provide isolation of the line.

Penetrations X-226A/B, X-210A/B and X-16A/B

The CS piping loops are considered an extension of containment and the valves do not receive a containment isolation signal. Valves V14-7A/B (X-226A/B), V14-26A/B (X-210 A/B) and V14-12 A/B (X-16A/B) are not required to provide containment isolation during a SBO and are excluded. Valves V14-7A/B provide a suction path from the torus to the CS pumps and V14-12A/B provide CS injection to the vessel.

Penetrations X-224A/B, X-13A/B, X-210A/B, X-211A/B and X-39A/B

The RHR piping loops are considered an extension of containment and the valves do not receive a containment isolation signal. Valves V10-13A, B, C, D (X-224 A/B), V10-15A, B, C, D, (X-224A/B), V10-27A, B (X-13A/B), V10-39A, B and V10-34 A/B and V10-38 A/B (X-210A,B and X-211 A/B) and V10-31 A/B and V10-26 A/B (X-39 A/B) are not required to provide containment isolation during a SBO event and are excluded. Valves V10-13 A, B, C, D provide a suction path from the torus to the RHR pumps and V10-27A, B provide injection to the vessel.

Penetrations X-225 AND X-227

The HPCI pump suction from the torus, V23-58(X-225) and RCIC pump suction from the torus, V13-41 (X-227) are normally closed which is the desired position during a SBO. The HPCI and RCIC pump suction is normally aligned to the CST which required that the valves from the torus be closed.

No modifications or procedure changes are required to establish required containment integrity.

2.5 Compressed Air

The coping analysis is based on using the HPCI system as the high pressure makeup source. HPCI system operation is independent of the compressed air system. VY only relies on those air operated valves which fail to their required position on loss of air or power during a SBO event.

The SRVs which are used to depressurize the reactor are provided with nitrogen accumulators. Additionally, a backup N_2 supply system was installed to support manual operation of the SRVs for 72 hours (Reference 5). The backup system automatically (via a check valve) provides makeup to the SRV nitrogen accumulators.

Following restoration of AC power, an instrument air compressor will be powered by the AAC source.

2.6 Torus Temperature

VYC-2398 (Reference 1) demonstrates that for the limiting suppression (Torus) pool temperature adequate NPSH is provided to the RHR and CS pumps without crediting containment overpressure.

VYC-1512 (Reference 14) documents the present ability to start and run SBO loads from the Vernon Tie. The loading in the calculation includes 1 RHRSW pump and the Vernon Town and Plant Support Building load of about 2500 kW. The town load is supplied by the 69kV/13.2 kV transformer at the Vernon Switchyard and this load decreases the available voltage to VY. The new REMVEC procedure trips the Vernon Town load prior to VY connecting to the Vernon Hydro during the Hydro Station Black Start. This more than compensates for adding the 2^{nd} RHRSW pump that is required for increased torus heat removal capability.

Therefore, the Vernon hydro (AAC source) is capable of providing the extra power required by the operation of the 2^{nd} RHRSW pump.

SECTION 3
SUMMARY OF RESULTS/CONCLUSIONS

This coping analysis report demonstrates that Vermont Yankee can withstand and recover from a 2 hour duration SBO event as required in 10CFR 50.63. This report demonstrates that using the guidance in RG 1.155 and NUMARC 87-00 that:

- There will be no fuel damage for a 2 hour duration SBO event.
- Sufficient condensate is available from the CST to removed decay heat, provide leakage makeup, and depressurize the reactor.
- Sufficient battery capacity is available for the 2 hour SBO duration.
- Required plant equipment can operate without ventilation for the SBO duration and recovery.
- The compressed air systems are not required for SBO and sufficient bottled nitrogen is available for the SRVs.
- Required containment isolation valves fail in the required position on loss of air or power. Although no fuel damage occurs, containment isolation can be established if required.
- Torus temperature calculations demonstrate that the RHR and CS pumps have sufficient NPSH without crediting containment overpressure.

SECTION 4
REFERENCES

(1) ENVY Calculation VYC-2398 Revision 0, "Torus Temperature Calculation for a Station Blackout Event at Extended Power Uprate".

(2) ENVY Technical Evaluation TE 2001-048, "Basis for Setpoint for HPCI/RCIC Suction Transfer to Suppression Pool".

(3) VYC-886, Revision 2, "Station Blackout Documentation Analysis"

(4) VYC-2154, Revision 0, "125 VDC Battery B-1 Electrical System Calculation".

(5) VYC-1835, Revision 0, "ADS System nitrogen bottle sizing for 72 hours Standby Period.

(6) VYC-1347, Revision 0, "Main Steam Tunnel Heatup Calculation".

(7) VYC-1502, Revision 0, "Control Room Heatup due to Loss of HVAC".

(8) 10 CFR 50.63, "Loss of all Alternating Current Power."

(9) NUMARC 87-00, Revision 1, "Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors".

(10) Regulatory Guide 1.155, "Station Blackout," Dated August 1988.

(11) U.S. Nuclear Regulatory Commission letter to Jay K. Thayer dated December 2, 2004, NRC Inspection Report 05-000271/2004008

(12) VYC-2405, Revision 0, "Drywell Temperature calculation for a Station Blackout Event at Extended Power Uprate".

(13) VYC-2279, Revision 0, "Evaluation of EPU impact on Ambient Space Temperatures during Normal Operation".

(14) VYC-1512, Revision 2, "Station Blackout Voltage Drop and Short Circuit Study".

(15) OP 0150, "Conduct of Operations and Operator rounds."

(16) OP 2192 Revision 31, "Heating, Ventilating, and Air Conditioning System".

(17) VYNPS "Updated Final Safety Analysis Report (UFSAR)", Revision 19.

(18) Drawing VY-E-75-002, Revision 19," Containment Atmosphere Dilution System"