Entergy

Entergy Nuclear Vermont Yankee, LLC
Entergy Nuclear Operations, Inc.
185 Old Ferry Road
Brattleboro, VT 05302-0500

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BVY 04-026

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

Subject: **Vermont Yankee Nuclear Power Station**
License No. DPR-28 (Docket No. 50-271)
Technical Specification Proposed Change No. 257 – Supplement No. 7
Implementation of ARTS/MELLLA at Vermont Yankee
Revised Anticipated Transient Without Scram Evaluation

By letter dated March 20, 2003, as supplemented by letters dated March 31, 2003, April 17, 2003, June 11, 2003, July 21, 2003, December 11, 2003, and February 10, 2004, Vermont Yankee[1] (VY) proposed to amend Facility Operating License DPR-28 for the Vermont Yankee Nuclear Power Station (VYNPS) by implementing an expanded power-to-flow operating domain based on the Average Power Range Monitor, Rod Block Monitor Technical Specifications/Maximum Extended Load Line Limit Analysis (ARTS/MELLLA) methodology.

During a recent review of the Anticipated Transient Without Scram (ATWS) event analysis that was performed by General Electric (GE) in support of the MELLLA, VY identified certain design input discrepancies. The subject ATWS analysis was included as Section 9.0 of Attachment 5[2] to the March 20, 2003 license amendment request (LAR). Due to the discrepancies, VY re-verified the entire set of inputs provided to GE and had GE re-perform the ATWS analysis. VY verified that no other ARTS/MELLLA analyses were affected by these changes. Because VY has now completed the design for a modification to install an additional spring safety valve (SSV) and increase the capacity of the existing SSVs during the upcoming refueling outage (scheduled for the spring 2004), the revised ATWS analysis also incorporates this design change.

The changes in key input parameters result in more accurate or realistic analytical inputs to better represent actual plant configuration or planned modifications that will be implemented during the upcoming refueling outage. The following are the key input parameter changes:

- Standby Liquid Control System (SLCS) Liquid Transport Time (changed from 33.3 sec to 44.9 sec) – Discrepancies noted in the length of SLCS piping led to a recalculation of the transport time. Additionally, conservatism was added by assuming the length of pipe between the tank and the pumps is not filled with sodium pentaborate solution.

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[1] Entergy Nuclear Vermont Yankee, LLC and Entergy Nuclear Operations, Inc. are the licensees of the Vermont Yankee Nuclear Power Station.

[2] GE Nuclear Energy, "Vermont Yankee Nuclear Power Station, APRM / RBM / Technical Specifications / Maximum Extended Load Line Limit Analysis (ARTS/MELLLA)," NEDC-33089P, March 2003.

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- ATWS Recirculation Pump Trip Sensor Time Constant (changed from 0.0 sec to 0.2 sec) – The original analysis assumed a generic value of 0.0 sec. Review of VYNPS plant-specific instrumentation resulted in the change to a more appropriate 0.2 sec value.

- Residual Heat Removal System Heat Exchanger Effectiveness – (changed from 176 BTU/sec-°F to 179.375 BTU/sec-°F) – This value was revised based on heat exchanger performance for the assumed suppression pool temperature range.

- SSV Capacity per Valve (changed from 932,500 lbm/hr to 1,126,200 lbm/hr) – When the original analysis was performed the specifics of the planned SSV modification had not yet been finalized. The revised analysis now assumes the new increased capacity for the three SSVs (i.e., the modifications to the two existing SSVs and the addition of another SSV. These modifications will be implemented during the upcoming refueling outage).

- Safety Relief Valve (SRV)/SSV Configuration (changed from 4/2 to 3/3) – The original ARTS/MELLLA ATWS analysis assumed the then-current configuration. The revised analysis updates the configuration to the post-refueling outage configuration with one SRV conservatively-assumed to be out-of-service.

The revised analysis is provided as Attachment 1 to this letter. It supplements, but does not totally replace the evaluation provided as Section 9.0 of Attachment 5 to the March 20, 2003, LAR. In particular, statements including proprietary information regarding fuel integrity and the acceptance criteria of 10CFR50.46 are unchanged.

The change in some of the input parameters to the ATWS analysis caused certain subtle and readily understandable changes in the key performance parameters noted in this submittal. The peak suppression pool temperature and peak containment pressure for the limiting ATWS events increased slightly, due mainly to the increase in the transport time from the SLCS tank to the point of vessel injection. The calculated peak vessel pressure decreased slightly for these events due to the increased capacity of the SSVs. As can be expected, the timing of some of these events also changed slightly. The net results of these changes are increases in peak suppression pool temperature of approximately 2°F and peak containment pressure of 0.4 psi, and a decrease in peak vessel pressure of approximately 9 psi. These results remain within applicable limits.

Additionally, the input parameter changes caused some less subtle and more apparent changes in certain output parameters. For instance, the peak neutron flux for the pressure regulator failure-open (PRFO) event at end-of-cycle changed from 696 % rated in the original analysis to 334 % rated in the revised analysis. This change is attributed to the fact that the changes that were made to the input parameters caused a slight decrease in the void reactivity at the time of the peak neutron flux. The void reactivity behavior is driven by pressure waves developed during main steam isolation valve closure. The difference in the neutron flux, integrated over time, is small enough that the difference in the peak heat flux is insignificant.

Another change to the output is noted in the times of peak suppression pool temperature. While the times in most events increased slightly, the time of peak suppression pool temperature for the PRFO event at beginning-of-cycle (BOC) decreased slightly. Since the suppression pool temperature response is essentially flat from about 1,000 to 2,000 seconds, the timing of SRV cycles can have an impact on the location of the peak, while not affecting the magnitude of the peak. Because the original ATWS analysis was performed with four SRVs, and the revised analysis assumed three SRVs, a change in timing would be expected. A similar situation occurs in the time when hot shutdown is achieved. The time for most events increased slightly, while the PRFO event at BOC time decreased slightly.

VY evaluated the impact of the above changes on the response[3] to Question 8 of NRC's request for additional information. There are no consequential impacts on the key ATWS mitigation success criteria for the events evaluated.

Although analytical inputs have been changed in regard to some operating conditions and equipment performance for the ATWS events, the results of the revised ATWS analysis illustrate that the key performance parameters of reactor vessel pressure, suppression pool temperature, and containment pressure remain within applicable limits. Therefore, operation of VYNPS under the conditions proposed by the LAR has no adverse effect on the capability of plant systems to mitigate postulated ATWS events.

This supplement to the LAR does not change the scope or conclusions in the original application, nor does it change VY's determination of no significant hazards consideration. VY regrets any inconvenience this change may have caused. If you have any questions in this regard, please contact Mr. James DeVincentis at (802) 258-4236.

Sincerely,

Jay K. Thayer
Site Vice President

STATE OF VERMONT)
)ss
WINDHAM COUNTY)

Then personally appeared before me, Jay K. Thayer, who, being duly sworn, did state that he is Site Vice President of the Vermont Yankee Nuclear Power Station, that he is duly authorized to execute and file the foregoing document, and that the statements therein are true to the best of his knowledge and belief.

Sally A. Sandstrum, Notary Public
My Commission Expires February 10, 2007

SALLY A. SANDSTRUM NOTARY PUBLIC WINDHAM COUNTY, VERMONT

Attachment

cc: USNRC Region 1 Administrator (w/o attachment)
USNRC Resident Inspector – VYNPS (w/o attachment)
USNRC Project Manager – VYNPS
Vermont Department of Public Service

[3] Vermont Yankee letter to U.S. Nuclear Regulatory Commission, "Technical Specification Proposed Change No. 257, Implementation of ARTS/MELLLA at Vermont Yankee, Response to Request for Additional Information," BVY 03-56, June 11, 2003.

Attachment 1

Vermont Yankee Nuclear Power Station

Proposed Technical Specification Change No. 257 – Supplement No. 7

Implementation of ARTS/MELLLA at Vermont Yankee

Revised Anticipated Transient Without Scram Evaluation

1.0 ANTICIPATED TRANSIENT WITHOUT SCRAM

1.1 Introduction

Section 9 of Reference 1 detailed the Vermont Yankee Nuclear Power Station (VYNPS) plant-specific evaluation of the Anticipated Transient Without Scram (ATWS) event in support of VYNPS operation in the Maximum Extended Load Line Limit Analysis (MELLLA) domain. Subsequent to the submittal of Reference 1 to the NRC, Entergy identified several discrepancies in the input parameters used in the ATWS evaluation. In addition, VYNPS has completed the design for the modification of the spring safety valve (SSV) capacity that will be installed in the refueling outage (scheduled for spring 2004) prior to APRM / RBM / Technical Specifications / Maximum Extended Load Line Limit Analysis (ARTS/MELLLA) implementation. Therefore, a revised ATWS analysis was performed to correct the input parameter discrepancies and reflect the final design of the SSV modification.

The key input parameters that have changed from the Reference 1 analysis are:

Parameter	Reference 1 Analysis	Revised Analysis
Standby Liquid Control System (SLCS) Liquid Transport Time (sec)	33.3	44.9
ATWS Recirculation Pump Trip Sensor Time Constant (sec)	0.0	0.2
Reactor Heat Removal (RHR) heat exchanger effectiveness (Btu/sec-°F)	176	179.375
SSV Capacity – per valve (lbm/hr) / Reference Pressure (psig)	932,500 / 1240	1,126,200 / 1240
Safety Relief Valve (SRV) / SSV Configuration used in the analysis	4 / 2	3 / 3

1.2 Approach/Methodology

The approach/methodology for the revised ATWS analysis is unchanged from that of Reference 1.

The basis for the current ATWS requirements is 10 CFR 50.62. This regulation includes requirements for an ATWS Recirculation Pump Trip (RPT), an Alternate Rod Insertion (ARI) system, and an adequate SLCS injection rate. The purpose of the ATWS analysis is to demonstrate that these systems are adequate for plant changes associated with operation in the MELLLA region. This is accomplished by performing a plant-specific analysis in accordance with the approved licensing methodology (Reference 2), to demonstrate that ATWS acceptance criteria are met for operation in the MELLLA region.

The ATWS analysis takes credit for ATWS-RPT and SLCS, but assumes that ARI fails. If reactor vessel and fuel integrity are maintained, then the ATWS-RPT setpoint is adequate for the proposed plant modifications. If containment integrity is maintained, then the SLCS injection rate is adequate for the proposed plant modifications.

The two limiting ATWS events for VYNPS were re-evaluated at the most limiting MELLLA point (100% of Current Licensed Thermal Power (CLTP) and 75% of rated core flow (RCF)) with ARI assumed to fail, thus requiring the operator to initiate SLCS injection for shutdown. These limiting events are:

(1) Closure of all Main Steam Isolation Valves (MSIVC); and

(2) Pressure Regulator Failure (Open) to Maximum Steam Demand Flow (PRFO).

The loss of offsite power (LOOP) and inadvertent opening of a relief valve (IORV) events were also considered, but found to be non-limiting. The following ATWS acceptance criteria were used to determine acceptability of VYNPS operation in the MELLLA region:

(1) Fuel integrity:

- Maximum clad temperature < 2200° F
- Maximum local clad oxidation < 17%

(2) Reactor Pressure Vessel integrity:

- Peak RPV pressure < 1500 psig (ASME service level C)

(3) Containment integrity:

- Peak suppression pool bulk temperature < 281°F
- Peak containment pressure < 62 psig

The disposition of the compliance with the fuel clad integrity criteria is unchanged from that provided in Reference 1.

The adequacy of the margin to the SLCS relief valve lifting as described in NRC Information Notice 2001-13, "Inadequate Standby Liquid Control System Relief Valve Margin," was also assessed and determined to be adequate.

1.3 Input Assumptions

Along with the initial operating conditions given in Table 1-1, the following assumptions were used in the analysis. These assumptions are unchanged from the Reference 1 analysis:

Analytical Assumptions	Bases/Justifications
Both beginning-of-cycle (BOC) and end-of-cycle (EOC) nuclear dynamic parameters were used in the calculations.	Consistency with generic ATWS evaluation bases.
Dynamic void and Doppler reactivity are based on VYNPS Cycle 23 data.	ATWS analyses are performed conservatively compared to a nominal basis, which bounds cycle to cycle variation. Thus, utilization of VYNPS Cycle 23 fuel parameters is appropriate.
One SRV out-of-service (SRVOOS), specified as the valve with the lowest setpoint.	Consistency with the VYNPS Technical Specifications.
SRV setpoints are adjusted to be consistent with the 3% setpoint tolerance relaxation.	Consistency with the VYNPS Technical Specifications.
An additional SSV will be installed and the capacity of the existing SSVs will be increased prior to the implementation of MELLLA.	In order to ensure compliance with the reactor vessel overpressure criterion.
Main Steam Isolation Valve (MSIV) closure starts at event initiation (time zero) for the MSIVC event.	Consistency with generic ATWS evaluation bases.
Maximum combined flow through the main steam line flow limiters is 125% of rated steam flow (PRFO event).	Conservatively bounds current VYNPS Updated Final Safety Analysis Report (UFSAR) PRFO analysis basis.

Currently, VYNPS has four SRVs and two SSVs. As stated in Reference 1, prior to the implementation of MELLLA, an additional SSV will be installed with the capacity listed in Table 1-1.

1.4 Analyses Results

MELLLA conditions provide the greatest effect on peak vessel pressure and peak long-term containment response (suppression pool temperature and containment pressure). The constraints of one SRVOOS and SRV setpoint tolerance relaxation provide the greatest effect on the peak short-term reactor vessel pressure.

Tables 1-2 and 1-3 summarize the key transient responses for the MSIVC and PRFO events analyzed for the Reference 1 analysis and the revised analysis. As shown, the peak vessel bottom pressure result for both events in the revised ATWS analysis is 1358 psig, which is below the ATWS vessel overpressure protection criterion of 1500 psig. Also as shown, the revised analysis result is a decrease of 9 psi from the Reference 1 analysis peak vessel bottom pressure of 1367 psig. The decrease in the peak pressure is due to the higher SSV capacity used in the revised analysis that more than offsets the effect of a slightly longer ATWS Recirculation Pump Trip Sensor Time Constant.

The highest calculated peak suppression pool temperature is 185°F for the revised analysis, which is well below the ATWS limit of 281°F. Also, the peak containment pressure of 11.5 psig is a small fraction of the 62 psig limit. Thus, the RPV and containment integrity criteria for ATWS are met. The highest calculated peak suppression pool temperature for the revised ATWS analysis is slightly higher (2°F) than that reported in Reference 1. This difference is due to the following:

- The longer Standby Liquid Control (SLC) transport time used in the revised analysis results in a slightly longer delay to start boron injection and initiate reactor shutdown with SLC.

- The use of a 3 SRV / 3 SSV configuration in the revised ATWS analysis results in a longer time before the boron injection initiation temperature is achieved and subsequently the start of boron injection and the action to reduce feedwater flow to the reactor pressure vessel. The net result of these longer delays is a slight increase in the integrated heat addition to the suppression pool and a subsequent slightly higher suppression pool temperature.

As stated in Reference 1, compliance with the applicable acceptance criteria necessitates the installation of the third SSV. The additional SSV, as well as the increased SSV capacity of the existing two SSVs, has been designed and will be installed during the upcoming refueling outage (scheduled for spring 2004) in accordance with applicable codes and standards. In addition, the installation was evaluated for jet impingement considerations and found acceptable. The heat load to the drywell by this additional SSV and the modification to increase the capacity of the existent SSVs was evaluated and found to be acceptable.

For the revised ATWS analysis, the maximum SLCS pump discharge pressure during the limiting ATWS event is 1318.5 psig. This value is based on a peak reactor vessel lower plenum pressure of 1289.2 psia that would occur during the PRFO BOC event at the time of SLCS initiation. The results of the revised ATWS analysis show a decrease of less than 1 psi in peak reactor vessel lower plenum pressure from the Reference 1 analysis. Even though the revised ATWS analysis indicates a slight reduction in the required SLC test pressure, VYNPS will continue to test the SLC system using the revised Technical Specification 4.4.A.1. that was submitted with Reference 1.

Finally, there is adequate margin to prevent the SLCS relief valve from lifting (per NRC Information Notice 2001-13). With a nominal SLCS relief valve setpoint of 1400 psig, there is a margin of 81.5 psi between the peak SLCS pump discharge pressure and the relief valve nominal setpoint, using the result of the revised ATWS analysis. This is a slight improvement from that reported in Reference 1.

1.5 Conclusions

The results of the ATWS analysis performed for VYNPS to support operation in the MELLLA region show that the maximum values of the key performance parameters (reactor vessel pressure, suppression pool temperature, and containment pressure) remain within the applicable limits. Therefore, VYNPS operation in the MELLLA region has no adverse effect on the capability of the plant systems to mitigate postulated ATWS events in the expanded operating region.

Table 1-1

Operating Conditions and Equipment Performance Characteristics for ATWS Analyses

Parameter	Reference 1 Analysis	Revised Analysis
Dome Pressure (psig)	1010	1010
Core Flow (Mlb/hr / % rated)	36.0 / 75	36.0 / 75
Core Thermal Power (MWt / %NBR)	1593 / 100	1593 / 100
Steam / Feed Flow (Mlb/hr / %NBR)	6.45 / 99.8	6.45 / 99.8
Feedwater Temperature (°F)	376.0	376.0
Initial Void Reactivity Coefficient - BOC / EOC (c/%)	-16.8 / -12.0	-16.8 / -12.0
Core Average Void Fraction - BOC / EOC (%)	58.7 / 46.5	58.7 / 46.5
Sodium Pentaborate Solution Concentration in the SLCS Storage Tank (% by weight)	10.42	10.42
Nominal Boron 10 Enrichment (atom %)	43.0	43.0
SLCS Injection Location	Lower Plenum	Lower Plenum
Number of SLCS Pumps Operating	One	One
SLCS Injection Rate (gpm)	40.5	40.5
SLCS Liquid Transport Time (sec)	33.3	44.9
ATWS Recirculation Pump Trip Sensor Time Constant (sec)	0.0	0.2
Initial Suppression Pool Liquid Volume (ft^3)	68,000	68,000
Initial Suppression Pool Temperature (°F)	90	90
Initial Suppression Pool Mass (Mlbm)	4.216	4.216
Number of RHR cooling loops	2	2
RHR heat exchanger effectiveness (Btu/sec-°F)	176	179.375
Service Water Temperature (°F)	85	85
High Dome Pressure ATWS-RPT Setpoint (psig)	1150	1150
SRV Capacity – per valve (lbm/hr) / Reference Pressure (psig)	800,000 / 1080	800,000 / 1080

Parameter	Reference 1 Analysis	Revised Analysis
SSV Capacity – per valve (lbm/hr) / Reference Pressure (psig)	932,500 / 1240	1,126,200[(a)] / 1240
SRV / SSV Configuration	4 / 2[(b)]	3 / 3

Notes:

(a) The SSV capacity is increased by the plant modification planned for the upcoming refueling outage (scheduled for spring 2004), which is the plant refueling outage for ARTS/MELLLA implementation. The increase in SSV capacity supports future changes to VYNPS' licensing basis, e.g., Maximum Extended Load Line Limit Analysis Plus (MELLLA+).

(b) Currently, VYNPS has four SRVs and two SSVs. Prior to the implementation of MELLLA, an additional SSV will be installed with the capacity listed above. The Reference 1 ATWS analysis assumed a four SRV / two SSV configuration, which is shown through evaluation to be representative of a three SRV / three SSV alignment, i.e., one SRVOOS.

Table 1-2
Summary of Key Parameters for Short-term ATWS Calculation

	Reference 1 Analysis MSIVC		Reference 1 Analysis PRFO	
	BOC	**EOC**	**BOC**	**EOC**
Peak Vessel Bottom Pressure (psig)	1360	1357	1367	1362
Time of Peak Vessel Pressure (sec)	10.4	9.9	38.9	42.2
Peak Neutron Flux (% rated)	210	224	224	696
Time of Peak Neutron Flux (sec)	4.1	4.1	29.9	33.0
Peak Vessel Heat Flux (% rated)	127	129	135	139
Time of Peak Heat Flux (sec)	5.8	5.2	34.0	36.8

	Revised Analysis MSIVC		Revised Analysis PRFO	
	BOC	**EOC**	**BOC**	**EOC**
Peak Vessel Bottom Pressure (psig)	1353	1352	1358	1353
Time of Peak Vessel Pressure (sec)	8.7	8.2	45.4	42.6
Peak Neutron Flux (% rated)	210	238	223	334
Time of Peak Neutron Flux (sec)	4.1	4.1	41.1	34.9
Peak Vessel Heat Flux (% rated)	131	133	142	143
Time of Peak Heat Flux (sec)	5.8	6.1	42.6	40.1

Table 1-3
Summary of Key Parameters for Long-term ATWS Calculation

	Reference 1 Analysis MSIVC		Reference 1 Analysis PRFO	
	BOC	EOC	BOC	EOC
Peak Suppression Pool Temperature (°F)	170	183	172	182
Time of Peak Temperature (sec)	1259	1485	1672	1574
Peak Containment Pressure (psig)	8.5	11.1	8.8	10.8
Time of Peak Pressure (sec)	1259	1485	1672	1574

	Revised Analysis MSIVC		Revised Analysis PRFO	
	BOC	EOC	BOC	EOC
Peak Suppression Pool Temperature (°F)	175	185	175	184
Time of Peak Temperature (sec)	1349	1657	1362	1731
Peak Containment Pressure (psig)	9.4	11.5	9.4	11.3
Time of Peak Pressure (sec)	1568	1657	1587	1731

Table 1-4
ATWS Calculation Sequence of Events
(Time in seconds)

Event	Reference 1 Analysis MSIVC		Reference 1 Analysis PRFO	
	BOC	EOC	BOC	EOC
Turbine control and bypass valves start open	-	-	0.1	0.1
MSIV isolation initiation	0.0	0.0	24.7	28.9
MSIVs closed	4.0	4.0	28.7	32.9
High pressure ATWS setpoint	4.5	4.5	29.9	33.0
Opening of the first relief valve	4.5	4.5	32.8	36.5
Recirculation pumps tripped	5.0	5.0	33.2	37.0
Boron injection initiation temperature achieved	80	80	108	112
SLCS pumps start	124.5	124.5	152.7	156.4
Boron solution reaches lower plenum	157.8	157.8	186.0	189.7
RHR cooling initiated	660	660	660	660
Hot shutdown achieved	1431	1650	1569	1740

Event	Revised Analysis MSIVC		Revised Analysis PRFO	
	BOC	EOC	BOC	EOC
Turbine control and bypass valves start open	-	-	0.1	0.1
MSIV isolation initiation	0.0	0.0	33.8	31.0
MSIVs closed	4.0	4.0	37.8	35.0
High pressure ATWS setpoint	4.7	4.7	41.5	38.7
Opening of the first relief valve	4.6	4.6	41.4	38.7
Recirculation pumps tripped	5.2	5.2	42.0	39.3
Boron injection initiation temperature achieved	105	105	142	139
SLCS pumps start	124.7	124.7	161.5	158.7
Boron solution reaches lower plenum	169.6	169.6	206.4	203.6
RHR cooling initiated	660	660	660	660
Hot shutdown achieved	1435	1760	1425	1779

2.0 REFERENCES

1. GE Nuclear Energy, "Vermont Yankee Nuclear Power Station APRM / RBM / Technical Specifications / Maximum Extended Load Line Limit Analysis (ARTS/MELLLA)," NEDC-33089P, March 2003, (Attachment to Letter, BVY 03-23, VY to USNRC, "Technical Specification Proposed Change No. 257, Implementation of ARTS/MELLLA at Vermont Yankee," dated March 20, 2003).

2. NEDC-24154P-A, "Qualification of the One Dimensional Core Transient Model (ODYN) for Boiling Water Reactors (Supplement 1 – Volume 4)", February 2000.