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March 26, 2006

Docket No. 50-271  
BVY 06-031  
TAC No. MC0761

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

Subject: **Vermont Yankee Nuclear Power Station  
Revision 1 to Steam Dryer Monitoring Plan**

- 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) Entergy letter to U.S. Nuclear Regulatory Commission, "Vermont Yankee Nuclear Power Station, Extended Power Uprate – Regulatory Commitment Information Regarding Steam Dryer Monitoring and FIV Effects," BVY 06-019, February 26, 2006

This letter provides updated information pursuant to a regulatory commitment made in connection with the application by Entergy Nuclear Vermont Yankee, LLC and Entergy Nuclear Operations, Inc. (Entergy) for a license amendment (Reference 1, as supplemented) to increase the maximum authorized power level of the Vermont Yankee Nuclear Power Station (VYNPS) from 1593 megawatts thermal (MWt) to 1912 MWt.

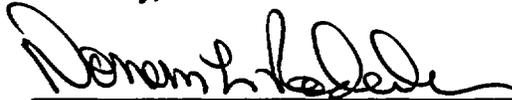
Attachment 1 includes a revision (Revision 1) to the Steam Dryer Monitoring Plan (SDMP) that was previously provided in Reference 2. The SDMP will remain in effect until License Condition 3.M expires. The SDMP, together with the EPU Power Ascension Test Procedure (PATP) provides for monitoring, inspecting, evaluating, and prompt action in response to potential adverse flow effects on the steam dryer as a result of power uprate operation. These actions provide assurance of the continued structural integrity of the steam dryer under Extended Power Uprate conditions. Attachment 2 provides the justification, consistent with License Condition 3.M.4 for why this change does not require prior NRC approval.

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There are no new regulatory commitments contained in this submittal.

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

Sincerely,



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Norman L. Rademacher  
Director Nuclear Safety Assurance  
Vermont Yankee Nuclear Power Station

Attachments (2)

cc: Mr. Samuel J. Collins (w/o attachments)  
Regional Administrator, Region 1  
U.S. Nuclear Regulatory Commission  
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Mr. Richard B. Ennis, Project Manager  
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**Attachment 1**

**Vermont Yankee Nuclear Power Station**

**Steam Dryer Monitoring Plan**

**Revision 1**

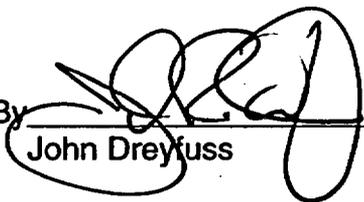
Total number of pages in Attachment 1  
(excluding this cover sheet) is 20.

# Entergy Vermont Yankee Steam Dryer Monitoring Plan

Revision 1  
March 25, 2006

Prepared By  3/25/06  
\_\_\_\_\_  
Craig J. Nichols Date

Reviewed By  3/25/06  
\_\_\_\_\_  
James Callaghan Date

Approved By  5-25-06  
\_\_\_\_\_  
John Dreyfuss Date

## VERMONT YANKEE NUCLEAR POWER STATION STEAM DRYER MONITORING PLAN

### **Introduction and Purpose**

The Vermont Yankee Steam Dryer Monitoring Plan (SDMP) describes the course of action for monitoring and evaluating the performance of the Vermont Yankee Nuclear Power Station (VYNPS) steam dryer during power ascension testing and operation above 100% of the original licensed thermal power (OLTP), i.e., 1593 MWt, to the full 120% extended power uprate (EPU) condition of 1912 MWt to verify acceptable performance. The SDMP also addresses long-term actions necessary to implement proposed License Condition 3.M. Through operating limits, periodic surveillances, and required actions, the impact of potentially adverse flow effects on the structural integrity of the steam dryer will be minimized.

The SDMP also provides information about the equipment and computer analysis methodologies used to monitor Steam Dryer performance.

Unacceptable steam dryer performance is a condition that could challenge steam dryer structural integrity and result in the generation of loose parts, cracks or tears in the steam dryer that result in excessive moisture carryover. During reactor power operation, performance is demonstrated through the measurement of a combination of plant parameters.

### **Scope**

The SDMP is primarily an initial power ascension test plan designed to assess steam dryer performance from 100% OLTP (i.e., 1593 MWt) to 120% OLTP (i.e., 1912 MWt) and to perform confirmatory inspections for a period of time following initial and continued operation at uprated power levels. Power ascension to 120% OLTP will be achieved in a series of power step increases and holds at plateaus corresponding to 80 MWt increments above OLTP. Elements of this plan will be implemented before EPU power ascension testing, and others may continue after power ascension testing.

There are three main elements of the SDMP:

1. Slow and deliberate power ascension with defined hold points and durations, allowing time for monitoring and analysis;
2. A detailed power ascension monitoring and analysis program to trend steam dryer performance (primarily through the monitoring of steam dryer load signals and moisture carryover); and
3. A long term inspection program to verify steam dryer performance at EPU operating conditions.

Several elements of the SDMP also provide for completion of the necessary actions to satisfy the requirements of license conditions associated with the EPU license amendment. A complete tabulation of the provisions of the license condition and the implementing strategy to complete them is contained in Table 3.

### Power Ascension

VYNPS procedure ERSTI-04-VY1-1409-000, "Power Ascension Test Procedure for Extended Power Conditions 1593 to 1912 MWth," (PATP) will provide controls during power ascension testing and confirm acceptable plant performance. Other procedures may be entered to conduct specialized testing, such as condensate and feedwater testing. The VYNPS power ascension will occur over an extended period with gradual increases in power, hold periods, and engineering analyses of monitored data that must be approved by station management. Relevant data and evaluations will be transmitted to the NRC staff in accordance with the provisions of the license condition. The PATP includes:

1. Power ascension rate of 16 MWt/hr;
2. Hourly monitoring of steam dryer performance during power ascension (required by License Condition 3.M);
3. Four hour holds at each 40 MWt; and
4. Minimum 96 hour holds at each 80 MWt power plateau to perform steam dryer analysis allowing for NRC review, as appropriate (required by License Condition 3.M).

### Monitoring Plans

Table 1 outlines the steam dryer surveillance requirements during reactor power ascension testing for EPU. The monitoring of moisture carryover and main steam line (MSL) pressure data provide measures for ensuring acceptable performance of the steam dryer. Frequent monitoring of these parameters will provide early detection capability of off-normal performance.

Proposed License Condition 3.M will require that steam dryer performance criteria are met and prompt action is taken if unacceptable performance is detected. Entergy has established two performance levels (Level 1 criteria and Level 2 criteria) as described in Table 2 for evaluating steam dryer performance during EPU power ascension testing. The Level 1 criteria correspond to the limits specified in the proposed license condition, while the Level 2 criteria are operating action levels that may indicate reductions in margin.

The comparison of measured plant data against defined criteria derived from the steam dryer analyses described below provide a means to assess continued steam dryer structural integrity under EPU conditions.

#### Main Steam Fluctuating Pressure Monitoring System (Details contained in VYC-3001)

- **Main Steam Line Strain Gages**  
Entergy has installed strain gages at two locations on each of the four MSLs in the primary containment and a data acquisition system (DAS) designed to reduce uncertainties in the evaluation of steam dryer loads. These strain gages and the associated data acquisition system have been selected and configured to maximize sensitivity and reliability while reducing data uncertainty.
- **Acoustic Circuit Model (ACM)**  
The CDI Acoustic Model has been improved based on results of the instrumented Steam Dryer at Exelon's Quad Cities Station. The revision has resulted in reduced uncertainty and a more conservative representation of the peak frequencies.

- **Finite Element Model (FEM)**  
In response to industry operating experience with steam dryer cover plate cracking, the ANSYS FEM has been updated to include more refined analysis of key dryer structural components such as the lower cover plate, the gussets, gusset shoes, and associated welds.
- **Acoustic Circuit Analysis (ACA) System Uncertainty Evaluation**  
The VY Acoustic Circuit Model (ACM) has been updated. The revised ACM was developed to bound maximum pressure loads from three sets of test data from the instrumented QC2 dryer testing performed in 2005. This updated ACM uncertainty assessment is based on the enhanced VY strain gage and data acquisition system and the revised CDI Bounding Pressure model parameters. The Scale Model Test (SMT) benchmark evaluation and previous 790 MWe QC2 benchmark assessment that provided the uncertainty bases for the prior ACM have been accordingly deleted from this calculation.  
The overall system uncertainty is based on the combination of the uncertainties of each of the elements. The uncertainty in the ACM loads is derived from the following sources:
  - Uncertainty of the ACM to conservatively predict pressure response at the significant frequencies
  - Uncertainty introduced by differences in sensor locations between QC2 and VY
  - Uncertainty introduced as a result of the ability of the ACM or Structural Model to match load and structural frequencies
  - Uncertainty resulting from strain gage and measure uncertainties.

These uncertainties will then be combined by the square root sum of the squares (SRSS) method to assess the ACM load uncertainty.

As calculated in VYC-3001 the overall system uncertainty is 38%. This value is used in the determination of the reduction of the limit curve factor resulting in the final limit curve, shown as Figures 1 through 8 of the SDMP. The contribution of each of the factors noted above is as follows:

#### **Maximum Uncertainty of the ACA Methodology**

ACM ability to conservatively match peak response at the highest frequencies:	32%
Difference in sensor locations from QC2 to VY	7%
Ability of ACM or Structural Model to match response frequencies:	15%
SG and DAS ability to measure pressure in Pipe	11%
 Combined Uncertainty by Square Root Sum of the Squares	 38%

- **CFD Load Uncertainty (Remains unchanged from Revision 0 of VYC 3001)**  
The CFD predictions using the Large Eddy Simulation runs for VY are on average 118% above the RMS values of in-plant data with a standard deviation of 82%. Therefore a conservative estimate of uncertainty is  $118\% - 82\% = +38\%$ . This would support 0% uncertainty for the CFD load. Conservatively, VY has maintained a 15% CFD load uncertainty in the Limit Curve Factor assessment.

The CFD analysis with the +/-10% change in load step had an impact on the limiting stress by 4%. Therefore the CFD frequency uncertainty is determined to be 4%. The total CFD uncertainty;  $unc_{CFD} = \sqrt{15^2 + 4^2} = 16\%$ .

- **System Monitoring Requirements**
  - During power ascension, steam dryer performance will be monitored hourly through the evaluation of pressure fluctuation data collected from strain gages installed on the MSLs.
  - The strain gage data collected hourly during power ascension will be compared against the stress limit curve that is provided as Figures 1 - 8 of the SDMP and is based on Entergy Calculation VYC-3001. If any frequency peak from the MSL strain gage data exceeds the stress limit curve (Level 1), Entergy will reduce the reactor power to a level at which the stress limit curve is not exceeded.
  - Additionally, Entergy will monitor data collected from accelerometers mounted to the main steam piping inside the drywell to provide additional insights into the strain gage signals.
  - During hold points at each 80 MWt power level above current licensed thermal power, the collected data, along with a comparison to the steam dryer limit curve, will be transmitted to the NRC staff.
  - For any circumstance requiring a revision to the steam dryer limit curve, Entergy will resolve uncertainties in the steam dryer analysis and provide the results of that evaluation to the NRC staff prior to further increases in reactor power.
  - Entergy will resolve uncertainties in the steam dryer analysis with the NRC staff within 90 days of issuance of the EPU license amendment. If resolution is not made within this time interval, reactor operation will not exceed 1593 MWt. These planned actions are in compliance with proposed License Condition 3.M.

#### *Moisture Carryover*

- Moisture carryover trending provides an indicator of steam dryer integrity. At each 40 MWt step, moisture carryover data will be taken and compared to the predetermined acceptance criteria (Table 2).
- Level 1 criterion (0.35%) is based on the maximum analyzed value.
- The data taken at each 80 MWt plateau will be evaluated and documented in the assessment sent to the NRC for information.

#### *Other Monitoring*

- Plant data that may be indicative of off-normal steam dryer performance will be monitored during power ascension (e.g., reactor water level, steam flow, feed flow, steam flow distribution between the individual steam lines). Plant data can provide an early indication of unacceptable steam dryer performance. The enhanced monitoring of selected plant parameters will be controlled by the PATP and other plant procedures.

#### *NRC Notifications*

- In accordance with proposed License Condition 3.M., at discrete power levels, and if the steam dryer stress limit curve (i.e., Level 1 criterion) is exceeded, Entergy will provide notifications to the NRC staff consisting of data and evaluations performed during EPU power ascension testing above 1593 MWt. Detailed discussions regarding new plant data, inspections, and evaluations will be held with NRC staff upon request. The designated NRC point of contact for such information is the NRC Project Manager for the VYNPS EPU.
- The results of the SDMP will be submitted to the NRC staff in a report within 60 days following the completion of all EPU power ascension testing. In addition the final full EPU power performance criteria spectra (i.e., steam dryer stress limit curve) will be submitted to the NRC staff within 90 days of license amendment issuance. Contemporary data and results from steam dryer monitoring will be available on-site for review by NRC inspectors as it becomes available. The written report on steam dryer performance during EPU power

ascension testing will include evaluations or corrective actions that were required to obtain satisfactory steam dryer performance. The report will include relevant data collected at each power step, comparisons to performance criteria (design predictions), and evaluations performed in conjunction with steam dryer structural integrity monitoring.

### Long Term Monitoring

The long-term monitoring of plant parameters potentially indicative of steam dryer failure will be conducted, as recommended by General Electric Service Information Letter 644, Rev. 1 and consistent with License Condition 3.M.

#### *Moisture Carryover*

Per VYNPS station operating procedure OP-0631, "Radiochemistry," moisture carryover is periodically monitored for moisture carryover during normal plant operations. VYNPS off-normal procedure ON-3178, "Increased Moisture Carryover," provides guidance to evaluate any elevated moisture carryover results including that resulting from potential vessel internals damage. This monitoring will also provide insight into changes in moisture carryover values during changing reactor core configurations (control rod patterns)

#### *Strain Gage Monitoring*

As the strain gages will remain operational and can provide for future data collection, additional strain gage monitoring will be performed as determined appropriate during the remainder of the operating cycle following EPU implementation.

#### *Inspections*

The VYNPS steam dryer will be inspected during the refueling outages scheduled for the Spring 2007, Fall 2008, and Spring 2010. The inspections conducted after power uprate implementation will be comparable in scope to the inspection conducted during the Spring 2004 refueling outage and will be in accordance with the guidance in SIL 644, Rev. 1.

#### *Reporting to NRC*

Steam Dryer Visual Inspections: The results of the visual inspections of the steam dryer conducted during the next three refueling outages shall be reported to the NRC staff within 60 days following startup from the respective refueling outage.

**Table 1**  
**Steam Dryer Surveillance Requirements During Reactor Power**  
**Operation Above a Previously Attained Power Level**

Parameter	Surveillance Frequency
1. Moisture Carryover	Every 24 hours (Notes 1 and 2)
2. Main steam line pressure data from strain gages	Hourly when initially increasing power above a previously attained power level  AND  At least once at every 40 MWt (nominal) power step above 100% OLTP (Note 3)
3. Main steam line data from accelerometers	At least once at every 40 MWt (nominal) power step above 100% OLTP (Note 3)  AND  Within one hour after achieving every 40 MWt (nominal) power step above 100% OLTP

Notes to Table 1:

1. If a determination of moisture carryover cannot be made within 24 hours of achieving an 80 MWt power plateau, an orderly power reduction shall be made within the subsequent 12 hours to a power level at which moisture carryover was previously determined to be acceptable. For testing purposes, a power ascension step is defined as each power increment of 40 MWt, i.e., at thermal power levels of approximately 102.5%, 105%, 107.5%, 110%, 112.5%, 115%, 117.5%, and 120% OLTP. Power level plateaus are nominally every 80 MWt.
2. Provided that the Level 2 performance criteria in Table 2 are not exceeded, when steady state operation at a given power exceeds 168 consecutive hours, moisture carryover monitoring frequency may be reduced to once per week.
3. The strain gage surveillance shall be performed hourly when increasing power above a level at which data was previously obtained. The surveillance of both the strain gage data and MSL pressure data is also required to be performed once at each 40 MWt power step above 1593 MWt and within one hour of achieving each 40 MWt step in power, i.e., at thermal power levels of approximately 102.5%, 105%, 107.5%, 110%, 112.5%, 115%, 117.5%, and 120% OLTP (i.e., 1593 MWt). If the surveillance is met at a given power level, additional surveillances do not need to be performed at a power level where data had previously been obtained.

If valid strain gage data cannot be recorded hourly or within one hour of initially reaching a 40 MWt power step from at least three of the four MSLs, an orderly power reduction shall be made to a lower power level at which data had previously been obtained. Any such power level reduction shall be completed within two hours of determining that valid data was not recorded.

**Table 2  
Steam Dryer Performance Criteria and Required Actions**

Performance Criteria Not to be Exceeded	Required Actions if Performance Criteria Exceeded and Required Completion Times
<p><u>Level 2:</u></p> <ul style="list-style-type: none"> <li>• Moisture carryover exceeds 0.1%</li> </ul> <p>OR</p> <ul style="list-style-type: none"> <li>• Moisture carryover exceeds 0.1% and increases by &gt; 50% over the average of the three previous measurements taken at &gt; 1593 MWt</li> </ul> <p>OR</p> <ul style="list-style-type: none"> <li>• Pressure data exceed Level 2 Spectra<sup>1</sup></li> </ul>	<ol style="list-style-type: none"> <li>1. Promptly suspend reactor power ascension until an engineering evaluation concludes that further power ascension is justified.</li> <li>2. Before resuming reactor power ascension, the steam dryer performance data shall be reviewed as part of an engineering evaluation to assess whether further power ascension can be made without exceeding the Level 1 criteria.</li> </ol>
<p><u>Level 1:</u></p> <ul style="list-style-type: none"> <li>• Moisture carryover exceeds 0.35%</li> </ul> <p>OR</p> <ul style="list-style-type: none"> <li>• Pressure data exceed Level 1 Spectra<sup>1</sup></li> </ul>	<ol style="list-style-type: none"> <li>1. Promptly initiate a reactor power reduction and achieve a previously acceptable power level (i.e., reduce power to a previous step level) within two hours, unless an engineering evaluation concludes that continued power operation or power ascension is acceptable.</li> <li>2. Within 24 hours, re-measure moisture carryover and perform an engineering evaluation of steam dryer structural integrity. If the results of the evaluation of steam dryer structural integrity do not support continued plant operation, the reactor shall be placed in a hot shutdown condition within the following 24 hours. If the results of the engineering evaluation support continued power operation, implement steps 3 and 4 below.</li> <li>3. If the results of the engineering evaluation support continued power operation, reduce further power ascension step and plateau levels to nominal increases of 20 MWt and 40 MWt, respectively, for any additional power ascension.</li> <li>4. Within 30 days, the transient pressure data shall be used to calculate the steam dryer fatigue usage to demonstrate that continued power operation is acceptable.</li> </ol>

<sup>1</sup> The EPU spectra shall be determined and documented in an engineering calculation or report. Acceptable Level 2 spectra shall be based on maintaining  $\leq 80\%$  of the ASME allowable alternating stress ( $S_a$ ) value at  $10^{11}$  cycles (i.e., 10.88 ksi). Acceptable Level 1 Spectra shall be based on maintaining the ASME  $S_a$  at  $10^{11}$  cycles (i.e., 13.6 ksi).

**Table 3**  
**Steam Dryer License Conditions**

License Condition	Requirement	Implementing Actions
3.M.1.a	<p>Entergy shall monitor hourly the 32 main steam line (MSL) strain gages during power ascension above 1593 MWt for increasing pressure fluctuations in the steam lines.</p>	<p>During initial power ascension above 1593 MWt, data from at least 32 strain gages will be collected and evaluated by Entergy's power ascension test team to verify that acoustic signals indicative of increasing pressure fluctuations in the steam lines are not challenging the steam dryer stress limit curve. Monitoring will be conducted hourly during any power ascension above a previously attained power level.            (Reference ERSTI-04-VY1-1409-000)            (Reference PCRS tracking item WT-VTY-2005-00000-01803)</p>
3.M.1.b	<p>Entergy shall hold the facility for 24 hours at 105%, 110%, and 115% of OLTP (i.e., 1593 MWt) to collect data from the 32 MSL strain gages required by License Condition 3.M.1.a, conduct plant inspections and walkdowns, and evaluate steam dryer performance based on these data; shall provide the evaluation to the NRC staff by facsimile or electronic transmission to the NRC project manager upon completion of the evaluation; and shall not increase power above each hold point until 96 hours after the NRC project manager confirms receipt of the transmission.</p>	<p>The PATP has established test plateau increments of approximately 80 MWt (corresponding to 105%, 110%, and 115% of 1593 MWt). Reactor power will not be increased above the plateau for a minimum of 96 hours. During the first 24 hours of steady state operation at each plateau, strain gage data will be collected from all available strain gages (minimum of 32) and evaluated to demonstrate acceptable steam dryer performance. Additionally, moisture carryover measurements will be made at each plateau and every 24 hours during power ascension testing. At the 80 MWt plateau hold points, Entergy will conduct plant walkdowns and inspections of plant equipment, including piping and components identified as potentially vulnerable to flow-induced vibration (FIV) in accordance with the PATP and other plant procedures. Steam dryer performance will be evaluated based on these data.</p> <p>The 24-hour period and the 96-hour period may overlap once the transmittal is provided to the NRC staff.</p> <p>The evaluations of steam dryer performance, based on the data collected during each of the 80 MWt plateaus, as well as the results of walkdowns and other measurements of FIV for various piping and plant components, will be provided to the NRC staff. Arrangements have been made for electronic transmission through email and/or uploading to a designated website. Upon the NRC Project Manager confirming receipt of the steam dryer data and performance evaluation, the 96 hours of hold</p>

License Condition	Requirement	Implementing Actions
		<p>time will commence. Power will not be increased above each of the 80 MWt hold points until the expiration of the 96-hour hold.</p> <p>If during the hold periods, or at any other time, the NRC staff requests a discussion or requires clarification of the engineering evaluations provided in fulfillment of this requirement, Entergy will promptly arrange for such discussions. Entergy will maintain a power ascension control center, including management oversight, available 24/7 on-site during power increases to previously unattained power levels. (Reference ERSTI-04-VY1-1409-000) (Reference PCRS tracking item WT-VTY-2005-00000-01803)</p>
3.M.1.c	<p>If any frequency peak from the MSL strain gage data exceeds the limit curve established by Entergy Nuclear Operations, Inc. and submitted to the NRC staff prior to operation above OLTP, Entergy Nuclear Operations, Inc. shall return the facility to a power level at which the limit curve is not exceeded. Entergy Nuclear Operations, Inc. shall resolve the uncertainties in the steam dryer analysis, document the continued structural integrity of the steam dryer, and provide that documentation to the NRC staff by facsimile or electronic transmission to the NRC project manager prior to further increases in reactor power.</p>	<p>The steam dryer stress limit curve provided herewith contains Level 1 and Level 2 criteria. If frequency peaks from MSL strain gage data exceed either Level 1 or Level 2 criteria, prompt action will be taken in response to the potential adverse flow effects that might result. Similar actions will occur if moisture carryover is excessive and previously established Level 1 or Level 2 criteria are exceeded. The Level 2 criteria represent a conservative action level for evaluation and close monitoring of steam dryer performance—not a limit. The Level 1 criteria represent analytical limits and additional actions may be warranted.</p> <p>If any frequency peak from the MSL strain gage data exceeds the Level 1 steam dryer stress limit curve, Entergy will reduce reactor power to a power level at which the limit curve is not exceeded. (Reference ERSTI-04-VY1-1409-000)</p> <p>Prior to any further increase in power above the reduced power level, Entergy will (1) resolve the uncertainties in the steam dryer analysis, (2) evaluate and document the adequate structural integrity of the steam dryer, and (3) provide that documentation to the NRC staff. Any revision to the limit curve based on this evaluation will be provided to the NRC staff. (Reference PCRS tracking item WT-VTY-2005-00000-01803)</p>

License Condition	Requirement	Implementing Actions
3.M.1.d	<p>In addition to evaluating the MSL strain gage data, Entergy Nuclear Operations, Inc. shall monitor reactor pressure vessel water level instrumentation or MSL piping accelerometers on an hourly basis during power ascension above OLTP. If resonance frequencies are identified as increasing above nominal levels in proportion to strain gage instrumentation data, Entergy Nuclear Operations, Inc. shall stop power ascension, document the continued structural integrity of the steam dryer, and provide that documentation to the NRC staff by facsimile or electronic transmission to the NRC project manager prior to further increases in reactor power.</p>	<p>Accelerometers mounted on MSL piping will be monitored on an hourly basis during power ascension testing to identify if resonances are increasing above nominal levels in proportion to MSL strain gage data. If abnormally increasing resonant frequencies are detected, power ascension will be halted. Prior to any further increase in power, Entergy will (1) evaluate and document the adequate structural integrity of the steam dryer, and (2) provide that documentation to the NRC staff.            (Reference ERSTI-04-VY1-1409-000)            (Reference PCRS tracking item WT-VTY-2005-00000-01803)</p>
3.M.1.e	<p>Following start-up testing, Entergy Nuclear Operations, Inc. shall resolve the uncertainties in the steam dryer analysis and provide that resolution to the NRC staff by facsimile or electronic transmission to the NRC project manager. If the uncertainties are not resolved within 90 days of issuance of the license amendment authorizing operation at 1912 MWt, Entergy Nuclear Operations, Inc. shall return the facility to OLTP.</p>	<p>After collecting strain gage data at approximately the EPU full power level, Entergy will resolve the uncertainties in the steam dryer analysis and provide documentation of the resolution to the NRC staff. If these actions cannot be achieved within 90 days of issuance of the license amendment, reactor power will be limited to 1593 MWt. This uncertainty evaluation may be prepared and provided to the NRC prior to reaching EPU full power levels associated with any proposed revision to the steam dryer limit curve.            (Reference PCRS tracking item WT-VTY-2005-00000-01803)</p>
3.M.2.a	<p>Prior to operation above OLTP, Entergy Nuclear Operations, Inc. shall install 32 additional strain gages on the main steam piping and shall enhance the data acquisition system in order to reduce the measurement uncertainty associated with the acoustic circuit model (ACM).</p>	<p>COMPLETE - To enhance performance and improve the accuracy of the steam dryer measurement system, Entergy has installed 48 strain gages on MSL piping and will maintain a minimum of 32 operable strain gages during power ascension testing. The data acquisition system (DAS) was upgraded to reduce the uncertainty associated with the ACM.            (Reference Entergy VYNPS Temporary Alteration TA-2005-15 R1)</p>
3.M.2.b	<p>In the event that acoustic signals are identified that challenge the limit curve during power ascension</p>	<p>COMPLETE - As part of the evaluation performed at 1673MWt Entergy Vermont Yankee employed a new revision of the Acoustic Circuit Model. In</p>

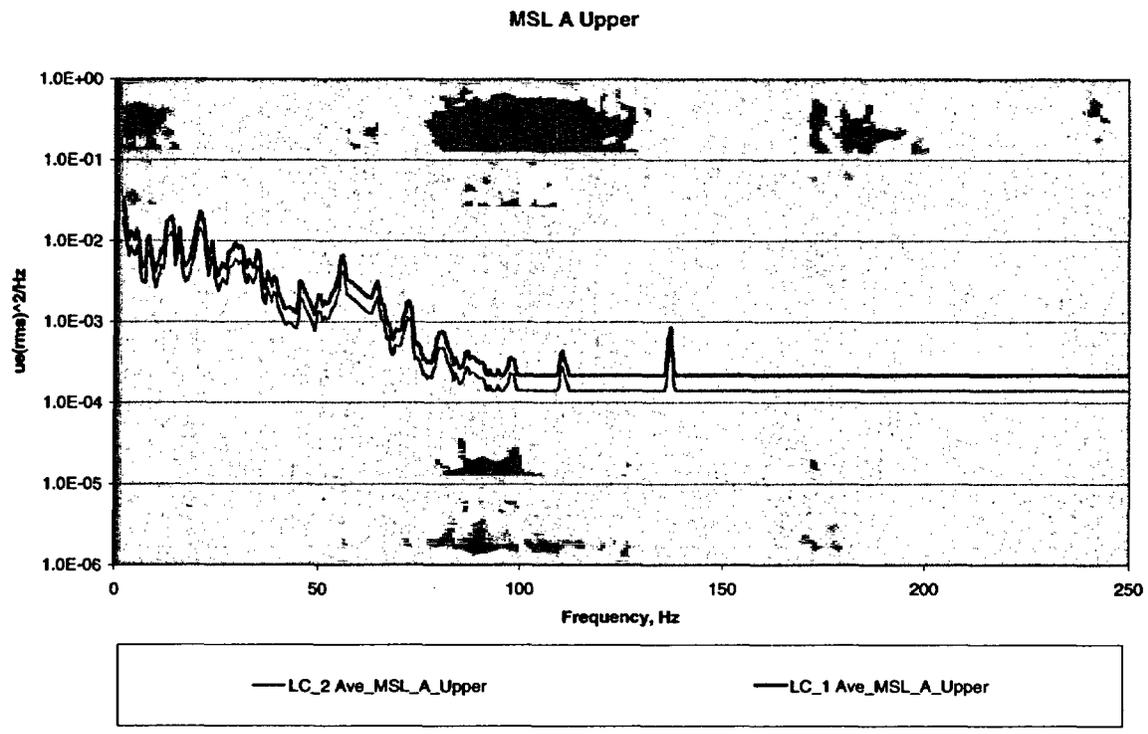
License Condition	Requirement	Implementing Actions
	<p>above OLTP, Entergy Nuclear Operations, Inc. shall evaluate steam dryer loads and re-establish the limit curve based on the new strain gage data, and shall perform a frequency-specific assessment of ACM uncertainty at the acoustic signal frequency.</p>	<p>association with the benchmarking of the new ACM a frequency specific assessment of the ACM uncertainty was performed and is contained in Calculation VYC-3001, Rev. 1.            (Reference ERSTI-04-VY1-1409-000)            (Reference VYC-3001 Rev. 1)</p>
3.M.2.c	<p>After reaching 120% of OLTP, Entergy Nuclear Operations, Inc. shall obtain measurements from the MSL strain gages and establish the steam dryer flow-induced vibration load fatigue margin for the facility, update the steam dryer stress report, and re-establish the steam dryer monitoring plan (SDMP) limit curve with the updated ACM load definition and revised instrument uncertainty, which will be provided to the NRC staff.</p>	<p>After collecting strain gage data at approximately the EPU full power level, Entergy will establish the steam dryer flow-induced vibration load fatigue margin for the facility, update the steam dryer stress report, and re-establish the stress limit curve with the updated ACM load definition and revised instrument uncertainty. This information will be included in the report to the NRC staff being made in accordance with License Condition 3.M.1.e. (Reference PCRS tracking item WT-VTY-2006-00000-00249)</p>
3.M.2.d	<p>During power ascension above OLTP, if an engineering evaluation is required in accordance with the SDMP, Entergy Nuclear Operations, Inc. shall perform the structural analysis to address frequency uncertainties up to <math>\pm 10\%</math> and assure that peak responses that fall within this uncertainty band are addressed.</p>	<p>COMPLETE - As part of the evaluation performed at 1673MWt Entergy Vermont Yankee completed revisions to the VY Steam Dryer model used in the Finite Element Model (FEM). Additional analysis of the FEM output was performed to assess the frequency uncertainties. The results of this assessment are contained in Calculation VYC-3001, Rev. 1.            ((Reference ERSTI-04-VY1-1409-000)</p>
3.M.2.e	<p>Entergy Nuclear Operations, Inc. shall revise the SDMP to reflect long-term monitoring of plant parameters potentially indicative of steam dryer failure; to reflect consistency of the facility's steam dryer inspection program with General Electric Services Information Letter 644, Revision 1; and to identify the NRC Project Manager for the facility as the point of contact for providing SDMP information during power ascension.</p>	<p>The revised SDMP provides long-term monitoring of steam dryer performance in accordance with GE SIL 644 Rev. 1.            (Reference PCRS tracking item WT-VTY-2006-00000-00250)</p> <p>COMPLETE - The SDMP and the PATP identify the NRC Project Manager for the VYNPS EPU as the point of contact for providing SDMP information during power ascension.            (Reference ERSTI-04-VY1-1409-000)</p> <p>COMPLETE - For moisture carryover, procedures OP-0631 and ON-3178 provide for long-term monitoring and controls.</p>

License Condition	Requirement	Implementing Actions
3.M.2.f	Entergy Nuclear Operations, Inc. shall submit the final extended power uprate (EPU) steam dryer load definition for the facility to the NRC upon completion of the power ascension test program.	The final EPU steam dryer load definition will be included in the report provided to the NRC staff in accordance with License Conditions 3.M.1.e. and 3.M.2.c. (Reference PCRS tracking item WT-VTY-2006-00000-00251)
3.M.2.g	Entergy Nuclear Operations, Inc. shall submit the flow-induced vibration related portions of the EPU startup test procedure to the NRC, including methodology for updating the limit curve, prior to initial power ascension above OLTP.	<p>COMPLETE - Entergy letter BVY 06-019 forwards the FIV-related portions of the EPU power ascension test procedure to the NRC. (Reference ERSTI-04-VY1-1409-000)</p> <p>The methodology for updating the steam dryer stress limit curve is as follows:</p> <p>Prerequisite: Generate report resolving uncertainties in the steam dryer analysis.</p> <ol style="list-style-type: none"> <li>1. Collect representative data from 32 strain gages at eight MSL locations.</li> <li>2. Using a plant-specific ACM, analyze strain gage data to determine steam dryer loads.</li> <li>3. Input ACM loads into a finite element model to determine dryer stresses.</li> <li>4. Perform an updated uncertainty evaluation.</li> <li>5. Generate revised steam dryer stress limit curve(s).</li> </ol> <p>(Reference PCRS tracking item WT-VTY-2006-00000-00252)</p>
3.M.3(a)	Entergy shall prepare the EPU startup test procedure to include the stress limit curve to be applied for evaluating steam dryer performance.	COMPLETE - The steam dryer stress limit curve to be applied for evaluating steam dryer performance during power ascension is provided herewith. The limit curve was developed on the basis of calculation VYC-3001, which is incorporated by reference into the EPU PATP. (Reference ERSTI-04-VY1-1409-000)
3.M.3(b)	Entergy shall prepare the EPU startup test procedure to include specific hold points and their duration during EPU power ascension.	COMPLETE - Specific hold points and durations are specified in the PATP. (Reference ERSTI-04-VY1-1409-000)
3.M.3(c)	Entergy shall prepare the EPU startup test procedure to include activities to be accomplished during hold points.	COMPLETE - Activities to be accomplished during hold points are specified in the PATP. (Reference ERSTI-04-VY1-1409-000)

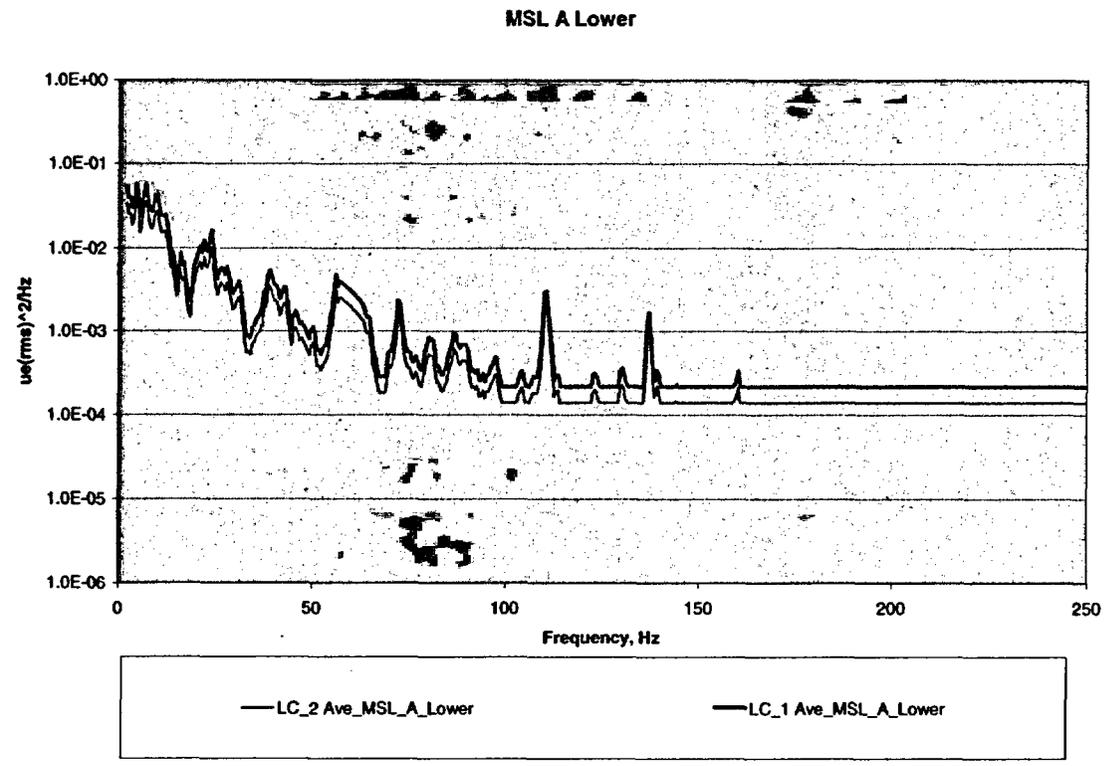
License Condition	Requirement	Implementing Actions
β.M.3(d)	Entergy shall prepare the EPU startup test procedure to include plant parameters to be monitored.	COMPLETE - Plant parameters to be monitored are specified in Attachment 9 to the PATP. (Reference ERSTI-04-VY1-1409-000)
β.M.3(e)	Entergy shall prepare the EPU startup test procedure to include inspections and walkdowns to be conducted for steam, feedwater, and condensate systems and components during the hold points.	COMPLETE - Inspections and walkdowns to be conducted for steam, feedwater, and condensate systems and components during hold points are specified in Attachment 9 to the PATP. (Reference ERSTI-04-VY1-1409-000)
β.M.3(f)	Entergy shall prepare the EPU startup test procedure to include methods to be used to trend plant parameters.	COMPLETE - Methods to be used to trend plant parameters are specified in Attachment 9 to the PATP. (Reference ERSTI-04-VY1-1409-000)
β.M.3(g)	Entergy shall prepare the EPU startup test procedure to include acceptance criteria for monitoring and trending plant parameters, and conducting the walkdowns and inspections.	COMPLETE - Acceptance criteria for monitoring and trending plant parameters, and conducting the walkdowns and inspections are specified in Attachment 9 to the PATP. (Reference ERSTI-04-VY1-1409-000)
β.M.3(h)	Entergy shall prepare the EPU startup test procedure to include actions to be taken if acceptance criteria are not satisfied.	COMPLETE - Actions to be taken if acceptance criteria are not satisfied are specified in the PATP. (Reference ERSTI-04-VY1-1409-000)
β.M.3(i)	Entergy shall prepare the EPU startup test procedure to include verification of the completion of commitments and planned actions specified in the license amendment application and all supplements to the application in support of the EPU license amendment request pertaining to the steam dryer.	COMPLETE - Verification of the completion of commitments and planned actions specified in the license amendment application and all supplements to the application in support of the EPU license amendment request pertaining to the steam dryer is specified in the PATP. (Reference ERSTI-04-VY1-1409-000)

3.M.4	<p>When operating above OLTP, the operating limits, required actions, and surveillances specified in the SDMP shall be met. The following key attributes of the SDMP shall not be made less restrictive without prior NRC approval:</p> <ul style="list-style-type: none"> <li>a. During initial power ascension testing above OLTP, each test plateau increment shall be approximately 80 MWt;</li> <li>b. Level 1 performance criteria; and</li> <li>c. The methodology for establishing the stress spectra used for the Level 1 and Level 2 performance criteria.</li> </ul> <p>Changes to other aspects of the SDMP may be made in accordance with the guidance of NEI 99-04.</p>	<p>These restrictions are provided in the PATP and/or the SDMP. (Reference ERSTI-04-VY1-1409-000)</p>
3.M.5	<p>During each of the three scheduled refueling outages (beginning with the spring 2007 refueling outage), a visual inspection shall be conducted of all accessible, susceptible locations of the steam dryer, including flaws left "as is" and modifications.</p>	<p>The VYNPS steam dryer will be inspected during the refueling outages scheduled for the Spring 2007, Fall 2008, and Spring 2010. The inspections conducted after power uprate implementation will be comparable to the inspections conducted during the Spring 2004 and Fall 2005 refueling outages and will be in accordance with the guidance in SIL 644, Rev. 1. (Reference PCRS tracking item WT-VTY-2006-00000-00253) (Reference PCRS tracking item WT-VTY-2006-00000-00254) (Reference PCRS tracking item WT-VTY-2006-00000-00255)</p>

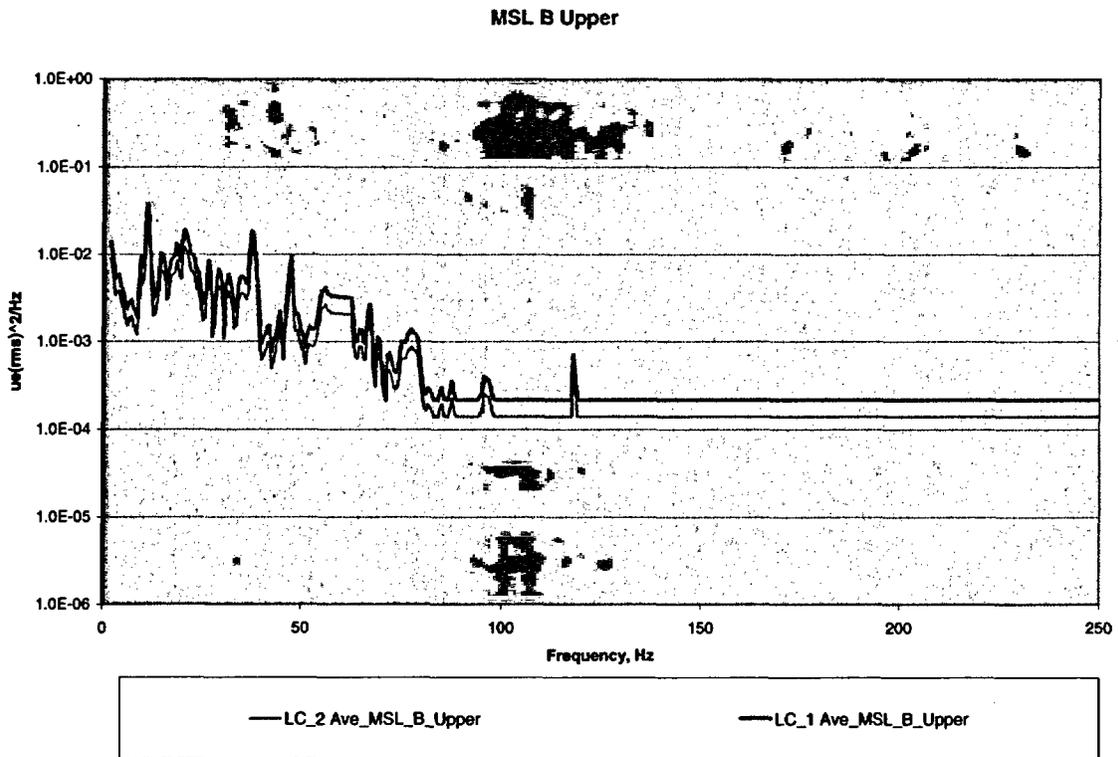
<p>3.M.6</p>	<p>The results of the visual inspections of the steam dryer conducted during the three scheduled refueling outages (beginning with the spring 2007 refueling outage) shall be reported to the NRC staff within 60 days following startup from the respective refueling outage. The results of the SDMP shall be submitted to the NRC staff in a report within 60 days following the completion of all EPU power ascension testing.</p>	<p>The VYNPS steam dryer will be inspected during the refueling outages scheduled for the Spring 2007, Fall 2008, and Spring 2010. The inspections conducted after power uprate implementation will be comparable to the inspections conducted during the Spring 2004 and Fall 2005 refueling outages and will be in accordance with the guidance in SIL 644, Rev. 1. The results will be documented in a report and submitted to the NRC within 60 days following completion of all EPU power ascension testing.          (Reference PCRS tracking item WT-VTY-2006-00000-00256)          (Reference PCRS tracking item WT-VTY-2006-00000-00257)          (Reference PCRS tracking item WT-VTY-2006-00000-00258)</p>
<p>3.M.7</p>	<p>The requirements of paragraph 3.M.4 above for meeting the SDMP shall be implemented upon issuance of the EPU license amendment and shall continue until the completion of one full operating cycle at EPU. If an unacceptable structural flaw (due to fatigue) is detected during the subsequent visual inspection of the steam dryer, the requirements of paragraph 4 shall extend another full operating cycle until the visual inspection standard of no new flaws/flaw growth based on visual inspection is satisfied.</p>	<p>When operating above 1593 MWt, the operating limits, required actions, and surveillances specified in the SDMP will be met. Those key attributes of the SDMP specified in License Condition 3.M.4 will not be made less restrictive without prior NRC approval.          (Reference PCRS tracking item WT-VTY-2006-00000-00259)</p>
<p>3.M.8</p>	<p>This license condition shall expire upon satisfaction of the requirements in paragraphs 5, 6, and 7 provided that a visual inspection of the steam dryer does not reveal any new unacceptable flaw or unacceptable flaw growth that is due to fatigue.</p>	<p>(Reference PCRS tracking item WT-VTY-2006-00000-00260)</p>



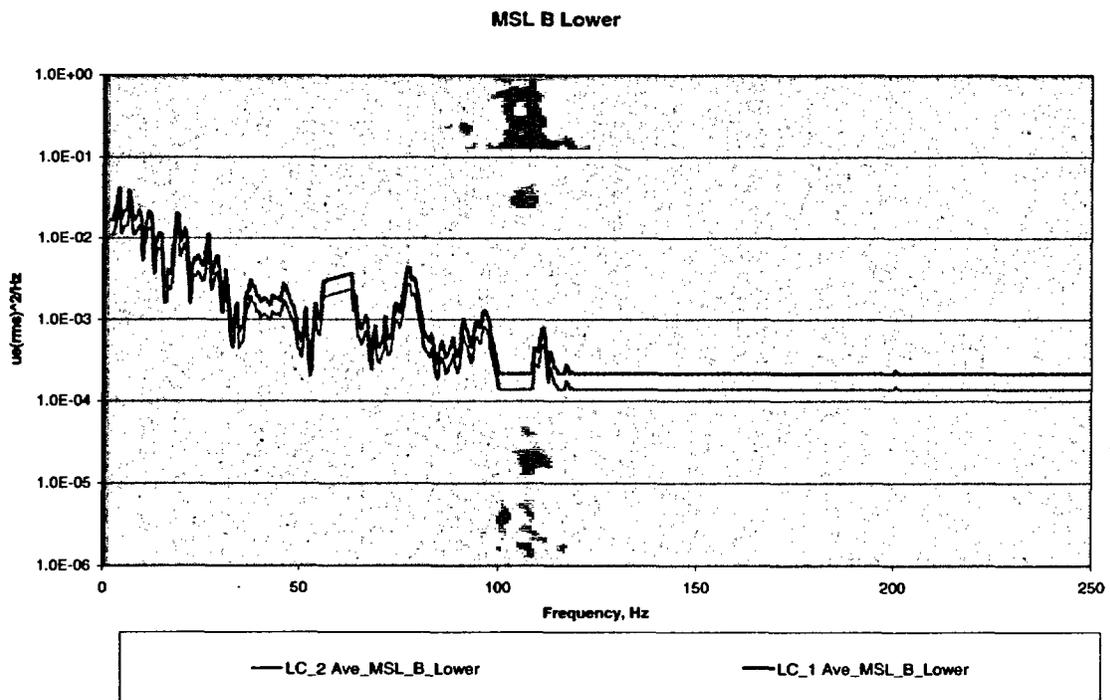
**Figure 1: Steam Dryer Stress Limit Curve – MSL 'A' Upper**



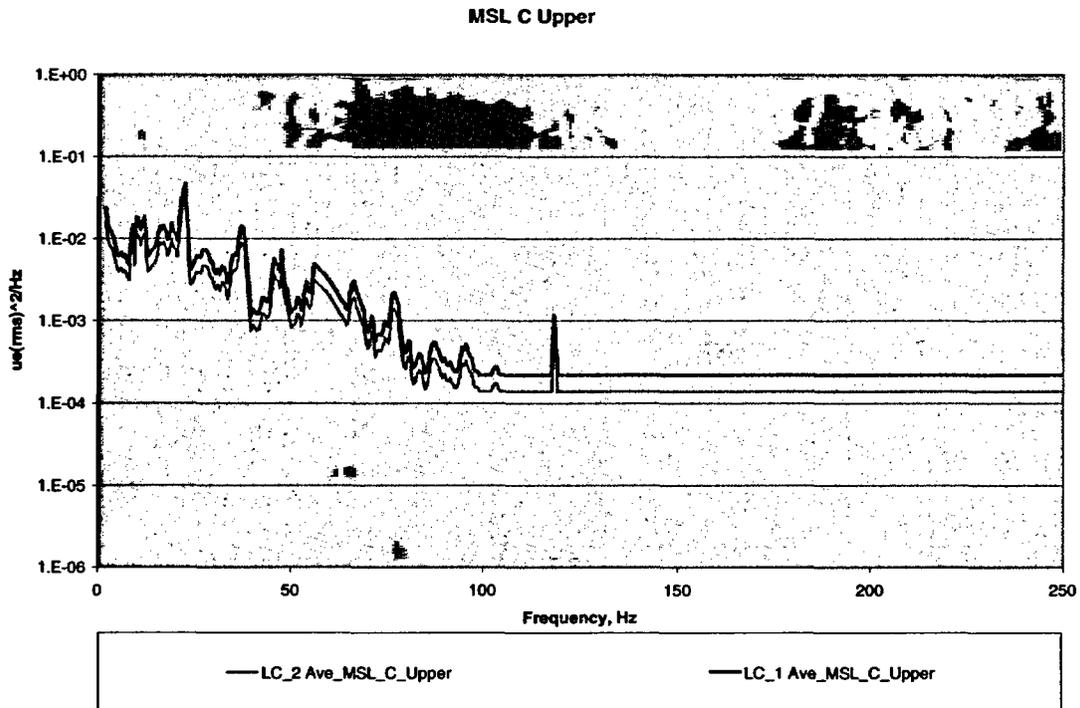
**Figure 2: Steam Dryer Stress Limit Curve – MSL 'A' Lower**



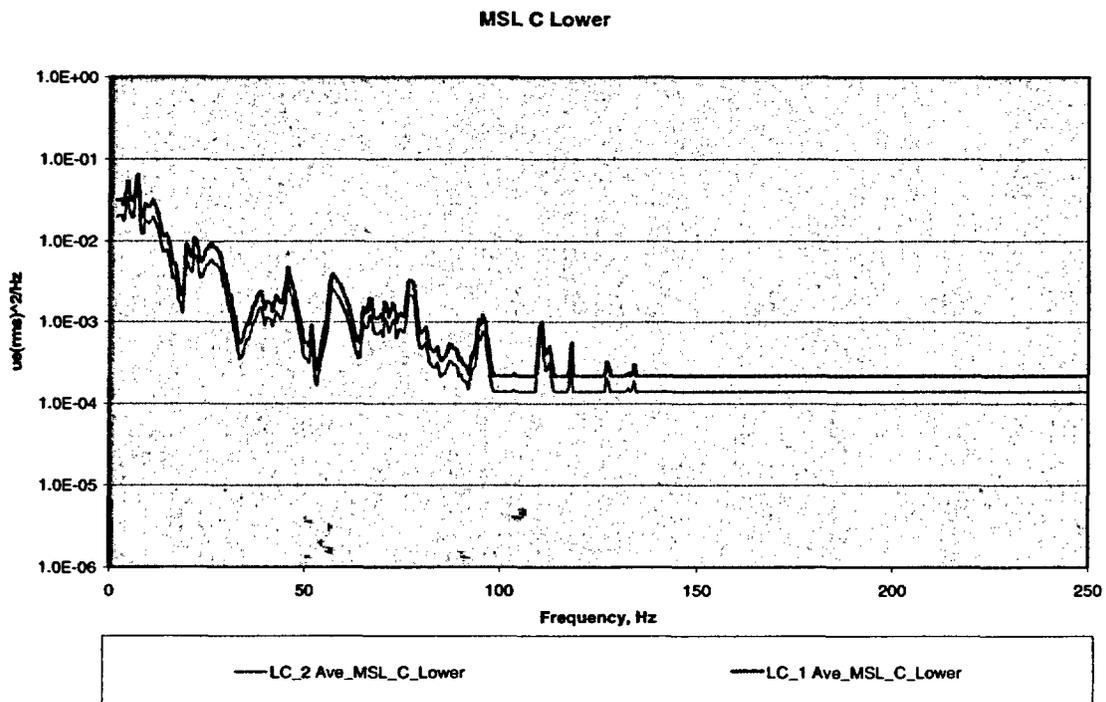
**Figure 3: Steam Dryer Stress Limit Curve – MSL 'B' Upper**



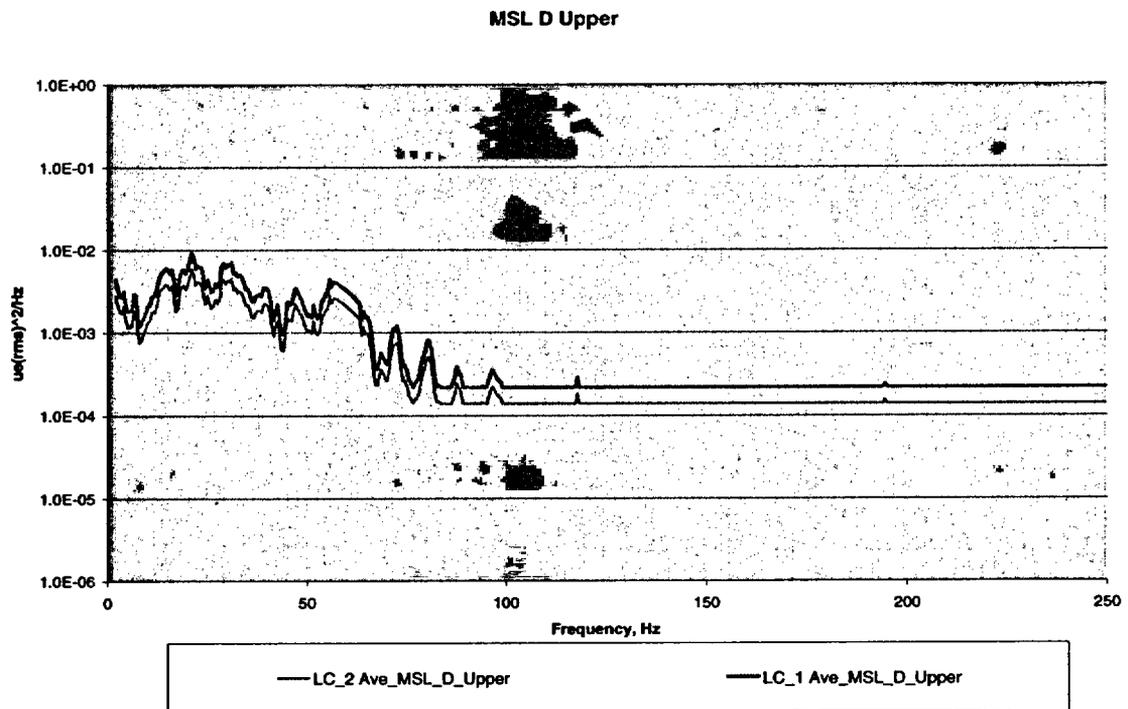
**Figure 4: Steam Dryer Stress Limit Curve – MSL 'B' Lower**



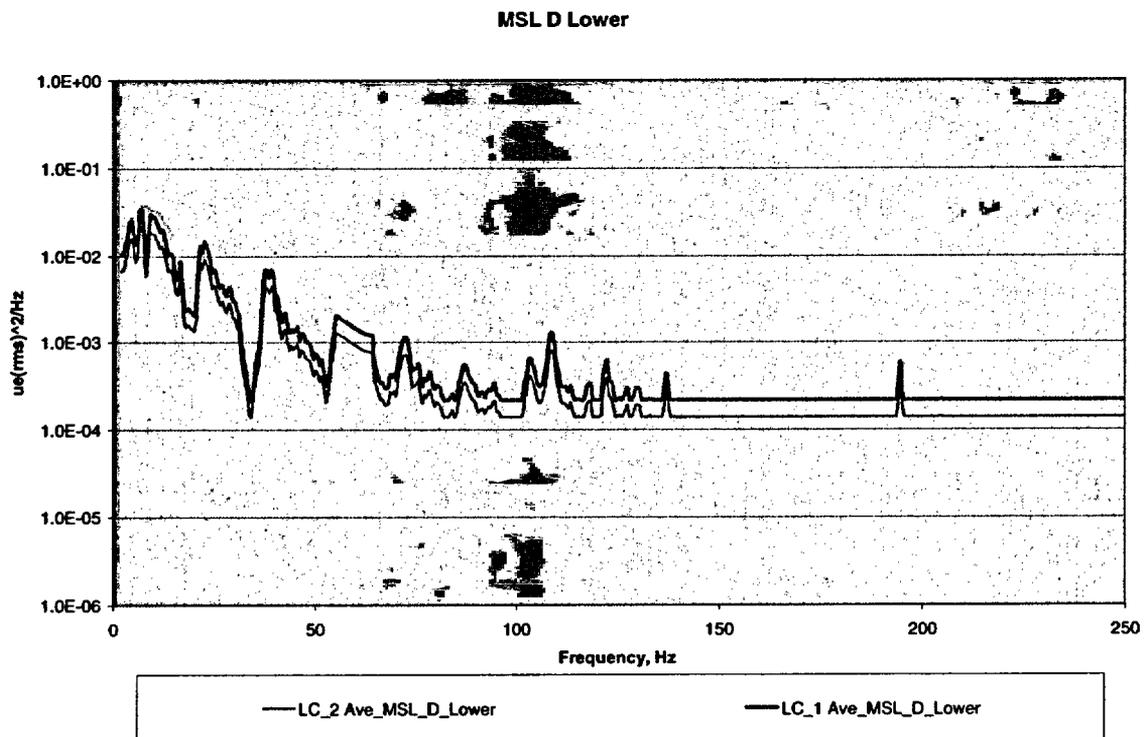
**Figure 5: Steam Dryer Stress Limit Curve – MSL 'C' Upper**



**Figure 6: Steam Dryer Stress Limit Curve – MSL 'C' Lower**



**Figure 7: Steam Dryer Stress Limit Curve – MSL 'D' Upper**



**Figure 8: Steam Dryer Stress Limit Curve – MSL 'D' Lower**

**Attachment 2**

**Vermont Yankee Nuclear Power Station**

**Steam Dryer Monitoring Plan**

**Basis for Compliance with License Condition 3.M.4**

**Total number of pages in Attachment 2  
(excluding this cover sheet) is 3).**

Bases for Compliance with License Condition 3.M.4

Reference: ERSTI-04-VY1-1409-000, "Power Ascension Test Procedure for Extended Power Conditions 1593 to 1912 MWt (PATP)

Purpose:

This document assesses compliance of changes to the Vermont Yankee steam dryer monitoring models with Vermont Yankee License Condition 3.M.4. In addition, an assessment of the ability of the steam dryer to support operation at the next power plateau is also included herein.

Discussion:

On March 4, 2006 Vermont Yankee Nuclear Power Stations (VYNPS) raised reactor power from 1593 MWt to approximately 1673 MWt, the first power ascension plateau. At that power level the lower set of strain gages on the 'A' main steam line provided an indication at 137 Hz that exceeded the Level 2 Acceptance Criteria of the Steam Dryer Monitoring Plan (SDMP). Entergy Vermont Yankee entered the corrective action program and performed an engineering evaluation which concluded that continuous operation at the first power plateau (1673 MWt) would not challenge steam dryer integrity.

Entergy Vermont Yankee uses an Acoustic Circuit Model (ACM) and an ANSYS Finite Element Model (FEM) to monitor performance of the steam dryer. To address the aforementioned 137 Hz peak, these models have been updated in accordance with requirements established in License Condition 3.M of the Vermont Yankee Extended Power Uprate License Amendment. Details of these changes are discussed later in this document.

The scope of the analyses performed and the results are included in Entergy Vermont Yankee calculation VYC-3001, Revision 1. This calculation includes in part:

- Strain Gage Data from 1593 MWt and 1673 MWt
- Acoustic Circuit Model Benchmark Report
- ACM Uncertainty Evaluation
- Stress Analysis Model Description
- Stress Analysis Results
- Limit Curve Development
- Revised Limit Curves

Based on the improvements in the monitoring system and analysis techniques and evaluation of the VYNPS specific signals at 1673 MWt, an engineering evaluation has been completed and has concluded that the strain gage signals are expected to remain below the Level 1 Acceptance Criteria during operation up to and including the next power ascension plateau at 1753 MWt. A summary of the changes to the models and the uncertainty evaluation, along with the new Steam Dryer Strain Gage Limit Curves is contained in the Steam Dryer Monitoring Plan (SDMP) (Attachment 1 of BVY 06-031). The details of these analyses, including any proprietary documents, have been made available to the NRC Technical Staff for review.

The changes made to the steam dryer models and generation of revised steam dryer limit curves have been assessed against the requirements of License Condition 3.M.4 which states:

*“When operating above OLTP, the operating limits, required actions, and surveillances specified in the SDMP shall be met. The following key attributes of the SDMP shall not be made less restrictive without prior NRC approval:*

- a. During initial power ascension testing above OLTP, each test plateau increment shall be approximately 80 MWt;*
- b. Level 1 performance criteria; and*
- c. The methodology for establishing the stress spectra used for the Level 1 and Level 2 performance criteria.*

*Changes to other aspects of the SDMP may be made in accordance with the guidance of NEI 99-04.”*

As described above, License Condition 3.M.4 specifies those attributes of the approach to steam dryer monitoring that require NRC approval prior to being made less restrictive. As addressed below, Vermont Yankee concludes that the key attributes have NOT been made less restricted and, therefore, the proposed model and limit curve changes do NOT require NRC approval.

The following changes have been incorporated into the VY approach to steam dryer monitoring:

1. Incorporation of strain gage accuracy improvements in accordance with License Condition 3.M requirements.
2. Use of an updated CDI Acoustic Circuit Model (ACM) that has been modified to be conservative in the areas of interest and benchmarked against instrumented dryer data from several power levels at Quad Cities. The ACM update to address industry operating experience is required by the License Condition.
3. Revisions to the Finite Element Model (FEM) to incorporate refinement of model in areas of concern related to past failures at Quad Cities and Dresden as required by the License Condition.
4. Generation of a new Uncertainty Calculation based on plant data and the changes above as required by the License Condition.
5. An updated Level 1 Limit Curve representing a conservative reduction of the ASME design limit (13.6 ksi) by the values obtained in the uncertainty assessment.
6. There have been no changes to the Computation Fluid Dynamics (CFD) Model or the role of the CFD analysis to provide additional conservatism for low frequency flow sources.

This revision of the SDMP was evaluated against the criteria in License Condition 3.M.4 to determine if NRC approval is required as summarized below:

- a. This revision proposes no change in the test plateau increments from those specified in the criteria.
- b. The Level 1 performance criteria is defined as a limit curve for strain gage results that represents a stress on the dryer equal to the ASME Design Limit of 13.6 ksi minus the calculated total model and measurement uncertainty.

The application of model refinements that provide for higher accuracy in determining Vermont Yankee specific dryer stress limits does not constitute a change in methodology. The updated limit curves still represent the ASME criteria minus the calculated uncertainty.

- c. The methodology for establishing stress spectra for the Level 1 and Level 2 criteria is not altered by this change.

As required by License Condition 3.M the output of the strain gages is generated as input to the Acoustic Circuit Model (ACM) analysis. The ACM generates pressure loads on the Steam Dryer using the Helmholtz equations. The ANSYS FEM code is used to generate stress loads for affected components of the dryer.

The above changes were evaluated using the guidance provided in NEI 99-04.

**Conclusion:**

1. Based on the analysis performed using VYNPS Strain Gage data taken at the 1673 MWt plateau and employing the improved models as required by the EPU License Amendment the VYNPS Steam Dryer is not expected to reach Level 1 Acceptance Criteria prior to or at the next power ascension plateau (1753 MWt) and Power Ascension can continue.
2. The SDMP has not been made less restrictive by the changes made to the ACM and FEM and prior NRC approval is not required to implement these changes.

Preparer: Craig Nichols		3/25/06
Name	Signature	Date
Reviewer: James Callaghan		3/25/06
Name	Signature	Date
Reviewer: James DeVincentis		3/25/06
Name	Signature	Date