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UNITED STATES
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

Before Administrative Judges:

Alex S. Karlin, Chairman
Dr. Richard E. Wardwell
Dr. William H. Reed

In the Matter of	)	
	)	
ENTERGY NUCLEAR VERMONT YANKEE, LLC and ENTERGY NUCLEAR OPERATIONS, INC.	)	Docket No. 50-271-LR ASLBP No. 06-849-03-LR
	)	
(Vermont Yankee Nuclear Power Station)	)	

NEW ENGLAND COALITION, INC.

CONTENTION 3

PREFILED EXHIBITS

NEC-JH_54 – NEC-JH_61

April 28, 2008

Template Secy-028

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NEC-JH_54

Assessment of Proposed Program to Manage Aging of the Vermont Yankee Steam Dryer Due to Flow-Induced Vibrations

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I. Basic Concepts

NEC's Contention Three addresses Entergy's plan to manage aging of the Vermont Yankee (VY) steam dryer due to flow-induced vibration, mechanical vibration resulting from interactions between the elastic forces in the dryer and the dynamic forces of the flowing steam. Such vibrations can result when the dryer or one of its components sheds vortices due to boundary layer flow separation at the surface. These vortices create pressure oscillations near the dryer, causing the dryer to vibrate. When the natural frequency of the dryer or one of its components is close to the shedding frequency of the vortex, the resulting vibrations can cause catastrophic damage to the dryer.

The frequencies at which vortices are shed from a structure are correlated with a nondimensional number called the Strouhal number; $S = f D/V$, f is the frequency, D is a dimensional length, V is the flow velocity, S is an empirical number that depends on the Reynolds number. For high Reynolds numbers and simple geometries, such as a cylinder, S is approximately a constant, making the frequency directly proportional to the flow velocity. For a given structure, a small change in velocity may cause the vortex shedding frequency to increase and approach the natural frequency of the structure.

II. Background.

The steam dryer has no safety functions. However, the structural integrity of the dryer must be maintained such that the generation of loose parts is prevented during normal operation, transients[1] and accident events. A public safety hazard would result if the dryer was damaged and some of its parts broke loose and were transported by flow or gravity to other areas of the reactor system. Loose parts may block flow channels in the reactor core, block spray cooling nozzles, or prevent the main steam isolation valves ("MSIVs") from isolating the system during loss of coolant accidents ("LOCA"). This is a direct threat to public health and safety and in violation of General Design Criteria GDC 1 and Draft GDC -40 and -42, 10 CFR Part 50, Appendix A insofar as they require that protection must be provided against the dynamic effects of loss of coolant accidents, LOCA.

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[1] A "transient" is the plant response to a change in power level.

At the beginning of 2006, the operating power at the Vermont Yankee plant was increased by 20%. This also increased the velocities by 20%. Other plants where the velocity was increased experienced crack formation in the steam dryer as described in GE SIL No. 644[2], as discussed further below. Consequently, Entergy installed strain gauges to monitor the condition of the dryer during accession to power. The strain gauges were installed in the main steam line (MSL) to monitor pressure fluctuations within the main steam flow. The data were then used as inputs to an acoustic circuit model (ACM) to calculate pressure loads on the steam dryer and the resulting stress in steam dryer components using a finite element model (FEM).[3]

III. Dryer Failures

GE Nuclear Entergy Service Information Letter, SIL No. 644, Revision 1 (November 9, 2004) provides a summary of experience with dryer failures following power uprates.[4] Failures due to both localized high and low frequency pressure loading occurred on dryers at two different power plants. In both cases, the failures at different locations on the dryer occurred from high cycle fatigue. The small pressure fluctuations in the steam lines (3-4 psi) indicate that even small pressure fluctuations on the dryer can generate altering stresses that exceed the endurance limit at some dryer locations.[5] This is important because it indicates that in order to predict whether the dryer will crack one must first know what the loads are on the dryer at various locations.

The history of steam dryer cracking at the VY plant indicates that Entergy's program to date of visual inspection and moisture monitoring have

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[2] Exhibit NEC-JH_55.

[3] See, ML060050028, Safety Evaluation by Office of Nuclear Reactor Regulation Related to Amendment No. 229 to Facility Operating License No. DPR28, Entergy Nuclear Vermont Yankee, LLC and Entergy Nuclear Operations, Inc., Vermont Yankee Nuclear Power Station Docket 50-271 at § 2.2.6.2.1.

[4] Exhibit NEC-JH_55 at 1-5, Appendices A, B; See also, Exhibit NEC-JH_56.

[5] Exhibit NEC-JH_55.

been ineffective in identifying cracking at the time it occurs, when it occurs in between inspections.[6] General Electric evaluated crack formation in the dryer during the last refueling outage RF026.[7] GE believes that all the cracks were caused by intergranular stress corrosion cracking ("IGSCC"). However, GE did not rule out the possibility of continued crack growth by fatigue.

IV. Entergy's Proposed Steam Dryer Aging Management Plan Program

Entergy has represented that its aging management program for the steam dryer during the period of extended operations will consist exclusively of periodic visual inspection and monitoring of plant parameters as described in GE-SIL-644, and will not involve the use of any analytical tool to estimate stress loads on the steam dryer.[8] Entergy described its proposed program as follows:

> The aging management program for the VY steam dryer during the twenty-year license renewal period will consist of well-defined monitoring and inspection activities that are defined in GE SIL-644 guidelines and are identical to those being conducted during the current post-EPU phase. Steam dryer integrity will be monitored continuously via operator monitoring of certain plant parameters. VY Off-normal Procedure ON-3178 alerts the operators that any of the following events could be indicative of reactor internals damage and/or loose parts generation: a) a sudden drop in main steam line flow > 5%; b) > 3 inch difference in reactor vessel water level instruments; c) sudden drop in steam dome pressure > 2 psig. In addition, periodic measurements of moisture carryover will be evaluated in accordance with the requirements of GE-SIL-644. This monitoring program will continue for the entire license renewal period. The inspection activities will include

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6 Exhibit NEC-JH_57; Exhibit NEC-JH_58 at 4-5; Exhibit NEC-JH_59; Exhibit NEC-JH_60.

7 Exhibit NEC-JH_59.

8 Exhibit NEC-JH_61 at ¶¶ 23-24.

> visual inspections of the steam dryer every two refueling outages consistent with GE and BWR Vessel Internals Program (VIP) requirements. The inspections will focus on areas that have been repaired, those where flaws exist, and areas that have been susceptible to cracking based on reactor operating experience throughout the industry.
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> The aging management plan for the license renewal period, consisting of the monitoring and inspection activities described above, does not depend on, or use, the CFD and ACM computer codes or the [finite element modeling] conducted using those codes.[9]

GE- SIL-644 recommends visual inservice inspections during each refueling outage, but does not require any measurements that could indicate whether existing cracks in the dryer grow in number or length. Visual inspection of the dryer is done with a camera only in accessible areas.

V. Assessment of Proposed Steam Dryer Aging Management Plan

A. Basic Considerations

The steam dryer is susceptible to two types of cracks, (a) stress corrosion cracks, ("SC") and (b) fatigue cracks. Even when one can measure with Eddy Current the density or depth of existing SC cracks, there is no way of predicting how fast such cracks would reach a critical size and then propagate through the wall very rapidly given the presence of sufficiently high loads. Fatigue cracks are usually initiated at points of high stress concentrations which were formed during the fabrication process. Fatigue cracks may be slow to initiate, but once initiated they propagate very fast when exposed to alternating stresses of sufficient magnitude and frequency. Because of the two-stage process of crack formation, when one does not find cracks during inspection, there is absolutely no reason why such cracks would not start propagating once the plant is restarted. The steam dryer problem at VY is serious because we already know that the 20%

[9] Id.; see also, License Renewal Application § 3.1.2.2.11.

increase in velocity increased the potential for the creation of fluctuating pressure loadings. Small changes in local velocity may cause pressure frequencies of local pressure fluctuations to approach the natural frequency of the dryer.

There were problems in the interpretation of the strain gauge data during the accession to 120% at VY and the ACRS questioned the validity of the analytical models.[10] Following the accession to power, Entergy removed the instrumentation that was used to monitor the pressure fluctuations within the dryer.[11]

B. Aging Management Requirements

A sufficient steam dryer aging management plan at VY must include both 1) visual inspection of the steam dryer, and 2) some means of estimating and predicting stress loads on the steam dryer, establishing dryer flow induced vibration load fatigue margins, and demonstrating that stresses on the dryer at selected locations will fall below ASME fatigue limits. The ability to accurately assess and predict stress loads that may act on the dryer during the fuel cycle is essential to ensure the dryer's structural integrity. The visual inspection program and any repairs to the dryer must be informed by knowledge of dryer loads. Plant experience (see Part III, above) demonstrates that an aging management plans that consists solely of parameter monitoring, and partial visual inspection, uninformed by knowledge of dryer loading, will not be sufficient.

Plant parameter monitoring is not effective to prevent the generation of loose parts that can damage safety-related plant components. Most parameter monitoring (moisture, steam flow, water level, dome pressure) may indicate the formation of only those steam dryer cracks that increase moisture carryover; those cracks that do not lead to significant moisture carryover may continue to grow undetected. Moisture monitoring only indicates that a failure has occurred; it does not prevent the failure from occurring. In fact, GE-SIL-644 states the limitations of parameter monitoring as follows: "monitoring steam moisture content and other reactor

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[10] See, ML060040431, Letter to Nils J. Diaz from Graham B. Wallis re. Vermont Yankee Extended Power Uprate (January 4, 2006) at 5.

[11] Exhibit NEC-JH_61 at ¶ 27.

parameters does not consistently predict imminent dryer failure nor will it preclude the generation of loose parts."[12]

VI. Conclusions

For the above-stated reasons, I believe that the operation of the steam dryer, as currently intended by Entergy, is a direct threat to public health and safety and is in violation of GDC 1 and Draft GDC -40 and -42 insofar as they require that protection must be provided against the dynamic effects of a LOCA. I also believe that it was a mistake to remove the instrumentation for the determination of the loads on the dryer. Instead of eliminating all instruments, VY should have improved the analytical tools for predicting, the loads on the dryer, perhaps by conducting additional scaling test at GE at the San Jose facility.

Entergy must formulate a new plan to manage steam dryer cracking before entering the extended period of operation. The plan should be reviewed by a competent party with no financial ties to Entergy.

[12] Exhibit NEC-JH_ at 6.

GE Nuclear Energy

SIL
Services Information Letter

BWR steam dryer integrity

SIL No. 644
Revision 1

November 9, 2004

SIL No. 644 ("BWR/3 steam dryer failure"), issued August 21, 2002, described an event at a BWR/3 that involved the failure of a steam dryer cover plate resulting in the generation of loose parts, which were ingested into a main steam line (MSL). The most likely cause of this event was identified as high cycle fatigue caused by a flow regime instability that resulted in localized high frequency pressure loadings near the MSL nozzles. SIL No. 644 Supplement 1, issued September 5, 2003, described a second steam dryer failure that occurred at the same BWR/3 approximately one year following the initial steam dryer failure. This second failure occurred at a different location with the root cause identified as high cycle fatigue resulting from low frequency pressure loading. SIL No. 644 included focused recommendations. For BWR/3-style steam dryers, it recommended monitoring steam moisture content (MC) and other reactor parameters, and for those plants operating at greater than the original licensed thermal power (OLTP), it recommended inspection of the cover plates at the next refueling outage. SIL No. 644 Supplement 1 broadened the earlier recommendations for BWR/3-style steam dryer plants and provided additional recommendations for BWR/4 and later steam dryer design plants planning to or already operating at greater than OLTP.

Following this revised guidance, inspections were performed on plants operating at OLTP, stretch uprate (5%), and extended power uprate conditions. These inspections indicate that steam dryer fatigue cracking can also occur in plants operating at OLTP.

The purpose of this Revision 1 to SIL No. 644 is to describe additional significant fatigue cracking that has been observed in steam dryer hoods subsequent to the issuance of SIL No. 644 Supplement 1 and to provide inspection and monitoring recommendations for all BWR plants based on these observations. In that the occurrence of fatigue cracking has been observed in several BWRs, this revision contains inspection and monitoring recommendations that apply to all plants. SIL No. 644 Revision 1 voids and supercedes SIL No. 644 and SIL No. 644 Supplement 1.

Discussion

Instances of fatigue cracking in the steam dryer hood region have been observed recently in several BWR plants. The cracking has led to failure of the hood and the generation of loose parts in two BWR/3 plants. Details of the cracking in these plants are described below. These observations have potential generic significance for all BWR steam dryers that will be discussed in the generic implications section below.

BWR/3-Style Dryer Observations

Lower horizontal cover plate failure occurred in a BWR/3 in 2002. In this failure, almost the entire lower horizontal cover plate came completely loose, with some large pieces falling down onto the steam separators and one piece being ingested into the main steamline and lodging in the flow restrictor. This failure was accompanied by a significant increase in moisture content, along with changes in other monitored reactor parameters. The cause of this failure was attributed to the higher fluctuating pressure loads at extended power uprate (EPU) operation. In particular, there may have been a potential resonance condition between a high frequency fluctuating pressure loading (in the 120-230 Hz range) and the natural frequency of the cover plate. Appendix A provides a more detailed description of this event.

The same BWR/3 experienced extensive through-wall cracking in the outer bank hood on the 90° side in May 2003. On the opposite side of the steam dryer (270° side), incipient cracking was observed on the inside of the outer hood cover plate. Several internal braces were detached and found on top of the steam separators. No damage was found on the inner banks of the dryer. Again, the failure was accompanied by a significant increase in moisture content. Of the other monitored reactor parameters, only the flow distribution between the individual steamlines was affected. The cause of this failure was attributed to high cycle fatigue resulting from low frequency oscillating pressure loads (<50 Hz) of higher amplitude at EPU operation and the local stress concentration introduced by the internal brackets that anchor the diagonal internal braces to the dryer hoods. Appendix B provides a more detailed description of this event.

In November 2003, a hood failure occurred in the sister unit to the BWR/3 that had experienced the previously noted failures. This unit was also operating at EPU conditions. The observed hood damage and associated root cause determination were virtually the same as the May 2003 failure described above. During the event, the moisture content exceeded the previously defined action level. However, the monitored plant parameters (primarily individual steamline flow rates) showed only subtle changes and were well within the previously defined action levels for the plant. This failure resulted in the generation of loose parts from the outer vertical hood plate. In addition, inspections during the repair outage showed fatigue cracking in the inner hood vertical braces below where the lower ends of the diagonal braces were attached. The cracking of these braces was attributed to poor fit-up of the parts during the dryer fabrication. The diagonal braces should have terminated on the vertical braces where they were butted up against the drain trough, which would have transferred the diagonal brace loads directly to the drain trough. Instead, the diagonal braces terminated on the vertical braces above the top of the drain trough and the diagonal brace loads were transmitted through the unsupported section of the vertical braces, thus overstressing the vertical braces.

In October 2003 and December 2003, inspections were made of the steam dryers of the sister units to the BWR/3s described above at another site. These units had also been operating at EPU conditions. Incipient cracking was observed on the inside of the outer hood vertical plates on each of the outer dryer banks. At one location, the cracking had grown through-wall. The cracking was also attributed to high cycle fatigue resulting from low frequency pressure loading.

In March 2004, inspections were performed of the repairs made to the BWR/3 dryer in 2003. Incipient fatigue cracks were found at the tips of the external reinforcing gussets that were added as part of the 2003 repairs. Fatigue cracks were also found in tie bars that were reinforced during the 2003 repairs. The cracking in these repairs was attributed to local stress concentration introduced by the as-installed repairs. In both cases, the local stress concentrations had not been modeled in sufficient detail in the analyses that supported the repair design. Fatigue cracks were also found in perforated plate insert modifications that were made in 2002 as part of the extended power uprate implementation. These cracks were also attributed to the displacements and stresses imposed by the dryer banks that caused the tie bar cracking.

In April 2004, inspections were made of a BWR/3-style dryer (square hood) in a BWR/4 plant in preparation for implementing an extended power uprate during the upcoming cycle. This inspection found cracking at two diametrically opposed locations on the exterior steam dam near the lifting lug. Both cracks were similar in length. The cause of the cracking was not identified. It has been postulated that the crack initiation was due to high residual stresses generated during the dryer fabrication process. The structural analysis of the steam dryer for EPU conditions did not predict these locations as highly susceptible to fatigue cracking. Two other symmetrical locations in the steam dryer that experienced the same loading conditions did not exhibit any evidence of cracking. These observations point to the likelihood of the presence of an additional contributing factor aside from the pressure loads during normal operation. Specifically, the evidence indicates that a high residual stress condition was probably developed by the original dryer fabrication welding sequence. Other "cold spring" type loading could also have been generated during the fabrication process. After the cracking developed, the residual stresses would have been relieved and the crack growth would have subsided.

BWR/5-Style Dryer Observation

In March 2004, inspection of the steam dryer at a BWR/5 revealed a fatigue crack in the hood panel to end plate weld. The hood crack occurred in the weld joint between the 1/8" curved hood and the 1/4" end plate on the second dryer bank. This particular weld location is vulnerable to fatigue cracking because of the small weld size associated with the thin 1/8" hood material. Fabrication techniques (e.g., feathering the 1/8" plate during fit-up) may further reduce the weld size. Fatigue cracking has been observed in the second bank hood-end plate weld at several other plants with the curved BWR/4-5 hood design at OLTP power levels. An undersized weld was determined to be the root cause of the cracking observed in at least two of the plants. Incorporating lessons learned from the weld cracks at the other plants, the dryer for this BWR/5 was built with an additional 1/4" fillet weld on the inside of the hood-end plate joint. This weld extended as high up in the hood as was practical for the welder to make (approximately 50") and spanned the probable initiation location for the earlier cracks. The weld crack at the subject BWR/5 occurred in the upper part of the 1/8" weld, above this reinforced section.

The weld joint between the 1/8" curved hood and the 1/4" end plate on the second dryer bank is a known high stress location for the BWR/4-5 curved hood dryer design; therefore, periodic inspection of this location was recommended by SIL No. 644 Supplement 1. The hood cracks at the other four plants occurred early in plant life, within the first three or four cycles of operation. In-plant vibration testing of one of the cracked dryers showed that the dynamic pressure oscillations were high enough that the 1/8" hood to end plate weld was vulnerable to fatigue cracking at pre-uprate power levels. The hood crack at the subject BWR/5 occurred after approximately 16 years of operation, the last nine of which were at a 5% stretch uprate power level. While power uprate operation does increase the loading on the dryer, the length of operating time at uprated power levels before the cracking was observed indicates that the weld was not grossly overstressed and that power uprate was only a secondary factor in the cracking observed at the subject BWR/5.

BWR Fleet Operating History

Steam dryer cracking has been observed throughout the BWR fleet operating history. The operating environment has a significant influence on the susceptibility of the dryer to cracking. Most of the steam dryer is located in the steam space with the lower half of the skirt immersed in reactor water at saturation temperature. These environments are highly oxidizing and increase the susceptibility to IGSCC cracking. Average steam flow velocities through the dryer vanes at rated conditions are relatively modest (2 to 4 feet per second). However, local regions near the steam outlet nozzles may be continuously exposed to steam flows in excess of 100 feet per second. Thus, there is concern for fatigue cracking resulting from flow-induced vibration and fluctuating pressure loads acting on the dryer.

In addition to the recent instances described above, steam dryer cracking has been observed in the following components at several BWRs: dryer hoods, dryer hood end plates, drain channels, support rings, skirts, tie bars, and lifting rods. These crack experiences have predominately occurred during OLTP conditions, and are briefly described below.

Dryer Hood Cracking

As discussed above, outer hood cracking has occurred recently in square hood design dryers. Additionally, other hood cracking has occurred in the BWR operating fleet. Cracking of this type was first found in BWR/2s in the inner banks. These hood cracks were attributed to high cycle fatigue. Other cracking has since been observed in other types of dryers including BWR/4s and attributed to high cycle fatigue as well. Susceptible plants were typically reinforced with weld material or plates.

Dryer End Plate Cracking

Cracking has been detected in end plates of the dryer banks at several BWRs. These cracks have been attributed to IGSCC based on the location and morphology of the cracks. These cracks have been followed over several cycles and shown to be stable when operating conditions (power levels) are not changed. Typically no repairs have been necessary.

Drain Channel Cracking

Drain channel cracking has been found in all types of BWRs. This cracking has been primarily categorized as being attributable to fatigue, although many cracks have been attributed to IGSCC. The steam dryers were originally fabricated using Type 304 stainless steel, a material susceptible to sensitization by welding processes and prone to crack initiation in the presence of cold work. Drain channel cracking has been associated with at least 17 plants. The occurrence of the cracking prompted GE to issue SIL No. 474 ("Steam Dryer Drain Channel Cracking" issued October 26, 1988) after cracks were discovered in the drain channel attachment welds during routine visual examination of dryers at several BWR/4, 5 and 6 plants. The cracks generally were through the throat of vertical welds that attach the side of the drain channel to the exterior of the 0.25-inch thick dryer skirt. The cracks were as long as 21 inches. The cracks are thought to have originated at the bottom of the drain channel where there is maximum stress in the welds. The appearance of the cracking and analysis of potential sources of stress on the welds indicate that high cycle fatigue initiated the cracks in drain channel welds. With the internal dryer inspections performed following the issuance of SIL No. 644, similar cracking has been observed in the internal drain channels of BWR/3-type steam dryers. Typically, drain channel cracks have been repaired by replacing and adding reinforcement weld material, stop-drilling the crack tip, or by replacing the drain channels.

Support Ring Cracking

Support ring cracking has been found in many BWRs. Cracking has been found in at least 19 plants, ranging from BWR/4s to BWR/6s. The cause of cracking has been IGSCC with a potential contributor being the cold working of the support ring during the fabrication process. These cracks are typically monitored for growth. To date, no repairs have been necessary since cracks have reached an arrested state.

Skirt

Skirt cracking has been found along with drain channel cracking. These cracks are either due to IGSCC or could be related to fatigue due to imposed local loads on the dryer. The cracking has also been found in the formed channel section of the dryer. The complex structural dynamic mode shapes of the dryer skirt, the stiffness added by the drain and guide channels, and residual weld stresses all contribute to the cracking observed in these components. Cracking in the dryer skirt region has been observed in plants operating at both OLTP and uprated power levels. Typically, repairs have been implemented at the time that cracking was found.

Tie Bar Cracking

Fatigue cracking has been observed in tie bars of plants operating at both OLTP and uprated power levels. In most cases, the potential for cracking is related to the cross section of the tie bar itself because the tie bar must withstand the displacements and stresses imposed by the dryer banks. Typically, repairs have been implemented at the time that cracking was found.

Lifting Rod

Several plants have exhibited damage in the lifting rods. This cracking has often been in tack welds or in lateral brackets and has been attributed to fatigue.

Other Crack Locations

Other locations have also exhibited cracking. These locations include the level screws or leveling screw welds, seismic blocks, dryer bank end plates and internal attachment welds, vertical internal hood angle brackets and bottom plates.

Generic Implications

The steam dryer is a non-safety component. However, the structural integrity of the dryer must be maintained such that the generation of loose parts is prevented during normal operation, transients, and accident events. With the exception of the significant outer hood cracking at the two BWR/3 plants, the dryer cracking observed in the BWR fleet to date is unlikely to result in the generation of loose parts provided that a periodic inspection program is in place. However, given that the steam dryers operate in an environment that is conducive to crack initiation and that many plants are pursuing power uprates and operating license extensions, further cracking in steam dryers should be anticipated. Therefore, the material condition of the dryer should be actively managed to ensure that structural integrity is maintained throughout the life of the dryer.

The experience described above has several generic implications with respect to the susceptibility of steam dryers to fatigue or IGSCC cracking.

- Fatigue cracking may result from stress concentrations inherent in the design of the dryer. The design of the BWR/3-style steam dryers with a square hood and internal braces results in maximum stresses where the internal braces attach to the outer hood. The hood crack initiation at the BWR/3s described above occurred at these high stress locations. Also, the undersized hood-to-end plate welds on the BWR/5 curved hood dryers have cracked in several plants.
- The actual dryer fabrication may have introduced stress concentrations that may lead to fatigue cracking. The poor fit-up of the diagonal and vertical braces in the BWR/3 dryer led to the cracking of the vertical braces. Feathering of the 1/8" plate during fit-up, and the corresponding reduction in weld area, was considered a contributing factor in the through-wall cracking of the hood-end plate weld in one of the BWR/5-style dryers. Residual stresses or "cold spring" introduced during the fabrication sequence may also lead to crack initiation.
- The fabrication quality for each dryer may vary from one unit to the next, even if the dryers were built by the same fabricator to the same specifications.
- The design of dryer repairs and modifications should consider the local stress concentrations that may be introduced by the modification design or installation. Repairs and modifications to the dryer should be inspected at each outage following the installation until structural integrity of the repairs and modifications can be confirmed.
- Steam dryers are susceptible to IGSCC due to the material and fabrication techniques used in the dryer construction. Weld heat affected zone material is likely to be sensitized. Many dryer assembly welds have crevice areas at the weld root, which were not sealed from the reactor environment. Cold formed 304 stainless steel dryer parts were generally not solution annealed after forming and welding. Therefore, steam dryers are susceptible to IGSCC.

Parameter monitoring programs had been previously recommended with the intent of detecting structural degradation of the steam dryer during plant operation. The experience described above also has generic implications with respect to monitoring reactor system parameters during operation for the purposes of detecting steam dryer degradation.

- o The November 2003 BWR/3 hood failure demonstrated that monitoring steam moisture content and other reactor parameters does not consistently predict imminent dryer failure nor will it preclude the generation of loose parts. Monitoring is still useful in that it does allow identification of a degraded dryer allowing appropriate action to be taken to minimize the damage to the dryer and the potential for loose parts generation.
- o Monitoring the trends in parameter values may be more important than monitoring the parameter values against absolute action thresholds. An unexplained change in the trend or value of a parameter, particularly steam moisture content or the flow distribution between individual steamlines may be an indication of a breach in the dryer hood, even though the absolute value of the parameter is still within the normal experience range.
- o Statistical smoothing techniques such as calculating running averages using a large quantity of samples may be necessary to eliminate the process noise and allow the changes in the trend to be identified.
- o An experience base should be developed for each plant that correlates the changes in monitored parameters to changes in plant operation (rod patterns, core flow, etc.) in order to be able to distinguish the indications of a degraded dryer from normal variations that occur during the operating cycle.

Recommended Actions:

GE Nuclear Energy recommends that owners of GE BWRs consider the following:

A. For all plants:

A1. Perform a baseline visual inspection of all susceptible locations of the steam dryer within the next two scheduled refueling outages. Inspection guidelines showing the susceptible locations for each dryer type are provided in Appendix C.

a. Repeat the visual inspection of all susceptible locations of the steam dryer at least once every two refueling outages.

b. For BWR/3-style steam dryers with internal braces in the outer hood that are operating above OLTP, repeat the visual inspection of all susceptible locations of the steam dryer during every refueling outage.

c. Flaws left "as-is" should be inspected during each scheduled refueling outage until it has been demonstrated that there is no further crack growth and the flaws have stabilized.

Note: This recommendation does not supercede the inspection schedules for existing flaws for which plant-specific evaluations already exist.

d. Modifications and repairs to cracked components should be inspected during each scheduled refueling outage until the structural integrity of the modifications and repairs has been demonstrated. Once structural integrity of any modifications and repairs has been demonstrated, longer inspection intervals for these locations may be justified.

Note: This recommendation does not supercede the inspection schedules for existing modifications or repairs for which plant-specific evaluations already exist.

A2. Implement a plant parameter monitoring program that measures moisture content and other plant parameters that may be influenced by steam dryer integrity. Initial monitoring should be performed at least weekly. Monitoring guidelines are provided in Appendix D.

A3. Review drawings of the steam dryer to determine if the lower cover plates are less than 3/8 inch thick or if the attachment welds are undersized (less than the lower cover plate thickness). If this is the case, and the plant has operated above OLTP, review available visual inspection records to determine if there are any pre-existing flaws in the cover plate and/or the attachment welds.

B. In addition, for plants planning on increasing the operating power level above the OLTP or above the current established uprated power level (i.e., the plant has operated at the current power level for several cycles with no indication of steam dryer integrity issues), the recommendations presented in A (above) should be modified as follows:

B1. Perform a baseline visual inspection of the steam dryer at the outage prior to initial operation above the OLTP or current power level. Inspection guidelines for each dryer type are provided in Appendix C.

B2. Repeat the visual inspection of all susceptible locations of the steam dryer during each subsequent refueling outage. Continue the inspections at each refueling outage until at least two full operating cycles at the final uprated power level have been achieved. After two full operating cycles at the final uprated power level, repeat the visual inspection of all susceptible locations of the steam dryer at least once every two refueling outages. For BWR/3-style steam dryers with internal braces in the outer hood, repeat the visual inspection of all susceptible locations of the steam dryer during every refueling outage..

B3. Once structural integrity of any repairs and modifications has been demonstrated and any flaws left "as-is" have been shown to have stabilized at the final uprated power level, longer inspection intervals for these locations may be justified.

To receive additional information on this subject or for assistance in implementing a recommendation, please contact your local GE Nuclear Energy Representative.

This SIL pertains only to GE BWRs. The conditions under which GE Nuclear Energy issues SILs are stated in SIL No. 001 Revision 6, the provisions of which are incorporated into this SIL by reference.

Product reference

B11 — Reactor Assembly
B13 — Reactor System

Issued by

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Appendix A

2002 BWR/3 Event

On June 7, 2002, while operating at approximately 113% of OLTP, the BWR/3 experienced a mismatch between the "A" and "B" reactor vessel level indication channels, a loss of approximately 12 MWt, and a reactor pressure decrease. Following the event, measurement indicated that the moisture content had increased by a factor of 10 (to a value of 0.27%). The reactor pressure decrease, reactor vessel level indication mismatch, and increase in moisture content comprised a set of concurrent indications suggesting a possible failure of the steam dryer. It was evaluated that there were no safety concerns associated with the observed conditions, and the plant continued to operate after implementing several compensatory measures (e.g., reactor water level setpoint adjustments, increased frequency of moisture content measurements).

Following the initial event, additional short duration (several minutes to ½ hour) perturbations occurred and the moisture content continued to increase. When the moisture content increased to approximately 0.7%, the power level was reduced to approximately 97% of OLTP. At this reduced power, the frequency of the plant perturbations decreased, along with the moisture content. Given the stable plant response at this lower power, the power was increased to 100% OLTP approximately one week later.

On June 30, subsequent to the power reduction to the OLTP level, a step change increase in the reactor steam dome pressure was noted. No changes in turbine control valve positions or pressure in the turbine steam chest were observed. Several additional perturbations occurred over the following week with the reactor steam dome pressure continuing to increase (to a total of 15 to 20 psi above normal conditions) along with a divergence of the measured total main steam line (MSL) flows compared to the total feedwater flow. The plant was shut down on July 12 to inspect the steam dryer.

Inspection Results:

Inspection of the steam dryer revealed that a ¼-inch stainless steel cover plate measuring approximately 120" x 15" had failed near the MSL "A" and "B" nozzles (Figure A-1). The failure of this cover plate allowed steam to bypass the dryer banks and exit through the reactor MSL nozzles, causing the observed increase in moisture content. The majority of the cover plate was found as a single piece on top of steam separators. However, a piece of the cover plate (approximately 16"x 6") had failed and was found lodged in and partially blocking the MSL "A" flow venturi contributing to the MSL flow imbalance and water level perturbations. Several smaller loose pieces (believed to have come from a startup pressure sensor bracket which may have been knocked off by the cover plate) were located at the turbine stop valve strainer basket. Minor gouges and scratches from the transport of foreign material were noted in the "A" steam nozzle cladding, the main steam piping and the MSL "A" flow venturi. All loose pieces were recovered. No collateral damage to other reactor vessel components was observed.

The cover plate was welded in place as part of the original equipment dryer assembly. No known prior repairs had been made to the cover plate. The cover plate is not connected or adjacent to the dryer modification performed at the previous outage; all flow distribution plates installed as part of the dryer modification were intact in the as-installed condition.

Metallurgical Evaluation:

Preliminary laboratory analysis has been completed. The main crack originated from the bottom side of the cover plate and propagated upward through both the plate base metal and weld metal. The transgranular, as opposed to intergranular, nature of the fracture surface and the relative lack of crack branching indicated that the failure was not caused by stress-corrosion cracking. The lack of macro and micro ductility features in and near the fracture indicated the cracking occurred over a period of time and not due to a mechanical overload. Additionally, there was no evidence that the failure was a result of an original manufacturing defect. Based on the available evidence, the most probable cause of the cover plate cracking was mechanical, high cycle fatigue.

Root Causes:

The results of the metallurgical analysis confirmed that the failure mechanism is high cycle fatigue. The cause of this high cycle fatigue is believed to be flow induced vibration. At this time there are two probable root causes of the cover plate failure:

1. Increased pressure oscillations on the steam dryer due to the increased steam flows at extended power uprate conditions, aggravated by the potential presence of a pre-existing crack in the cover plate.
2. A flow regime instability that results in localized, high cycle pressure loadings near the MSL nozzles. When the natural frequency of the installed cover plate coincides or nearly coincides with the frequency of the cyclic pressure forcing function, and the acoustic natural frequency of the steam zone, the resulting resonance or resonances can lead to high vibratory stresses and eventual high cycle fatigue failure of the cover plate.

Corrective Actions:

The cover plates on both sides of the dryer have been replaced with ½-inch continuous plates (this eliminates two intermediate welds on the original plates). The fillet weld connecting the plate to the support ring was increased to ⅜-inch and the weld to the vertical face of the dryer hood was increased to ½-inch. The plant has been returned to service with interim, enhanced monitoring of moisture content, reactor steam dome pressure, MSL flow rates and reactor water level. As an additional measure, the plant has implemented dynamic response monitoring of the MSLs to determine if higher flow induced vibration occurs as the steam flow is increased.

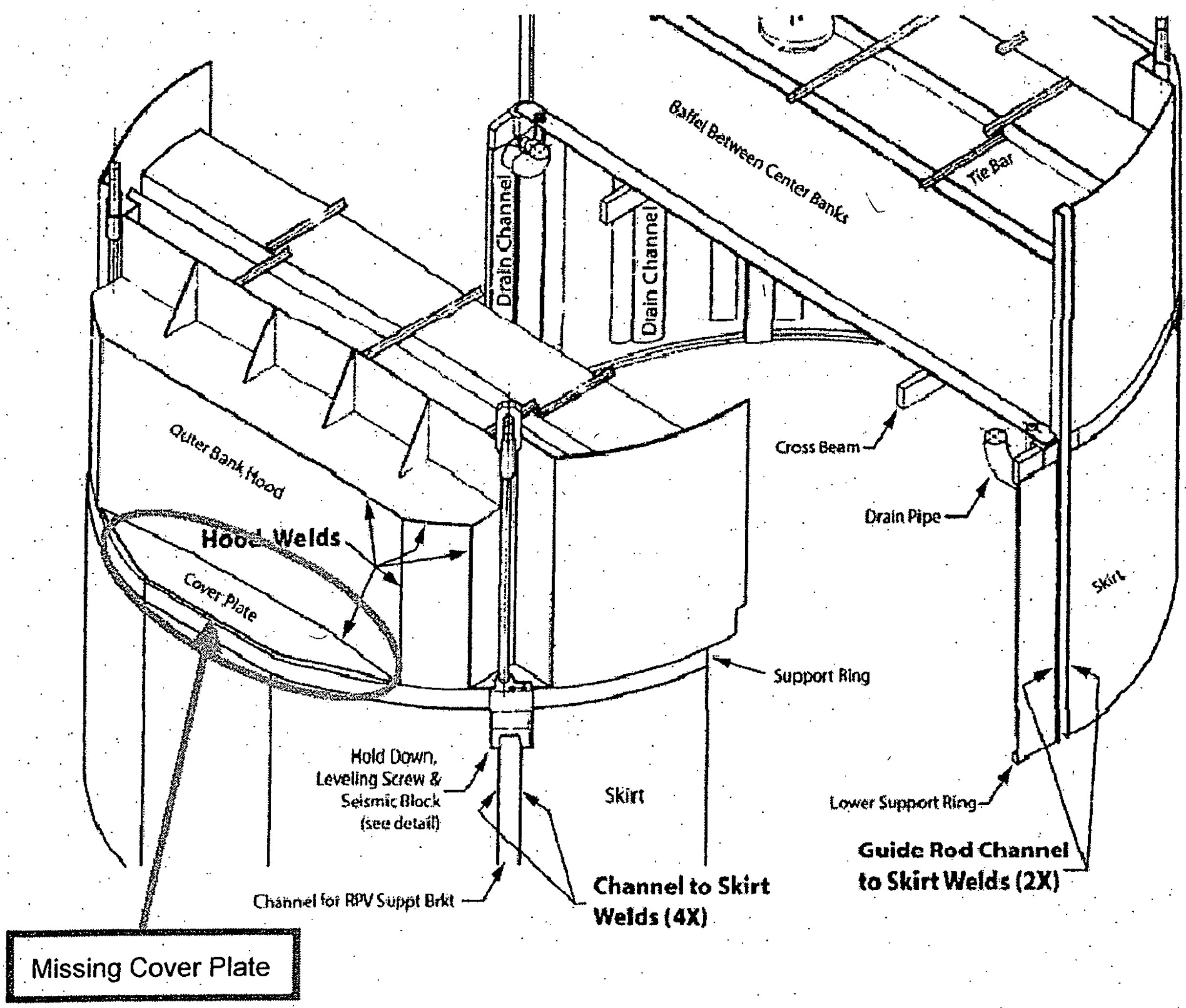


Figure A-1: Location of the 2002 Lower Cover Plate Failure

Appendix B

2003 BWR/3 Event

On April 16, 2003, with the plant operating at extended power uprate (EPU) conditions, an inadvertent opening of a pilot operated relief valve (PORV) occurred. The unit was shut down and the PORV replaced. On May 2, 2003, following return to EPU conditions, a greater than four-fold increase in the moisture content was measured. The moisture content continued to gradually increase until it exceeded a pre-determined threshold of 0.35% on May 28, 2003. The power level was reduced to pre-EPU conditions that resulted in a moisture content reduction to 0.2%. The moisture content remained steady at this value following the power reduction with no significant changes in other reactor operating parameters observed by the operators.

A detailed statistical evaluation of key plant parameters concluded that a subtle change in the MSL flows had occurred following the April 16, 2003 PORV event. Based on this information, concurrent with the moisture content increase, the utility elected to shut down the unit on June 10, 2003 and perform a steam dryer inspection.

Inspection results

A detailed visual inspection of the accessible external and internal areas of the steam dryer revealed significant steam dryer damage. The damage was most severe on the 90-degree side of the steam dryer, the side that was closest to the PORV that had opened. On the 90-degree side, a through-wall crack approximately 90 inches long and up to three inches wide was observed in the top of the outer hood cover plate and the top of the vertical hood plate (refer to Figures B-1 and B-2). Three internal braces in the outer hood were detached and one internal brace in the outer hood was severed. The detached braces were found on top of the steam separator. All detached parts were accounted for and retrieved. On the opposite side of the steam dryer (270-degree side), incipient cracking was observed on the inside of the outer hood cover plate and one vertical brace in the outer hood was cracked. No damage was found in the cover plates that had been replaced following the first steam dryer failure in 2002.

Three tie bars on top of the steam dryer connecting the steam dryer banks were also cracked. Tie bar cracking has been observed on several other steam dryers (including plants that have not implemented EPU); therefore, tie bar cracking is believed to be unrelated to the other damage noted above.

Root cause of steam dryer failure

Extensive metallurgical and analytical evaluations (e.g., detailed finite element analyses, flow induced vibration analyses, computational fluids dynamics analyses, 1/16th scale model testing and acoustic circuit analyses) concluded that the root cause of the steam dryer failure was high cycle fatigue resulting from low frequency pressure loading. There are two potential contributing factors to the failure:

1. Continued operation for approximately 1 month following the failed cover plate in 2002 which resulted in additional stress loading on the vertical hood plate, and
2. Inadvertent opening of the PORV resulting in a decompression wave, which subjected the steam dryer to two to three times the normal pressure loading. (It is believed that there was incipient cracking in the steam dryer and the PORV event caused the cracks to open up).

The root cause identified in the first steam dryer failure was high cycle fatigue cause by high frequency pressure loading. The low frequency pressure loading was identified as the dominant cause in this failure. The low frequency pressure loading may have also been a significant contributing factor in the first failure.

Corrective Actions:

The following repairs and pre-emptive modifications were made to both the 90 and 270-degree sides of the steam dryer:

1. replaced damaged ½ inch outer hood plates with 1 inch plates
2. removed the internal brackets that attached the internal braces to the outer hood
3. added gussets at the outer vertical hood plate and cover plate junction
4. added stiffeners to the vertical welds and horizontal welds on the outer hood

The combined effect of these modifications was to increase the natural frequency of the outer hood, reduce the maximum stress by at least a factor of two, and reduce the pressure loading by reducing the magnitude of vortices in the steam flow near the MSLs.

Following the steam dryer modifications, the unit was returned to service on June 29, 2003.

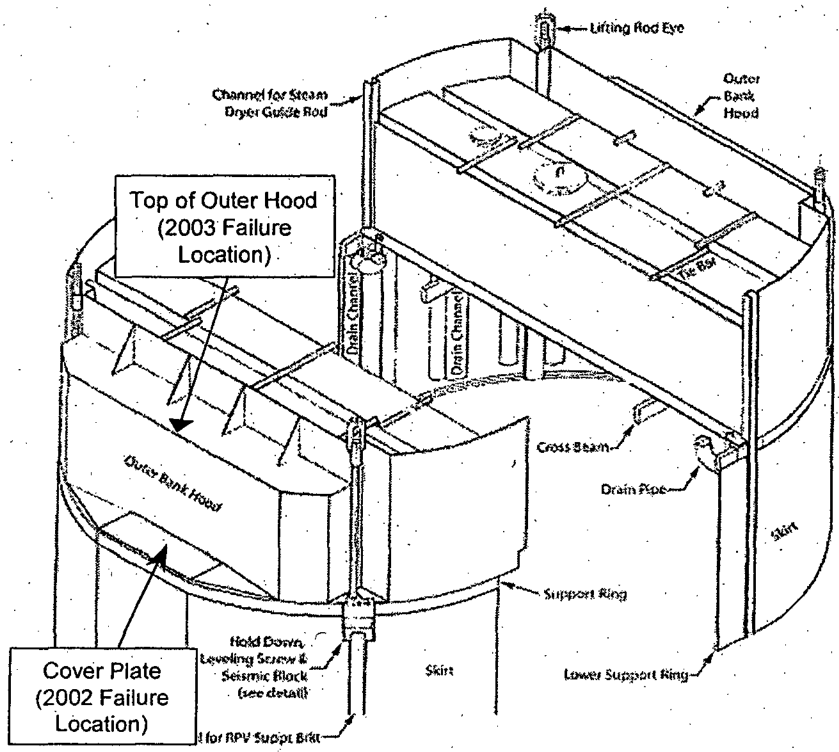


Figure B-1: Location of the 2003 Outer Hood Failure

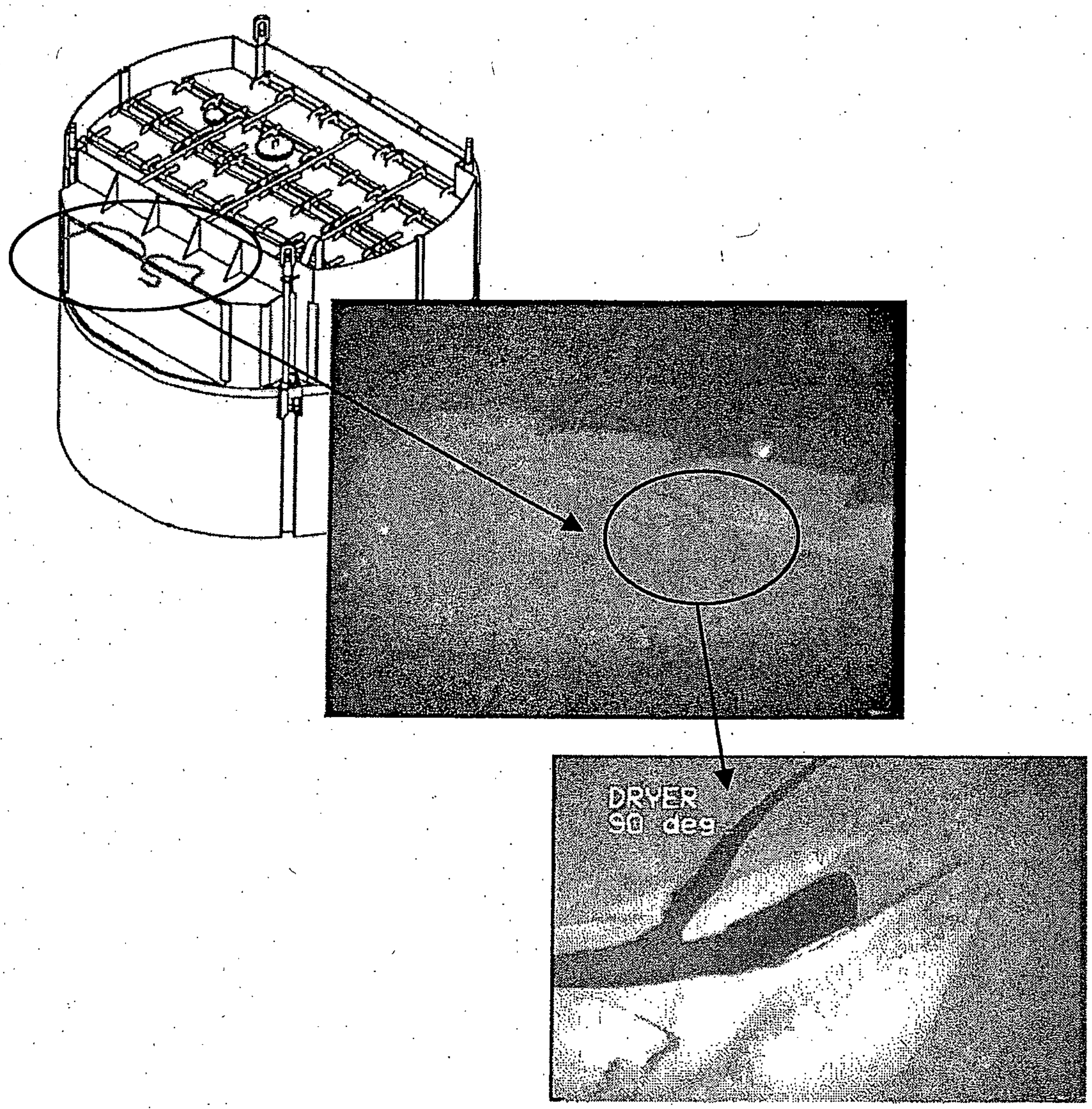


Figure B-2: Steam Dryer Damage 90 Degree Side

Appendix C
Inspection Guidelines

Overview

The steam dryers have been divided into four broad types with fourteen sub-groups: BWR/2 design, square hood design, slanted hood design and the curved hood design. The focus of the inspections for each dryer type is divided into two categories. The first category is directed at the outer surfaces of the dryer that are subject to fluctuating pressure loads during normal operation and are potentially susceptible to fatigue cracking. The second category is directed at the cracking that has been found in the drain channels and in inner bank end plates. These latter locations are not associated with any near term risk of loose part generation. They have often been associated with IGSCC cracking in the heat-affected-zones of stainless steel welds.

Inspection Techniques

Based on the current experience in inspecting the dryer components, VT-1 is the recommended technique to be employed for the inspections. VT-1 resolution, distance, and angle of view requirements should be maintained to the extent practical. In instances where component geometry or remote visual examination equipment limitations preclude the ability to maintain the VT-1 requirements over the entire length of the different weld seams, "best effort" examinations should be performed. In that cracking will be expected to have measurable length (several inches), field experience has confirmed that “best effort” approaches are sufficient to find the cracking that is present.

Steam Dryer Integrity Inspection Recommendations

The recommendations are divided into three categories: BWR/2 and square hood taken together, slanted hood and curved hood steam dryers. The inspection recommendations for each type of dryer will be detailed using schematics of the outer dryer structure. The key weld seams that must be inspected are outlined in red or green. High stress locations associated with structural integrity are outlined in red. Locations associated with field dryer cracking experience are outlined in green. Typical horizontal and vertical welds are shown thereby providing guidance for establishing a plant specific inspection plan. The weld numbering approach shown in the figures is only given as an example. Due to the many welds and size differences, each plant should employ their own weld numbering system. If an indication is detected, care should be exercised when inspecting the symmetrical locations on the dryer. If an indication is detected on the external surface of a plate or weld, consideration should be given to inspecting the location from the inside of the dryer in order to determine if the indication is through-wall.

Square Hood Design: applicable to BWR/2 plants and BWR/3 plants

Several square hood dryers were built with interior brackets and diagonal braces. These structures produce stress concentration locations, which have been found to aid in the initiation of fatigue cracking. These brackets exist in both the outer and the inner dryer banks. The recommended inspections follow.

Steam Dryer Bank Inspections

Figure C-1 provides the overview of the square dryer design. These dryers will require both an external and internal inspection. All dryers are symmetrical from this perspective. Outlined in red are the key weld seams that must be inspected. These welds, both horizontal and vertical outline the outer dryer bank. These locations considered as high stress locations. Figure C-2 displays a cross-section of the BWR/2 steam dryer with the outer bank peripheral welds highlighted. This configuration has no lower cover plate. However, the external locations that match those shown in Figure C-1 need to be inspected in a similar fashion to the other square hood dryers. Figures C-3 and C-4 provide the details of the weld seams as viewed from the dryer bank interior. As shown in Figure C-3, the outer bank welds need to be inspected from both the dryer exterior and the dryer interior. In addition, for the dryers where there are interior brackets that were present in the original design and are still present, the interior inspection must be conducted of the weld region where the bracket is joined to the hood vertical and top plates. Figure C-3 shows these locations for the outer banks hoods. Figure C-4 shows the brackets for the inner hood. In addition, Figure C-5 provides a cross section of the bracket-diagonal brace substructure. The intersection locations between the bracket and the top and outer hood are also outlined in red in these figures. In that the concern is primarily fatigue cracking, several inches of base material adjacent to welds should be examined as well as any obvious discontinuity, e.g., the exterior base material should be examined in the general area where there is an internal weld. This inspection examination region includes the heat-affected-zone and will therefore detect any IGSCC cracking. This figure also shows locations in green that exhibited cracking in the field. The region of inspection should be the same.

Tie Bar Inspections

In addition to the outer bank and interior bracket locations, tie bars also require inspection. Figure C-6 provides a schematic of the tie bars. These are located between each set of dryer banks.

Inspections Based on Field Experience

The other locations of interest are primarily associated with IGSCC in drain channels (shown for information in Figures C-7 and C-8). These components will be part of the internal examination. While these indications have been historically associated with BWR/4 through BWR/6 plants (SIL No. 474 "Steam Dryer Drain Channel Cracking" issued October 26, 1988), recent findings indicate that cracking can occur in these locations in square hood dryers. The additional weld seams associated with the outer side of the next set of inner banks should also be inspected in that this represents a steam path through the dryer. These areas are shown in green in Figure C-1. Cracking has been detected in these end panels in later design dryers. Finally, cracking at the steam dams as indicated in green in Figure C-6 has occurred in one BWR/4. These locations need to be included in the inspection plan for all of these plants. Finally, bank inner surface welds have cracked in the BWR/2. These locations, shown in Figure C-2 in green, also need to be inspected.

Slanted Hood Design: applicable to BWR/4 plants

The slanted hood steam dryers fall into three categories for which the primary difference is diameter and the number of banks. These dryers use 2 or 3 stiffener plates to strengthen each dryer bank. All inspections are on the external surface of the dryer. However, if an indication is detected on the external surface of a plate or weld, consideration should be given to inspecting the location from the inside of the dryer in order to determine if the indication is through-wall. The recommended inspections follow.

Steam Dryer Bank Inspections

Figure C-9 provides the overview of the slanted dryer design. All dryers are symmetrical from this perspective. Outlined in red are the key weld seams that must be inspected from the external surface. These welds, both horizontal and vertical outline the outer dryer bank as well as the cover plate between the outer hood vertical plate and the support ring. Additional red lines represent the outside projected location where the stiffener plates are welded to the outer hood vertical plate. These locations are considered as high stress locations. The man-way welds (on one side) are also shown as locations requiring inspection.

Tie Bar Inspections

In addition to the outer bank and interior bracket locations, tie bars also require inspection. Figure C-10 provides a schematic of the tie bar locations joining the tops of each set of banks. The primary concern is the presence of fatigue cracking through the bar base material cross-section at axial location where the tie bar is attached to the bank.

Inspections Based on Field Experience

Cracking has been detected in these end panels in later design dryers. Therefore, these additional weld seams associated with the outer side of the inner banks should also be inspected in that this represents a steam path through the dryer. These areas are shown in green in Figure C-9. Cracking has been observed in these locations in dryers of this design. The other locations of interest are primarily associated with IGSCC in drain channels (refer to SIL No. 474 "Steam Dryer Drain Channel Cracking" issued October 26, 1988), support ring, and lifting rod attachments.

Curved Hood Design: applicable to BWR/4-BWR/6 and ABWR plants

The curved hood steam dryers fall into five categories for which the primary differences are diameter and inner bank hood thickness. Similar to the slanted hood dryers, these dryers also have 2 or 3 interior stiffener plates to strengthen each dryer bank. All inspections are on the external surface of the dryer. However, if an indication is detected on the external surface of a plate or weld, consideration should be given to inspecting the location from the inside of the dryer in order to determine if the indication is through-wall. The recommended inspections follow.

Steam Dryer Bank Inspections

Figure C-11 provides the overview of the curved hood dryer design. All dryers are symmetrical from this perspective. Outlined in red are the key weld seams that must be inspected from the external surface. These welds, both horizontal and vertical outline the outer dryer bank as well as the cover plate between the outer hood vertical plate and the support ring. Additional red lines represent the outside projected location where the stiffener plates are welded to the outer hood vertical plate. Inspection locations also include outer plenum end plates and inner hood vertical weld seams for BWR/4 and BWR/5 plants with 1/8 inch thick hood plates on the inner banks. The location shown is the region where these thinner hood plates are attached to the stiffeners. All of these locations are considered as relative high stress locations. The man-way welds (on one side) are also shown as locations requiring inspection.

Tie Bar Inspections

In addition to the outer bank and interior bracket locations, tie bars also require inspection. Figure C-11 provides a schematic of the tie bar locations joining the tops of each set of banks. In that the attachment of the tie bars may have employed high heat input welds, the inspection should also include the entire welded region to assess the presence of IGSCC on the bank top plate. This region is adjacent to the region shown in red around the end of the inner bank tie bars.

Inspections Based on Field Experience

Cracking has been detected in the end panels in later design dryers. Therefore, these additional weld seams associated with the outer side of the inner banks should also be inspected in that this represents a steam path through the dryer. These areas are shown in green in Figure C-11. Cracking has been observed in these locations in dryers of this design. The other locations of interest are primarily associated with IGSCC in drain channels (refer to SIL No. 474 "Steam Dryer Drain Channel Cracking" issued October 26, 1988) and lifting rod attachments.

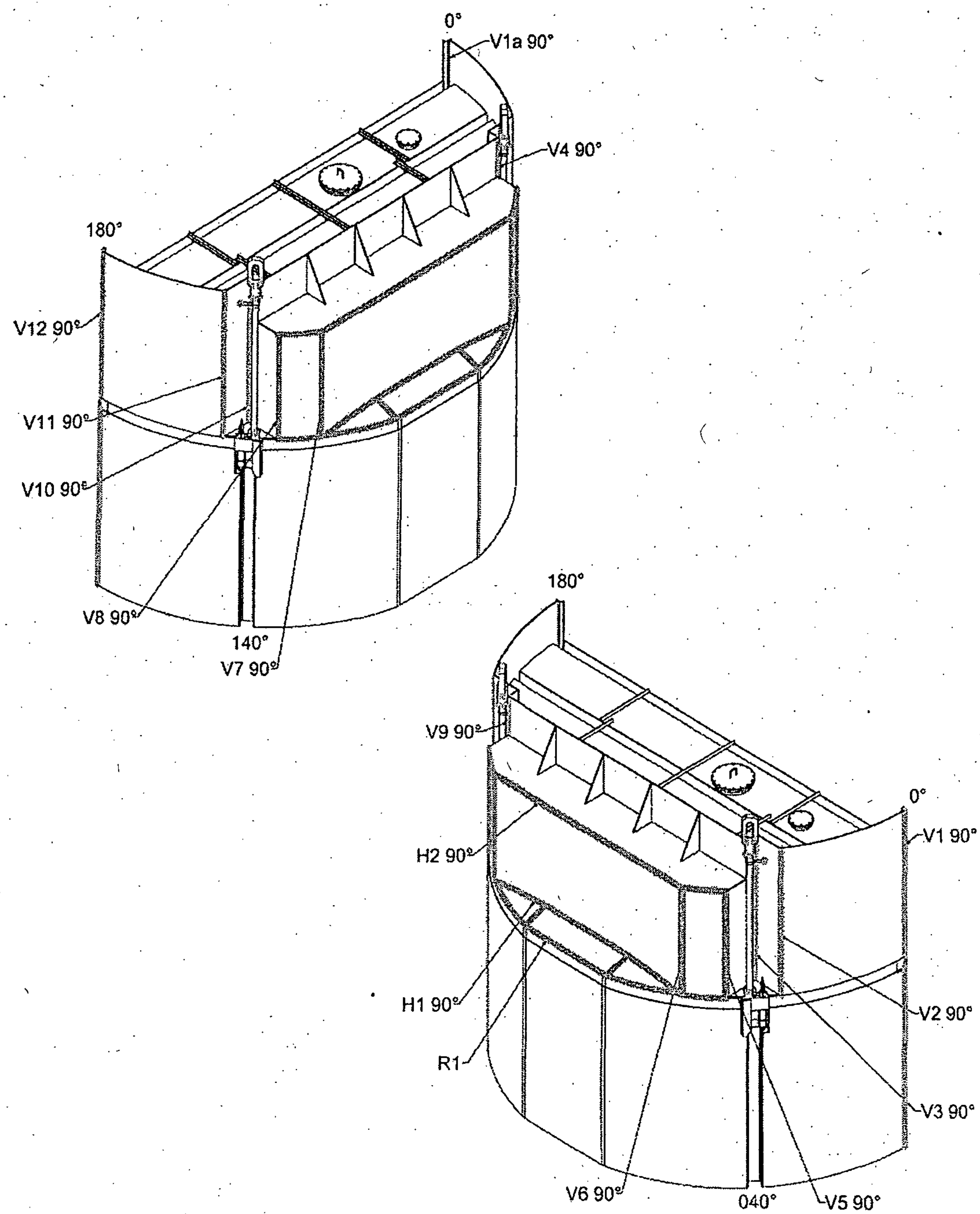


Figure C-1: Inspections: Outer Dryer Hood and Cover Plate (Square Hood Dryer)

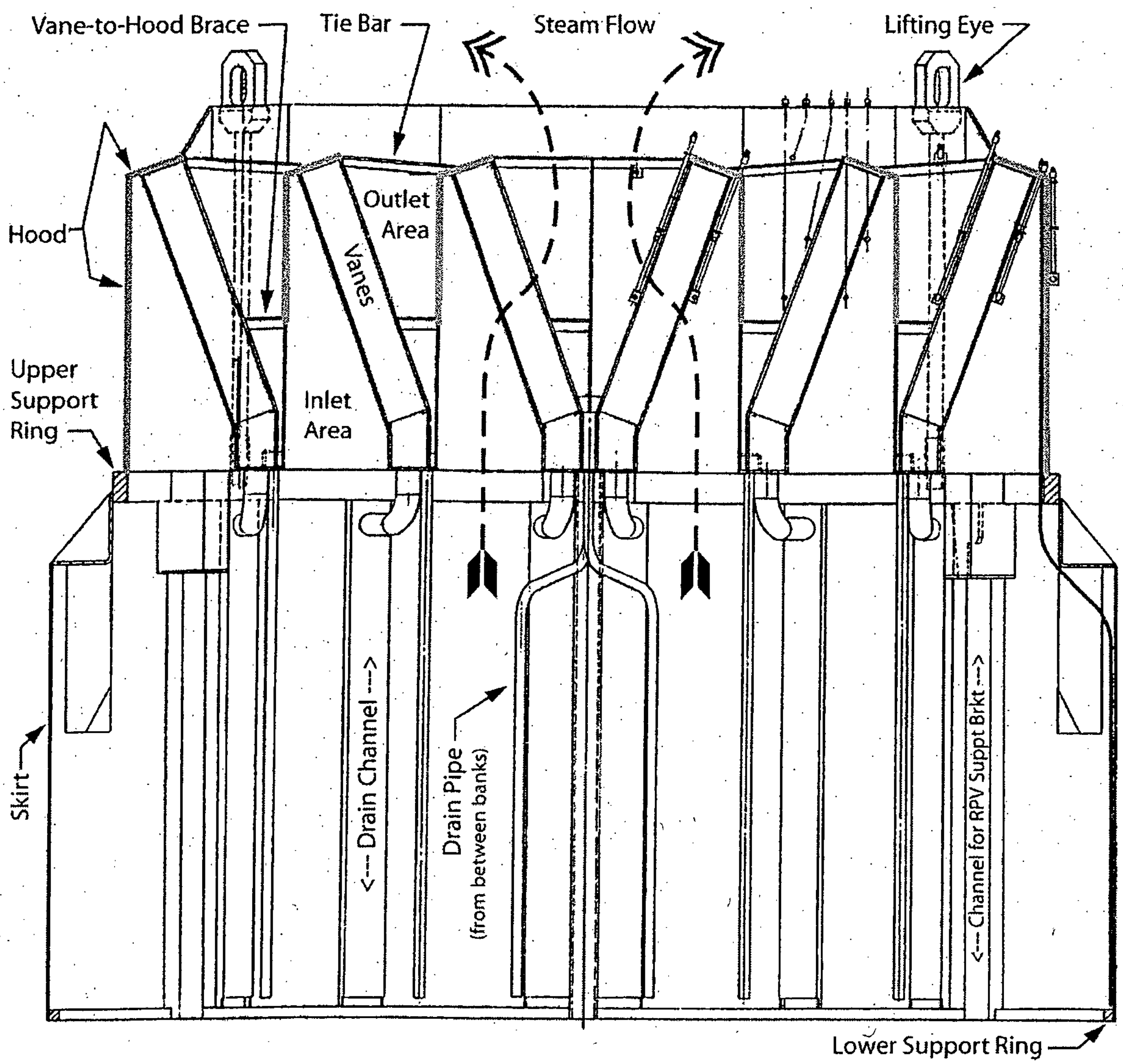


Figure C-2: Cross-Section of BWR/2 Steam Dryer

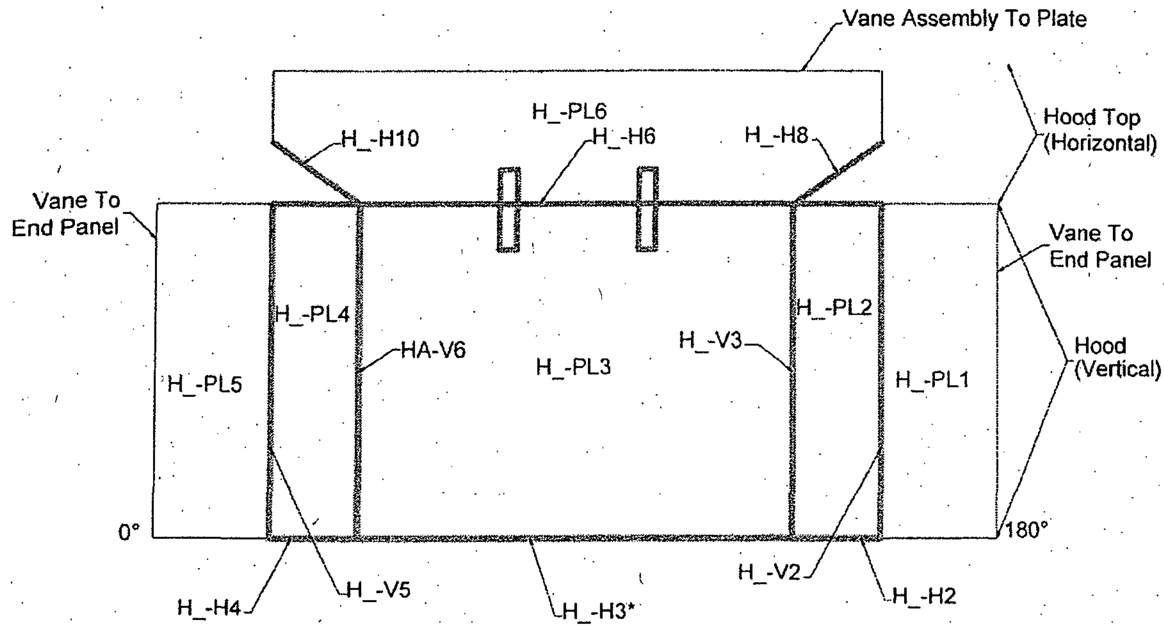
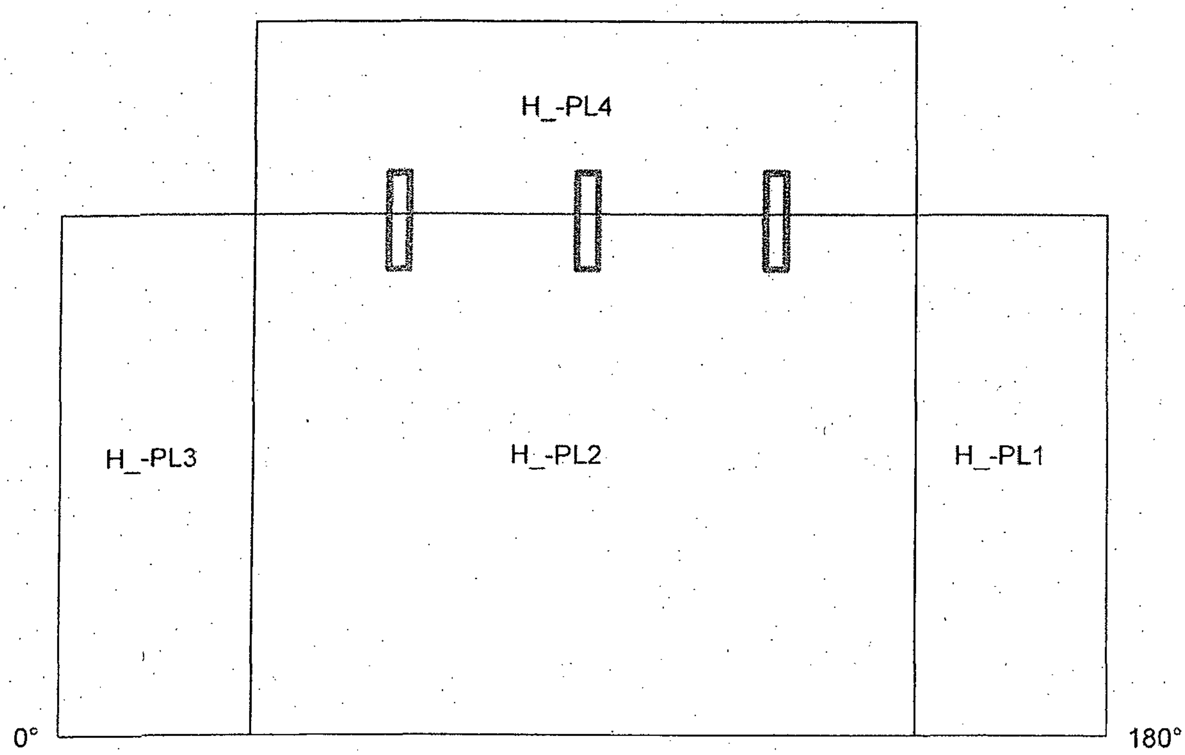


Figure C-3: Weld layout for interior of outer banks (Square Hood Dryer)

The brackets shown only exist in those plants where they were part of the original design and were not removed as part of dryer modifications.



H_-PL# = Plate (Bank B, C, D or E) (Ex. HB-PL1)
Internal View - View Is Looking Away From Vane Assembly

Figure C-4: Weld Rollout – Inner banks with internal brackets (Square Hood Dryer)

The brackets shown only exist in those plants where they were part of the original design and were not removed as part of dryer modifications.

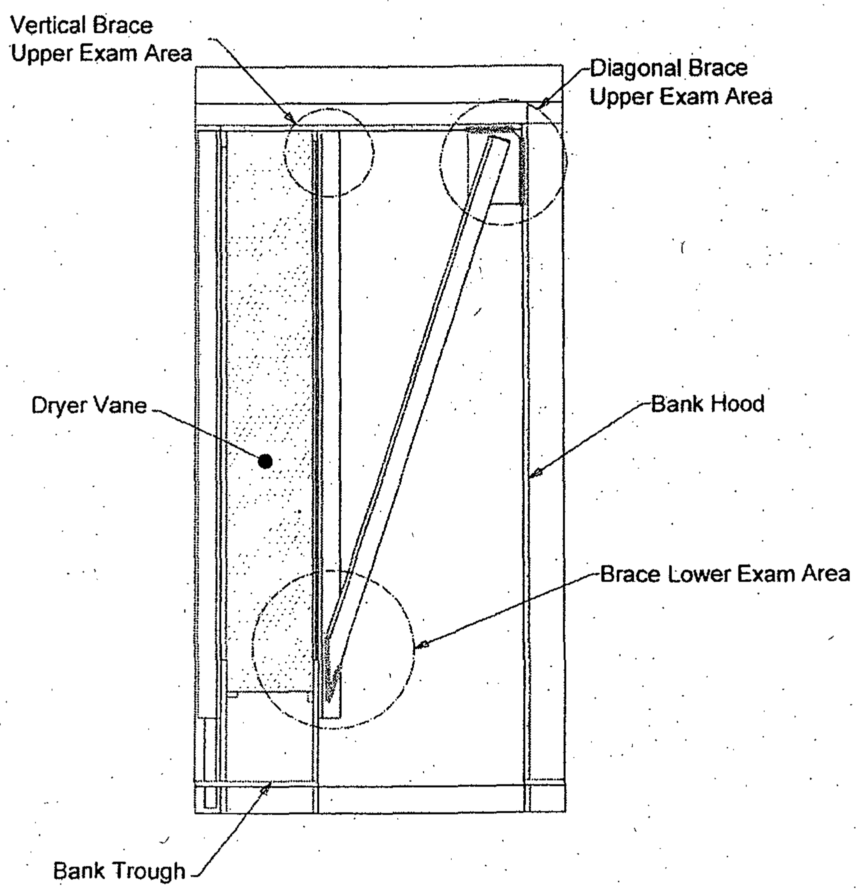


Figure C-5: Dryer Brace Detail (Square Hood Dryer)

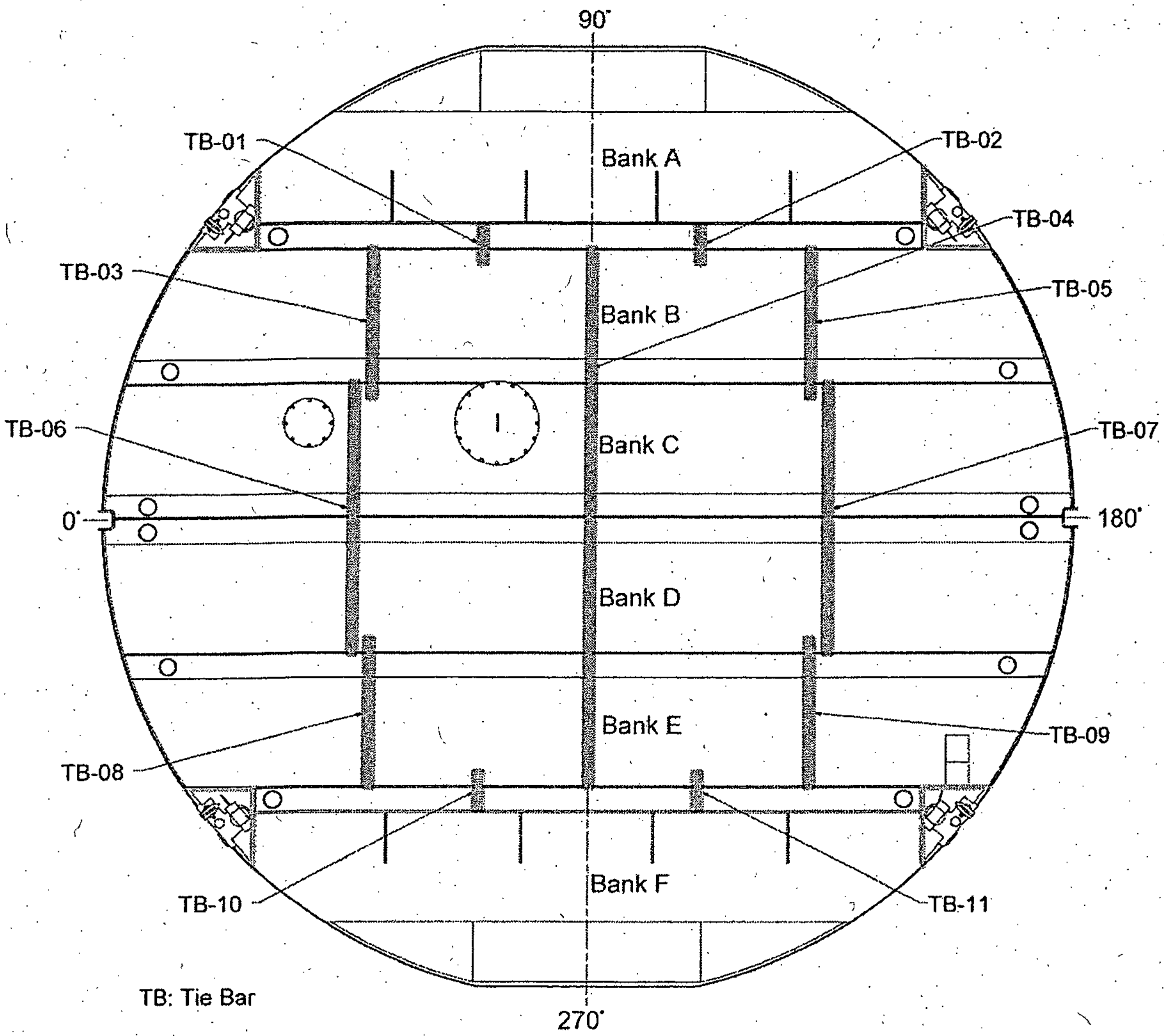
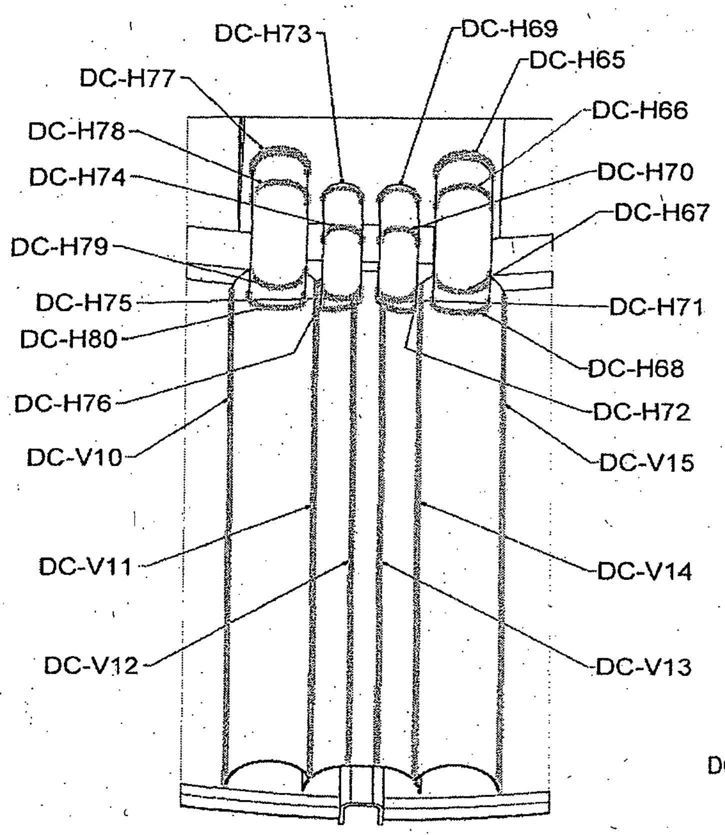


Figure C-6: Inspection Locations: Tie Bars and Steam Dam Inspections (Square Hood Dryer)



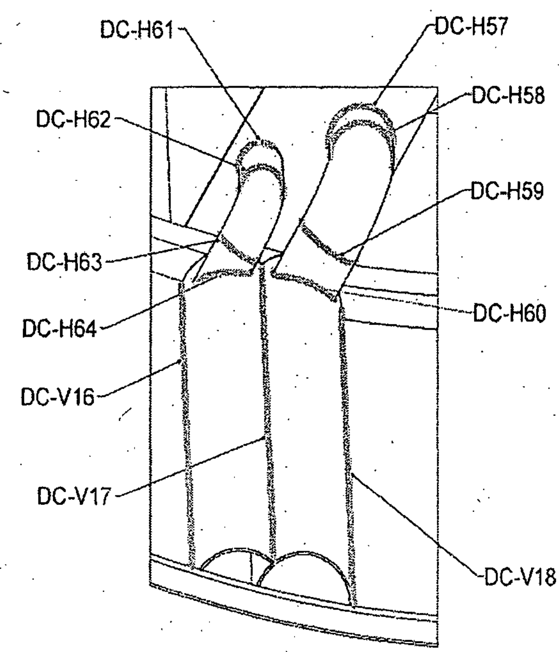


Figure C-7: Drain Channel Locations (Square Hood Dryer)

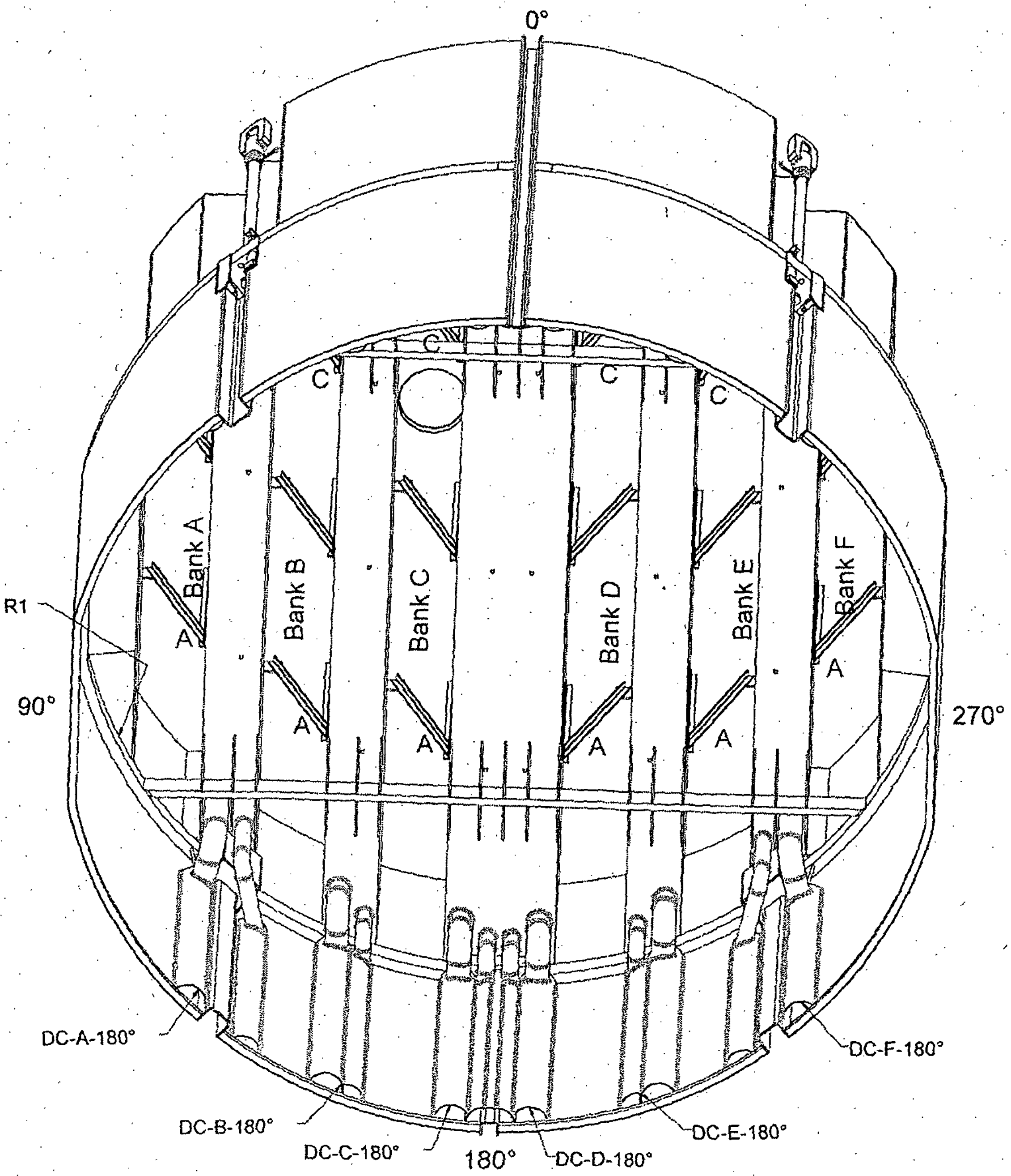


Figure C-8: Dryer Drain Channel, Guide channels and Guide Rod - Bottom View (Square Hood Dryer)

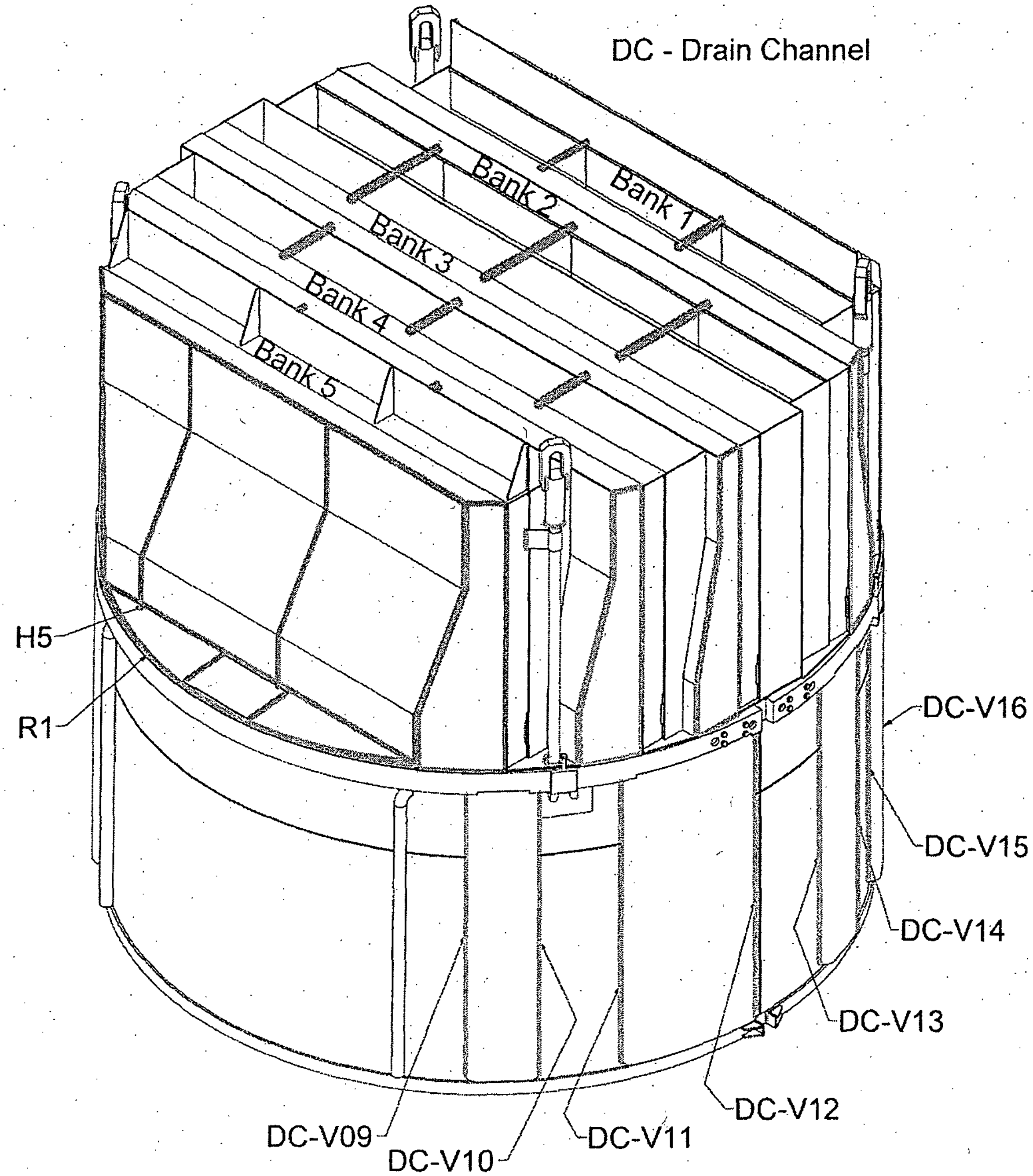


Figure C-9: Inspection Locations (Slanted Hood Dryer)

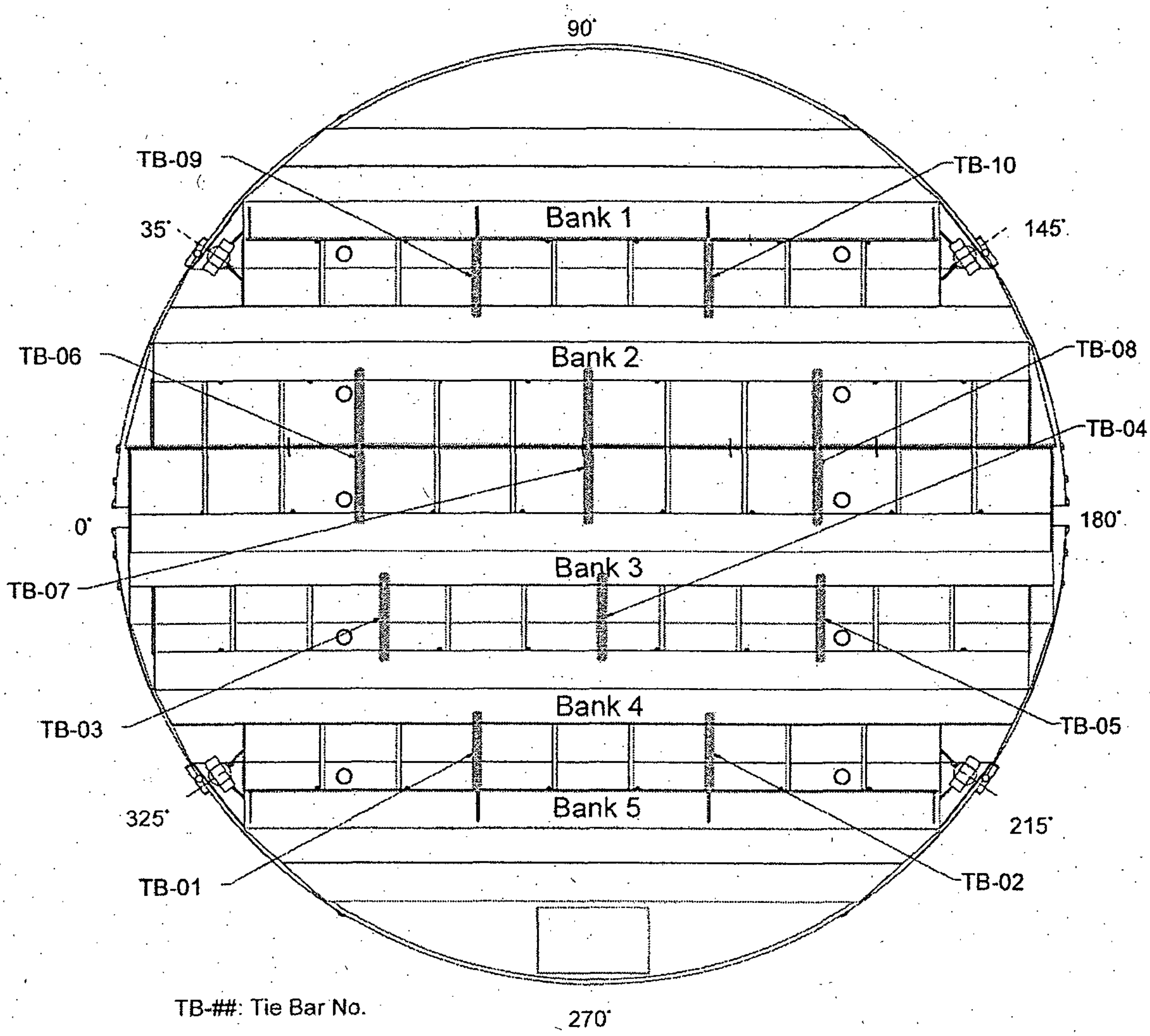


Figure C-10: Tie Bar Locations (Slanted Hood Dryers)

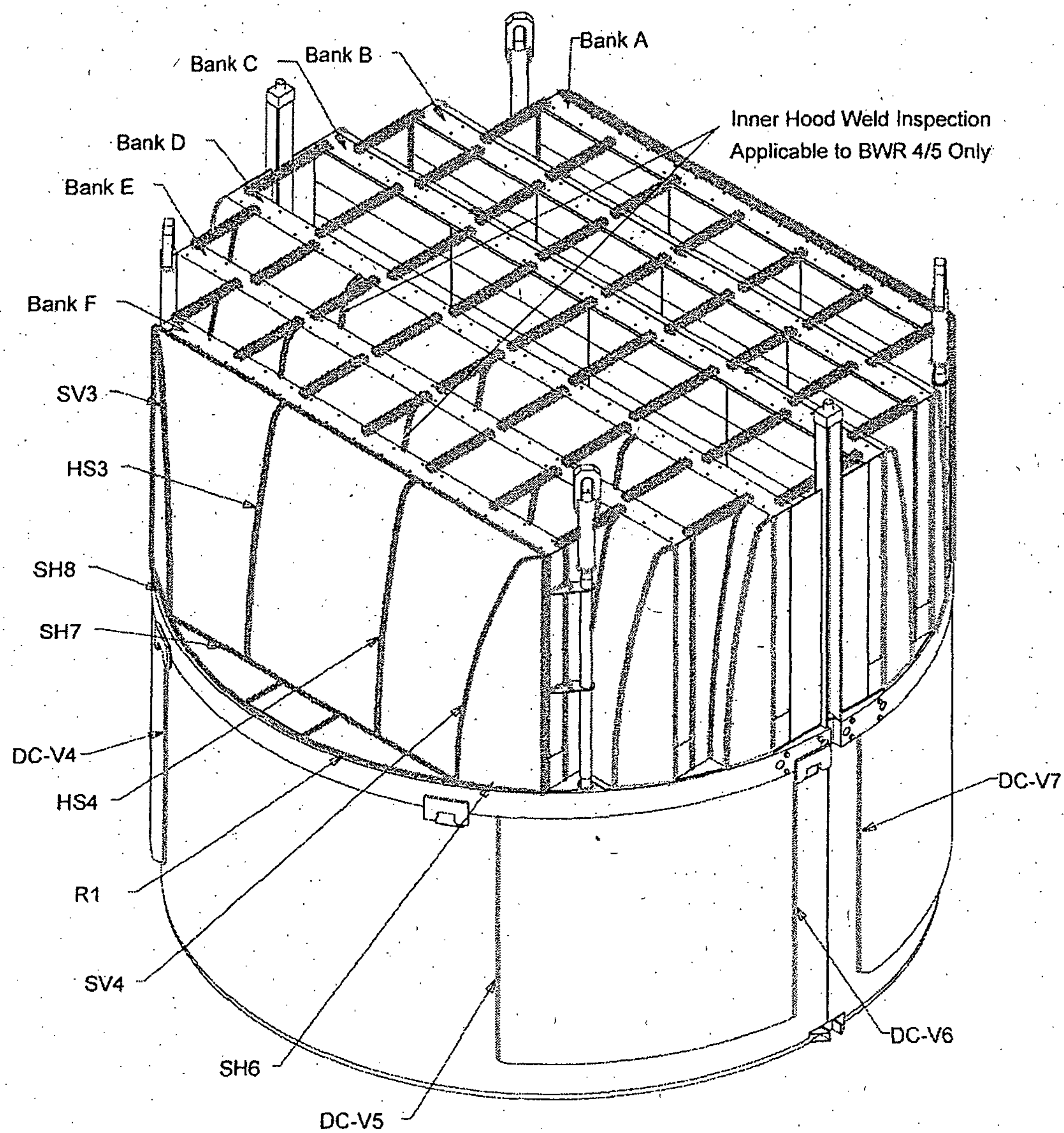


Figure C-11: Inspection Locations (Curved Hood Dryer)

Appendix D
Monitoring Guidelines

Applicability

In general, it is good practice to have access to as much performance data as practicable in order to make informed operational decisions. Therefore, GE recommends that all BWRs implement the moisture carryover and operational response guidance described here. However, plants that have sufficient baseline data and operating experience may elect to consider a less stringent monitoring program.

Background

A moisture carryover greater than 0.1% at the licensed power level is an indication of potential steam dryer damage, unless a higher threshold is established. A higher threshold may be warranted for a BWR with an unmodified square dryer hood (i.e., no addition of perforated plates) and/or operating with MELLLA+ at off-rated core flow.

If plants are reporting measured moisture carryover values of "less than" a value because of inability to measure Na-24 in the condensed steam sample and the "less than" value is greater than 0.025%, then the moisture carryover measurement process should be modified to reduce the minimum detectable threshold (preferably such that "less than" values are never reported). Without quantitative data, the plant staff will be unable to develop operational recommendations based on statistically valid moisture carryover and other plant data.

BWR moisture carryover may be impacted by: (1) reactor power level, (2) core flow and power distributions, (3) core inlet subcooling (which is related to final Feedwater temperature), and (4) reactor water level.

> Moisture carryover is very sensitive to power level. Therefore, data should be collected during steady state operations at the highest possible power levels.
>
> Moisture carryover has increased in cases where steam flow is increased towards the center of the core.
>
> Moisture carryover has increased in cases where core inlet sub-cooling is decreased (i.e., final Feedwater temperature is increased).
>
> Moisture carryover has increased in cases where reactor water level is increased (due to degraded separator performance).

Note that the standard deviation of moisture carryover measurements is not expected to change significantly following power distribution changes. However, if a significant condenser tube leak occurs, then the standard deviation of moisture carryover measurements may change significantly due to the resulting increased Na-24 concentrations.

Plants are recommended to accurately determine the flow distribution between individual steam lines. If significant steam dryer damage occurs, steam line flow distribution changes may result.

It may be helpful to have pressure data at each main steam flow element (venturi) to better understand the pressure drops and possible pressure changes due to moisture content changes in the steam line flow. This pressure data would have been beneficial at Quad Cities to help identify the flow blockage upstream of the flow element following significant steam dryer damage. Note that flow element performance calculations are based on the RPV steam dome pressure.

An increased feed-to-steam mismatch (i.e., total Feedwater flow plus CRD flow minus total steam flow, with reactor water level constant) may validate an increase in moisture carryover. Plant application has confirmed this correlation exists when the initial moisture carryover value is low (~0.01%), however the correlation showed significant scatter at higher initial moisture carryover values (0.04% to 0.10%).

Baseline Data

NOTE
Data should be collected during steady state operations at the highest possible power levels.

Moisture Carryover

Measure moisture carryover daily to obtain at least five (5) measurements.

Statistically evaluate the moisture carryover data (e.g., determine the mean and standard deviation for the data) to determine if there is a significant increasing trend. Qualitatively review the data to ascertain if there is a significant increasing trend. If there is an increasing trend in moisture carryover, review the changes in plant operational parameters to determine if there is an operational basis for the trend.

If an unexplained increasing trend is evident, then collect additional moisture carryover data with consideration for increasing the measurement frequency (e.g., from "once per day" to "once per 12 hours").

If an unexplained increasing trend is not evident, then begin collecting periodic data for moisture carryover.

Plant Operational Parameters

NOTE
Most plant operational data is available from the process computer, which can normally be input into an Excel spread sheet for evaluation and storage.

The following parameters should be measured under the same (or similar) plant conditions that existed during collection of moisture carryover baseline data:

Reactor power (MWt)

Core flow (Mlb/hr)

Core inlet sub-cooling (deg F)

Reactor water level, average of at least 1000 data points over a one to three hour time period.

Individual main steam line flows (Mlb/hr), average of at least 1000 data points over a one to three hour time period. Include pressure data at each MSL flow element (venturi), if available.

Total Feedwater flow (Mlb/hr), average of at least 1000 data points over a one to three hour time period.

CRD flow (Mlb/hr)

Periodic Data and Operational Response

NOTE

Data should be collected during steady state operations at the highest possible power levels.

If a moisture carryover measurement is suspect (e.g., less than "mean minus 2-sigma"), then repeat the moisture carryover measurement to verify sampling and analysis were performed correctly. Consider eliminating data shown to be incorrect/invalid.

Moisture carryover should be monitored weekly.

Statistically evaluate the moisture carryover data and qualitatively determine if there is a significant increasing trend that cannot be explained by changes in plant operational parameters.

If an unexplained increasing trend is evident, then collect additional moisture carryover data with consideration for increasing the measurement frequency (e.g., from "once per week" to "once per day").

If the latest moisture carryover measurement is greater than "mean plus 2-sigma" and this increase cannot be explained by changes in plant operational parameters, then obtain a complete set of data for the plant operational parameters (identified above). Compare the current plant operational data with the baseline data to explain the increased moisture carryover (i.e., is there steam dryer damage or not).

If an increase in moisture carryover occurs immediately following a rod swap, additional moisture carryover data should be obtained to assure that an increasing trend does not exist. Note that occurrence of steam dryer damage immediately following a rod swap would be highly unlikely.

If the increasing trend of moisture carryover cannot be explained by evaluation of the plant operational data, then initiate plant-specific contingency plans for potential steam dryer damage.

If the evaluation of plant data confirms that significant steam dryer damage has most likely occurred, then initiate a plant shutdown.

If there are no statistically significant changes in moisture carryover for an operating cycle, then decreasing the moisture carryover measurement frequency (e.g., from "once per week" to "once per month") may be considered, provided the highest operating power level is not significantly increased.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, D.C. 20555

January 9, 2004

NRC INFORMATION NOTICE 2002-26, SUPPLEMENT 2: ADDITIONAL FLOW-INDUCED VIBRATION FAILURES AFTER A RECENT POWER UPRATE

Addressees

All holders of an operating license or a construction permit for nuclear power reactors, except those that have permanently ceased operations and have certified that fuel has been permanently removed from the reactor.

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this supplement to a previously issued information notice (IN) to alert addressees to the failure of the steam dryer and other plant components at Quad Cities Nuclear Power Station, Unit 1 (QC-1), a boiling water reactor (BWR), during operations following a power uprate. The NRC expects that the recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this information notice are not NRC requirements. Therefore, no specific action or written response is required.

Description of Circumstances

As discussed in IN 2002-26, "Failure of Steam Dryer Cover Plate After a Recent Power Uprate" (ML022530291), a cover plate on the outside of the steam dryer at Quad Cities Nuclear Power Station, Unit 2 (QC-2), broke loose in June 2002 and caused pieces of the dryer to be swept down the main steamline. The failure followed completion of a refueling outage in March 2002 and subsequent implementation of an extended power uprate (EPU) from 2511 MWt to 2957 MWt (17.8% increase). Before the unit was shut down in 2002, steam dryer degradation was indicated by an increase in moisture carryover and minor perturbations in reactor pressure, water level, and steam flow. The licensee evaluated the cause of the steam dryer cover plate failure and determined that the failure of the plate was due to high-cycle fatigue. The licensee recovered all loose dryer pieces and did not identify any additional damage other than minor scratches and gouges to the main steamline. Prior to returning the unit to service, the licensee modified the steam dryer by installing thicker cover plates with higher strength welds, and implemented enhanced monitoring of steam moisture content, reactor steam dome pressure, main steamline flow rates, and reactor water level.

The second failure of the steam dryer in May 2003 at QC-2 was discussed in IN 2002-26, Supplement 1, "Additional Failure of Steam Dryer After a Recent Power Uprate" (ML031980434). In that case, the licensee again noted increasing moisture carryover in late May 2003; however, there were no discernible changes in other reactor parameters. On May 28, 2003, the licensee reduced power on QC-2 to the pre-EPU 100% power level. Moisture carryover levels remained above normal, and on June 11, 2003, the licensee shut down QC-2 to inspect the dryer. Inspection of the dryer revealed (1) through-wall cracks (about 90 inches long) in the vertical and horizontal portions of the outer bank hood, 90-degree side, (2) one vertical and two diagonal internal braces detached from the outer bank hood, 90-degree side, (3) one severed vertical internal brace on the outer bank hood, 270-degree side, and (4) three cracked tie bars on top of the dryer. The licensee believes the most probable cause of the failure of the steam dryer in QC-2 is low-frequency, high-cycle fatigue driven by flow-induced vibrations associated with the higher steam flows present during EPU operating conditions.

In late October 2003 at QC-1, the licensee observed changes in main steamline flows, steamline pressure drop, and increasing moisture carryover measurements. The symptoms observed were consistent with previous events at QC-2 that resulted in the discovery of damage to the steam dryer. The licensee subsequently reduced the power level of QC-1 to pre-EPU conditions. After power was reduced, the moisture carryover was lower than before the power reduction, but higher than the anticipated level. On November 12, the licensee shut down QC-1 to inspect the steam dryer and identified significant damage to several areas. For example, an identified crack was determined to have initiated at the top corner portion of the steam dryer hood and then extended horizontally toward the center of the hood and downward into the vertical section of the hood. The crack terminated in the vertical section where a portion of the dryer was missing. This missing piece of the steam dryer outer bank hood is approximately 6.5 inches (16.5 cm) by 9.0 inches (22.9 cm) and 0.5 inches (1.3 cm) thick. The licensee believes that a piece or pieces the size of this opening or smaller broke off due to fatigue cracking. The licensee performed an extensive but unsuccessful search for the lost part or parts. However, the licensee did identify impact marks on the impeller of the 1B recirculation pump that suggested that the missing part or parts passed through the pump. The licensee concluded that the missing part or parts migrated to the bottom head region of the reactor vessel. In addition to damage to the steam dryer at QC-1, the licensee identified significant flow-induced vibration damage to main steam line tieback supports and a main steam electromatic relief valve (including its attached drain line, actuator, and support), as well as loose clamps on the main steam line supports. Before restarting QC-1 on November 29, the licensee repaired the steam dryer and other damaged plant components identified during its inspections. With respect to the missing steam dryer metal plate, the licensee performed an operability evaluation for continued operation with the missing part or parts and will decide, prior to the next refueling outage, whether to continue efforts to locate and retrieve the missing dryer material.

Discussion

When operating above the original licensed thermal power (OLTP) level, BWR plants can experience a significant increase in the velocity of the steam generated from feedwater in the reactor core and directed through piping to the plant turbine generator. This increased steam velocity could damage plant components through flow-induced vibration. While major safety-related components undergo detailed review to demonstrate their capability to perform the applicable safety functions, nonsafety-related components and safety-related subcomponents have received less attention by the licensee and the NRC during preparation for nuclear power plant operation above the OLTP level.

Although performing a nonsafety-related function, the steam dryer in a BWR plant must maintain its structural integrity to avoid loose dryer parts from entering the reactor vessel or steam lines and adversely affecting plant operation. Industry representatives say that cracking occurred in steam dryers during the early operational phase of some BWR plants. The steam dryer failures at Quad Cities while operating at EPU conditions have led the BWR Owners Group (BWROG) to ask its BWR Vessel and Internals Project (BWRVIP) to develop inspection and evaluation guidelines for BWR steam dryers. In addition, General Electric (GE) Nuclear Energy issued Service Information Letter (SIL) 644, "BWR/3 steam dryer failure," on August 21, 2002, and Supplement 1 to SIL 644 on September 5, 2003, to provide monitoring and inspection recommendations for BWR plants that are operating, or plan to operate, at power levels greater than the OLTP.

In addition to the BWR steam dryers, flow-induced vibration during nuclear power plant operation above the OLTP level can potentially damage other plant components. For example, the QC-1 licensee identified significant flow-induced vibration damage to a main steam electromatic relief valve (including its attached drain line, actuator, and support), as well as main steam line support clamps and tieback supports. Therefore, information obtained from the review of the flow-induced vibration damage at QC-1 might also be applicable to other BWR plants with different steam dryer designs and to pressurized water reactor (PWR) plants operating at conditions above their OLTP level. The significance of the lessons learned is increased because operation of a nuclear power plant under conditions above the OLTP level might place additional reliance on the capability of plant equipment, such as relief valves or seismic restraints, to perform their intended functions as a result of higher reactor power levels and steam and feedwater flow rates.

The NRC staff is reviewing plant-specific and industry-wide activities to address the potential for flow-induced vibration damage to steam dryers and other plant components in BWR plants operating or planning to operate at conditions above the OLTP level. Although it is very unlikely that loose parts would adversely affect the safe shutdown of a plant, it is important to understand the extent of damage that might be caused by steam dryer failures and to identify the lessons learned from recent steam dryer failures for application to steam dryers at other BWR plants. It is also important to address the potential for similar failures in other plant components in BWR or PWR plants operating or planning to operate at conditions above the OLTP level.

Licensees should be alert to the possibility of unanticipated effects from increasing flow, power, or differential pressure associated with a major modification such as a power uprate. This information notice requires no specific action or written response. If you have any questions about the information in this notice, please contact one of the technical contacts listed below or the appropriate Office of Nuclear Reactor Regulation (NRR) project manager.

/RA/
William D. Beckner, Chief
Reactor Operations Branch
Division of Inspection Program Management
Office of Nuclear Reactor Regulation

Technical Contacts:

Karla Stoedter, Region III
(309) 654-2227
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Jack Foster, NRR
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Larry Rossbach, NRR
(301) 415-2863
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Thomas G. Scarbrough, NRR
(301) 415-2794
E-mail: tgs@nrc.gov

Attachment: List of Recently Issued NRC Information Notices

LIST OF RECENTLY ISSUED
NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
2003-11, Sup 1	Leakage Found on Bottom-Mounted Instrumentation Nozzles	01/08/2004	All holders of operating licenses or construction permits for nuclear power reactors, except those that have permanently ceased operations and have certified that fuel has been permanently removed from the reactor.
2003-22	Heightened Awareness for Patients Containing Detectable Amounts of Radiation from Medical Administrations	12/09/2003	All medical licensees and NRC Master Materials License medical use permittees.
2003-21	High-Dose-Rate-Remote-Afterloader Equipment Failure	11/24/2003	All medical licensees.
2003-20	Derating Whiting Cranes Purchased Before 1980	10/22/2003	All holders of operating licenses for nuclear power reactors, except those who have permanently ceased operations and have certified that fuel has been permanently removed from the reactor vessel; applicable decommissioning reactors, fuel facilities, and independent spent fuel storage installations.

Note: NRC generic communications may be received in electronic format shortly after they are issued by subscribing to the NRC listserver as follows:

To subscribe send an e-mail to <listproc@nrc.gov >, no subject, and the following command in the message portion:

subscribe gc-nrr firstname lastname

OL = Operating License
CP = Construction Permit

NEC-JH_57

From: Rick Ennis
To: Alan Wang; Allan Barker; Allen Howe; Anthony McMurtray; Brian Sheron; Cheng-Ih Wu; Christopher Grimes; David Terao; Diane Screnci; Donna Skay; Eric Leeds; Gene Imbro; James Clifford; Jim Dyer; John Craig; John Jolicoeur; Kamal Manoly; Neil Sheehan; Richard Barrett; Richard Borchardt; Scott Burnell; Tae Kim; Terrence Reis; Thomas Scarbrough; William Beckner; William Ruland
Date: 4/16/04 1:31PM
Subject: Fwd: VY Steam Dryer Crack Info

Attached is a little more detail on the steam dryer cracking at Vermont Yankee.

CC: Cliff Anderson; David Pelton

D-21

Mail Envelope Properties (40801878.B4F : 15 : 20516)

Subject:	Fwd: VY Steam Dryer Crack Info
Creation Date:	4/16/04 1:31PM
From:	Rick Ennis
Created By:	RXE@nrc.gov

Recipients	**Action**	**Date & Time**
kp1_po.KP_DO	Delivered	04/16/04 01:31PM
CJA CC (Cliff Anderson)	Opened	04/16/04 01:31PM
DLP1 CC (David Pelton)	Opened	04/19/04 07:13AM
DPS (Diane Screnci)	Opened	04/16/04 01:53PM
NAS (Neil Sheehan)	Opened	04/16/04 01:43PM
owf1_po.OWFN_DO	Delivered	04/16/04 01:31PM
SRB3 (Scott Burnell)	Opened	04/16/04 01:32PM
owf2_po.OWFN_DO	Delivered	04/16/04 01:31PM
ACM2 (Anthony McMurtray)	Opened	04/16/04 01:58PM
CIW1 (Cheng-Ih Wu)	Opened	04/17/04 10:14AM
DMS6 (Donna Skay)	Opened	04/16/04 03:12PM
DXT (David Terao)	Opened	04/16/04 01:48PM
EXI (Gene Imbro)	Opened	04/21/04 01:46PM
KAM (Kamal Manoly)		
RJB3 (Richard Barrett)	Opened	04/19/04 07:30AM
RWB1 (Richard Borchardt)	Opened	04/16/04 02:20PM
TGS (Thomas Scarbrough)	Opened	04/16/04 01:34PM
TXR (Terrence Reis)		
owf4_po.OWFN_DO	Delivered	04/16/04 01:31PM
ABW (Alan Wang)	Opened	04/16/04 02:02PM
AGH1 (Allen Howe)	Opened	04/19/04 07:24AM
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JWC (James Clifford)	Opened	04/19/04 09:09AM
JWC1 (John Craig)	Opened	04/16/04 01:32PM
TJK3 (Tae Kim)	Opened	04/16/04 01:40PM
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JRJ1 (John Jolicoeur)		Opened	04/19/04 12:16PM

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Files	Size	Date & Time
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MESSAGE	578	04/16/04 01:31PM

Options

Auto Delete:	No
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Notify Recipients:	Yes
Priority:	Standard
Reply Requested:	No
Return Notification:	None
Concealed Subject:	No
Security:	Standard
To Be Delivered:	Immediate
Status Tracking:	Delivered & Opened

From: Cliff Anderson RI
To: Rick Ennis NRR
Date: 4/16/04 12:59PM
Subject: Fwd: VY Steam Dryer Crack Info

fyi

From: Raymond Lorson RI
To: A. Randolph Blough; Brian Holian; Cliff Anderson; David Pelton; Hubert J. Miller; James Wiggins; Richard Crlenjak; Wayne Lanning
Date: 4/16/04 12:11PM
Subject: VY Steam Dryer Crack Info

FYI:

The attached write-up summarizes what we know about the VY steam dryer cracks to date.

Ray

While performing visual inspections of the reactor vessel steam dryer, Entergy and General Electric personnel identified several indications on both the interior and exterior surfaces of the dryer:

- Two external cracks were identified on outer plenum vertical welds (the longest crack was approximately 3 inches in length). The licensee plans to grind out, repair and install additional supports to reinforce these welds;

- Two internal cracks were identified in the drain channel weld. The longest crack was 14 inches in length. These cracks are inaccessible for repair. The licensee (based on input from GE) believes that they can demonstrate that operation with these cracks is acceptable

In addition to the cracks noted above, multiple axial indications were identified on the internal surface of the curved end plate of the dryer vane bank. The licensee has not determined whether these indications are cracks or manufacturing anomalies. The licensee (based on input from GE) believes that they can demonstrate that operation with these indications is acceptable.

The licensee is considering a press release on this topic and has indicated that the cracks are in low-stress, low-steam flow, areas of the dryer, and not in the areas affected at the EPU plants.

Region I reviewed the licensee's steam dryer inspection activities during a scheduled, routine ISI inspection and is continuing to monitor this situation. Similar external weld cracks were identified and repaired earlier this spring at Nine Mile Unit 2.

July 26, 2004

Mr. Jay K. Thayer
Site Vice President
Entergy Nuclear Operations, Inc.
Vermont Yankee Nuclear Power Station
P.O. Box 0500
185 Old Ferry Road
Brattleboro, VT 05302-0500

SUBJECT: VERMONT YANKEE NUCLEAR POWER STATION - NRC INTEGRATED INSPECTION REPORT 05000271/2004003

Dear Mr. Thayer:

On June 30, 2004, the US Nuclear Regulatory Commission (NRC) completed an inspection at your Vermont Yankee Nuclear Power Station (VY). The enclosed report documents the inspection findings which were discussed on July 12, 2004, with members of your staff.

The inspection examined activities conducted under your license as they relate to safety and compliance with the Commission's rules and regulations and with the conditions of your license. The inspectors reviewed selected procedures and records, observed activities, and interviewed personnel.

This report documents one finding of very low safety significance (Green) which was also determined to involve a violation of NRC requirements. Because of the very low safety significance and because the finding was entered into your corrective actions program, the NRC is treating it as a non-cited violation (NCV), consistent with Section VI.A of the NRC's Enforcement Policy. If you contest this non-cited violation, you should provide a response within 30 days of the date of this inspection report, with the basis for your denial, to the Nuclear Regulatory Commission, ATTN.: Document Control Desk, Washington, D.C. 20555-0001; with copies to the Regional Administrator Region I; the Director, Office of Enforcement, United States Nuclear Regulatory Commission, Washington, D.C. 20555-0001; and the NRC Resident Inspector at the Vermont Yankee Nuclear Power Station.

In accordance with 10 CFR 2.390 of the NRC's "Rules of Practice," a copy of this letter, its enclosure, and your response (if any) will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records (PARS) component of NRC's document system (ADAMS). ADAMS is accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html (the Public Electronic Reading Room).

Sincerely,

/RA/

Clifford J. Anderson, Chief
Projects Branch 5
Division of Reactor Projects

Docket No. 50-271
License No. DPR-28

Enclosure: Inspection Report 05000271/2004003
w/Attachment: Supplemental Information

Docket No. 50-271
License No. DPR-28

cc w/encl:

M. R. Kansler, President, Entergy Nuclear Operations, Inc.
G. J. Taylor, Chief Executive Officer, Entergy Operations
J. T. Herron, Senior Vice President and Chief Operating Officer
D. L. Pace, Vice President, Engineering
B. O'Grady, Vice President, Operations Support
J. M. DeVincentis, Manager, Licensing, Vermont Yankee Nuclear Power Station
Operating Experience Coordinator - Vermont Yankee Nuclear Power Station
J. F. McCann, Director, Nuclear Safety Assurance
M. J. Colomb, Director of Oversight, Entergy Nuclear Operations, Inc.
J. M. Fulton, Assistant General Counsel, Entergy Nuclear Operations, Inc.
S. Lousteau, Treasury Department, Entergy Services, Inc.
Administrator, Bureau of Radiological Health, State of New Hampshire
Chief, Safety Unit, Office of the Attorney General, Commonwealth of Mass.
D. R. Lewis, Esquire, Shaw, Pittman, Potts & Trowbridge
G. D. Bisbee, Esquire, Deputy Attorney General, Environmental Protection Bureau
J. Block, Esquire
D. Katz, Citizens Awareness Network (CAN)
M. Daley, New England Coalition on Nuclear Pollution, Inc. (NECNP)
R. Shadis, New England Coalition Staff
C. McCombs, Commonwealth of Massachusetts, SLO Designee
G. Sachs, President/Staff Person, c/o Stopthesale
J. Sniezek, PWR SRC Consultant
R. Toole, PWR SRC Consultant
J. P. Matteau, Executive Director, Windham Regional Commission
State of New Hampshire, SLO Designee
State of Vermont, SLO Designee

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D. Pelton, Senior Resident Inspector
C. Miller, RI EDO Coordinator
J. Clifford, NRR
R. Ennis, PM, NRR
D. Skay, Backup PM, NRR
Region I Docket Room (with concurrences)

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DATE	07/26/04		07/26/04		07/26/04					

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U.S. NUCLEAR REGULATORY COMMISSION

REGION I

Docket No.	50-271
Licensee No.	DPR-28
Report No.	05000271/2004003
Licensee:	Entergy Nuclear Vermont Yankee, LLC
Facility:	Vermont Yankee Nuclear Power Station
Location:	320 Governor Hunt Road Vernon, Vermont 05354-9766
Dates:	April 1, 2004 - June 30, 2004
Inspectors:	David L. Pelton, Senior Resident Inspector Beth E. Sienel, Resident Inspector E. Harold Gray, Senior Reactor Inspector Todd J. Jackson, Senior Project Engineer James D. Noggle, Senior Health Physicist Larry L. Scholl, Senior Reactor Inspector Keith A. Young, Senior Reactor Inspector Amar C. Patel, Reactor Inspector Jennifer A. Bobiak, Reactor Inspector Thomas P. Sicola, Reactor Inspector
Approved by:	Clifford J. Anderson, Chief Projects Branch 5 Division of Reactor Projects

TABLE OF CONTENTS

SUMMARY OF FINDINGS

IR 05000271/2004003; 04/01/04 - 06/30/04; Vermont Yankee Nuclear Power Station; Refueling and Outage Activities.

This report covered a 13-week period of baseline inspection conducted by resident inspectors. Additionally, announced inspections were performed by regional inspectors in the areas of occupational radiation protection; evaluations of changes, tests, and experiments; in-service inspections; and permanent plant modifications. One Green non-cited violation (NCV) was identified. The significance of most findings is indicated by their color (Green, White, Yellow, Red) using Inspection Manual Chapter (IMC) 0609, "Significance Determination Process" (SDP). Findings for which the SDP does not apply may be Green or be assigned a severity level after NRC management review. The NRC's program for overseeing the safe operation of commercial nuclear power reactors is described in NUREG-1649, "Reactor Oversight Process," Revision 3, dated July 2000.

A. NRC-Identified and Self-Revealing Findings

Cornerstone: Barrier Integrity

(Green) A self-revealing, non-cited violation (NCV) of 10 CFR 50 Criterion XVI was identified in that Entergy personnel did not develop effective corrective actions to prevent recurrence following a 2001 event wherein control room operators did not verify a suction path existed prior to starting the residual heat removal (RHR) system pump being used to support shutdown cooling (SDC) operations which caused the pump to trip. On April 10, 2004, an identical event occurred and again resulted in a trip of the RHR pump being used to support SDC operations.

The finding is greater than minor since it is associated with the Fuel Cladding Configuration Control Attribute of the Barrier Integrity Cornerstone and because it affects the associated Cornerstone objective. The inspectors conducted a SDP Phase 1 screening of the finding in accordance with IMC 0609, Appendix G, "Shutdown Operations Significance Determination Process [SDP]." In accordance with the SDP, the inspectors determined that the finding was of very low safety significance (Green) since the RHR pump was restarted within 15 minutes of being tripped and an adequate SDC thermal margin was maintained as demonstrated by a calculated reactor coolant system (RCS) time-to-boil of greater than 24 hours.

A contributing cause of this finding is related to the Cross-Cutting area of Problem Identification and Resolution. As stated above, Entergy personnel did not develop effective corrective actions to prevent recurrence following a 2001 event wherein control room operators did not verify a suction path existed prior to starting the RHR system pump being used to support SDC operations which caused the pump to trip. Entergy's corrective actions relied on the operator's skill to verify a suction path was open prior to restarting the RHR pump rather than proceduralize the step. As a result, an identical event occurred in April 2004 again resulting in a trip of the RHR pump being used to support SDC operations. (Section 4OA3.1)

Summary of Findings (cont'd)

B. <u>Licensee Identified Findings</u>

None.

REPORT DETAILS

Summary of Plant Status

Vermont Yankee Nuclear Power Station entered the inspection period at or near full power. The reactor was shutdown on April 3, 2004, in support of planned refueling outage (RFO) 24. Reactor startup activities began on May 3, 2004, following the completion of RFO 24. The reactor was returned to full power operation on May 8, 2004. On June 18, 2004, an automatic reactor scram occurred as a result of a turbine trip following multiple faults-to-ground on the 22 kilovolt (KV) electrical system. The reactor remained shutdown for the rest of the inspection period.

1. REACTOR SAFETY

Cornerstones: Initiating Events, Mitigating Systems, Barrier Integrity

1R01 Adverse Weather (71111.01)

a. Inspection Scope (one sample)

The inspectors reviewed measures established by Entergy for the restoration from cold weather operations. The inspectors reviewed Vermont Yankee Operating Procedure (OP) 2196, "Preparations for Cold Weather Operations," Form VYOPF 2196.02, "Cold Weather Restoration Operations Checklist," discussed the completion of items with operations personnel to confirm the items on the checklist had been completed or were appropriately tracked for completion, and independently walked down portions of the plant to verify selected actions to restore from cold weather operations had been completed appropriately.

b. Findings

No findings of significance were identified.

1R02 Evaluations of Changes, Tests, or Experiments (71111.02)

a. Inspection Scope (eight samples)

The inspectors reviewed the 10 CFR 50.59 safety evaluations or screening evaluations associated with plant modifications being installed during the current refueling outage to support a proposed power uprate. The inspectors assessed the adequacy of the safety evaluations through interviews with the cognizant plant staff and review of supporting documentation to verify the changes were performed in accordance with 10 CFR 50.59 and when required, NRC approval was obtained prior to implementation. The inspectors also reviewed a sample of changes the licensee had evaluated (using a screening process) and determined to be outside of the scope of 10 CFR 50.59, therefore not requiring a full safety evaluation. The inspectors performed this review to determine if Entergy conclusions with respect to 10 CFR 50.59 applicability were appropriate. A listing of the modifications for which associated safety evaluations, safety evaluation screenings, and other documents were reviewed is provided in the Attachment to this report.

b. Findings

No findings of significance were identified.

1R04 Equipment Alignments

1. Complete Equipment Alignment (71111.04S)

a. Inspection Scope (one sample)

The inspectors performed a complete equipment alignment inspection of the accessible portions of the core spray (CS) system. The inspectors walked down the CS system, both inside and outside of the primary containment, and compared actual equipment alignment to approved piping and instrumentation diagrams, operating procedure lineups, the Vermont Yankee updated final safety analysis report (UFSAR), and the Vermont Yankee design basis document (DBD). The inspectors observed valve positions, the availability of power supplies, and the general condition of selected components to verify there were no unidentified deficiencies. The inspectors also confirmed that licensee-identified equipment problems had been entered into the corrective actions program.

b. Findings

No findings of significance were identified.

2. Partial Equipment Alignments (71111.04)

a. Inspection Scope (four samples)

The inspectors performed four partial system walkdowns of risk significant systems to verify system alignment and to identify any discrepancies that would impact system operability. Observed plant conditions were compared with the standby alignment of equipment specified in the licensee's system operating procedures and drawings. The inspectors also observed valve positions, the availability of power supplies, and the general condition of selected components to verify there were no obvious deficiencies. The inspectors verified the alignment of the following systems:

- The spent fuel pool (SFP) cooling system while the "A" train of the residual heat removal (RHR) system was unavailable to support shutdown cooling on June 6, 2004;
- The "B" train of the standby gas treatment (SBGT) system during planned maintenance on the "A" SBGT fan on June 7, 2004;

- The “A” train of SBGT during planned instrument calibrations on the “B” train of SBGT on June 8; and
- The emergency diesel generators (EDGs), start-up transformers, the diesel oil storage tank (DOST) following the main transformer fire on June 18, 2004.

b. Findings

No findings of significance were identified.

1R05 Fire Protection (71111.05Q)

a. Inspection Scope (nine samples)

The inspectors identified fire areas important to plant risk based on a review of Entergy's the Vermont Yankee Safe Shutdown Capability Analysis, the Fire Hazards Analysis, and the individual plant evaluation of external events (IPEEE). The inspectors toured plant areas important to safety in order to verify the suitability of Entergy's control of transient combustibles and ignition sources, and the material condition and operational status of fire protection systems, equipment, and barriers. The following fire areas were inspected:

- Reactor building, 252 foot elevation-S1 cable trays (CFZ-3/4);
- Reactor building, 252 foot elevation-S2 cable trays (CFZ-3/4);
- Reactor building, 252 foot elevation, North (FZ RB3);
- Reactor building, 252 foot elevation, South (FZ RB4);
- Reactor building, 280 foot elevation, Recirc MG set area (SZ RB-MG);
- Turbine building, all elevations (FA TB);
- Torus room, 213 foot elevation, North (FZ RB1);
- Torus room, 213 foot elevation, South (FZ RB2);
- 345 KV relay house.

b. Findings

No findings of significance were identified.

1R06 Flood Protection Measures (71111.06)

a. Inspection Scope (one sample)

The inspectors reviewed Entergy's established flood protection barriers and procedures for coping with internal flooding in the EDG rooms including Vermont Yankee Off-Normal Procedure (ON) 3148, “Loss of Service Water”; and ON 3158, “Reactor Building High Area Temperature/Water Level.” The inspectors reviewed internal flooding information contained in Entergy's IPEEE, in the UFSAR, and in the Internal Flooding DBD as it related to the EDG rooms. Finally, the inspectors performed walk-downs of flood vulnerable portions of the EDG rooms to ensure equipment and structures needed to mitigate an internal flooding event were as described in the IPEEE and the DBD. Additionally, the inspectors reviewed condition reports (CRs) related to internal flooding and the EDG rooms to ensure identified problems were properly addressed for resolution.

b. Findings

No findings of significance were identified.

1R08 Inservice Inspection (71111.08G)

a. Inspection Scope (four samples)

The inspectors assessed the inservice inspection (ISI) activities using the criteria specified in the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section XI.

The inspectors observed selected in-process non-destructive examination (NDE) activities, reviewed documentation and interviewed personnel to verify that the activities were performed in accordance with the ASME Boiler and Pressure Vessel Code Section XI requirements. The sample selection was based on the inspection procedure objectives and risk priority of those components and systems where degradation would result in a significant increase in risk of core damage. The inspectors reviewed a sample of condition reports and quality assurance audit reports to assess the licensee's effectiveness in problem identification and resolution. The specific ISI activities selected for review included:

- Observation of the ultrasonic testing (UT) manual technique, UT procedure, weld overlay calibration test block, and performance of pre and post examination calibration for UT of the CS system N5A safe-end to nozzle structural weld overlay;
- Review of the computer based UT procedure and observation of its application for the reactor vessel welds and the eddy current (ET) examination method to quantify clad crack shadowing of volumetric vessel weld examinations and the results for the reactor vessel flange-to-vessel weld;
- Observation of the UT examination of a pre-existing reactor vessel weld indication for verification that the indication was appropriately characterized and had not increased in dimension since the previous examination;
- Review of CS system sparger video-visual examination records;
- Review of the inspection scope expansion and disposition of two small linear indications on a standby liquid control system socket weld (SL11-F12); and
- Review of the reactor vessel internals project (BWRVIP-03 Rev 6) procedure and observation of some of the initial visual examinations.

In response to Entergy's extended power up-rate request and recent industry operating experience, the inspectors observed portions of the steam dryer visual testing (VT) type

1 and type 3 examinations and reviewed the documented examination reports. The examination reports documented that cracks were identified on both the internal and external surfaces of the steam dryer. The inspectors reviewed Entergy's corrective actions for these indications to ensure that the actions were appropriate. Specifically, the inspectors reviewed the weld repair activities for the two cracks identified on the external surface of the steam dryer. The inspectors also reviewed the vendor technical reports which justified operation for the next operating cycle at the current maximum licensed power level without repair of the indications identified on internal portions of the steam dryer.

b. Findings

No findings of significance were identified.

1R11 Licensed Operator Requalification (71111.11Q)

a. Inspection Scope (one sample)

The inspectors observed simulator examinations for one operating crew to assess the performance of the licensed operators and the ability of Entergy's Training Department staff to evaluate licensed operator performance. Operating crew performance was evaluated during a simulated main steam line break inside the drywell coincident with a loss of normal power. The inspectors evaluated the crew's performance in the areas of:

- Clarity and formality of communications;
- Ability to take timely actions;
- Prioritization, interpretation, and verification of alarms;
- Procedure use;
- Control board manipulations;
- Oversight and direction from supervisors; and
- Group dynamics.

Crew performance in these areas was compared to Entergy management expectations and guidelines as presented in the following documents:

- Vermont Yankee Administrative Procedure (AP) 0151, "Responsibilities and Authorities of Operations Department Personnel";
- AP 0153, "Operations Department Communication and Log Maintenance"; and
- Vermont Yankee Department Procedure (DP) 0166, "Operations Department Standards."

The inspectors verified that the crew completed the critical tasks listed in the associated simulator evaluation guide (SEG). The inspectors also compared simulator configurations with actual control board configurations. For any weaknesses identified, the inspectors observed the licensee evaluators to verify that they also noted the issues to be discussed with the crew.

b. Findings

No findings of significance were identified.

1R12 Maintenance Effectiveness (71111.12Q)

a. Inspection Scope (three samples)

The inspectors performed three issue/problem-oriented inspections of actions taken by Entergy in response to the following issues:

- As-found local leakage rate testing (LLRT) failures of the high pressure coolant injection (HPCI) turbine exhaust vacuum breakers;
- Repeat failures of the "C" residual heat removal service water (RHRSW) system pump motor cooling solenoid valve; and
- A trend of unavailability associated with the diesel-driven fire pump.

The inspectors reviewed applicable system maintenance rule scoping documents, system health reports, corrective actions taken in response to the equipment problems, maintenance rule functional failure determinations, and applicable a(1) action plans. In addition, the issues were discussed with the responsible engineer.

b. Findings

No findings of significance were identified.

1R13 Maintenance Risk Assessment and Emergent Work Evaluation (71111.13)

a. Inspection Scope (seven samples)

The inspectors evaluated on-line and outage risk management for six planned and one emergent maintenance activities. The inspectors reviewed maintenance risk evaluations, work schedules, recent corrective actions, and control room logs to verify that other concurrent or emergent maintenance activities did not significantly increase plant risk. The inspectors also compared these items and activities to requirements listed in Vermont Yankee AP 0125, "Equipment Release"; AP 0172, "Work Schedule Risk Management - Online"; and AP 0173, "Work Schedule Risk Management - Outage." The inspectors reviewed the following work activities:

Online Risk:

- Planned maintenance on the service water (SW) system supply to turbine the building valve SW-19B breaker, resulting in Yellow online risk;
- Planned maintenance on the "A" train of SBGT; and
- Emergent work to implement minor modification on average power range monitors (APRMs), resulting in a ½ scram condition and "Yellow" online risk.

Outage Risk:

- Planned realignment and testing of offsite electrical power via the delayed backfeed through the auxiliary and main transformers;
- Planned maintenance resulting in 345 KV 340 line and "1T" breaker being out of service;
- Portions of planned maintenance on electrical buses 2, 4, and 9; and
- Planned performance of reactor pressure vessel leakage testing; considered by Entergy to be a "high risk evolution."

b. Findings

No findings of significance were identified.

1R14 Personnel Performance During Non-routine Plant Evolutions (71111.14)

a. Inspection Scope (two samples)

The inspectors assessed the control room operator performance during the following two non-routine evolutions:

- Entry into emergency operating procedure (EOP) 3, "Primary Containment Control," due to average torus temperature exceeding 90 degrees during HPCI system testing on May 26, 2004; and
- Reactor scram following the main transformer fire on June 18, 2004.

Specifically, the adequacy of personnel performance, procedure compliance, and use of the corrective action process were evaluated against the requirements and expectations contained in technical specifications and the following station procedures, as applicable:

- AP 0151, "Responsibilities and Authorities of Operations Department Personnel";
- AP 0153, "Operations Department Communication and Log Maintenance";
- Vermont Yankee DP 0166, "Operations Department Standards;"
- Vermont Yankee OP 105, "Reactor Operations"; and
- OP 2124, "Residual Heat Removal System."

b. Findings

No findings of significance were identified.

1R15 Operability Evaluations (71111.15)

a. Inspection Scope (five samples)

The inspectors reviewed five operability determinations prepared by the licensee. The inspectors evaluated the selected operability determinations against the requirements and guidance contained in NRC Generic Letter 91-18, "Resolution of Degraded and Nonconforming Conditions," as well as procedures AP 0167, "Operability Determinations," and ENN-OP-104, "Operability Determinations." The inspectors verified the adequacy of the following evaluations of degraded or non-conforming conditions:

- Flow noise from the "C" RHR system pump discharge orifice;
- Broken 4 KV breaker driving pawl;
- Missing "clam shell" from the control rod drive housing support system;
- Apparent non-conservative flow-biased scram setpoints; and
- Incomplete NDE for lifting and handling gear.

b. Findings

No findings of significance were identified.

1R16 Operator Workarounds (71111.16)

a. Inspection Scope (one sample)

The inspectors reviewed the cumulative effect of operator workarounds on the reliability, availability, and potential mis-operation of systems and the potential to affect the ability of operators to respond to plant transients and events. The inspectors reviewed identified operator burdens, control room deficiencies, disabled or illuminated control room alarms, and component deviations and discussed them with responsible operations personnel to ensure they were appropriately categorized and tracked for resolution. In addition, in-plant and control room tours were performed to identify any workarounds not previously identified in accordance with procure DP 0166, "Operations Department Standards."

b. Findings

No findings of significance were identified.

1R17 Permanent Plant Modifications

1. Annual Review (71111.17A)

a. Inspection Scope (one sample)

The inspectors performed an annual review of a permanent plant modification involving the installation of an additional main steam safety valve installed during RFO 24. The inspectors reviewed this modification to verify that the design bases, licensing bases, and performance capability of risk significant structures, systems, and components (SSCs) had not been degraded through the modifications. The review evaluated the impact of the modification on power operation at the current licensed power level and potential future operation at an increased power rating. This plant modification was selected for review based on risk insights for the plant and included SSCs associated with the initiating events, mitigating systems and barrier integrity cornerstones. The inspection included a walkdown of the modification, interviews with plant staff, and the review of applicable documents including procedures, Vermont Yankee Design Calculation (VYDC) 2003-013, the modification package, engineering evaluations, drawings, corrective action documents, the UFSAR and Technical Specifications. The inspectors verified that selected attributes were consistent with the current design and licensing bases. These attributes included component safety classification, energy requirements supplied by supporting systems, instrument set-points, and control system interfaces. Design assumptions were reviewed to verify that they were technically appropriate and consistent with the UFSAR. The inspectors verified that selected procedures, calculations and the UFSAR were properly updated with revised design information and operating guidance. The inspectors also verified that the as-built configuration was accurately reflected in the design documentation and that post-modification testing was appropriate.

b. Findings

No findings of significance were identified.

2. Biennial Review (71111.17B)

a. Inspection Scope (six samples)

The inspectors performed a biennial review of selected plant modifications that were being installed during RFO 24. The modifications support a proposed power uprate that is currently under review by the Office of Nuclear Reactor Regulation (NRR). The inspectors reviewed the modifications to verify that the design bases, licensing bases, and performance capability of risk significant SSCs had not been degraded through the modifications. The reviews evaluated the impact of the modifications on power operation at the current licensed power level and potential future operation at an increased power rating. Plant modifications were selected for review based on risk insights for the plant and included SSCs associated with the initiating events, mitigating systems and barrier integrity cornerstones. The inspection included walkdowns of selected plant systems and components, interviews with plant staff, and the review of applicable documents including procedures, calculations, modification packages, engineering evaluations, drawings, corrective action documents, the UFSAR and Technical Specifications. The inspectors verified that selected attributes were consistent with the current design and licensing bases. These attributes included component safety classification, energy requirements supplied by supporting systems, instrument set-points, and control system interfaces. Design assumptions were reviewed to verify that they were technically appropriate and consistent with the UFSAR. The inspectors verified that selected procedures, calculations and the UFSAR were properly updated with revised design information and operating guidance. The inspectors also verified that the as-built configuration was accurately reflected in the design documentation and that post-modification testing was appropriate. A listing of documents reviewed is provided in the Attachment to this report.

b. Findings

No findings of significance were identified.

1R19 Post Maintenance Testing (71111.19)

a. Inspection Scope (three samples)

The inspectors reviewed completed documentation for three post-maintenance test (PMT) activities to verify the test data met the required acceptance criteria contained in the licensee's Technical Specifications, UFSAR, and in-service testing program, and that the PMT was adequate to verify system operability and functional capability following maintenance. The inspectors reviewed the PMTs performed after the following maintenance activities:

- Installation of low feedwater pump suction pressure trip modifications in accordance with minor modification (MM) 2003-015;
- APRM flow control trip reference card replacement in accordance with MM 2003-028; and
- Disassembly and repair of HPCI turbine exhaust check valve V23-3 following failed as-found LLRT.

The inspectors verified that systems were properly restored following testing and that discrepancies were appropriately documented in the corrective action process. The inspectors also discussed the PMT results with the responsible engineers.

b. Findings

No findings of significance were identified.

1R20 Refueling and Outage Activities (71111.20)

1. Refueling Outage (RFO) 24

a. Inspection Scope (one sample)

The inspectors evaluated the following outage activities to verify that Entergy considered risk when developing outage schedules; that Entergy adhered to administrative risk reduction methodologies for plant configuration control; and to ensure that Entergy adhered to their operating license, Technical Specification requirements, and approved procedures:

- Review of the Outage Plan - The inspectors reviewed the RFO 24 shutdown risk assessment to verify that Entergy addressed the outage's impact on defense-in-depth for the five shutdown critical safety functions; electrical power availability, inventory control, decay heat removal, reactivity control, and containment. Adequate defense-in-depth was verified for each safety function and / or where redundancy was limited or not available, the existence of appropriate planned contingencies, to minimize the overall risk, was verified. Consideration of operational experience was also verified. The daily risk up-date, accounting for schedule changes and unplanned activities were also periodically reviewed;
- Monitoring of Shutdown Activities - The inspectors observed the shutdown of the reactor plant including reactor plant cooldown and transition to shutdown cooling operations. As soon as practical following the shutdown, the inspectors performed walkdowns of the primary containment;
- Electrical Power - The inspectors reviewed the status and configuration of safety-related buses throughout RFO 24. The inspectors ensured the electrical lineups met the requirements of Technical Specification and the outage risk control plan. The inspectors performed frequent walkdowns of affected portions of the electrical plant including startup transformers, the auxiliary transformer, and the emergency diesel generators;
- Decay heat removal (DHR) System Monitoring - The inspectors monitored decay heat removal status on a daily basis. Monitoring included daily reviews of residual heat removal system alignment, reviews of spent fuel pool cooling system alignment, and reviews of reactor coolant system (RCS) time-to-boil calculations and results;
- Inventory Control - The inspectors performed daily RCS inventory control reviews including reviews of available injection systems and flow paths to ensure consistency with the outage risk plan. The inspectors also ensured that operators maintained reactor vessel and/or refueling cavity levels within established ranges;
- Reactivity Control - The inspectors observed reactivity management actions taken by control room operators during refueling evolutions including procedure place keeping, communications with refueling floor personnel, the monitoring of source range nuclear instrumentation, and the monitoring of individual control rod positions;

- Containment Closure - The inspectors performed a torus internal cleanliness walkdown following completion of outage activities. The inspectors performed a primary containment closeout walkdown prior to final containment closure. Finally, the inspectors ensured secondary containment was maintained as required by Technical Specifications;
- Refueling Activities - The inspectors observed portions of refueling operations, including fuel handling and accounting in the reactor vessel and spent fuel pool. The inspectors also performed an independent core reload verification of approximately 34% of the core; and
- Heatup and Startup Activities - The inspectors observed portions of the heatup and startup of the reactor plant following the completion of RFO24.

The inspectors also verified that Entergy identified problems related to refueling activities and entered them into their corrective actions program.

b. Findings

Introduction: A very low safety significance (Green), self-revealing, non-cited violation (NCV) of 10 CFR 50 Criterion XVI was identified in that Entergy personnel did not develop effective corrective actions to prevent recurrence following a 2001 event wherein control room operators did not verify a suction path existed prior to starting a residual heat removal (RHR) system pump being used to support shutdown cooling (SDC) operations which caused the pump to trip. On April 10, 2004, an identical event occurred and again resulted in a trip of the RHR pump being used to support SDC operations.

Description: On April 10, 2004, control room operators realigned vital alternating current (AC) power from its normal power supply to the backup power supply to support planned maintenance on a vital AC motor generator. The reactor plant was in the refueling mode of operation at that time. In preparation for the vital AC realignment, operators temporarily secured the RHR system, which was running in the SDC mode of operation. One of the automatic actions that occurred during the vital AC alignment was the closure of the RHR pump suction valve V10-17 from a Group 4 containment isolation signal. Once the realignment of the vital AC power was completed, operators reset the expected partial Group 4 containment isolation signal, but did not recognize that this partial Group 4 containment isolation signal resulted in the closure of RHR system valve V10-17, isolating the suction path used for RHR system support of SDC. Operators subsequently attempted to reinitiate the RHR system in accordance with Vermont Yankee Operating Procedure (OP) 2124, "Residual Heat Removal System," Section J, "Short Term Shutdown Cooling Shutdown and Startup." When the "B" RHR pump was started, the pump's breaker immediately tripped open due to a designed electrical interlock requiring valve V10-17 to be open to provide a suction path for the RHR system. Operators investigated the cause of the pump breaker trip, identified that no suction path existed since valve V10-17 had closed, re-opened valve V10-17, and successfully restarted the "B" RHR pump within 15 minutes of the breaker trip.

SDC thermal margin was maintained throughout this event via continued operation of the spent fuel pool cooling system along with a calculated RCS time-to-boil value of greater than 24 hours.

In the apparent cause report for this event, Entergy identified that a nearly identical event had occurred during a refueling outage in May 2001. At that time, operators had performed a planned realignment of the vital AC power but did not recognize that valve V10-17 had closed which resulted in a trip of the "C" RHR pump breaker when operators attempted to reinitiate the RHR system. Entergy documented this previous event in event report (ER) 2001-01228. Corrective actions assigned at that time included discussions at shift supervisor meetings and the counseling of involved operators. In the apparent cause report, Entergy also concluded that the corrective actions taken to address the May 2001 event were insufficient to have prevented recurrence of the nearly identical April 2004 event. Specifically, no corrective actions were assigned to address the fact that OP 2124, Section J, did not specifically require operators to verify an adequate RHR system flow path to and from the reactor existed prior to reinitiating system operation.

Analysis: The performance deficiency associated with this finding is that Entergy personnel did not assign effective corrective actions to prevent recurrence as required by VY Administrative Procedure 0009 following a May 2001 trip of the "C" RHR pump which occurred when operations did not recognize that RHR system valve V10-17 had gone closed during a realignment of vital AC power. As a result, a similar event occurred in April of 2004 involving a trip of the "B" RHR pump resulting from operators again failing to recognize the closure of valve V10-17 during a realignment of vital AC power. The finding is greater than minor since it is associated with the Fuel Cladding Configuration Control Attribute of the Barrier Integrity Cornerstone and because it affects the associated Cornerstone objective. Specifically, the April 2004 trip of the "B" RHR pump, used to support SDC operations, reduced the assurance that the fuel cladding would protect the public from radio nuclide releases caused by accidents or events. The inspectors conducted a SDP Phase 1 screening of the finding in accordance with IMC 0609, Appendix G, "Shutdown Operations Significance Determination Process [SDP]." The inspectors determined that Entergy did not meet Item I.C. of Table 1, "BWR [Boiling Water Reactor] Refueling Operation with RCS Level > 23'" since the finding resulted in Entergy not having at least one RHR loop operating to support SDC. However, the inspectors also determined that the finding did not degrade Entergy's ability to recover SDC since the "B" RHR pump was restarted within 15 minutes of being tripped and an adequate thermal margin was maintained via a calculated RCS time-to-boil of greater than 24 hours. Therefore, in accordance with IMC 0609, Appendix G, the finding was of very low safety significance (Green).

A contributing cause of this finding is related to the Cross-Cutting area of Problem Identification and Resolution. As stated above, Entergy personnel did not develop effective corrective actions to prevent recurrence following a 2001 event wherein control room operators did not verify a suction path existed prior to starting the RHR system pump being used to support SDC operations which caused the pump to trip. Entergy's corrective actions relied on the operator's skill to verify a suction path was open prior to restarting the RHR pump rather than proceduralize the step. As a result, an identical event occurred in April 2004 again resulting in a trip of the RHR pump being used to support SDC operations.

Enforcement:

10 CFR 50, Appendix B, Criterion XVI states, in part, that measures shall be established to assure that conditions adverse to quality are promptly identified and corrected. Vermont Yankee AP 0009, "Event Reports," Revision 12, describes Entergy's requirements for the identification and correction of conditions adverse to quality including determining the cause(s) of the event and assigning corrective actions that prevent recurrence. Contrary to the above, in May 2001, Entergy did not assign effective corrective actions that prevent recurrence following a May 2001 trip of the "C" RHR pump which occurred when operators did not recognize that RHR system valve V10-17 had closed due to an expected partial Group 4 containment isolation during the realignment of vital AC power. As a result, a similar event occurred in April of 2004 involving the trip of the "B" RHR pump resulting from operators again failing to recognize the closure of valve V10-17 during a realignment of vital AC power. Because the finding is of very low safety significance and has been entered into the licensee's Corrective Actions Program (CR 2004-01005), this violation is being treated as an NCV, consistent with Section VI.A of the NRC Enforcement Policy: **NCV 0500271/2004003-01, Ineffective Corrective Actions Assigned Following a May 2001 Trip of the "C" RHR System Pump During SDC Operation**.

2. Forced Outage Following the Main Transformer Fire of June 18, 2004.

a. Inspection Scope (partial sample)

The inspectors evaluated the following forced outage activities to verify that Entergy considered risk when developing outage schedules; that Entergy adhered to administrative risk reduction methodologies for plant configuration control; and to ensure that Entergy adhered to their operating license, Technical Specification requirements, and approved procedures:

- Review of the Outage Plan - The inspectors reviewed the shutdown risk assessment to verify that Entergy addressed the outage's impact on defense-in-depth for the five shutdown critical safety functions; electrical power availability, inventory control, decay heat removal, reactivity control, and containment. The daily risk up-date, accounting for schedule changes and unplanned activities were also periodically reviewed;
- Monitoring of Shutdown Activities - The inspectors observed the shutdown of the reactor plant including reactor plant cooldown activities and transition to shutdown cooling operations. As soon as practical following the shutdown, the inspectors performed walkdowns of the primary containment;
- DHR System Monitoring - The inspectors monitored decay heat removal on a daily basis. Monitoring included daily reviews of residual heat removal system

alignment, reviews of spent fuel pool cooling system alignment, and reviews of RCS time-to-boil calculations and results; and

- Inventory Control - The inspectors performed daily RCS inventory control reviews including reviews of available injection systems and flow paths to ensure consistency with the outage risk plan. The inspectors also ensured that operators maintained RCS level within established ranges.

The inspectors also verified that Entergy identified problems related to the forced outage and entered them into their corrective actions program.

b. Findings

No findings of significance were identified.

1R22 Surveillance Testing (71111.22)

a. Inspection Scope (eight samples)

The inspectors observed surveillance testing to verify that the test acceptance criteria specified for each test was consistent with Technical Specification and UFSAR requirements, was performed in accordance with the written procedure, the test data was complete and met procedural requirements, and the system was properly returned to service following testing. The inspectors observed selected pre-job briefs for the test activities. The inspectors also verified that discrepancies were appropriately documented in the corrective action program. The inspectors verified that testing in accordance with the following procedures met the above requirements:

- OP 4031, "Type B and C Primary Containment Leak Rate Calculations and Evaluations";
- OP 4100, "ECCS Integrated Automatic Initiation Test";
- OP 4114, "Standby Liquid Control [SLC] System Surveillance," Section C, "Flow Test Directly into the Reactor Vessel," and Section I, "SLC Explosive Charge Continuity Check";
- OP 4121, "Reactor Core Isolation Cooling System Surveillance," Section B, "RCIC Injection Check Valve (RCIC-22) Test";
- OP 4142, "Vernon Tie and Delayed Access Power Source Backfeed Surveillance";
- OP 4424, "Control Rod Scram Testing and Data Reduction," Section B, "Single Rod Scrams Using ERFIS Data Collection";
- OP 4430, "Reactivity Anomalies/Shutdown Margin Check," Section 1, "Strongest Control Rod Withdrawn Subcritical Check; and
- Special Test Procedure (STP) 2003-004, "Power Ascension Test Procedure.

b. Findings

No findings of significance were identified.

1R23 Temporary Modifications (71111.23)

a. Inspection Scope (two samples)

The inspectors reviewed the following temporary modifications (TMs) to ensure that the modifications did not adversely affect the availability, reliability, or functional capability of any risk-significant structures, systems, and components:

- TM 2003-039, "Bottom Head Drain Line Freeze Seal"; and
- TM 2003-022, "Vibration Monitoring Equipment Installation on MS & FW Piping."

The inspectors compared the information in the TM packages to Entergy's TM requirements contained in AP 0020, "Control of Temporary and Minor Modifications." The inspectors also walked down accessible portions of these TMs to verify that required tags and markings were applied and that the TMs were properly maintained. The inspectors also reviewed a sample of TM-related problems identified in the Entergy's corrective action program to verify that they had identified and implemented appropriate corrective actions.

b. Findings

No findings of significance were identified.

Cornerstone: Emergency Preparedness

1EP6 Drill Evaluation (71114.06)

a. Inspection Scope (one sample)

On June 17, 2004, the inspectors observed an operating crew evaluate a simulator-based event using the station emergency action levels (EALs) during licensed operator requalification training activities. The inspectors discussed the performance expectations and results with the lead instructor and operations training manager. The inspectors focused on the ability of licensed operators to perform event classification and make proper notifications in accordance with the following station procedures and industry guidance:

- AP 0153, Operations Department Communications and Log Maintenance";
- AP 0156, "Notification of Significant Events";
- AP 3125, "Emergency Plan Classification and Action Level Scheme";
- DP 0093, "Emergency Planning Data Management";
- OP 3540, "Control Room Actions During an Emergency"; and
- Nuclear Energy Institute (NEI) 99-02, "Regulatory Assessment Performance Indicator Guideline," Revision 2.

b. Findings

No findings of significance were identified.

2. RADIATION SAFETY

Cornerstone: Occupational Radiation Safety

2OS1 Access Control to Radiologically Significant Areas (71121.01)

a. Scope (fourteen samples)

The inspectors conducted inspections to verify that Entergy was properly implementing physical, engineering, and administrative controls for access to high radiation areas, and other radiologically controlled areas, and that workers were adhering to these controls when working in these areas. Implementation of the access control program was reviewed against the criteria contained in 10 CFR 20, Technical Specifications, and approved Entergy procedures. The inspectors conducted independent radiation surveys and observed work area conditions, reviewed radiation surveys of these areas, and reviewed electronic dosimetry set points and other exposure controls specified in the radiation work permits (RWPs) that provided the access control requirements for the following radiologically significant work activities:

- Steam dryer underwater welding modifications;
- Drywell shielding installation;
- Drywell in-service inspection of core spray nozzle N5A;
- Drywell safety relief valve maintenance;
- Drywell main steam isolation valve maintenance; and
- Feedwater heater replacement modifications

b. Findings

No findings of significance were identified.

2OS2 ALARA Planning and Controls (71121.02)

Inspection Scope (four samples)

The inspectors reviewed Entergy's As Low As Reasonably Achievable (ALARA) Program performance against the requirements of 10 CFR 20.1101(b). The inspectors reviewed aspects of the implementation of exposure reduction requirements based on ALARA planning for the five highest exposure outage tasks. The ALARA-related work activities observed are listed in Section 2OS1 above. In addition, the following ALARA inspection activities were conducted:

- Independent shielding effectiveness radiation surveys conducted in the drywell;
- Observation of closed circuit television equipment and tele-dosimetry use in the drywell was conducted with respect to drywell remote health physics work surveillance capability and technical specification requirements; and

- Feedwater heater bay source term location was reviewed relative to worker occupancy areas.

b. Findings

No findings of significance were identified.

4. OTHER ACTIVITIES (OA)

4OA1 Performance Indicator Verification (71151)

a. Inspection Scope (two samples)

The inspectors sampled Entergy submittals for the performance indicators (PIs) listed below for the period from April 2003 to March 2004. The PI definitions and guidance contained in NEI 99-02 and AP 0094, "NRC Performance Indicator Reporting," were used to verify the accuracy and completeness of the PI data reported during this period.

Barrier Integrity Cornerstone

- Reactor Coolant System Specific Activity; and
- Reactor Coolant System Leakage.

The inspectors reviewed selected operator logs, plant process computer data, condition reports, and monthly operating reports for the period April 1, 2003, through March 31, 2004.

b. Findings

No findings of significance were identified.

4OA2 Identification and Resolution of Problems (71152)

1. Routine Review of Identification and Resolution of Problems

a. Inspection Scope

The inspectors routinely reviewed issues during baseline inspection activities and plant status reviews to verify they were being entered into Entergy's corrective action system at an appropriate threshold and that adequate attention was being given to timely corrective actions. Additionally, in order to identify repetitive equipment failures and/or specific human performance issues for follow-up, the inspectors performed a daily screening of items entered into Entergy's corrective action program. This review was accomplished by reviewing selected hard copies of condition reports (a listing of CRs reviewed is included in the Attachment to this report) and/or by attending daily screening meetings.

b. Findings

No findings of significance were identified.

2: Semi-Annual Trend Review

a. Inspection Scope

As required by Inspection Procedure 71152, "Identification and Resolution of Problems," the inspectors performed the semi-annual trend review to identify trends, either licensee or NRC identified, that might indicate the existence of a more significant safety issue. Included within the scope of this review were:

- CRs generated from January through May 2004;
- Corrective maintenance backlog listings from January through May 2004;
- The corrective action program 3rd and 4th quarter, 2003 trend report; and
- Daily review of main control room operator logs.

b. Findings

No findings of significance were identified.

3. Cross-Reference to PI&R Findings Documented Elsewhere

Section 1R20.1 describes a finding wherein Entergy personnel did not develop effective corrective actions to prevent recurrence following a 2001 event wherein control room operators did not verify a suction path existed prior to starting the RHR system pump being used to support SDC operations which caused the pump to trip. Entergy's corrective actions relied on the operator's skill to verify a suction path was open prior to restarting the RHR pump rather than proceduralize the step. As a result, an identical event occurred in April 2004 again resulting in a trip of the RHR pump being used to support SDC operations.

4OA3 Event Followup (71153)

1. Main Transformer Fire and Reactor Plant Scram

a. Inspection Scope (1 sample)

The inspectors evaluated Entergy's response to a main transformer fire and resultant reactor plant scram that occurred on June 18, 2004. The inspectors immediately responded to the main control room to observe reactor plant parameters, to evaluate individual safety system responses, and to evaluate licensed operator responses to the event. The inspectors evaluated the response of the reactor plant and the licensed operators against Entergy approved operating procedures, abnormal operating procedures, and emergency operating procedures. The inspectors evaluated Entergy's classification of the event (i.e., Unusual Event) in accordance with approved EAL procedures to ensure notifications were made to NRC and state/county governments as required. The inspectors also evaluated the ability of Entergy's fire brigade and automatic fire protection systems to extinguish the main transformer fire in a safe and timely manner.

The NRC Region I Office dispatched two inspectors, each a specialist in the areas of electrical and fire protection systems, to assist the resident inspectors with event follow-up activities. The inspectors monitored Entergy's efforts in determining the root cause of the event; monitored Entergy's efforts for the recovery, replacement, and repair of the effected portions of the 22KV electrical system; and monitored Entergy's reactor plant restart preparation activities.

b. Findings

Entergy has identified that the root cause of the main transformer fire relates to weaknesses with the preventive maintenance performed on the 22 KV electrical system. Because additional information is needed to determine if these issues are more than minor, they are considered to be an unresolved item (URI) pending completion of the inspectors review of Entergy's root cause analysis: **URI 0500271/2004003-02, Weaknesses Identified with the Preventive Maintenance Performed on the 22 KV Electrical System Resulted in Main Transformer Fire.**

4OA5 Other Activities

1. Temporary Instruction (TI) 2515/156, "Offsite Power System Operational Readiness."

a. Inspection Scope

The inspectors collected and reviewed information pertaining to the Vermont Yankee offsite power system as it related to the requirements of 10 CFR 50.65, "Requirements for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants"; 10 CFR 50.63, "Loss of All Alternating Current Power"; offsite power operability; and corrective actions. The inspectors also reviewed this data against the requirements of 10 CFR 50, Appendix A, General Design Criterion 17, "Electric Power Systems," and the Vermont Yankee Technical Specifications. This information was forwarded to NRR for further review. A listing of documents reviewed is included in the Attachment to this report.

b. Findings

No findings of significance were identified.

4OA6 Meetings, including Exit

Resident Exit

On July 12, 2004, the resident inspectors presented the inspection results to Mr. Kevin Bronson and members of his staff. The inspectors asked whether any materials examined during the inspection should be considered proprietary. No proprietary information was identified.

Meeting with the State of Vermont Public Service Board

On June 28, 2004, Region I and NRR staff met with the Vermont State Public Service Board (PSB) regarding Vermont Yankee's request for a 20% extended power uprate. The NRC staff discussed the NRC's power uprate review process and details regarding a planned pilot engineering inspection slated for Vermont Yankee in August 2004.

ATTACHMENT: SUPPLEMENTAL INFORMATION

Enclosure

SUPPLEMENTAL INFORMATION

KEY POINTS OF CONTACT

Licensee Personnel:

J. Thayer	Site Vice President
K. Bronson	General Plant Manager
J. Allen	Design Engineering
P. Corbett	Maintenance Manager
J. Dreyfuss	Project Engineering Manager
J. Devincentis	Licensing Manager
W. Fadden	Design Engineering
J. Geyster	Radiation Protection Superintendent
D. Giorowall	Programs Supervisor
Dennis Girrior	Programs Supervisor
S. Goodwin	Mechanical Design Department Manager
M. Gosekamp	Superintendent of Operations Training
M. Hamer	Licensing
D. Johnson	Design Engineering
Dave King	ISI Coordinator
R. Morissette	Principal As Low As Reasonably Achievable (ALARA) Engineer
M. Pletcher	Radiation Protection Supervisor - Instruments
P. Rainey,	Design Engineering
B. Renny	Supervisor, Access Authorization
K. Stupak	Technical Training
C. Wamser	Operations Manager
R. Wanczyk	Director of Nuclear Safety

LIST OF ITEMS OPENED, CLOSED, AND DISCUSSED

Opened and Closed

0500271/2004003-01 NCV	Ineffective Corrective Actions Assigned Following a May 2001 Trip of the "C" RHR System Pump During SDC Operation (Section 1R20.1)

Opened

0500271/2004003-02 URI	Weaknesses Identified with the Preventive Maintenance Performed on the 22 KV Electrical System Resulted in Main Transformer Fire (Section 4OA3.1)

LIST OF DOCUMENTS REVIEWED

Section 1R02: Evaluation of Changes, Tests, or Experiments

Power Uprate Modifications

TM 2003-022	Vibration Monitoring Equipment Installation on MS [Main Steam] & FW [Feedwater] Piping
MM 2003-015	Reactor Feed Pump Suction Pressure Trip
MM 2003-016	Reactor Recirculation System Runback"
MM 2003-026	AST [Alternate Source Term] Component Modification (OG-779 Installation)
MM 2003-028	APRM Flow Control Trip Reference Card Replacement
MM 2003-039	NSSS [Nuclear Steam Supply System]/BOP [Balance of Plant] Instrumentation Upgrades
MM 2003-054	381 Line Overload Relay Setting
VYDC 2003-013	Installation of Additional Main Steam Safety Valve

Section 1R08: Inservice Inspection

Procedures

ENN-NDE 9.29, Rev 0 for UT of structural overlay (weld N5A)
PDI-UT-8, Rev B. Generic Procedure for UT of Weld Overlaid Austenitic Pipe Welds
ISI - 254, Rev 5, for remote ISI of RPV Welds
NE 8048, Rev 1 - In Vessel Visual Inspection

Drawings

ISI-PPV-103, Rev 3. Reactor Vessel
ISI-SLC-Part 4, Rev 3. SLC Piping ISO
D-7983-621 Rev G. UT/ET clad crack calibration block
6D30047, Rev 0, Wesdyne Calibration Standard PDI-01

Miscellaneous Reports

QA (Quality Assurance) Audit Report AR-2003-22b&c, dated 11/13/2003
GE (General Electric) RICSIL No. 050 of 4/23/1990, and GE SIL NO. 539, dated 11/5/1991
GE Reports INR-VYR24-04-01R2, 02R2, 03, & 04R1 on Steam Dryer Visual Indications
GE Nuclear Engineering (GENE) 0000-0028-0130-01, Revision 3, dated April 2004 on Steam Dryer Unit End Plate Indications - Vermont Yankee R24
GENE-0000-0028-0130-02, Revision 3, dated April 2004 on Steam Dryer Drain Channel Indications - Vermont Yankee R24

Section 1R17: Permanent Plant Modifications

Power Uprate Modifications

MM 2003-015	Reactor Feed Pump Suction Pressure Trip
MM 2003-016	Reactor Recirculation System Runback
MM 2003-026	AST Component Modification (OG-779 Installation)
MM 2003-028	APRM Flow Control Trip Reference Card Replacement
MM 2003-039	NSSS/BOP Instrumentation Upgrades
MM 2003-054	381 Line Overload Relay Setting

Calculations

Vermont Yankee Calculation (VYC) 0693A Rev. 2 APRM Neutron Monitoring Trip Loops
VYC-2269 Rev. 0 Feedwater and Condensate Hydraulic Model Analysis
VYC-2309 Rev. 0 Steam Drain Line MS-189-D3 Check Valve Addition

License Amendment Documents

BVY 03-23	License Amendment Proposal for ARTS/MELLLA
BVY 03-39	Technical Specification Proposed Change # 257 (ARTS/MELLLA)
GE-NE-0000-0020	Entergy Nuclear Operations Incorporated Vermont Yankee Nuclear Power
GE-NE-1500-0001	Station MELLLA+ Transient Analysis
NEDO-33090	Safety Analysis Report for Vermont Yankee Nuclear Power Station Constant Pressure Power Uprate

NRC NRR Safety Evaluation for License Amendment No. 219 to DPR-28

Specifications/Procedures

AP 5226 Rev. 5	Calibration of Switchyard Breaker Failure Relays
VYSP-FS-074	Specifications for Safety Valves
VY IPE Vol 2	Individual Plant Examination for SRV/SV Reclosure

Section 4OA2.1: Routine Review of Problem Identification and Resolution

Condition Reports

2002-2581	RBCCW pumps failed to restart within time limit during ECCS [emergency core isolation cooling] test
2002-2584	ECCS test data was accepted as satisfactory when some data was outside of acceptance criteria
2003-1509	The "C" RHRSW pump cooling water supply solenoid valve failed to open as required on pump start
2003-2321	No indicated cooling flow upon "C" RHRSW pump start
2004-0700	While troubleshooting a 4KV breaker on Bus-2-7, the breaker driving pawl broke
*2004-0840	Incorrect status of Decay Heat Removal was logged on the Critical Outage Systems Status Form
*2004-0845	NRC resident question on RHR procedure wording
2004-0879	HPCI V23-845 failed IST testing
2004-0892	Water level in the reactor cavity exceeds limits during cavity floodup

*2004-0897	Incorrect start dates used in ORAM-Sentinel for alternate DHR capability determinations
2004-0918	Adverse trend - main steam isolation valve Appendix J test failures
2004-0942	HPCI V23-846 failed IST testing
2004-0955	As-found condition of V2-80 included a galled stem
2004-0968	Unsuccessful decon of diver
2004-0981	An observation was made from below vessel that a piece of control rod drive housing support (shoot-out steel) was missing
2004-0986	Instructions for RWP not adhered to
2004-0998	RHR-46A allowed to overflow while working on the valve
2004-1005	B RHR pump trip during restart due to no suction path
2004-1017	V2-13-3 failed Appendix J local leak rate test
2004-1058	Flow noise from RO-10-105C, "C" RHR pump discharge orifice
2004-1091	Rad survey maps indicate need to perform alpha survey
2004-1117	Flow noise from "C" RHR pump discharge orifice
2004-1160	ASME rejectable indication on SLC weld
2004-1190	Weld electrodeoven left unlocked and unattended
*2004-1339	Two fuel segments could not be confirmed in storage container
2004-1409	"A" RBCCW did not start within the allowed ECCS start time
2004-1426	ECCS test exceptions
2004-1428	Reactor water clean up pump started with no suction path
2004-1548	P-8-1A leaking oil from upper bearing reservoir area
2004-1653	Excessive overtime approved without documentation
2004-1665	Potentially non-conservative scram setpoint values
*2004-1916	#2 fan room has inadequate hose stream coverage due to modification to fan room door
*2004-1928	Slight leakage on "B" SBGT demister loop seal piping union
2004-1989	Generator Ground alarm came in
2004-2015	Reactor Scram
2004-2017	Notification of Unusual Event (NOUE) declared due to plant fire and automatic reactor scram
2004-2019	Main transformer fire
*2004-2022	Discrepancy in post scram rod position indication
*2004-2023	Torus-to-drywell vacuum breaker indicating lights and alarm indicate breakers may have cycled during the scram/transformer trip
*2004-2045	Repeat of P-8-1A leaking oil from upper bearing reservoir area
2004-2074	Failure to make timely notification of States upon declaration of unusual event on June 18, 2004

*Inspector-identified issues.

Section 4OA5.1: Temporary Instruction (TI) 2515/156, "Offsite Power System Operational Readiness."

Procedures

Vermont Yankee Operating Procedure Form (VYOPF) 0150.03, "CRO [Control Room Operator] Round Sheet
AP 0172, "Work Schedule Risk Management - On Line"
ISO New England Master/Satellite Procedure #1, "Nuclear Plant Transmission Operations," Revision 0
ISO New England Master/Satellite Procedure #2, "Abnormal Conditions Alert," Revision Dated 11/19/01

Licensee Event Reports (LERs)

Vermont Yankee Nuclear Power Station LER 87-008-00, "Loss of Normal Power During Shutdown Due to Routing All Off-Site Power Sources Through One Breaker"
Vermont Yankee Nuclear Power Station LER 84-022-00, "Diesel Generator Lockout Trip of Both Generators"

Maintenance Rule Documents

NRC Maintenance Rule Program Website Frequently Asked Questions (FAQs)
Vermont Yankee 10CFR50.65 NRC Maintenance Rule SSC Basis Document, "345K Volts AC Electrical (345KV)"
Vermont Yankee 10CFR50.65 NRC Maintenance Rule SSC Basis Document, "115K Volts AC Electrical (115KV)".

Operational Experience Documents

JA Fitzpatrick Operational Experience (OE) 16822, "Reactor Scram due to Grid Instability"
Significant Operating Experience Report (SOER) 9901, "Loss of Grid"

Miscellaneous Documents

Control room operator logs dated 8/17/87
VYC-1088, "Vermont Yankee 4160/480 Volt Short Circuit/Voltage Study," Revision 3

LIST OF ACRONYMS

AC	Alternating Current
ADAMS	Automated Document Access Management System
ALARA	As Low As Is Reasonably Achievable
AP	Vermont Yankee Administrative Procedure
APRMs	Average Power Range Monitors
ASME	American Society of Mechanical Engineers
CFR	Code of Federal Regulations
CR	Condition Report
CRO	Control Room Operator
CS	Core Spray
CY	Calendar Year
DBD	Design Basis Document
DHR	Decay Heat Removal
DOST	Diesel Oil Storage Tank
DP	Vermont Yankee Department Procedure
EALs	Emergency Action Levels
ECCS	Emergency Core Cooling System
EDGs	Emergency Diesel Generators
ET	Eddy Current Testing
EOP	Emergency Operating Procedure
ER	Event Report
FAQ	Frequently Asked Question
FW	Main Feedwater System
GE	General Electric
GENE	General Electric Nuclear Engineering
HPCI	High Pressure Coolant Injection
IMC	Inspection Manual Chapter
IPEEE	Individual Plant Examination External Events
IR	Inspection Report
ISI	Inservice Inspection
IST	Inservice Testing
KV	Kilovolt
LER	Licensee Event Report
LLRT	Local Leakage Rate Testing
MM	Minor Modification
MS	Main Steam System
NCV	Non-Cited Violation
NDE	Nondestructive Examination
NEI	Nuclear Engineering Institute
NOUE	Notice of Unusual Event
NRC	Nuclear Regulatory Commission
NRR	NRC Office of Nuclear Reactor Regulation
OE	Operating Experience
ON	Vermont Yankee Off-Normal Procedure
OP	Vermont Yankee Operating Procedure

PI	Performance Indicator
PMT	Post Maintenance Testing
PSB	Public Service Board
QA	Quality Assurance
RCS	Reactor Coolant System
RCIC	Reactor Core Isolation Cooling
RFO	Refueling Outage
RHR	Residual Heat Removal
RHRSW	Residual Heat Removal Service Water
RPS	Reactor Protection System
RWP	Radiation Work Permit
SBGT	Standby Gas Treatment
SDC	Shutdown Cooling
SDP	Significance Determination Process
SEG	Simulator Evaluation Guide
SEN	Significant Event Notification
SFP	Spent Fuel Pool
SLC	Standby Liquid Control
SOER	Significant Operating Experience Report
SSC	Structures, Systems and Components
STP	Special Test Procedure
SW	Service Water
TI	Temporary Instruction
TM	Temporary Modification
UFSAR	Updated Final Safety Analysis Report
URI	Unresolved Item
UT	Ultrasonic Testing
VT	Visual Examination Testing
VY	Vermont Yankee
VYC	Vermont Yankee Calculation
VYDC	Vermont Yankee Design Calculation
VYOPF	Vermont Yankee Operating Procedure Form

Entergy	CONDITION REPORT	CR-VTY-2007-02133

Originator: Fales,Neil
Originator Group: Eng P&C Codes Staff
Supervisor Name: Lukens,Larry D
Discovered Date: 05/28/2007 17:06

Originator Phone: 8024513057
Operability Required: Y
Reportability Required: Y
Initiated Date: 05/28/2007 17:11

Condition Description:
Steam Dryer Inspection Indications

During RFO26 reactor vessel inspections, linear indications on the Steam Dryer Interior Vertical Weld HB-V04 were identified by General Electric. Most of these indications were previously identified in RFO25 with no discernable changes noted in RFO26. One new relevant indication was observed of similar appearance, orientation and size as those previously seen. These were documented via GE's process by INR-IVVI-VYR26-07-10. See attached GE INR's for details.

Immediate Action Description:
Notified Supervisor and generated CR.

Suggested Action Description:
The new indication will need to be evaluated.

EQUIPMENT:

Tag Name	Tag Suffix Name	Component Code	Process System Code
STEAM-DRYER	REACTOR	MR=Y	NB

TRENDING (For Reference Purposes Only):

Trend Type	Trend Code
KEYWORDS	KW-PRE-SCREENED FOR MRFF
INPO BINNING	ER1
KEYWORDS	KW-ISI
REPORT WEIGHT	1
EM	ESPC
HEP FACTOR	E

Attachments:
Condition Description
GE INR 10

Entergy	ADMIN	CR-VTY-2007-02133

Initiated Date: 5/28/2007 17:11 **Owner Group :** Eng P&C Codes Mgmt

Current Contact: vw

Current Significance: C - INVEST & CORRECT

Closed by: Taylor,James M 6/18/2007 16:06

Summary Description:

Steam Dryer Inspection Indications

During RFO26 reactor vessel inspections, linear indications on the Steam Dryer Interior Vertical Weld HB-V04 were identified by General Electric. Most of these indications were previously identified in RFO25 with no discernable changes noted in RFO26. One new relevant indication was observed of similar appearance, orientation and size as those previously seen. These were documented via GE's process by INR-IVVI-VYR26-07-10. See attached GE INR's for details.

Remarks Description:

Closure Description:

CR closure review performed.

Attachment Header

Document Name:

untitled

Document Location

Condition Description

Attach Title:

GE INR 10

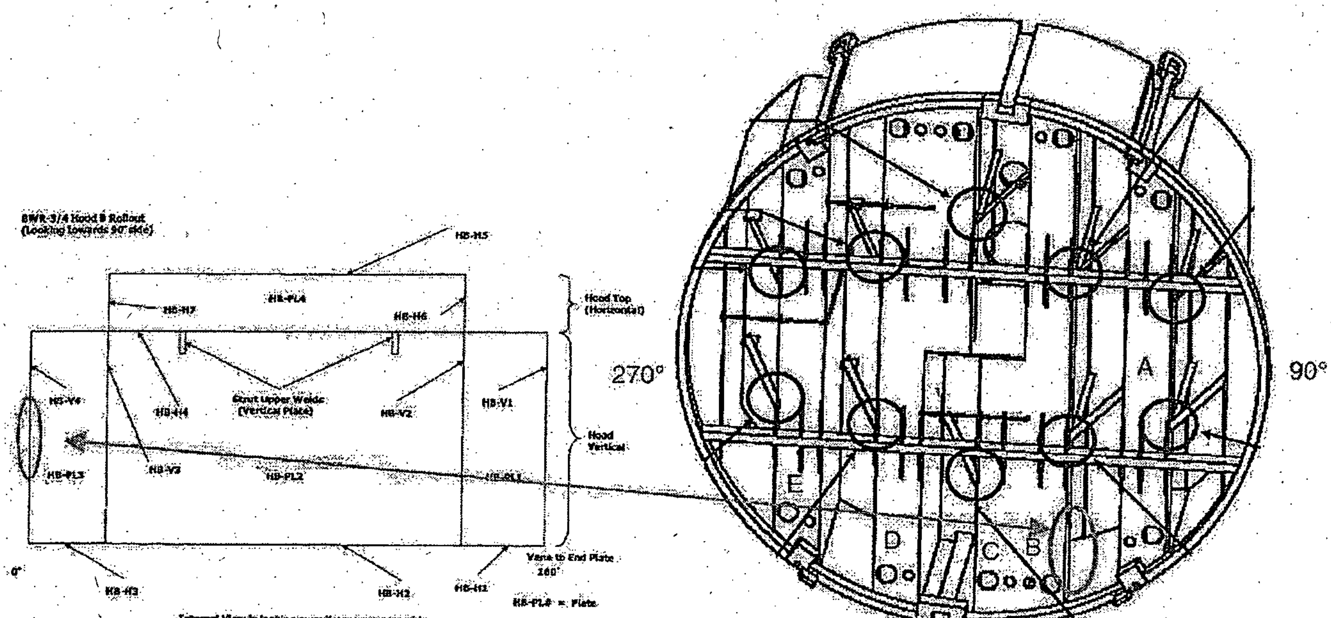
INR-IVVI-VYR26-07-10- Steam Dryer Interior HB-V04

Indication Notification Report

Plant / Unit	Component Description	Reference(s)
Vermont Yankee RFO26 Spring 2007	*Steam Dryer Interior Vertical Weld HB-V04*	DVD DISK IVVI-VYR26-07-58 Title 4 RFO-25 IVVI Report INF # 002.

Background

During the Vermont Yankee 2007 refueling outage, in accordance with the Vermont Yankee VT-VMY-204V10 Rev 2 Procedure, the Steam Dryer was inspected. The dryer inspection included inspection of the Steam Dryer interior welds and components. These inspections were done with GE's Fire Fly ROV with color camera. During the inspection of the HB-V04 weld (Dryer Unit Hood End Panel to HB-PL3 Plate weld), relevant linear indications were observed in the heat affected zone on the Dryer Unit side of the weld. Most of these linear indications were previously seen in RFO-25, Reference INF # 002. When comparing this outage with last outage, one new relevant indication is seen (3rd indication) of similar appearance, orientation and size as those previously seen; one indication was not seen (RFO25: 3th indication). No discernible change was noted in those indications which correlates to those of RFO26. See attached 2007 photos and sketches.



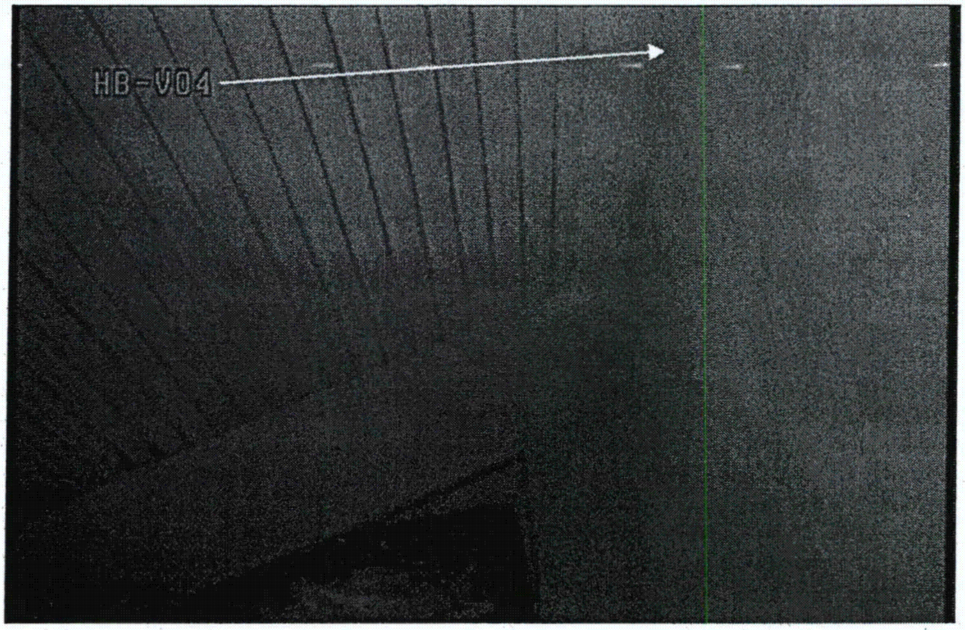
Sketch on the left shows the weld map rollout   The sketch on the right shows a bottom view of the dryer.

Prepared by: Dick Hooper   Date: *05/27/07*   Reviewed by: Rodney Drazich   Date: *05/27/07*

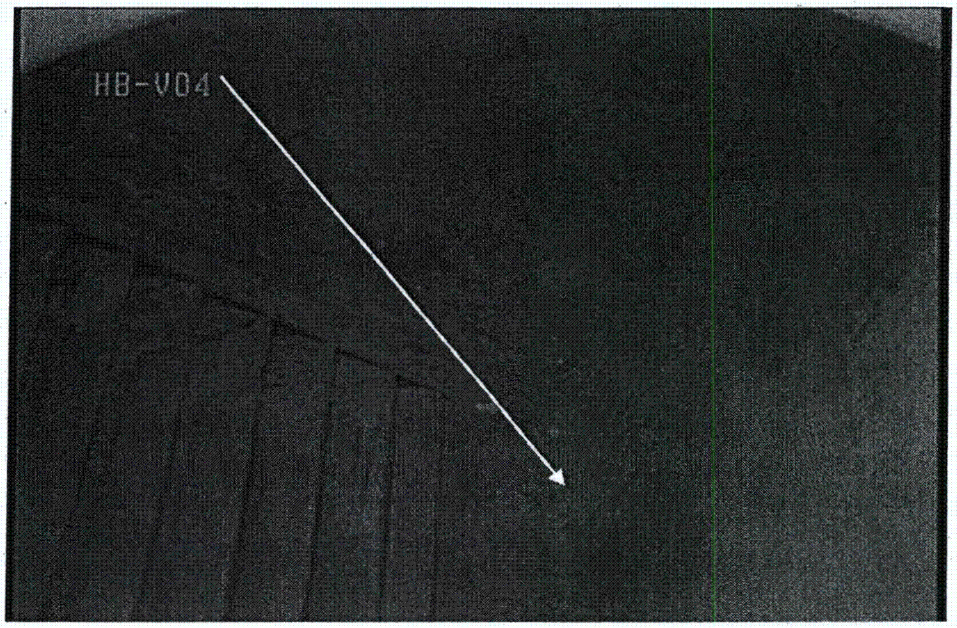
Utility Review By: R. Kvidu   Date: 5/27/07

INR-IVVI-VYR26-07-10- Steam Dryer Interior HB-V04

Indication Notification Report



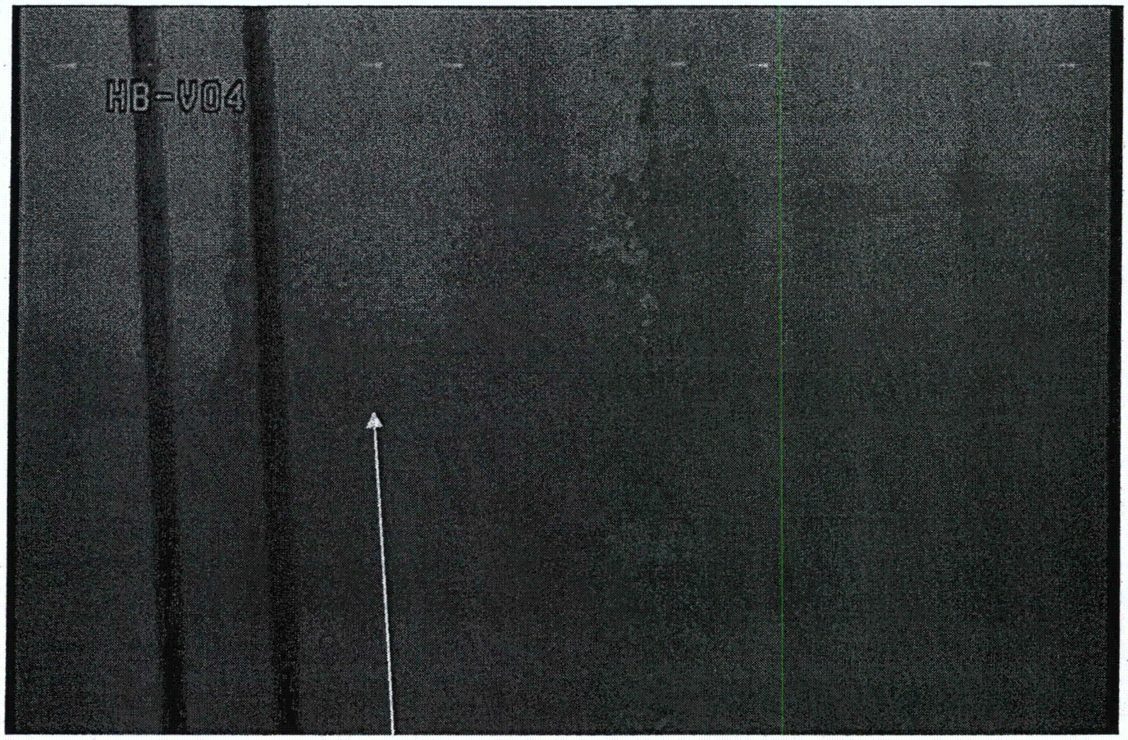
This 2007 photo shows the interior of the dryer and the location of HB-V04 vertical weld.



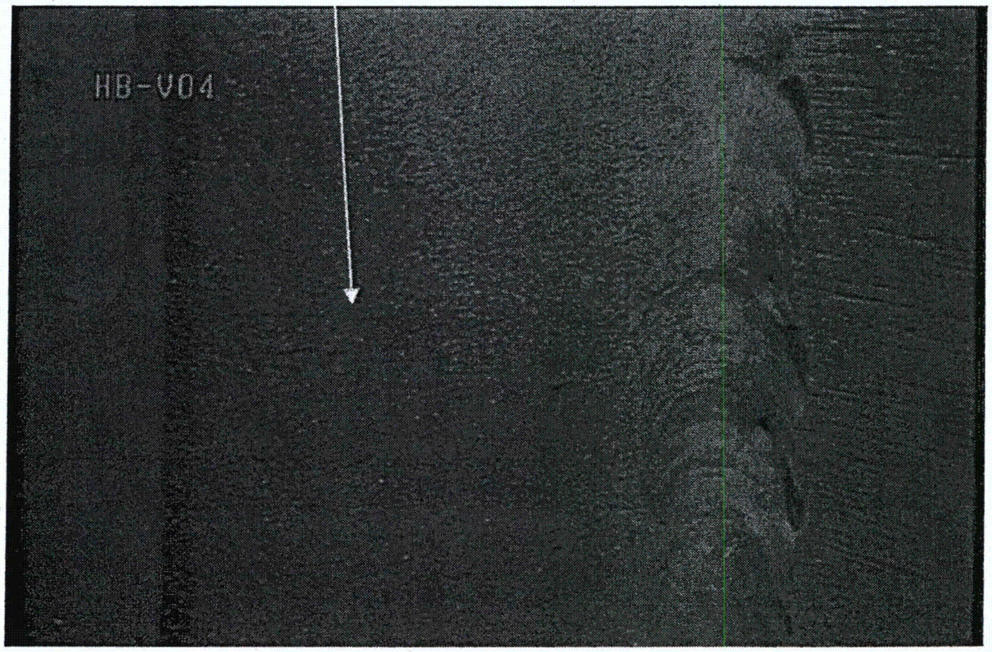
This 2007 photo shows the top of the vane bank (on the left) and the end panel (on the right) and the vertical weld in the center

INR-IVVI-VYR26-07-10- Steam Dryer Interior HB-V04

Indication Notification Report



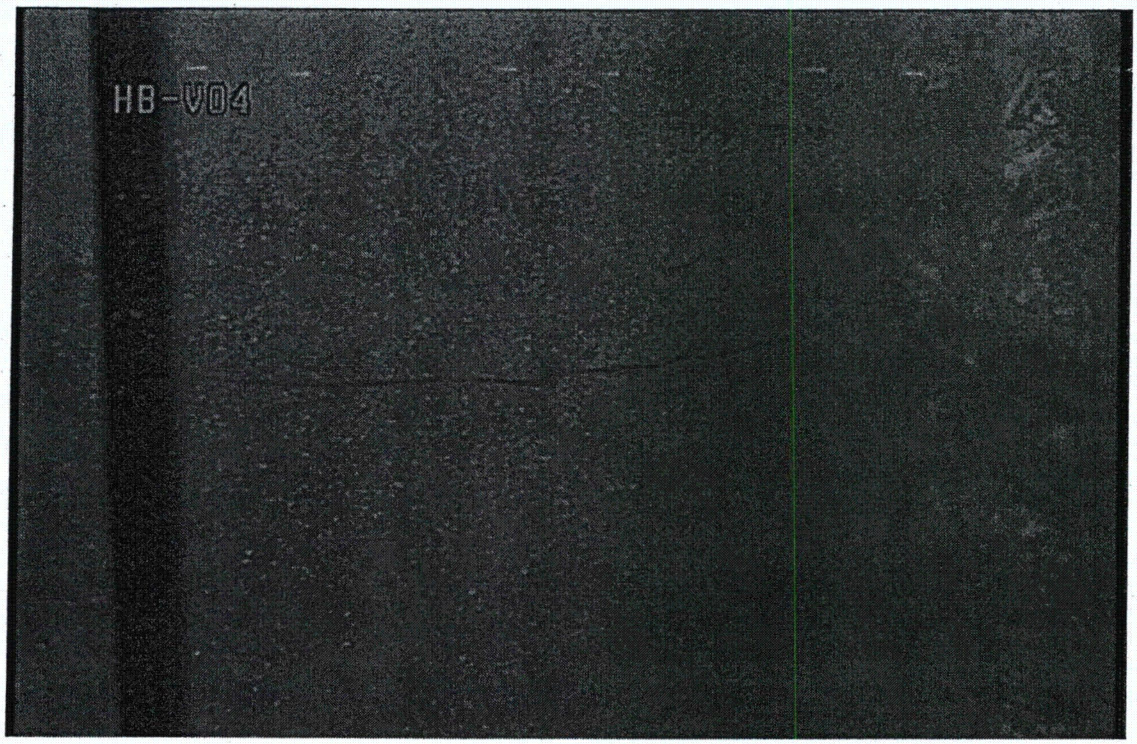
This 2007 photo is of the 1st indication from top down (Correlates to RFO25: 1st indication).



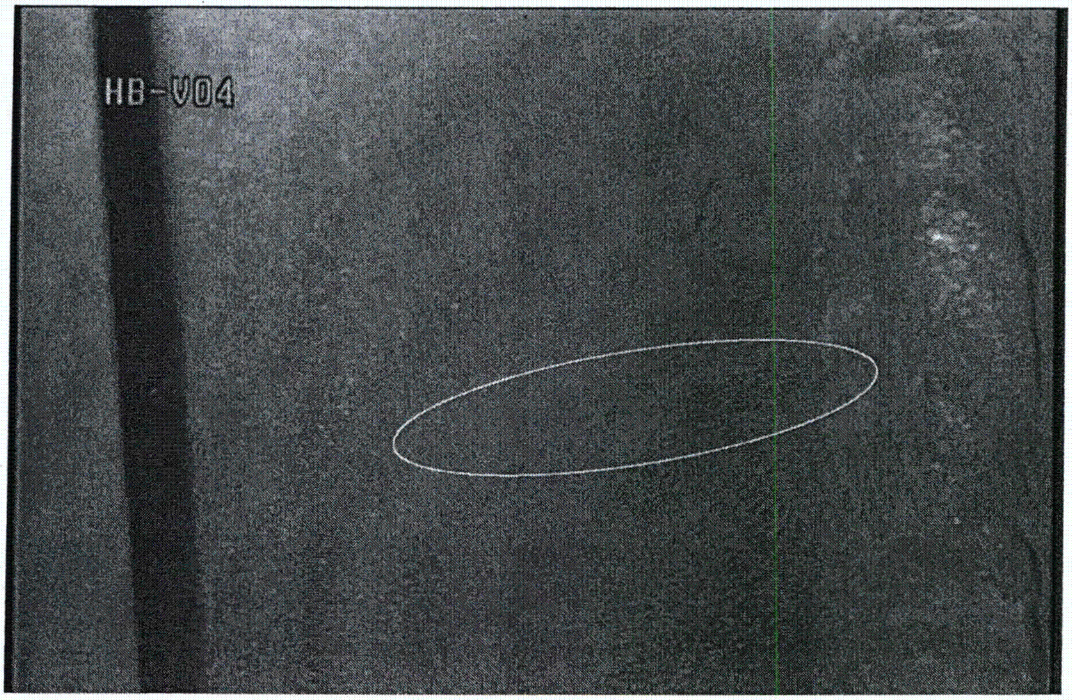
This 2007photo is a close-up of the 1st indication (Correlates to RFO25: 1st indication).

INR-IVVI-VYR26-07-10- Steam Dryer Interior HB-V04

Indication Notification Report



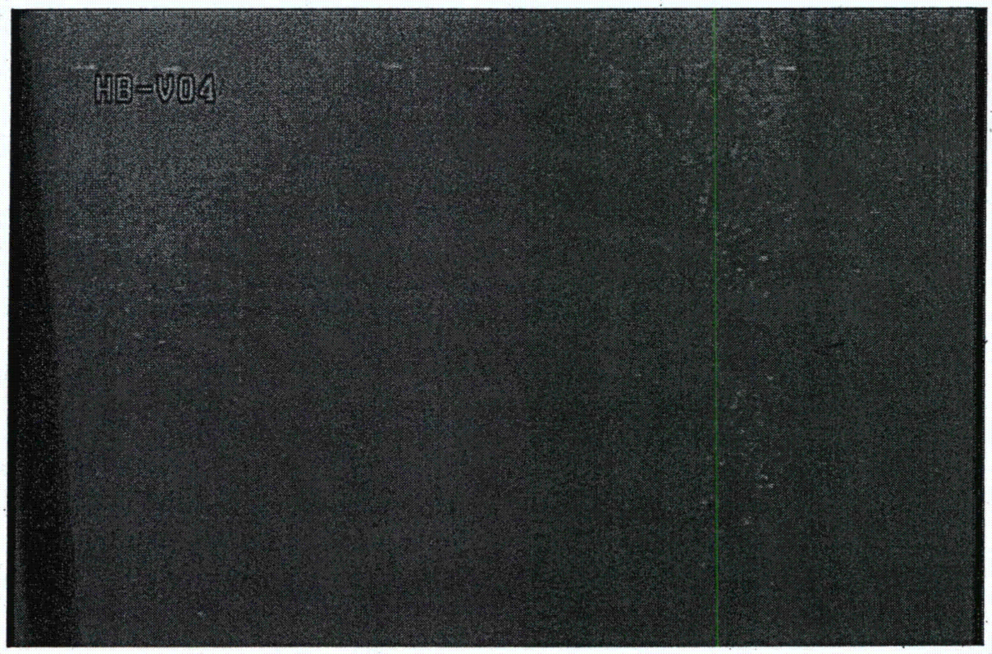
This 2007 photo is the 2nd indication (Correlates to RFO25: 2nd indication).



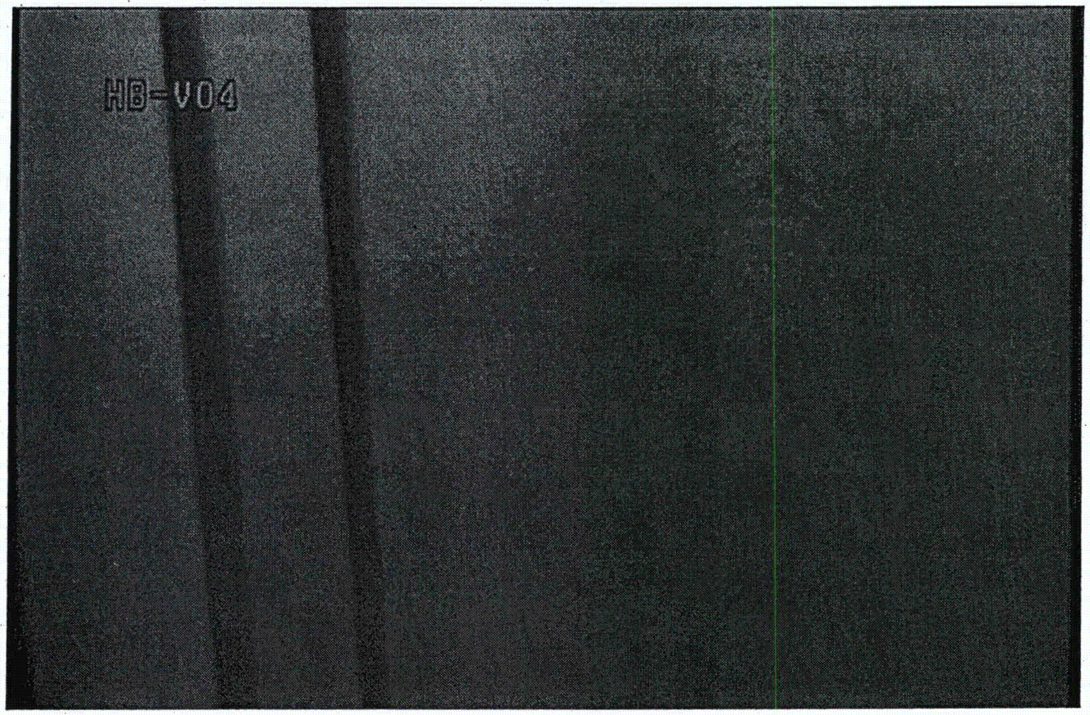
This is a 2007 photo of the 3rd indication and is a new RFO26 indication.

INR-IVVI-VYR26-07-10- Steam Dryer Interior HB-V04

Indication Notification Report



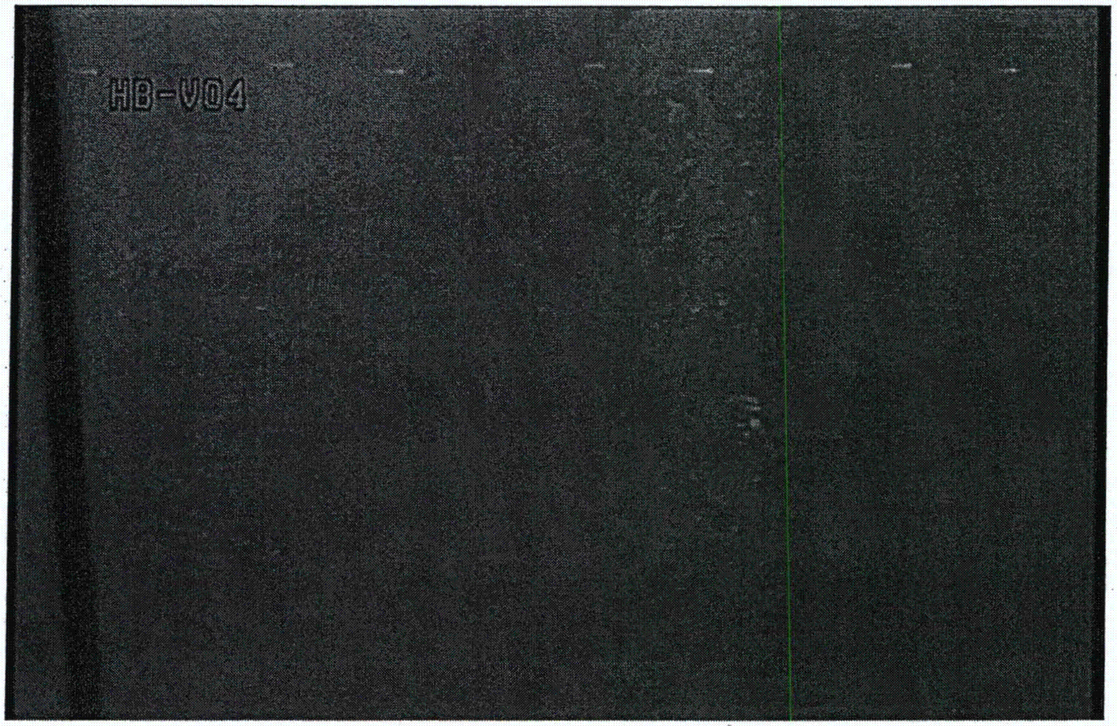
This is a 2007 photo of the 4th indication (Correlates to RFO25: 3rd indication)



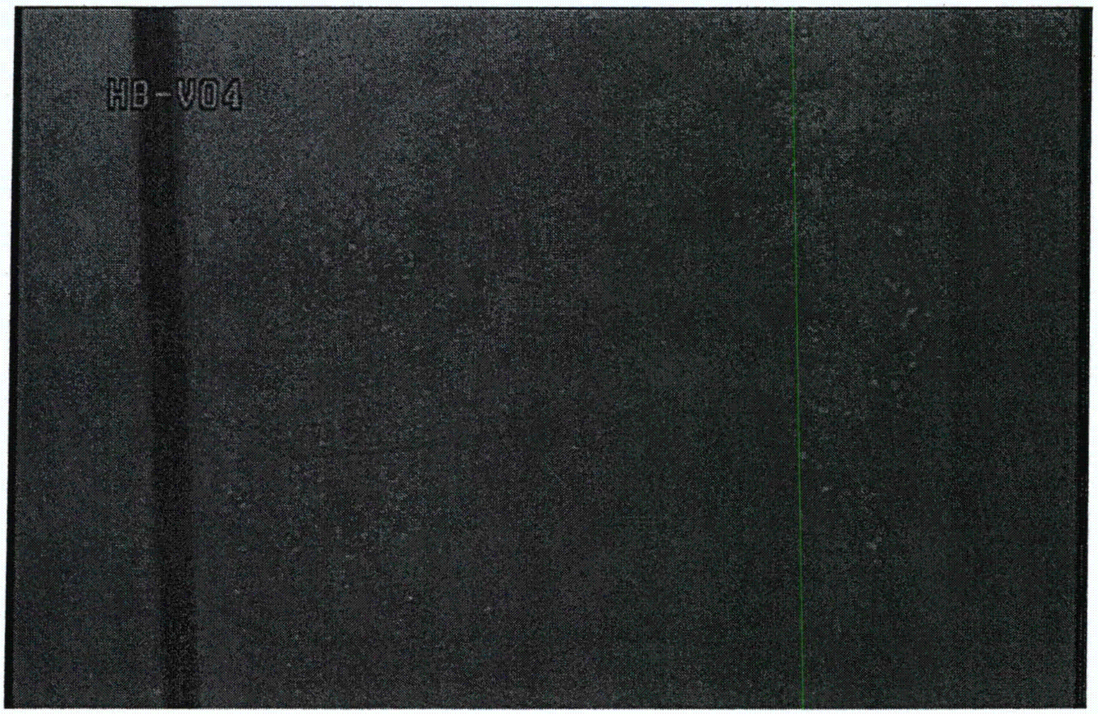
This is a 2007 photo of the 5th indication (Correlates to RFO25: 4th indication).

INR-IVVI-VYR26-07-10- Steam Dryer Interior HB-V04

Indication Notification Report



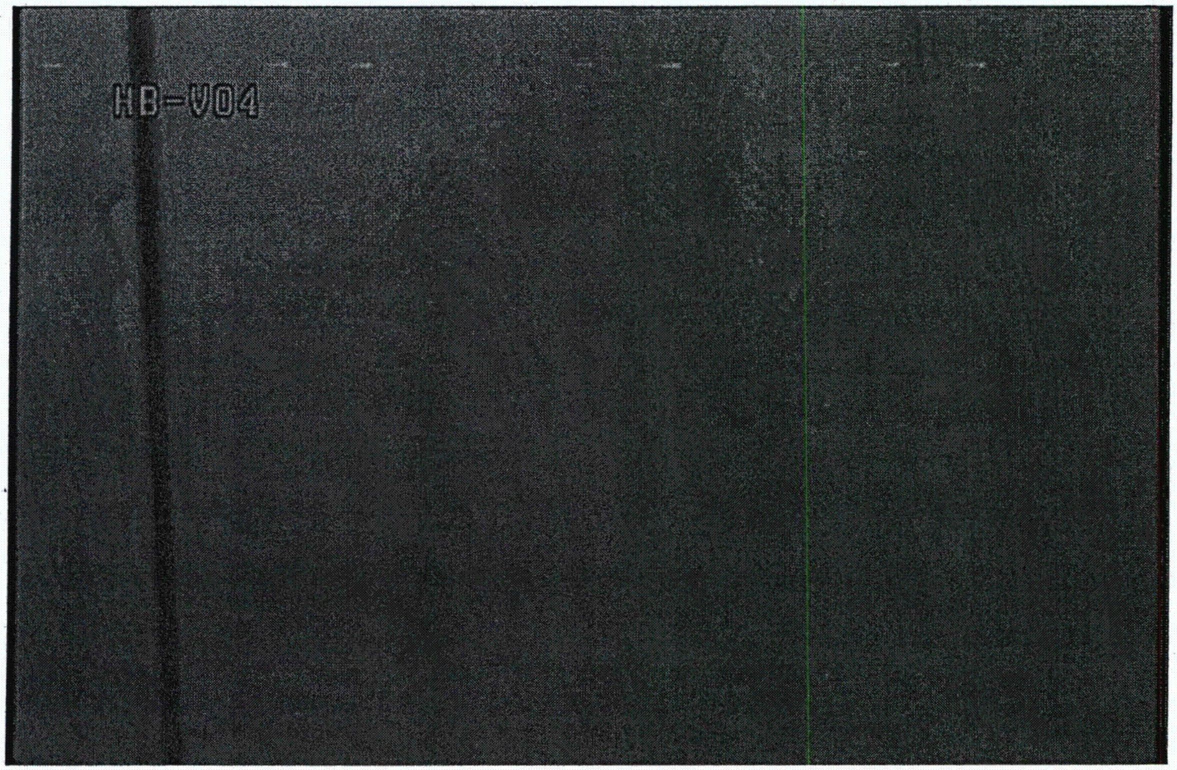
This is a 2007 photo of the 6th indication (Correlates to RFO25: 5th indication).



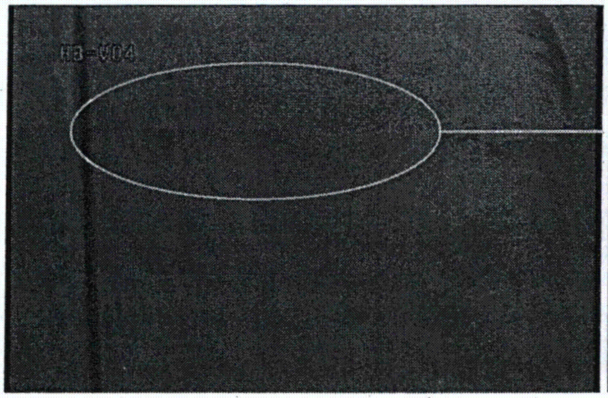
This is a 2007 photo of the 7th indication (Correlates to RFO25: 6th indication).

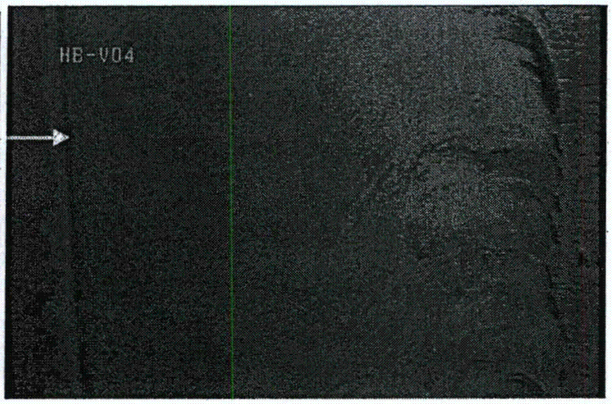
INR-IVVI-VYR26-07-10- Steam Dryer Interior HB-V04

Indication Notification Report



This is a 2007 photo of the 8th indication (Correlates to RFO25: 7th indication).

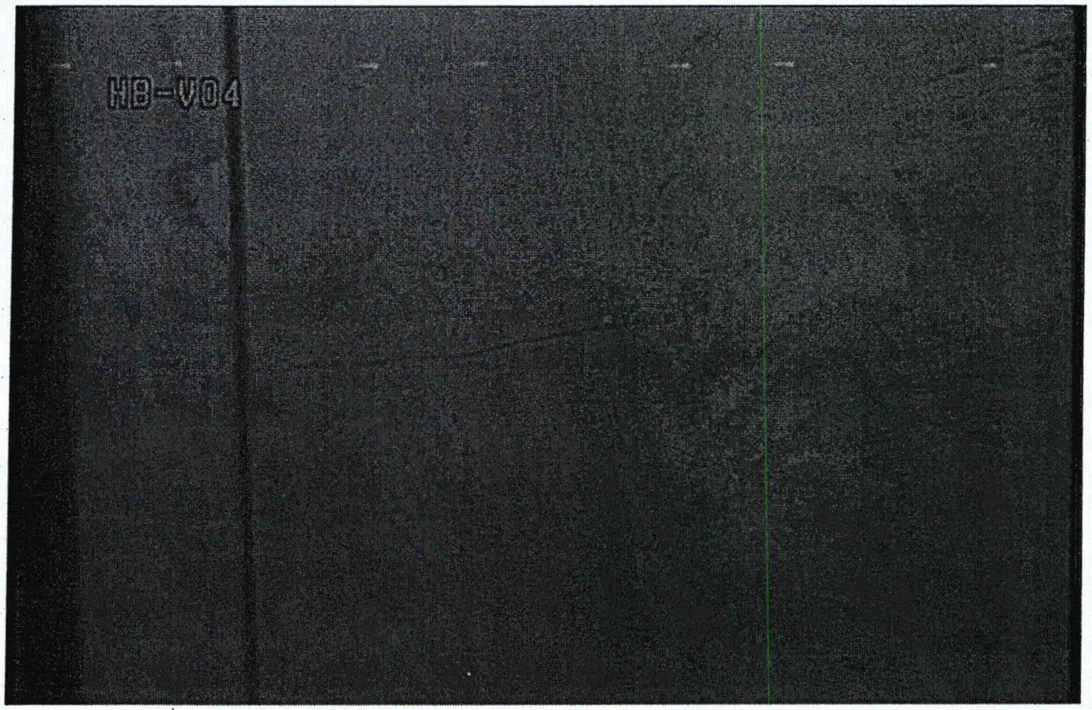




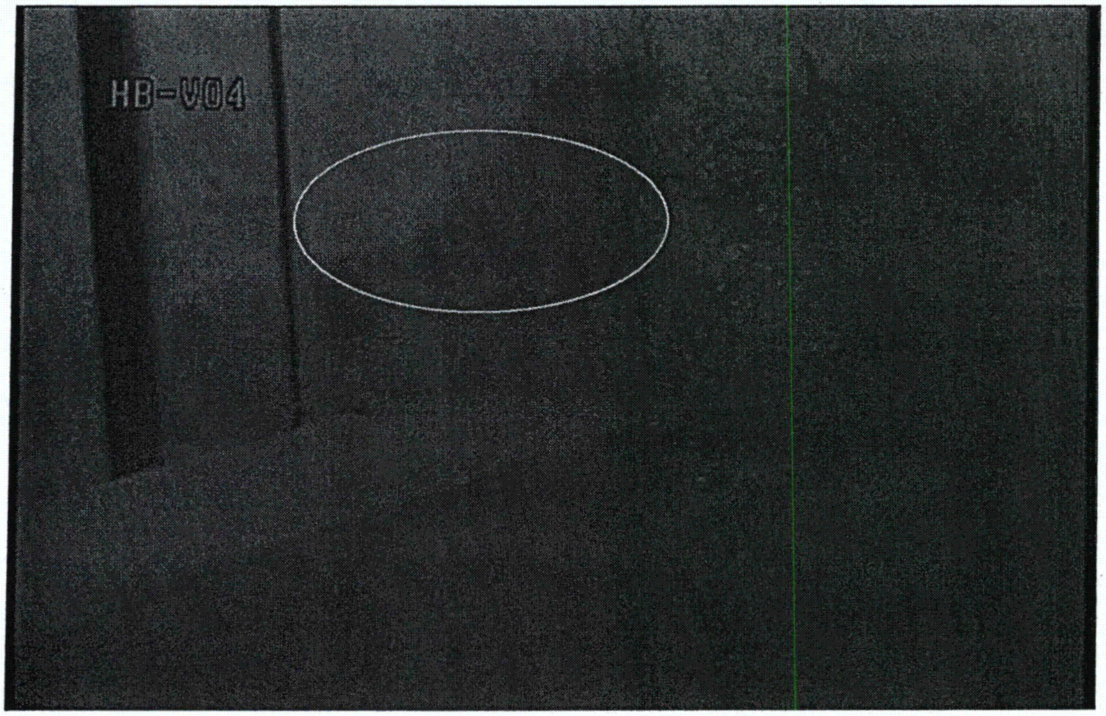
These 2007 photos show a linear indication and change of lighting and show a non-relevant indication (Correlates to RFO25: 9th indication).

INR-IVVI-VYR26-07-10- Steam Dryer Interior HB-V04

Indication Notification Report



This is a 2007 photo of the 9th indication (Correlates to RFO25: 10th indication).



This is a 2007 photo of the bottom weld area and crud line.

Entergy	OPERABILITY	CR-VTY-2007-02133

OperabilityVersion: 1

Operability Code: EQUIPMENT FUNCTIONAL

Immediate Report Code: NOT REPORTABLE

Performed By: Brooks,James C 05/29/2007 21:07

Approved By: Faupel,Robert F 05/30/2007 00:30

Operability Description:

Currently the plant is shutdown with the bolt in place. The bolt has one crimp fully engaged preventing the bolt from backing out. The need for having both crimps fully engaged will have to be evaluated prior to startup.

Approval Comments:

Entergy	ASSIGNMENTS	CR-VTY-2007-02133

Version: 2

Significance Code: C - INVEST & CORRECT

Classification Code: C

Owner Group: Eng P&C Codes Mgmt

Performed By: Wren,Vedrana 05/30/2007 13:04

Assignment Description:

Entergy	**ASSIGNMENTS**	**CR-VTY-2007-02133**

Version: 1

Significance Code: C - INVEST & CORRECT

Classification Code: C

Owner Group: Eng P&C Codes Mgmt

Performed By: Lukens,Larry D 05/29/2007 04:46

Assignment Description:

self identified
outage constraint

Entergy	REPORTABILITY	CR-VTY-2007-02133

Reportability Version: 1

Report Number:

Report Code: NOT REPORTABLE

Boilerplate Code: NOT REPORTABLE

Performed By : Devincentis,James M 05/29/2007 08:09

Reportability Description:

Not reportable - This condition does not meet the Reportability screening criteria contained in AP0010 or AP0156. The Steam Dryer is NNS and performs no safety releted functions. VY has a commitment to provide the results of the steam dryer inspections to the NRC following startup.

Entergy	**CORRECTIVE ACTION**	**CR-VTY-2007-02133**

CA Number: 1

	Group	Name
Assigned By:	CRG/CARB/OSRC	
Assigned To:	Eng P&C Codes Mgmt	Lukens,Larry D
Subassigned To :	Eng P&C Codes Staff	Fales,Neil

Originated By:	Wren,Vedrana	5/30/2007 13:00:53
Performed By:	Lukens,Larry D	6/15/2007 13:17:25
Subperformed By:	Fales,Neil	6/15/2007 11:49:49
Approved By:		
Closed By:	Taylor,James M	6/18/2007 16:02:38

Current Due Date: 06/28/2007 **Initial Due Date:** 06/28/2007

CA Type: DISP - CA

Plant Constraint: 0 NONE

CA Description:

C - INVEST & CORRECT (Review CR for full details)
□The CRG has initially classified this CR as "C" INVEST & CORRECT
□
□Per the CRG, Perform an Investigation of the issues identified in this CR and determine if additional actions are
□required within 30 days.
□
□Ensure all Screening Comments have been addressed in the investigation - (CR assignment tab)
□Develop adequate corrective actions and issue CAs. (Due Dates per LI 102 Attachment 9.4)
□LT CAs Require Approval from Site VP/ GMPO or Director prior to initiating. Completion of Attachment 9.9 LTCA
□Classification Form is required.

Response:

Approved. No additional corrective action required. Therefore, this CR may be closed. LI-102 Closure Statements follow:

CR CLOSURE STATEMENTS FROM LI-102:

o□The root cause or apparent cause is valid. VERIFIED
o□The specific condition is corrected or resolved. VERIFIED
o□Overall plant safety is not inadvertently degraded. VERIFIED
o□Generic implications of the identified condition are considered, as appropriate. VERIFIED
o□Actions were taken to preclude repetition, as appropriate. VERIFIED
o□Any potential operability or reportability issues identified during the resolution of the condition have been appropriately addressed. VERIFIED
o□All corrective action items are completed. VERIFIED
o□Effectiveness Reviews have been initiated via use of Learning Organization CR, when applicable. VERIFIED

Subresponse :

The new indication was evaluated by Code Programs, see the attached document. The evaluation accepts the indication as is with no repair required. The steam dryer will be inspected per the same scope in RFO27 and RFO28 per letter BVY 04-097, therefore the area of this indication will be inspected again during the next two outages.

Neil Fales 6/15/07

Closure Comments:

Attachments:

Subresponse Description

Evaluation

Attachment Header

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Evaluation

Engineering Report No. VY-RPT-07-00011 Rev 2

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Entergy

ENTERGY NUCLEAR
Engineering Report Cover Sheet

Engineering Report Title:
EVALUATION OF NEW RFO26 STEAM DRYER INDICATION

Engineering Report Type:

New ☒ Revision ☐ Cancelled ☐ Superseded ☐

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Approved by: Larry Lukens/ L.J. Lukens Date: 6/15/07
Supervisor (Print Name/Sign)

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

NEC-JH_60

STATE OF VERMONT
PUBLIC SERVICE BOARD
DOCKET NUMBER 7195

PETITION OF VERMONT DEPARTMENT OF PUBLIC SERVICE FOR AN INVESTIGATION INTO THE RELIABILITY OF THE STEAM DRYER AND RESULTING PERFORMANCE OF THE VERMONT YANKEE NUCLEAR POWER STATION UNDER UPRATE CONDITIONS.

Technical Hearing held before Board Members of the Vermont Public Service Board, at the Third Floor Conference Room, Chittenden Bank Building, 112 State Street, Montpelier, Vermont, on August 18, 2006, beginning at 9:30 a.m..

EXCERPT FROM PAGES 9-10 OF TRANSCRIPT

Redirect by John Marshall for ENVY

JOHN R. DREYFUSS- ENVY HEAD OF ENGINEERING- NOW HEAD OF NUCLEAR SAFETY ASSURANCE

SURREBUTTAL BY MR. MARSHALL:

Q. I have one question on live surrebuttal. Mr. Dreyfuss, Mr. Sherman testified yesterday that it can be difficult to distinguish IGSCC cracking related to uprate and uprate related fatigue cracking. He also testified with respect to the Department's recommendations concerning dispute resolution with respect to an extended ratepayer protection plan. Do you recall those questions and answers yesterday?

A. I do.

Q. My question is given his testimony about the difficulty of distinguishing IGSCC cracking and fatigue cracking related to uprate circumstances, does this give any concerns to the company about dispute resolution under an extended ratepayer protection plan?

A. Yes it does, and I do agree that you know it sometimes is very difficult to distinguish or differentiate between the type of cracking that you see with this intergranular stress corrosion cracking, IGSCC, and fatigue cracking. It can be particularly difficult when you're trying to do this work underwater as well.

So you know there are cases where it's clear and clean cut and the way that the kind of characteristics of this type of cracking where you can tell, but other cases that I have seen and have been brought to me you know it's less clear.

The other point that I think is important here too is that we are going to be shutting Vermont Yankee down for a refuel outage in May of next year and it's absolutely clear that we will see cracks. There were cracks before power uprate. You know we have evaluated all of them. They are not structurally significant, but there will be cracks and there can be debate about those cracks. If there's an IGSCC crack, there could be debate about whether it's IGSCC or otherwise or fatigue type of crack. So, you know, again these are not clear and easy distinctions to make in every case.

April 18, 2007

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board

In the Matter of	)	
	)	
Entergy Nuclear Vermont Yankee, LLC and Entergy Nuclear Operations, Inc.	)	Docket No. 50-271-LR ASLBP No. 06-849-03-LR
	)	
(Vermont Yankee Nuclear Power Station)	)	

DECLARATION OF JOHN R. HOFFMAN IN SUPPORT OF ENTERGY'S MOTION FOR SUMMARY DISPOSITION OF NEC CONTENTION 3

John R. Hoffman states as follows under penalties of perjury:

I. Introduction

1. Prior to September 2006 I was employed by Entergy Nuclear Operations, Inc. ("Entergy") and had, among other responsibilities, that of Project Manager for the License Renewal Project at the Vermont Yankee Nuclear Power Station ("VY"). I retired from Entergy's employment in September 2006. I am currently a consultant and provide this declaration in support of Entergy's Motion for Summary Disposition of New England Coalition's ("NEC") Contention 3 ("NEC Contention 3") in the above captioned proceeding.

2. My professional and educational experience is summarized in the *curriculum vitae* attached as Exhibit 1 to this declaration. Briefly summarized, I have over 37 years of nuclear power engineering experience, and have been associated with VY since 1971.

3. During my employment at VY I had no direct involvement with the power uprate implemented between 2003 and 2006. However, I have reviewed relevant materials and conducted interviews with plant personnel to familiarize myself with the manner in which steam dryer issues were addressed during the uprate process. I have personal knowledge of the manner in which VY intends to address the steam dryer during the period of extended operation.

4. NEC Contention 3 asserts that: "Entergy's License Renewal Application does not include an adequate plan to monitor and manage aging of the steam dryer during the period of extended operation." This contention lacks technical or factual basis.

5. I will demonstrate that the plan proposed by VY for monitoring and managing aging of the steam dryer during the period of extended operation is adequate and is consistent with manufacturer recommendations and the practice in the industry.

II. Background

6. In a boiling water reactor ("BWR"), the steam dryer is a stainless steel component whose function is to remove moisture from the steam before it leaves the reactor. The dryer is mounted in the reactor vessel above the steam separator assembly and is latched to the inside of the vessel wall below the steam outlet nozzles. Wet steam flows upward and outward through the dryer. Moisture is removed by impinging on the dryer vanes and flows down through drains to the reactor water in the downcomer annulus below the steam separators.

7. The steam dryer does not perform a safety function and is not required to prevent or mitigate the consequences of accidents. The VY steam dryer is a non-safety-related, non-Seismic Category I component. Although the steam dryer is not a safety-related component, the assembly is designed to withstand design basis events without the generation of loose parts and the dryer is designed to maintain its structural integrity through all the plant operating conditions.

8. On September 10, 2003, Entergy submitted its application to increase the maximum VY authorized power level from 1593 megawatts thermal ("MWt") to 1912 MWt. This power increase represented an increase of approximately 20% above original rated thermal power and was known as an "extended power uprate" or "EPU". Letter from J. Thayer to NRC, "Vermont Yankee Nuclear Power Station License No. DPR-28 (Docket No. 50-271) Technical Specification Proposed Change No. 263 Extended Power Uprate" (Sept. 10, 2003) ("EPU Application"), ADAMS Accession No. ML032580089.

9. In 2002, steam dryer cracking and damage to components and supports for the main steam and feedwater lines were observed at the Quad Cities Unit 2 nuclear power plant. These conditions were detected after implementation of an extended power uprate similar to the one proposed in 2003 for VY. It was determined that loose parts shed by the dryer due to flow-induced vibration had damaged the supports.

10. In response to this experience and to concerns about steam dryers at other nuclear power plants Entergy substantially modified the steam dryer at VY during the spring 2004 refueling outage to improve its capability to withstand potential adverse flow effects that could result from operation of the plant at EPU levels. The modifications, intended to increase the

structural strength of the dryer, are described in Attachment 2 to Supplement 8 (dated July 2, 2004) to the EPU Application, ADAMS Accession No. ML042090103.

III. VY Steam Dryer Analyses in Support of EPU

11. In addition to making substantial physical modifications to the VY steam dryer, Entergy conducted two categories of activities to assure that the structural integrity of the dryer would be maintained during EPU operations. The first category of activities included performing two types of complementary analyses to evaluate the pressure loads acting on the steam dryer during operation at EPU conditions: the computational fluid dynamics ("CFD") and acoustic circuit model ("ACM") analyses. The calculated loads obtained from the CFD and ACM analyses were inputs to a finite element model (FEM) that calculated peak stresses for specific steam dryer locations. This FEM output was then compared to the fatigue limits for the dryer material specified in the ASME Code.

12. The resulting maximum calculated stresses for EPU conditions were found to be well within the ASME fatigue endurance limit. (The endurance limit is the level of stress that a material can withstand over an infinite number of cycles without failure.) The analyses indicated that there is significant margin between the magnitude of the potential stresses imposed on the steam dryer and the level at which fatigue failure would occur.

13. Entergy also installed 32 additional strain gages on the main steam line piping during the fall 2005 refueling outage (beyond 16 strain gages installed previously). The data measured by the strain gages and other complementary instrumentation were monitored frequently during EPU power ascension to verify that the structural limits for the steam dryer were not reached. This data monitoring was accomplished as the power levels were increased towards EPU.

IV. Steam Dryer Monitoring and Inspection Program During Implementation of EPU

14. As a second set of activities intended to provide independent confirmation of the structural integrity of the steam dryer during operation at uprate levels, VY instituted a program of dryer monitoring and inspections to provide assurance that the structural loadings under EPU conditions did not result in the formation or propagation of vibration-induced cracks on the dryer. The program is described in Attachment 6 to Supplement 33 (dated September 14, 2005) to the EPU Application, ADAMS Accession No. ML052650122. The program was reviewed

and approved by the NRC and included as a license condition as part of the power uprate license amendment issued on March 2, 2006 (Exhibit 2 hereto).

15. The monitoring and inspection program measured the performance of the VY steam dryer during power ascension testing and operation as power was increased from the original licensed power level to full EPU conditions. The program included taking daily measurements of moisture carryover and periodic measurements of main steam line pressure. Pursuant to the program, following completion of EPU power ascension testing, moisture carryover measurements have continued to be made periodically, and other plant operational parameters that could be indicative of loss of steam dryer structural integrity continue to be monitored.

16. In addition to monitoring of plant operational parameters, the monitoring and inspection program calls for the steam dryer to be inspected during plant refueling outages in the fall of 2005, spring of 2007, fall of 2008, and spring of 2010. The inspections are conducted in accordance with the recommendations of General Electric's Service Information Letter ("SIL") No. 644, Revision 1 (Nov. 9, 2004), ADAMS Accession No. ML060120032 ("GE-SIL-644"). The provisions of GE-SIL-644 also govern the manner in which monitoring of plant parameters is being conducted since VY started operating at EPU levels. Plant procedures require that the periodic monitoring activities be conducted in a manner consistent with guidance in GE-SIL-644. See Exhibit 3 (VY Operating Procedure OP 0631, Appendix F).

17. The commitment to conduct dryer monitoring and inspections in accordance with the guidance of GE-SIL-644 is reflected in the above referenced license condition, proposed by Entergy in Attachment 1 to Supplement 36 to the EPU Application (October 17, 2005), ADAMS Accession No. ML052940225, and currently in effect. Entergy is committed to a program for ensuring the structural integrity of the VY steam dryer that consists of the following actions, specified in the VY operating license:

> 2e. Entergy Nuclear Operations, Inc. shall revise the SDMP [steam dryer monitoring program] 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.
>
> ****

> 5. 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.
>
> 6. 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.
>
> 7. The requirements of paragraph 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.
>
> 8. 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.

Exhibit 2 hereto at 2-4.

18. As required by the VY operating license, VY is operating under a program that provides for long-term monitoring of plant parameters potentially indicative of steam dryer failure plus inspections at three consecutive refueling outages, all in accordance with GE-SIL-644. The monitoring that has been performed since implementation of the EPU, and the inspections conducted to date, confirm that fatigue-induced cracking of the VY steam dryer is not occurring.

19. To summarize, Entergy performed two categories of activities in support of its EPU Application: on the one hand, the CFD/ ACM/ FEM and the associated measurement of stress levels by means of strain gages during power ascension; this set of activities has been completed. On the other hand, Entergy instituted a monitoring and inspection program, which was initiated during power ascension, is still ongoing, and will be in effect throughout EPU operations. The monitoring and inspection program does not rely on the CFD and ACM analyses.

V. <u>Steam dryer aging management plan for license renewal period</u>

A. Overview

20. In its License Renewal Application, Entergy addresses aging management of the VY steam dryer as follows:

> Cracking due to flow-induced vibration in the stainless steel steam dryers is managed by the BWR Vessel Internals Program. The BWR Vessel Internals Program currently incorporates the guidance of GE-SIL-644, Revision 1. VYNPS will evaluate BWRVIP-139 once it is approved by the staff and either include its recommendations in the VYNPS BWR Vessel Internals Program or inform the staff of VYNPS's exceptions to that document.

License Renewal Application, § 3.1.2.2.11 "Cracking due to Flow-Induced Vibration."

21. GE-SIL-644 recommends that BWR licensees institute a program for the long term monitoring and inspection of their steam dryers. It provides detailed inspection and monitoring guidelines (see SIL-644, ADAMS Accession No. ML050120032, Exhibit 4 hereto, Appendices C and D). With respect to monitoring, the guidelines call for the periodic monitoring of parameters that may be indicative of steam dryer failure, particularly moisture carryover:

> Moisture carryover should be monitored weekly:
>
> Statistically evaluate the moisture carryover data and qualitatively determine if there is a significant increasing trend that cannot be explained by changes in plant operational parameters. If an unexplained increasing trend is evident, then collect additional moisture carryover data with consideration for increasing the measurement frequency (e.g., from "once per week" to "once per day").
>
> If the latest moisture carryover measurement is greater than "mean plus 2-sigma" and this increase cannot be explained by changes in plant operational parameters, then obtain a complete set of data for the plant operational parameters (identified above). Compare the current plant operational data with the baseline data to explain the increased moisture carryover (i.e., is there steam dryer damage or not). If an increase in moisture carryover occurs immediately following a rod swap, additional moisture carryover data should be obtained to assure that an increasing trend does not exist. Note that occurrence of steam dryer damage immediately following a rod swap would be highly unlikely.

> If the increasing trend of moisture carryover cannot be explained by evaluation of the plant operational data, then initiate plant-specific contingency plans for potential steam dryer damage. If the evaluation of plant data confirms that significant steam dryer damage has most likely occurred, then initiate a plant shutdown.
>
> If there are no statistically significant changes in moisture carryover for an operating cycle, then decreasing the moisture carryover measurement frequency (e.g., from "once per week" to "once per month") may be considered, provided the highest operating power level is not significantly increased.

GE SIL-644, Rev. 1 (Nov. 2004), Appendix D at 32. As noted above, VY Operating Procedure OP 0631, Appendix F implements this guidance. This monitoring function is to continue for the balance of plant operations.

With respect to inspections, the GE guidelines establish a specific schedule for plants, like VY, that implement a power uprate:

> In addition, for plants planning on increasing the operating power level above the OLTP or above the current established uprated power level (i.e., the plant has operated at the current power level for several cycles with no indication of steam dryer integrity issues), the recommendations presented in A (above) should be modified as follows:
>
> B1. Perform a baseline visual inspection of the steam dryer at the outage prior to initial operation above the OLTP or current power level. Inspection guidelines for each dryer type are provided in Appendix C.
>
> B2. Repeat the visual inspection of all susceptible locations of the steam dryer during each subsequent refueling outage. Continue the inspections at each refueling outage until at least two full operating cycles at the final uprated power level have been achieved. After two full operating cycles at the final uprated power level, repeat the visual inspection of all susceptible locations of the steam dryer at least once every two refueling outages. For BWR/3-style steam dryers with internal braces in the outer hood, repeat the visual inspection of all susceptible locations of the steam dryer during every refueling outage.

> B3. Once structural integrity of any repairs and modifications has been demonstrated and any flaws left "as-is" have been shown to have stabilized at the final uprated power level, longer inspection intervals for these locations may be justified.

GE-SIL-644 at 7.

22. Because VY has a BWR-3 steam dryer, the details of the visual inspection program to be implemented are set forth in the corresponding section of GE SIL-644, which is Appendix C, p. 15-16. VY is implementing the above described applicable monitoring and visual inspection guidelines in GE-SIL-644.

B. Steam Dryer Monitoring and Inspection During License Renewal Period

23. The aging management program for the VY steam dryer during the twenty-year license renewal period will consist of well-defined monitoring and inspection activities that are defined in the GE SIL-644 guidelines and are identical to those being conducted during the current post-EPU phase. Steam dryer integrity will be monitored continuously via operator monitoring of certain plant parameters. VY Off-normal Procedure ON-3178 alerts the operators that any off the following events could be indicative of reactor internals damage and/or loose parts generation: a) sudden drop in main steam line flow >5%; b) >3 inch difference in reactor vessel water level instruments; c) sudden drop in steam dome pressure >2 psig. See Exhibit 5 hereto. In addition, periodic measurements of moisture carryover will be performed, and changes in moisture carryover will be evaluated in accordance with the requirements of GE-SIL-644. See Exhibit 3. This monitoring program will continue for the entire license renewal period. The inspection activities will include visual inspections of the steam dryer every two refueling outages consistent with GE and BWR Vessel Internals Program (VIP) requirements. The inspections will focus on areas that have been repaired, those where flaws exist, and areas that have been susceptible to cracking based on reactor operating experience throughout the industry.

24. The aging management plan for the license renewal period, consisting of the monitoring and inspection activities described above, does not depend on, or use, the CFD and ACM computer codes or the FEM conducted using those codes.

25. License Renewal Application, § 3.1.2.2.11 also commits to "evaluate BWRVIP-139 once it is approved by the staff and either include its recommendations in the VYNPS BWR Vessel Internals Program or inform the staff of VYNPS's exceptions to that document."

BWRVIP-139 is a 2005 industry standard developed by Electric Power Research Institute that provides steam dryer inspection and flaw evaluation guidelines. Those guidelines, currently issued in draft, are essentially the same as the ones contained in the GE SIL standard. BWRVIP-139 is currently under NRC Staff review, with an evaluation scheduled to be released in mid-2007. See http://www.nrc.gov/about-nrc/regulatory/licensing/topical-reports/under-review.html#boiling. If the guidelines in BWRVIP-139 are approved by the Staff, Entergy will evaluate any additional requirements that might result from the NRC's approval for applicability to VY. Any commitments made by Entergy will be consistent with the NRC regulatory requirements and guidance for aging management of plant components. VY has made a licensing commitment to "continue inspections in accordance with the Steam Dryer Monitoring Program, Revision 3 [i.e., the current inspection and monitoring program] in the event that the BWRVIP-139 is not approved prior to the period of extended operation." VY Licensing Renewal Commitment List, Commitment No. 37, Exhibit 6 hereto.

VI. Response to issues raised by NEC

26. NEC's consultant Dr. Joram Hopenfeld has addressed the steam dryer aging management commitment in the VY License Renewal Application as follows: "The license renewal application states at paragraph 3.1.2.2.11, and Table 3.1.2-2, that the management of cracking in the steam dryer will be in accordance with current guidance per NUREG 1801, GE-SIL-644 and possibly future guidance from BWRVIP-139, if approved by the NRC. No matter which guidance Entergy follows, the status of the existing dryer cracks must be continuously monitored and assessed by a competent engineer." Declaration of Dr. Joram Hopenfeld, dated May 12, 2006 at ¶ 19. Entergy's steam dryer aging management plan, however, does exactly what Dr. Hopenfeld requires, since it is based on continuous monitoring of plant parameters whose value is indicative of potential dryer cracking and crack propagation.

27. Dr. Hopenfeld also asserts that "Entergy's monitoring equipment does not measure crack propagation directly (because the strain gages are a distance away from the dryer) and therefore analytical tools would be required to interpret the data." Second Declaration of Joram Hopenfeld, dated June 27, 2006 at ¶ 14. The purpose of the monitoring equipment that was utilized during the EPU power ascension phase (strain gages installed on the main steam lines) was not to measure crack propagation, but to monitor pressure fluctuations in the steam piping that translate to pressure loads and ultimately to stresses on the steam dryer, to ensure that values

were below the maximum levels set by the ASME Code. The strain gages will not be used in the aging management program for the steam dryer during the license renewal period.

28. Dr. Hopenfeld also states that "Entergy has not demonstrated that the dryer will not fail and scatter loose parts in between the visual inspections, especially during design basis accidents, DBA." Id. at ¶ 15. The capability of the dryer to withstand design basis loads was demonstrated by the structural analyses and stress measurements performed as part of the EPU. It is important to note that only superficial cracks have been observed in the VY steam dryer and those cracks have not shown any measurable growth in the successive dryer inspections. Periodic visual examinations of the steam dryer in accordance with the license condition will continue to ensure that unacceptable flaw development or growth is not occurring.

29. It is also important to note that there are two types of loading imposed on the steam dryer (as well as other plant components.) There are the normal operating loads that are experienced day-in and day-out over the life of the plant. These loads are generally lower than the design basis accident loads, but because of the long time duration they can induce fatigue damage. The design basis loads are one-time loads. The purpose of the aging management process is to ensure that the condition of plant components is maintained in a status that is consistent with the design basis analyses for all plant conditions.

30. NEC asserts that "Entergy has previously used these computer models to establish a baseline for its steam dryer management program, and integrated code-based predictions into its aging management assessment. NEC's Contention 3 concerns regarding validity of these models are therefore current regardless of whether Entergy will make further use of them." New England Coalition, Inc's Opposition to Entergy's Request for Leave to File Motion for Reconsideration of NEC's Contention 3 (October 12, 2006) at 4. This assertion is incorrect. The purpose of the ACM and CFD analyses was to develop peak loads for the analysis of the steam dryer as a forward looking prediction that no unacceptable fatigue loadings would develop as a the power uprate was being implemented. The plant parameter monitoring and inspection program currently being conducted does not rely on the analyses performed during the implementation of the EPU and is sufficient to ensure satisfactory steam dryer performance during the license renewal period.

VII. Summary and Conclusions

31. My testimony in this Declaration justifies the following conclusions: (1) the steam dryer aging management plan for license renewal period proposed by Entergy is consistent with the vendor recommendations and industry guidance; (2) the monitoring and inspection activities called for in the plan are the same that the NRC has approved for assuring the structural integrity of the steam dryer during current post-EPU operation; and (3) the steam dryer aging management plan will adequately assure that the dryer's structural integrity will be maintained for all plant normal and transient operating conditions during the license renewal period.

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

Executed on April 18, 2007

John R. Hoffman