RAS 12343

October 2, 2006

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OFFICE OF SECRETARY
RULEMAKINGS AND
ADJUDICATIONS STAFF

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board

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

ENTERGY'S REQUEST FOR LEAVE TO FILE MOTION FOR RECONSIDERATION OF THE BOARD'S DECISION TO ADMIT NEW ENGLAND COALITION'S CONTENTION 3

Pursuant to 10 C.F.R. §2.323(e), Entergy Nuclear Vermont Yankee, LLC and Entergy Nuclear Operations, Inc. (hereinafter collectively referred to as "Entergy") seek leave of the Atomic Safety and Licensing Board herein ("Board") to file a motion for reconsideration of its Memorandum and Order (Ruling on Standing, Contentions, Hearing Procedures, State Statutory Claim, and Contention Adoption), LBP-06-20, 63 NRC ___ (September 22, 2006) ("LBP-06-20") to the extent that it held that New England Coalition ("NEC") Contention 3 meets the admissibility requirements of 10 C.F.R. § 2.309(f)(1). As shown in the attached motion, there was a clear and material error in the Board's admission of NEC Contention 3 which could not have been anticipated and which renders the decision with respect to that contention invalid.

Counsel for Entergy has discussed its intention to file such a motion for reconsideration with counsel for the other parties and all parties have indicated that they do not object to the filing of such a motion, although they reserve the right to contest whether the standards for granting reconsideration of the Board's decision have been met.

Template = SECY-041

SECY-02

Respectfully Submitted,

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Dated: October 2, 2006

October 2, 2006

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board

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ENTERGY'S MOTION FOR RECONSIDERATION OF THE BOARD'S DECISION TO ADMIT NEW ENGLAND COALITION'S CONTENTION 3

Entergy Nuclear Vermont Yankee, LLC and Entergy Nuclear Operations, Inc. (hereinafter collectively referred to as "Entergy")[1] hereby move, pursuant to 10 C.F.R. § 3.23(a), for reconsideration by the Board of its Memorandum and Order (Ruling on Standing, Contentions, Hearing Procedures, State Statutory Claim, and Contention Adoption), LBP-06-20, 63 NRC ___ (September 22, 2006) ("LBP-06-20") to the extent that it held that New England Coalition ("NEC") Contention 3 meets the admissibility requirements of 10 C.F.R. § 2.309(f)(1). See LBP-06-20, slip op. at 67-70. As more fully discussed below, the contention does not challenge Entergy's specific program for managing the aging of the VY steam dryer, which NEC counsel admitted NEC and its consultant had not even reviewed, and raises concerns clearly inapplicable to Entergy's program. For that reason, NEC Contention 3 raises no genuine dispute on a material issue of law or fact regarding the VY license renewal application and the contention therefore should have been rejected.

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

I. PROCEDURAL BACKGROUND

On January 25, 2006, Entergy submitted its application requesting renewal of Operating License DPR-28 for the Vermont Yankee Nuclear Power Station (the "Application"). On March 27, 2006, the Nuclear Regulatory Commission ("NRC" or "Commission") published a Notice of Acceptance for Docketing of the Application and Notice of Opportunity for Hearing ("Notice") regarding Entergy's application. 71 Fed. Reg. 15,220 (March 27, 2006). The Notice permitted any person whose interest may be affected to file a request for hearing and petition for leave to intervene within 60 days of the notice. Id. at 15,220-21. On May 26, 2006, NEC filed its "Petition for Leave to Intervene, Request for Hearing, and Contentions" (the "Petition"). The Petition was supported, inter alia, by the declaration of Dr. Joram Hopenfeld, dated May 12, 2006, Petition Exhibit 7 ("Hopenfeld Decl.").

One of the contentions submitted by NEC, Contention 3, alleges that the Application "does not include an adequate plan to monitor and manage aging of the steam dryer during the period of extended operation" (Petition at 17). The related opinions by Dr. Hopenfeld in support of the contention are contained in ¶¶ 15-20 of his Declaration. In LBP-06-20, the Board admitted NEC Contention 3 into this proceeding, finding that the following statements by Dr. Hopenfeld had demonstrated a genuine dispute under the standards of 10 C.F.R. § 2.309(f)(1)(vi) by raising a challenge to Entergy's plans for aging management of the steam dryer beyond 2012:

> [T]he management of cracking at the steam dryer will be in accordance with current guidance per NUREG 1801, GE-SIL-644 and possibly future guidance from BWRRVIP-139, if approved by NRC. No matter which guidance Entergy follows, the status of the existing dryer cracks must be continuously monitored and assessed by a competent engineer.
>
> Entergy's proposed monitoring techniques are not adequate to detect crack propagation and growth because they are not based on actual measurements of crack initiation and growth. Instead, Entergy relies on unproven computer models and moisture monitors which only indicate that the dryer was already damaged.

> The estimated fatigue loads on the dryer are based on theoretical calculations of two computer models: the [CFD] Model and the [AC] Model. Neither the CFD nor the ACM were benchmarked against properly scaled dryer structure and therefore their predictions are subject to large uncertainties.

LBP-06-20, slip op. at 67, quoting Hopenfeld Decl. ¶¶ 18-19. In so doing, the Board was apparently unaware that the basic premise of the contention, and of Dr. Hopenfeld's opinion, was demonstrably incorrect and therefore there is no "genuine dispute" between the parties that warrants litigation of this contention.

II. ARGUMENT

As a threshold matter, "an intervention petitioner has an ironclad obligation to examine the publicly available documentary material pertaining to the facility in question with sufficient care to enable [the petitioner] to uncover any information that could serve as the foundation for a specific contention." Duke Power Co. (Catawba Nuclear Station, Units 1 and 2), ALAB-687, 16 NRC 460, 468 (1982), vacated in part on other grounds, CLI-83-19, 17 NRC 1041 (1983). NEC has totally failed to observe this obligation.

NEC admits that it did not review the actual license renewal application commitments for the management of aging of the VY steam dryer. Dr. Hopenfeld was aware that that Entergy's aging management program for VY's steam dryer "will be in accordance with current guidance per NUREG 1801, GE-SIL-644 and possibly future guidance from BWRRVIP-139, if approved by the NRC." Hopenfeld Decl. at ¶ 18. However, at the prehearing conference on August 2, 2006, NEC's counsel stated that Dr. Hopenfeld had not read the guidance document on which Entergy's management program for the steam dryer is based, GE-SIL-644, Rev. 1, because it was "proprietary." Tr. 333 (Tyler). In reality, the document is not proprietary, was available in the NRC ADAMS system, and could have easily been retrieved by NEC prior to the formulation of its contention. See Tr. 338-39 (Travieso-Diaz). Indeed, NEC has never addressed, or found fault with, the recommendations in GE-SIL-644.[2]

Instead of analyzing the guidance document, Dr. Hopenfeld apparently relied on his review of documents produced in the EPU proceeding. Tr. 333 (Tyler). This led him to a fundamental factual error and, as the Board ruled in LBP-06-20, was inappropriate.[3]

NEC Contention 3, and the Hopenfeld Declaration on which it rests, reject the monitoring programs proposed by Entergy to manage the aging of the VY steam dryer during the license renewal period because the programs are allegedly based on unreliable theoretical calculations using two computer models, the Computational Fluid Dynamics Model and the Acoustic Circuit Model. See, e.g., NEC Petition at 17; Hopenfeld Decl. at ¶ 19. As noted above, the Board cited those allegations by Dr. Hopenfeld as its rationale for admitting the contention. LBP-06-20, slip op. at 67-68.

Dr. Hopenfeld's allegation is, however, indisputably without basis in fact. The monitoring plan for the VY steam dryer during the license renewal period does NOT depend on

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[2] The Board appears to infer that Dr. Hopenfeld's reference to GE-SIL-644 meant that he had reviewed the monitoring program referenced therein and "even with such monitoring, reliance on the [computer] models during the renewal period that starts in 2012 is inappropriate." LBP-06-20, slip op. at 68. We respectfully disagree with any such inference. The record is clear that Dr. Hopenfeld had not reviewed GE-SIL-644 when he signed his declaration, thus he could not have possibly taken exception to it because it called for use of computer models. In fact, as discussed below, the GE guidance document makes no reference to the use of computer models but recommends visual inspections and plant parameter monitoring.

[3] In LBP-06-20, the Board drew a distinction between VY's plans and commitments for steam dryer monitoring and inspection, and those during the license renewal term. The Board indicated that "[s]team dryer monitoring and inspection plans for the time period prior to 2012 are not directly relevant to, nor dispositive of, our ruling on NEC Contention 3 except to the extent that Entergy's license renewal application, or other materials properly before this Board at this stage in the proceeding, indicates a commitment to continue existing programs." LBP-06-20, slip op. at 66, emphasis in original. Thus, reliance on the EPU record was an error on the part of NEC and Dr. Hopenfeld.

theoretical calculations using computer models.[4] Therefore, the contention fails to meet the requirements of 10 C.F.R. 2.309(f)(1)(vi) and should have been dismissed.

As discussed at the prehearing conference on August 2, 2006 (Tr. 339-40) it is a matter of record that the VY operating license contains several conditions imposing obligations on the licensee with respect to steam dryer inspection and monitoring. These conditions, which are set forth in section 2.M of the license as amended, include the following:

> 2e. Entergy Nuclear Operations, Inc. shall revise the SDMP [steam dryer monitoring plan] 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 spring2007 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.
>
> ****
>
> 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.

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[4] Indeed, the steam dryer monitoring program implemented by Entergy in connection with the recent VY power uprate did not depend either on the challenged computer programs. See Entergy's Answer to New England Coalition's Petition for Leave to Intervene, Request For Hearing, and Contentions (June 22, 2006) at 26-29.

Vermont Yankee Nuclear Power Station, Amendment No. 229 to License No. DPR-28 (March 2, 2006), sections 2.M.2.e, 5, 6 and 8, ADAMS Accession No. ML 060050022, copy enclosed as Attachment 1.

These terms of Vermont Yankee's license impose two sets of obligations on the licensee: (a) to perform visual inspections of the steam dryer during, at a minimum, the first three refueling outages starting with the spring 2007 outage, and potentially extending to later time periods if a visual inspection of the steam dryer reveals "any new unacceptable flaw or unacceptable flaw growth that is due to fatigue" (sections 2.M.5 and 2.M.8), and (b) to include in VY's steam dryer monitoring plan the long-term monitoring of plant parameters potentially indicative of steam dryer failure, and reflect consistency of the facility's steam dryer inspection program with General Electric Services Information Letter 644, Revision 1 (section 2.M.2.e). Unless modified when the VY license is renewed, these conditions will remain in effect during the renewal term. Therefore, to the extent that NEC Contention 3 seeks the imposition of additional obligations on Entergy, the contention challenges VY's valid, existing license, which it may not do in this proceeding.[5]

With respect to long term visual inspection and monitoring of the steam dryer, the VY license requires "long-term monitoring of plant parameters potentially indicative of steam dryer failure and reflect consistency of the facility's steam dryer inspection program with General

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[5] A contention may not attempt to impose greater requirements on a licensee than otherwise required by applicable regulations or the terms of its license. See, e.g., Private Fuel Storage, L.L.C. (Independent Spent Fuel Storage Installation), CLI-01-12, 53 NRC 459, 470 (2001) (Intervenor "could not have argued that the design earthquake should be set more conservatively than our regulations require, because that would have constituted an impermissible collateral attack on our regulations."); Dominion Nuclear Connecticut, Inc. (Millstone Nuclear Power Station, Unit 2), CLI-03-14, 58 NRC 207, 217-18 (2003) (While evidence confirms that offsite dose remains below regulatory criterion, intervenor argues that "any increase...is unacceptable...But this kind of argument amounts to a collateral attack on NRC regulations...This is impermissible." (citations omitted)).

Electric Services Information Letter 644, Revision 1." The aging management plan for the steam dryer complies with this license requirement. It states:

> 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.

Application, § 3.1.2.2.11 "Cracking due to Flow-Induced Vibration." There is no question that Entergy's aging management plan for the steam dryer is to follow the guidance of GE-SIL-644, as required by the VY license.[6]

In turn, the guidance in GE-SIL-144 requires licensees to institute a program for the long term monitoring and inspection of the steam dryers. It provides detailed inspection and monitoring guidelines (see SIL-644, ADAMS Accession No. ML060120032, Attachment 2 hereto, Appendices C and D). With respect to monitoring, the guidelines call for the frequent 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,

[6] The Memorandum and Order suggests that there may be ambiguities regarding Entergy's commitments and plans for steam dryer monitoring, finding that "future commitments in this area appear tentative and unspecific." Memorandum and Order at 68, n. 68. If the Board is referring to Entergy's plan to "evaluate BWRVIP-139 once it is approved by the staff" that guidance document is still under review by the Staff and has not been approved, so it is not possible for Entergy to decide whether to commit to following its recommendations. See Tr. 339. Should Entergy decide to implement some or all of the provisions of BWRVIP-139, it will need NRC approval to do so.

> 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. There is no time limit for performing this monitoring function. The monitoring involves no use of the computer codes challenged by NEC.

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. Thus, the recommendations in the GE guidance document call for monitoring and inspections that do not stop with the term of the existing license but would continue into the extended license period. This is exactly what the license requires and what NEC sought in its contention.[7]

Neither the inspection nor the monitoring recommendations in GE SIL-644 call for the use of computer codes. The inspections recommended by GE are visual inspections performed in accordance with the instructions in Appendix C of the guidelines. The monitoring consists of physical measurements of various parameters, particularly moisture carryover in the steam. GE SIL-644, Appendix D. See Attachment 2. Had Dr. Hopenfeld reviewed the GE guidelines, he would have realized that his concerns about reliance on computer codes, even if they had been valid in the context of the power uprate process (which they were not) are inapplicable after the uprate has been implemented, or in future plant operations including those during the renewal period.

III. CONCLUSION

A motion for reconsideration affords the opportunity to correct a Board error by pointing out a factual misapprehension that was overlooked in a Board decision. Duke Cogema Stone & Webster (Savannah River Mixed Oxide Fuel Fabrication Facility), CLI-02-2, 55 NRC 5, 7

[7] At oral argument, NEC's counsel asked that it was NEC's position that Entergy should conduct visual inspection and monitoring of the steam dryer during the extended plant operation term and sought whether Entergy had committed to such a program. Tr. 335 (Tyler). Later, NEC's counsel indicated that what NEC is seeking is a "license condition, a similar license condition for the renewed license" that requires long term visual inspection and monitoring of the steam dryer. Tr. 363 (Tyler). The terms of VY's amended license are explicit and impose the same requirements sought by NEC.

(2002); Private Fuel Storage, L.L.C. (Independent Spent Fuel Installation), CLI-00-21, 52 NRC 261, 264 (2000). The Board's admission of NEC Contention 3 presents an instance in which reconsideration of a Board ruling is appropriate. NEC's Contention 3 did not address the adequacy of the aging management plan that was referenced in the Application and was readily available in ADAMS. By failing to identify a deficiency in the program committed to in the Application, NEC failed to demonstrate any genuine dispute on a material issue regarding the Application, as required by 10 C.F.R. § 2.309(f)(1)(vi). Therefore, NEC's Contention 3 was not admissible and Entergy respectfully submits that the Board should reconsider its ruling.

CERTIFICATION OF COUNSEL PURSUANT TO 10 CFR 2.323(B)

In accordance with 10 C.F.R. §2.323(b), counsel for Entergy has discussed this motion with counsel for the other parties in this proceeding in an attempt to resolve this issue has not been successful in resolving it. All parties have indicated that they do not object to the filing of this motion, although they reserve the right to contest whether the standards for granting reconsideration of the Board's decision have been met.

Respectfully Submitted,

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Counsel for Entergy Nuclear Vermont Yankee, LLC and Entergy Nuclear Operations, Inc.

Dated: October 2, 2006

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board

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

CERTIFICATE OF SERVICE

I hereby certify that copies of "Entergy's Request for Leave to File Motion for Reconsideration of the Board's Decision to Admit New England Coalition's Contention 3" and "Entergy's Motion for Reconsideration of the Board's Decision to Admit New England Coalition's Contention 3," both dated October 2, 2006, were served on the persons listed below by deposit in the U.S. Mail, first class, postage prepaid, or with respect to Judge Elleman by overnight mail, and where indicated by an asterisk by electronic mail, this 2nd day October, 2006.

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Matias F. Travieso-Diaz

March 2, 2006

Mr. Michael Kansler
President
Entergy Nuclear Operations, Inc.
440 Hamilton Avenue
White Plains, NY 10601

SUBJECT: VERMONT YANKEE NUCLEAR POWER STATION - ISSUANCE OF AMENDMENT RE: EXTENDED POWER UPRATE (TAC NO. MC0761)

Dear Mr. Kansler:

The Commission has issued the enclosed Amendment No. 229 to Facility Operating License No. DPR-28 for the Vermont Yankee Nuclear Power Station (VYNPS), in response to your application dated September 10, 2003, as supplemented by letters dated October 1, and October 28 (2 letters), 2003; January 31 (2 letters), March 4, May 19, July 2, July 27, July 30, August 12, August 25, September 14, September 15, September 23, September 30 (2 letters), October 5, October 7 (2 letters), December 8, and December 9, 2004; February 24, March 10, March 24, March 31, April 5, April 22, June 2, August 1, August 4, September 10, September 14, September 18, September 28, October 17, October 21 (2 letters), October 26, October 29, November 2, November 22, and December 2, 2005; January 10, and February 22, 2006.

The amendment increases the maximum authorized power level for VYNPS from 1593 megawatts thermal (MWt) to 1912 MWt, which is an increase of approximately 20 percent. The increase in power level is considered an extended power uprate (EPU). The amendment includes revisions to the VYNPS Operating License and Technical Specifications that are necessary to implement the EPU.

The related Safety Evaluation (SE) has been determined to contain proprietary information pursuant to Title 10 of the *Code of Federal Regulations*, Section 2.390. Accordingly, the NRC staff has prepared a redacted, publicly-available, non-proprietary version of the SE. Copies of the proprietary and non-proprietary versions of the SE are enclosed.

A copy of the "Notice of Issuance of Amendment to Facility Operating License and Final Determination of No Significant Hazards Consideration," which is being forwarded to the Office of the Federal Register for publication, is also enclosed.

Sincerely,

/RA/

Richard B. Ennis, Senior Project Manager
Plant Licensing Branch I-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-271

Enclosures:
1. Amendment No. 229 to License No. DPR-28
2. Non-proprietary SE
3. Proprietary SE
4. Notice

cc w/encls 1, 2, and 4: See next page

A copy of the "Notice of Issuance of Amendment to Facility Operating License and Final Determination of No Significant Hazards Consideration," which is being forwarded to the Office of the Federal Register for publication, is also enclosed.

Sincerely,
/RA/
Richard B. Ennis, Senior Project Manager
Plant Licensing Branch I-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-271
Enclosures: 1. Amendment No. 229 to License No. DPR-28
2. Non-proprietary SE
3. Proprietary SE
4. Notice
cc w/encls 1, 2, and 4: See next page

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Cover letter, Amendment, and Notice: ML060050022
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*Cover letter only

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ENTERGY NUCLEAR VERMONT YANKEE, LLC

AND ENTERGY NUCLEAR OPERATIONS, INC.

DOCKET NO. 50-271

VERMONT YANKEE NUCLEAR POWER STATION

AMENDMENT TO FACILITY OPERATING LICENSE

Amendment No. 229
License No. DPR-28

1. The Nuclear Regulatory Commission (the Commission) has found that:

A. The application for amendment filed by Entergy Nuclear Vermont Yankee, LLC and Entergy Nuclear Operations, Inc. (the licensee) on September 10, 2003, as supplemented by letters dated October 1, and October 28 (2 letters), 2003; January 31 (2 letters), March 4, May 19, July 2, July 27, July 30, August 12, August 25, September 14, September 15, September 23, September 30 (2 letters), October 5, October 7 (2 letters), December 8, and December 9, 2004; February 24, March 10, March 24, March 31, April 5, April 22, June 2, August 1, August 4, September 10, September 14, September 18, September 28, October 17, October 21 (2 letters), October 26, October 29, November 2, November 22, and December 2, 2005; January 10, and February 22, 2006, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations set forth in 10 CFR Chapter I;

B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;

C. There is reasonable assurance: (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;

D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and

E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

2. Accordingly, the license is amended by changes to the Technical Specifications as indicated in the attachment to this license amendment, and paragraph 3.B of Facility Operating License No. DPR-28 is hereby amended to read as follows:

(B) Technical Specifications

The Technical Specifications contained in Appendix A, as revised through Amendment No. 229, are hereby incorporated in the license. The licensee shall operate the facility in accordance with the Technical Specifications.

In addition, the license is amended to revise paragraph 3.A of Facility Operating License No. DPR-28 to reflect the new maximum licensed reactor core power level of 1912 megawatts thermal. The licensee is also amended to add new license conditions 3.K, 3.L, and 3.M as follows:

K. Minimum Critical Power Ratio

When operating at thermal power greater than 1593 megawatts thermal, the safety limit minimum critical power ratio (SLMCPR) shall be established by adding 0.02 to the cycle-specific SLMCPR value calculated using the NRC-approved methodologies documented in General Electric Licensing Topical Report NEDE-24011-P-A, "General Electric Standard Application for Reactor Fuel," as amended, and documented in the Core Operating Limits Report.

L. Transient Testing

1. During the extended power uprate (EPU) power ascension test program and prior to exceeding 168 hours of plant operation at the nominal full EPU reactor power level, with feedwater and condensate flow rates stabilized at approximately the EPU full power level, Entergy Nuclear Operations, Inc. shall confirm through performance of transient testing that the loss of one condensate pump will not result in a complete loss of reactor feedwater.

2. Within 30 days at nominal full-power operation following successful performance of the test in (1) above, through performance of additional transient testing and/or analysis of the results of the testing conducted in (1) above, confirm that the loss of one reactor feedwater pump will not result in a reactor trip.

M. Potential Adverse Flow Effects

This license condition provides for monitoring, evaluating, and taking prompt action in response to potential adverse flow effects as a result of power uprate operation on plant structures, systems, and components (including verifying the continued structural integrity of the steam dryer).

1. The following requirements are placed on operation of the facility above the original licensed thermal power (OLTP) level of 1593 megawatts thermal (MWt):

a. Entergy Nuclear Operations, Inc. shall monitor hourly the 32 main steam line (MSL) strain gages during power ascension above 1593 MWt for increasing pressure fluctuations in the steam lines.

b. Entergy Nuclear Operations, Inc. shall hold the facility for 24 hours at 105%, 110%, and 115% of OLTP to collect data from the 32 MSL strain gages required by Condition M.1.a, conduct plant inspections and walkdowns, and evaluate steam dryer performance based on these data; shall provide the evaluation to the NRC staff by facsimile or electronic transmission to the NRC project manager upon completion of the evaluation; and shall not increase power above each hold point until 96 hours after the NRC project manager confirms receipt of the transmission.

c. If any frequency peak from the MSL strain gage data exceeds the limit curve established by Entergy Nuclear Operations, Inc. and submitted to the NRC staff prior to operation above OLTP, Entergy Nuclear Operations, Inc. shall return the facility to a power level at which the limit curve is not exceeded. Entergy Nuclear Operations, Inc. shall resolve the uncertainties in the steam dryer analysis, document the continued structural integrity of the steam dryer, and provide that documentation to the NRC staff by facsimile or electronic transmission to the NRC project manager prior to further increases in reactor power.

d. In addition to evaluating the MSL strain gage data, Entergy Nuclear Operations, Inc. shall monitor reactor pressure vessel water level instrumentation or MSL piping accelerometers on an hourly basis during power ascension above OLTP. If resonance frequencies are identified as increasing above nominal levels in proportion to strain gage instrumentation data, Entergy Nuclear Operations, Inc. shall stop power ascension, document the continued structural integrity of the steam dryer, and provide that documentation to the NRC staff by facsimile or electronic transmission to the NRC project manager prior to further increases in reactor power.

e. Following start-up testing, Entergy Nuclear Operations, Inc. shall resolve the uncertainties in the steam dryer analysis and provide that resolution to the NRC staff by facsimile or electronic transmission to the NRC project manager. If the uncertainties are not resolved within 90 days of issuance of the license amendment authorizing operation at 1912 MWt, Entergy Nuclear Operations, Inc. shall return the facility to OLTP.

2. As described in Entergy Nuclear Operations, Inc. letter BVY 05-084 dated September 14, 2005, Entergy Nuclear Operations, Inc. shall implement the following actions:

   a. Prior to operation above OLTP, Entergy Nuclear Operations, Inc. shall install 32 additional strain gages on the main steam piping and shall enhance the data acquisition system in order to reduce the measurement uncertainty associated with the acoustic circuit model (ACM).

b. In the event that acoustic signals are identified that challenge the limit curve during power ascension above OLTP, Entergy Nuclear Operations, Inc. shall evaluate dryer loads and re-establish the limit curve based on the new strain gage data, and shall perform a frequency-specific assessment of ACM uncertainty at the acoustic signal frequency.

c. After reaching 120% of OLTP, Entergy Nuclear Operations, Inc. shall obtain measurements from the MSL strain gages and establish the steam dryer flow-induced vibration load fatigue margin for the facility, update the dryer stress report, and re-establish the steam dryer monitoring plan (SDMP) limit curve with the updated ACM load definition and revised instrument uncertainty, which will be provided to the NRC staff.

d. During power ascension above OLTP, if an engineering evaluation is required in accordance with the SDMP, Entergy Nuclear Operations, Inc. shall perform the structural analysis to address frequency uncertainties up to ±10% and assure that peak responses that fall within this uncertainty band are addressed.

e. Entergy Nuclear Operations, Inc. shall revise the SDMP to reflect long-term monitoring of plant parameters potentially indicative of steam dryer failure; to reflect consistency of the facility's steam dryer inspection program with General Electric Services Information Letter 644, Revision 1; and to identify the NRC Project Manager for the facility as the point of contact for providing SDMP information during power ascension.

f. Entergy Nuclear Operations, Inc. shall submit the final extended power uprate (EPU) steam dryer load definition for the facility to the NRC upon completion of the power ascension test program.

g. Entergy Nuclear Operations, Inc. shall submit the flow-induced vibration related portions of the EPU startup test procedure to the NRC, including methodology for updating the limit curve, prior to initial power ascension above OLTP.

3. Entergy Nuclear Operations, Inc. shall prepare the EPU startup test procedure to include the (a) stress limit curve to be applied for evaluating steam dryer performance; (b) specific hold points and their duration during EPU power ascension; (c) activities to be accomplished during hold points; (d) plant parameters to be monitored; (e) inspections and walkdowns to be conducted for steam, feedwater, and condensate systems and components during the hold points; (f) methods to be used to trend plant parameters; (g) acceptance criteria for monitoring and trending plant parameters, and conducting the walkdowns and inspections; (h) actions to be taken if acceptance criteria are not satisfied; and (i) verification of the completion of commitments and planned actions specified in its application and all supplements to the application in support of the EPU license amendment request pertaining to the steam dryer prior to power increase above OLTP. Entergy Nuclear Operations, Inc. shall provide the related EPU startup test procedure sections to the NRC by facsimile or electronic transmission to the NRC project manager prior to increasing power above OLTP.

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

   a. During initial power ascension testing above OLTP, each test plateau increment shall be approximately 80 MWt;

   b. Level 1 performance criteria; and

   c. The methodology for establishing the stress spectra used for the Level 1 and Level 2 performance criteria.

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

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.

3. This license amendment is effective as of its date of issuance and shall be implemented within 120 days.

FOR THE NUCLEAR REGULATORY COMMISSION

/RA/

J. E. Dyer, Director
Office of Nuclear Reactor Regulation

Attachment: Changes to the Operating License
and Technical Specifications

Date of Issuance: March 2, 2006

ATTACHMENT TO LICENSE AMENDMENT NO. 229

FACILITY OPERATING LICENSE NO. DPR-28

DOCKET NO. 50-271

Replace the following pages of the Facility Operating License and Appendix A Technical Specifications with the attached revised pages. The revised pages are identified by amendment number and contain marginal lines indicating the areas of change.

Facility Operating License

Remove	Insert
3	3
9	9
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Technical Specifications

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U.S. NUCLEAR REGULATORY COMMISSION

ENTERGY NUCLEAR VERMONT YANKEE, LLC AND

ENTERGY NUCLEAR OPERATIONS, INC.

DOCKET NO. 50-271

NOTICE OF ISSUANCE OF AMENDMENT TO FACILITY OPERATING LICENSE

AND FINAL DETERMINATION OF NO SIGNIFICANT

HAZARDS CONSIDERATION

The U.S. Nuclear Regulatory Commission (Commission) has issued Amendment No. 229 to Facility Operating License No. DPR-28, issued to Entergy Nuclear Vermont Yankee, LLC and Entergy Nuclear Operations, Inc. (the licensee), which revised the Technical Specifications (TSs) and License for operation of the Vermont Yankee Nuclear Power Station (VYNPS) located in Windham County, Vermont. The amendment was effective as of the date of its issuance.

The amendment increases the maximum authorized power level for VYNPS from 1593 megawatts thermal (MWt) to 1912 MWt, which is an increase of approximately 20 percent. The increase in power level is considered an extended power uprate.

The application for the amendment complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations. The Commission has made appropriate findings as required by the Act and the Commission's rules and regulations in 10 CFR Chapter I, which are set forth in the license amendment.

The Commission published a "Notice of Consideration of Issuance of Amendment to Facility Operating License and Opportunity for a Hearing" related to this action in the FEDERAL REGISTER on July 1, 2004 (69 FR 39976). This Notice provided 60 days for the public to request a hearing. On August 30, 2004, the Vermont Department of Public Service and the New England Coalition filed requests for hearing in connection with the proposed amendment. By Order dated November 22, 2004, the Atomic Safety and Licensing Board (ASLB) granted those hearing requests and by Order dated December 16, 2004, the ASLB issued its decision to conduct a hearing using the procedures in 10 CFR Part 2, Subpart L, "Informal Hearing Procedures for NRC Adjudications."

The Commission published a "Notice of Consideration of Issuance of Amendment to Facility Operating License and Proposed No Significant Hazards Consideration Determination" related to this action in the FEDERAL REGISTER on January 11, 2006 (71 FR 1744). This Notice provided 30 days for public comment. The Commission received comments on the proposed no significant hazards consideration as discussed below.

Under its regulations, the Commission may issue and make an amendment immediately effective, notwithstanding the pendency before it of a request for a hearing from any person, in advance of the holding and completion of any required hearing, where it has determined that no significant hazards consideration is involved.

The Commission has applied the standards of 10 CFR 50.92 and has made a final determination that the amendment involves no significant hazards consideration. Public comments received on the proposed no significant hazards consideration determination were considered in making the final determination. The basis for this determination is contained in the Safety Evaluation related to this action. Accordingly, as described above, the amendment has been issued and made immediately effective and any hearing will be held after issuance.

The Commission published an Environmental Assessment related to the action in the FEDERAL REGISTER on January 27, 2006 (71 FR 4614). Based on the Environmental Assessment, the Commission concluded that the action will not have a significant effect on the quality of the human environment. Accordingly, the Commission determined not to prepare an environmental impact statement for the proposed action.

For further details with respect to this action, see the application for amendment dated September 10, 2003, as supplemented by letters dated October 1, and October 28 (2 letters), 2003; January 31 (2 letters), March 4, May 19, July 2, July 27, July 30, August 12, August 25, September 14, September 15, September 23, September 30 (2 letters), October 5, October 7 (2 letters), December 8, and December 9, 2004; February 24, March 10, March 24, March 31, April 5, April 22, June 2, August 1, August 4, September 10, September 14, September 18, September 28, October 17, October 21 (2 letters), October 26, October 29, November 2, November 22, and December 2, 2005; January 10, and February 22, 2006, which is available for public inspection at the Commission's PDR, located at One White Flint North, Public File Area O1 F21, 11555 Rockville Pike (first floor), Rockville, Maryland. Publicly available records will be accessible electronically from the Agencywide Documents Access and Management System's (ADAMS) Public Electronic Reading Room on the Internet at the NRC Web site, http://www.nrc.gov/reading-rm/adams.html. Persons who do not have access to ADAMS or who encounter problems in accessing the documents located in ADAMS, should contact the NRC PDR Reference staff by telephone at 1-800-397-4209, 301-415-4737, or by e-mail to pdr@nrc.gov.

Dated at Rockville, Maryland, this 2nd day of March, 2006.

FOR THE NUCLEAR REGULATORY COMMISSION

/RA/

Richard B. Ennis, Senior Project Manager
Plant Licensing Branch I-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

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.

- 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.
- 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.
- 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.
- 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

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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 ¾-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.

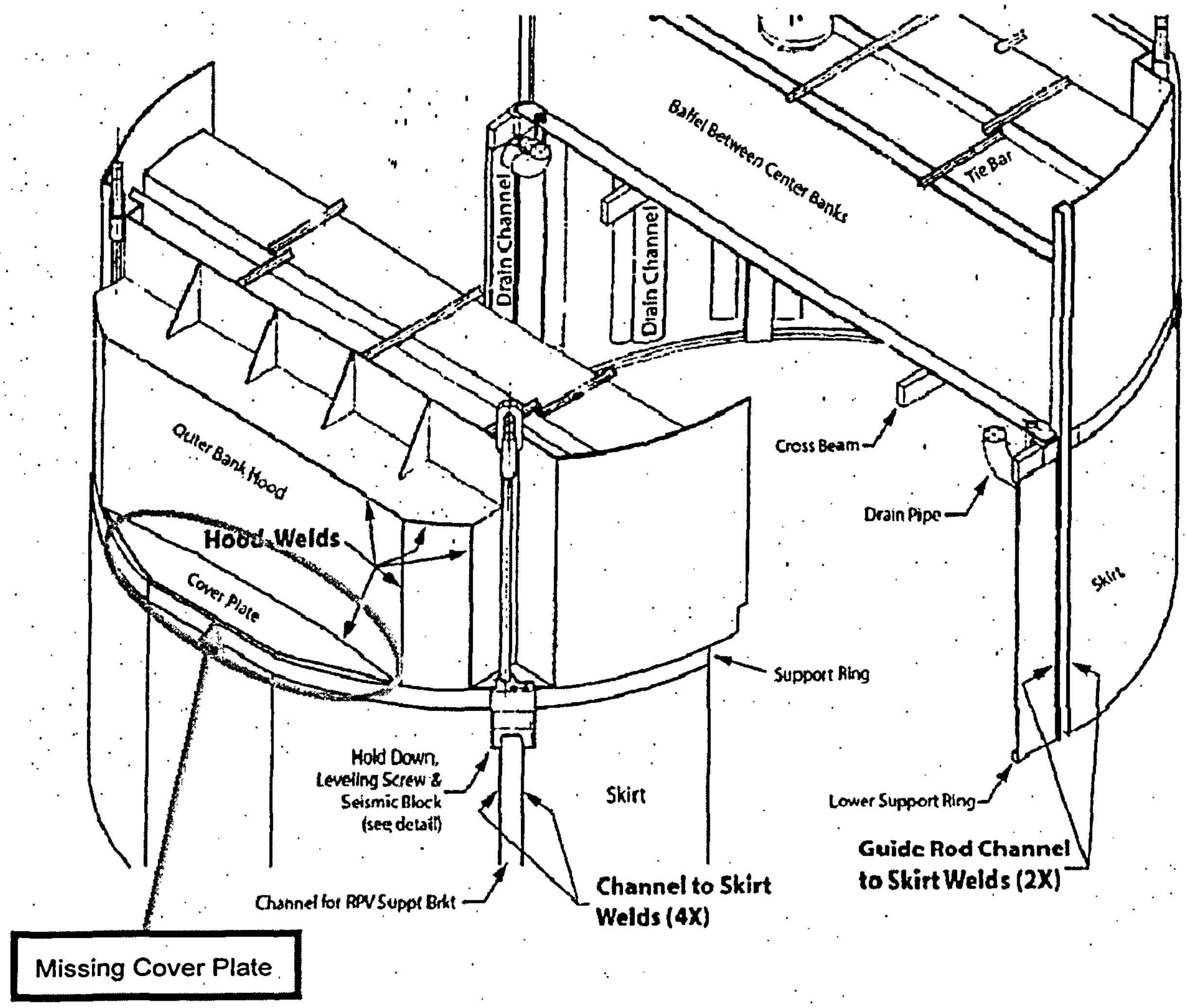


Figure A-1: Location of the 2002 Lower Cover Plate Failure

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.

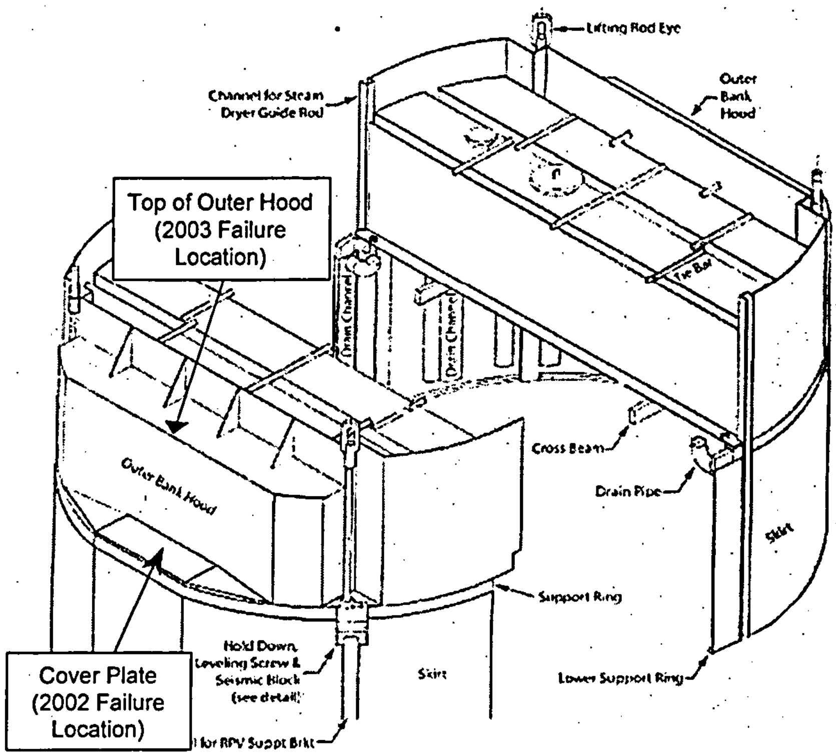


Figure B-1: Location of the 2003 Outer Hood Failure

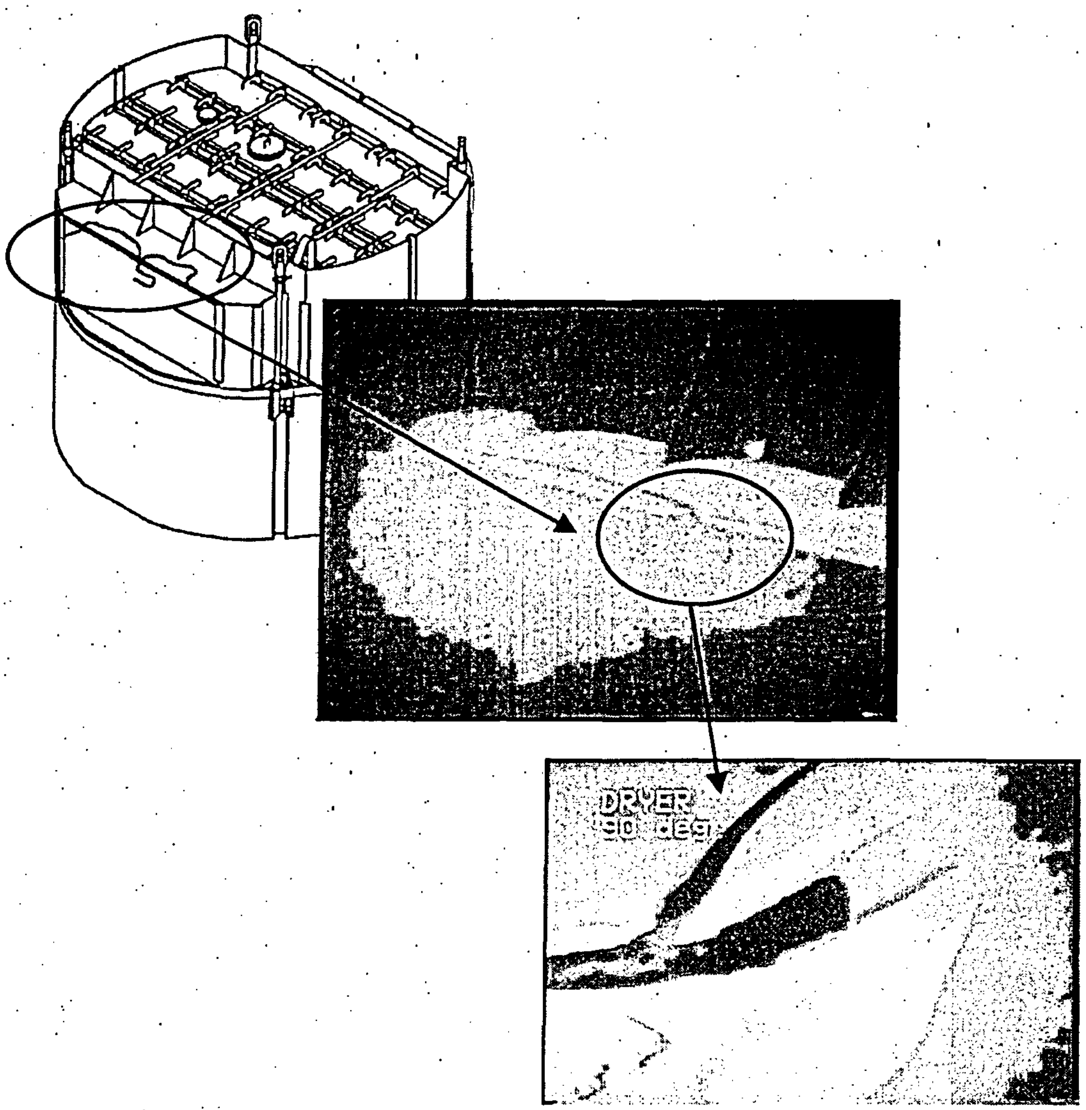


Figure B-2: Steam Dryer Damage 90 Degree Side

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.

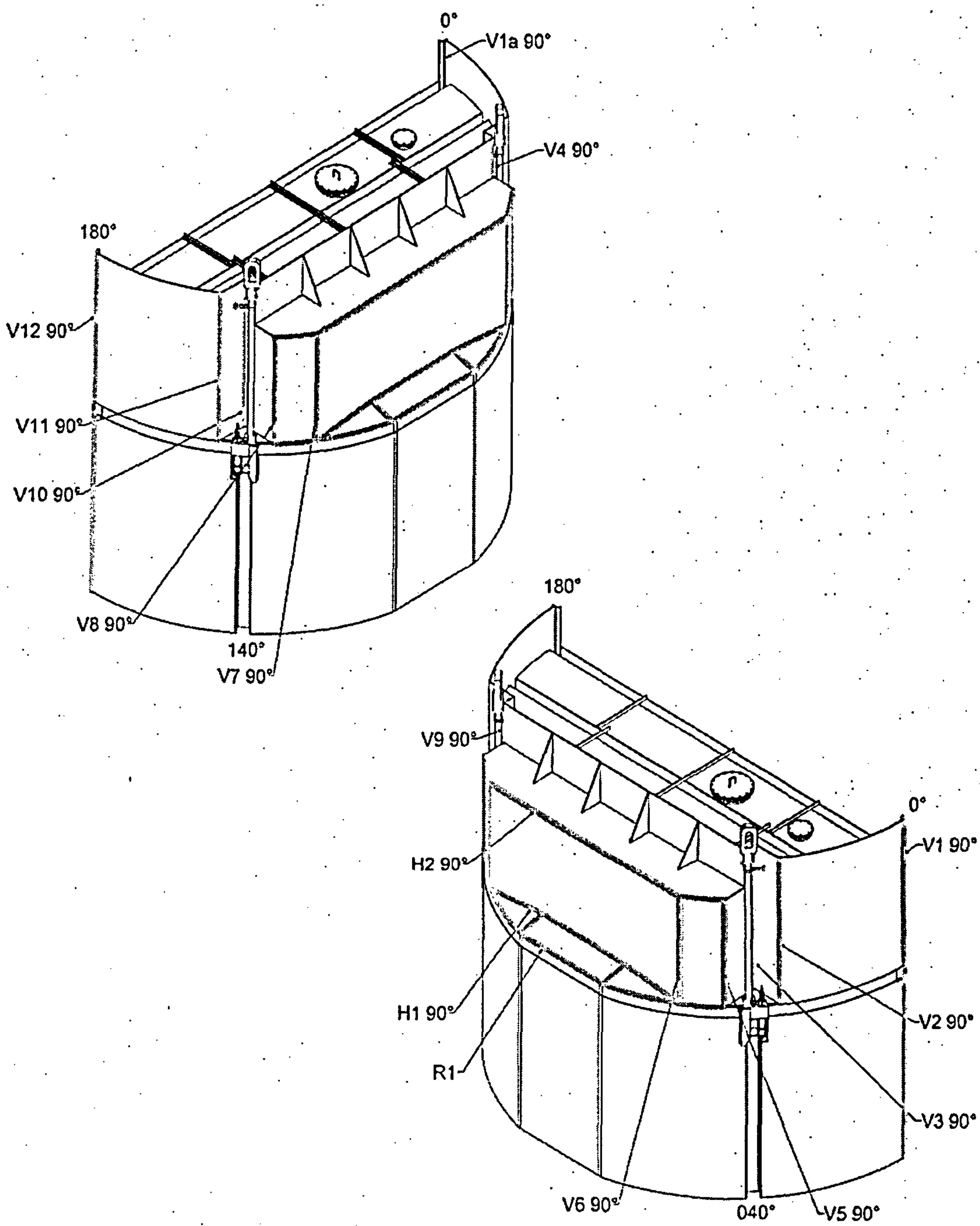


Figure C-1: Inspections: Outer Dryer Hood and Cover Plate (Square Hood Dryer)

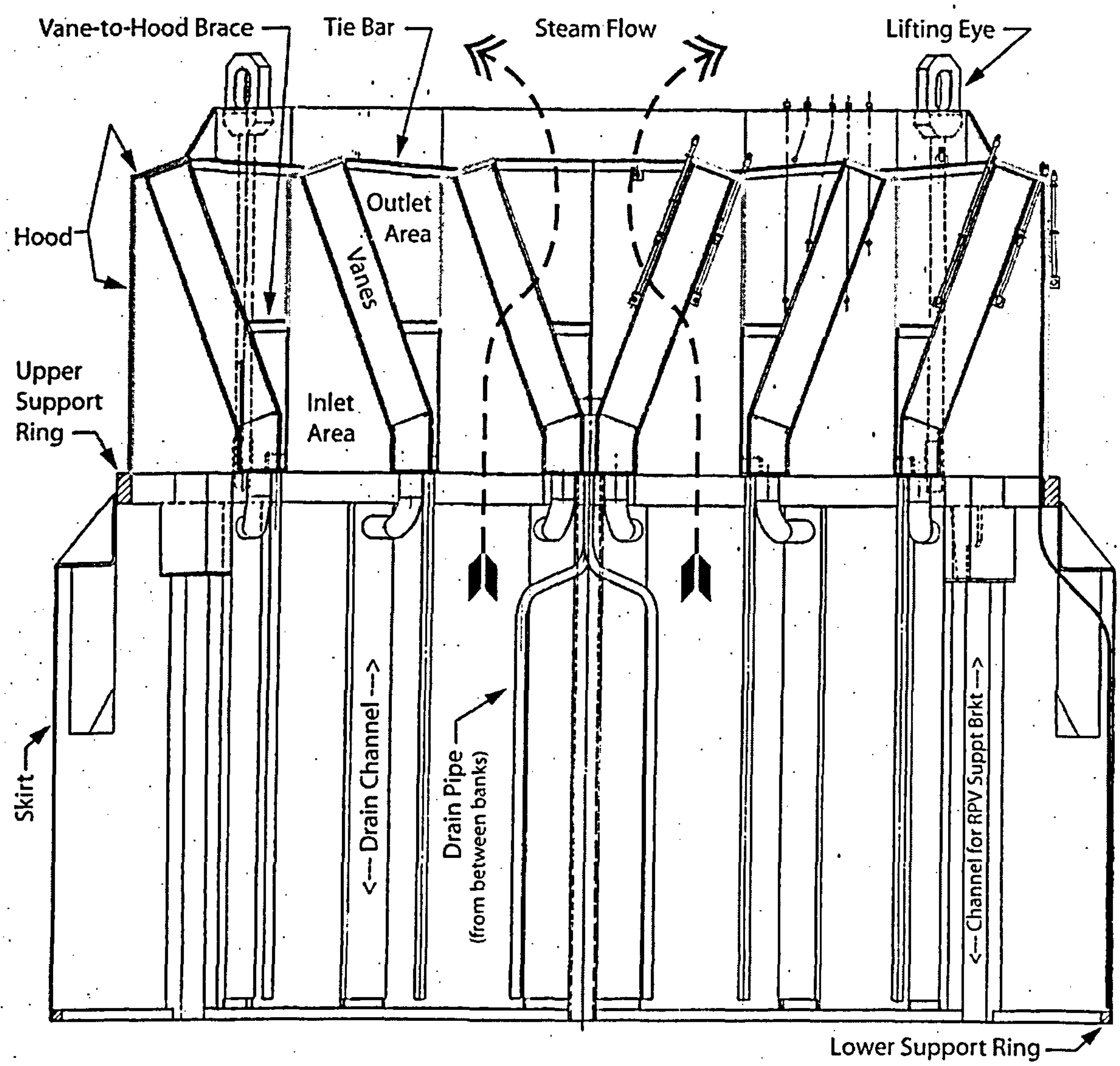


Figure C-2: Cross-Section of BWR/2 Steam Dryer

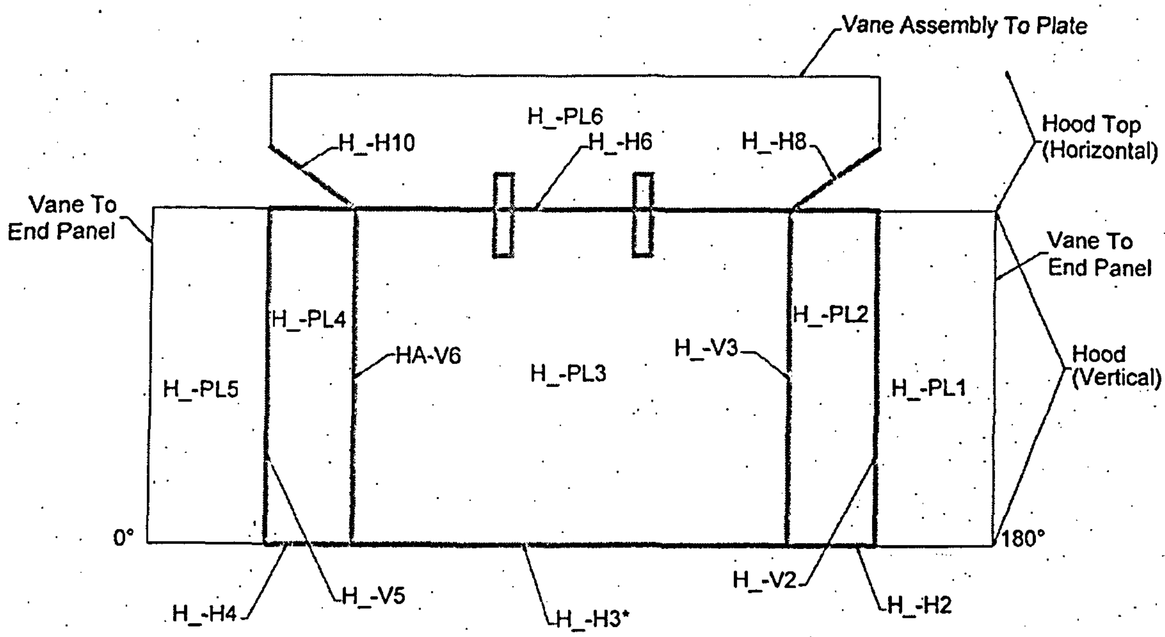
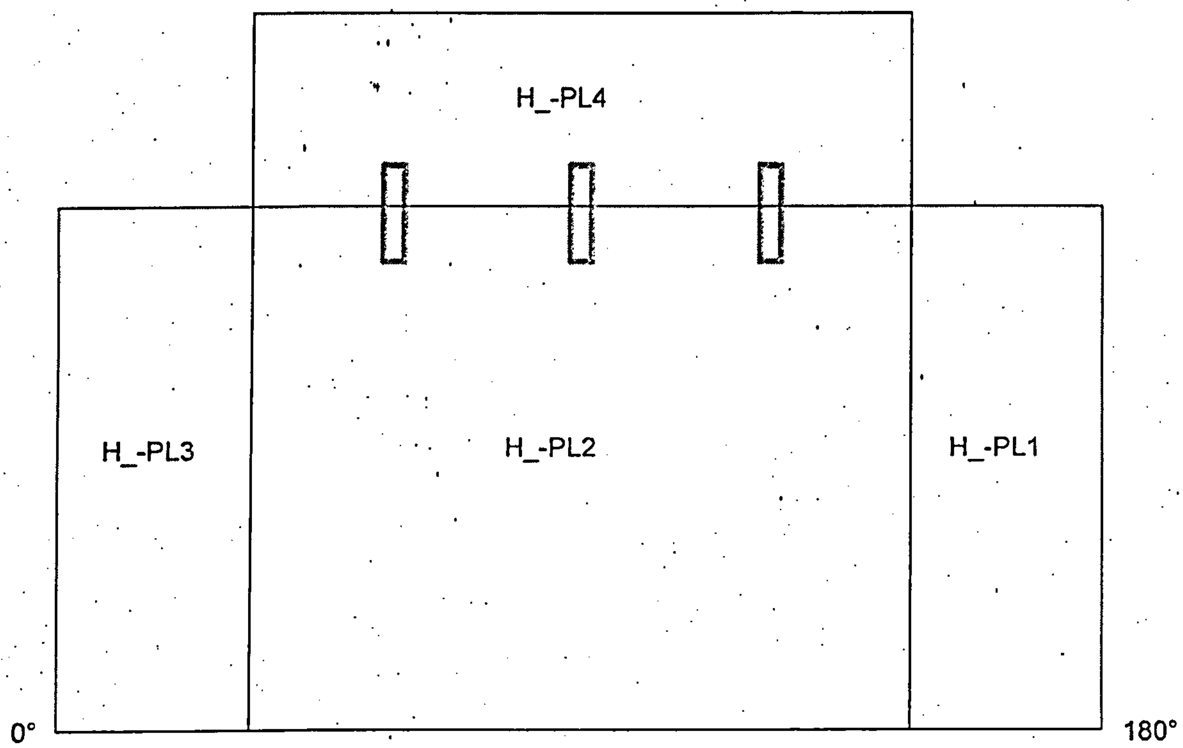


Figure C-3: Weld layout for interior of outer banks (Square Hood Dryer)

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.

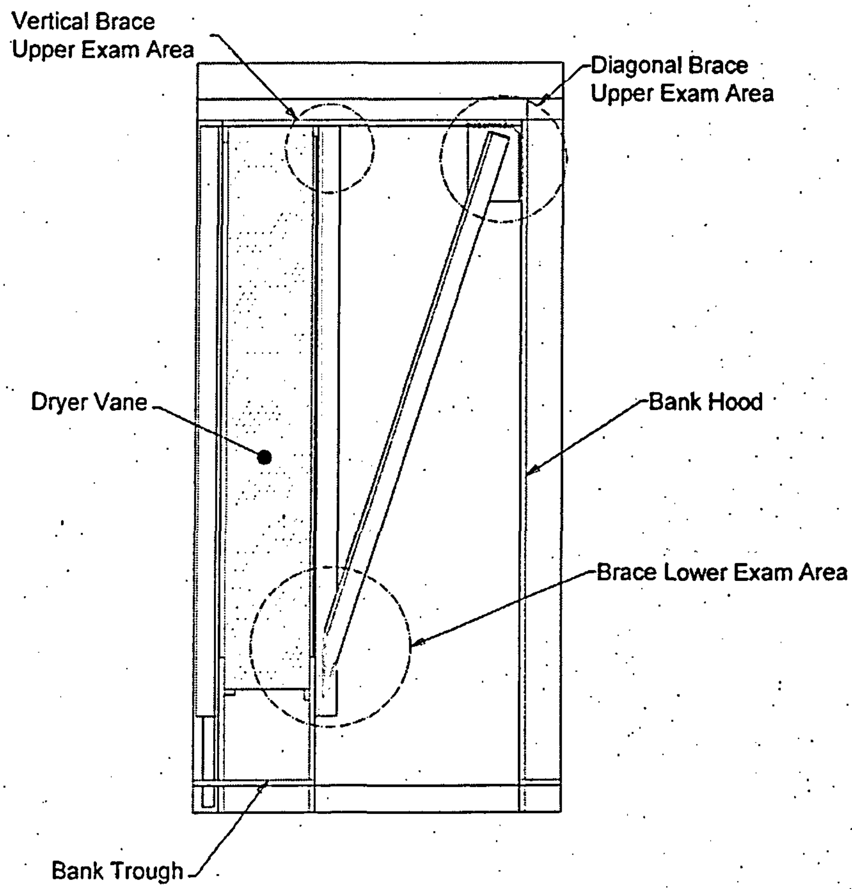


Figure C-5: Dryer Brace Detail (Square Hood Dryer)

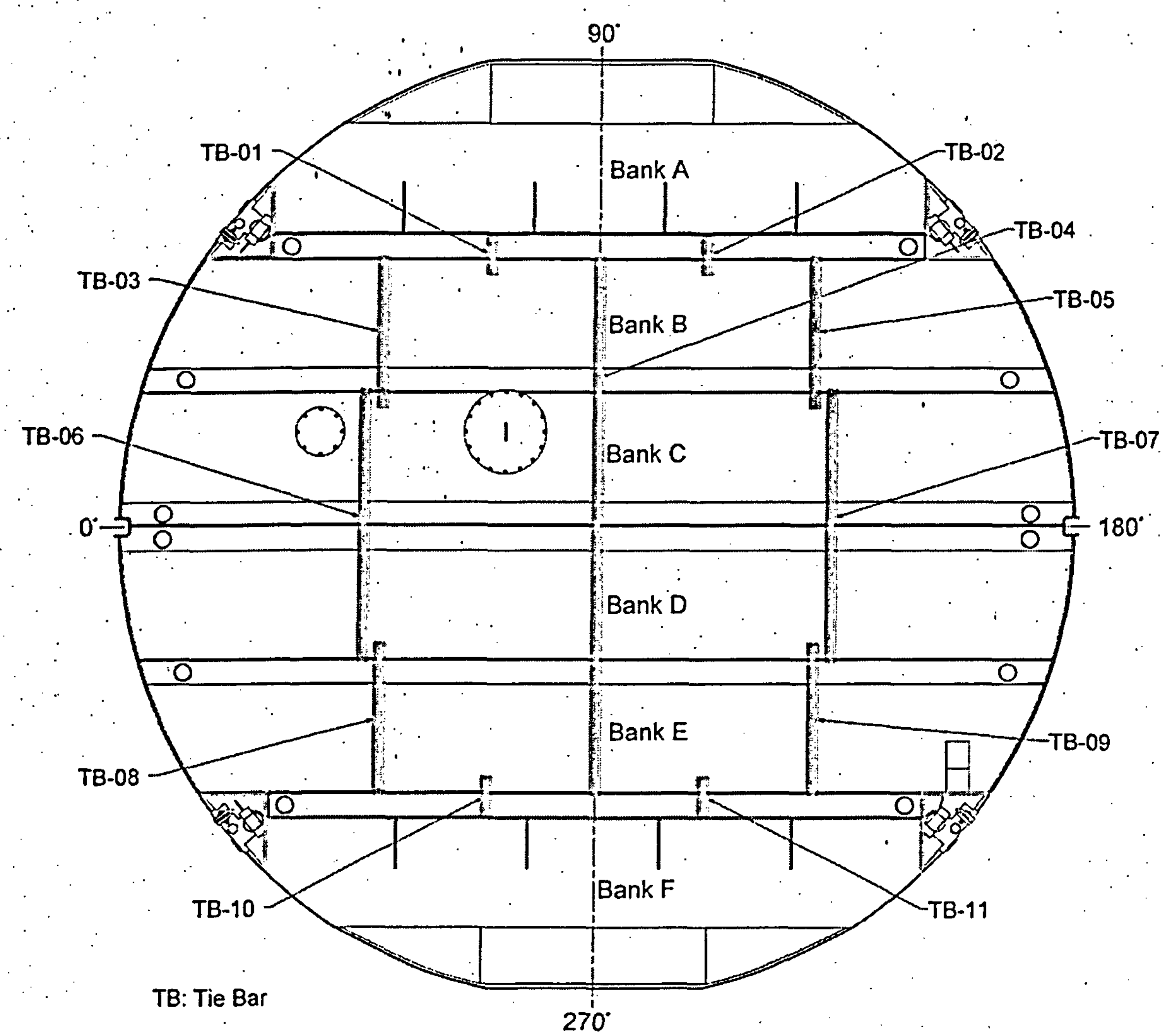


Figure C-6: Inspection Locations: Tie Bars and Steam Dam Inspections (Square Hood Dryer)

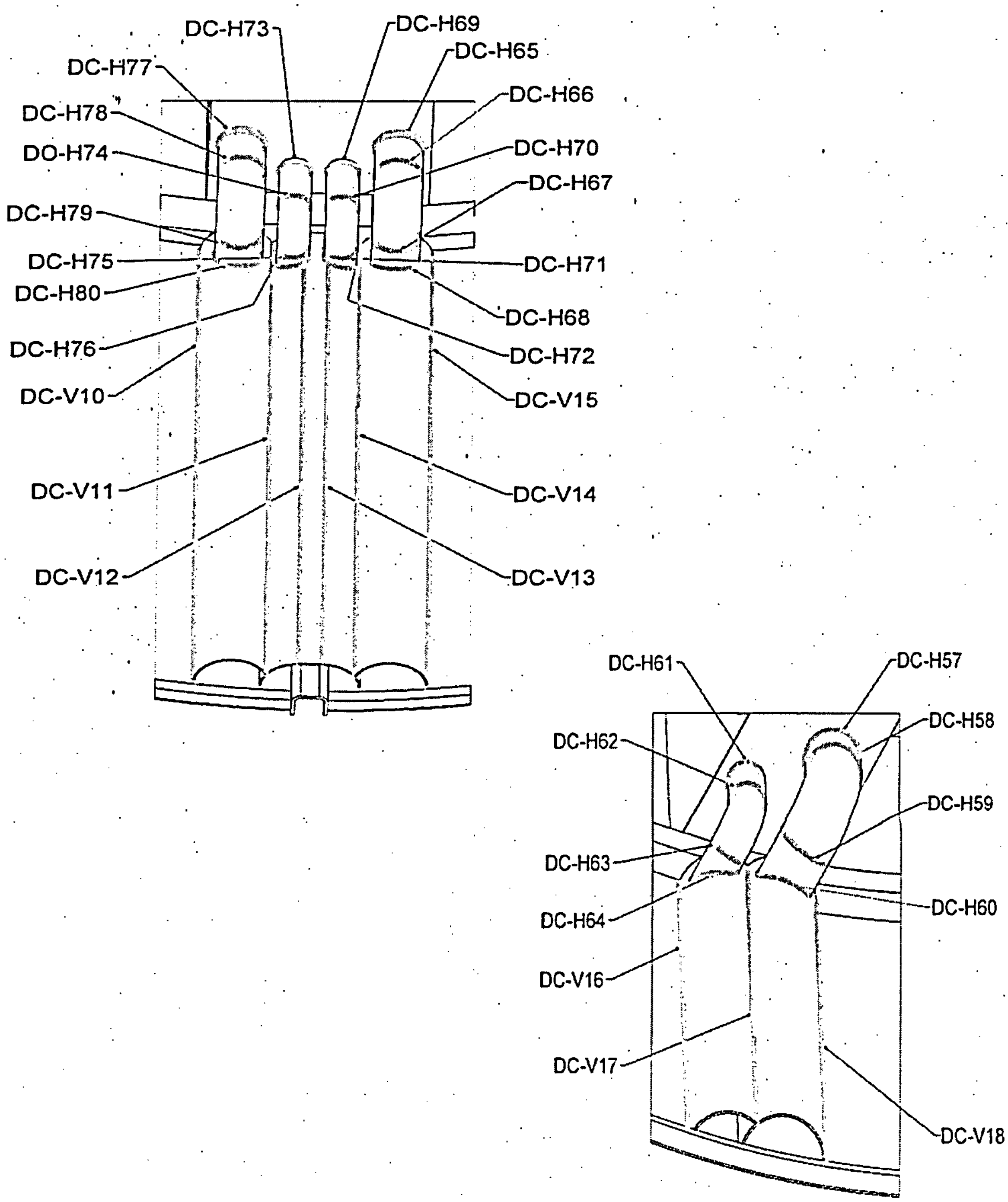


Figure C-7: Drain Channel Locations (Square Hood Dryer)

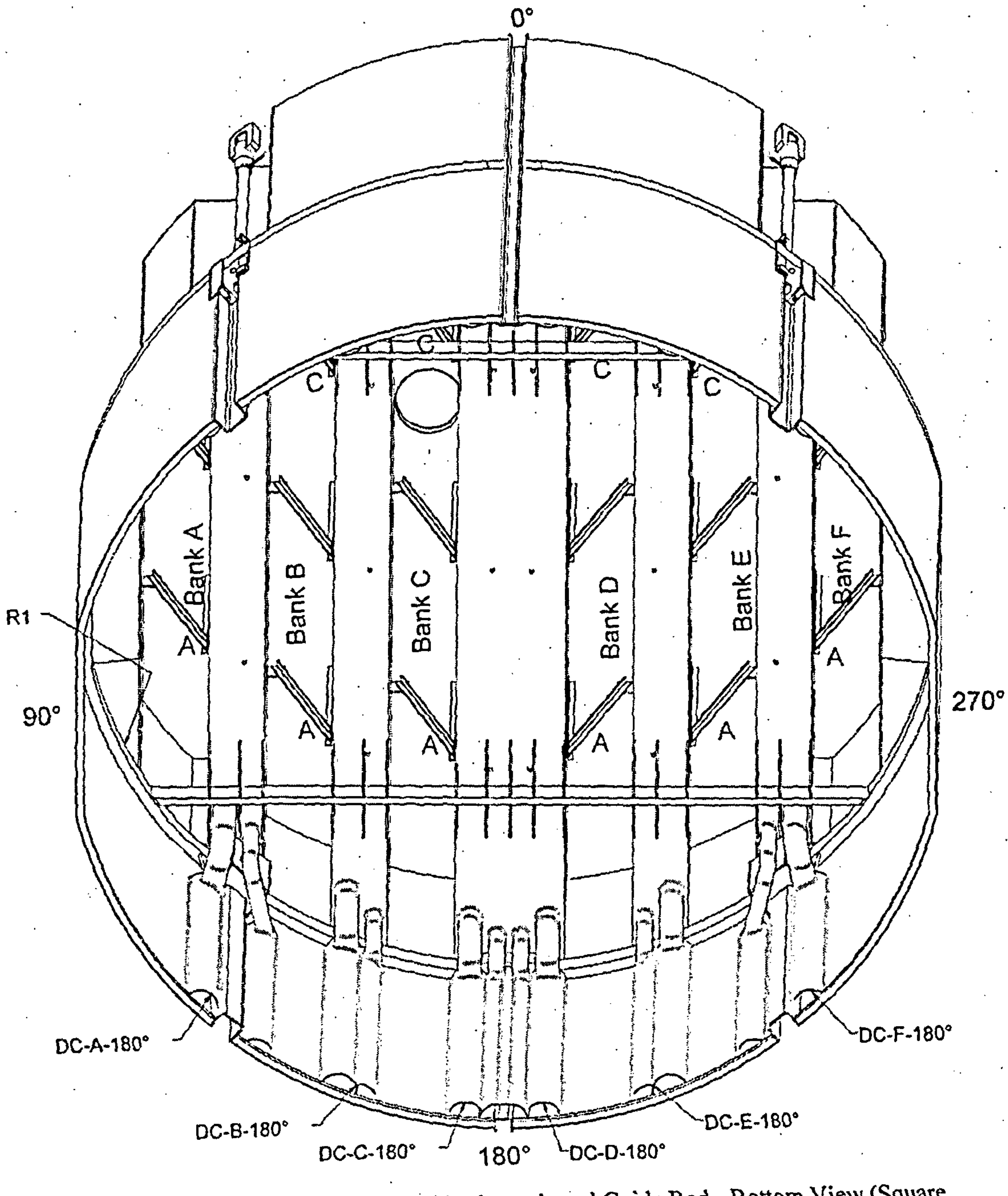


Figure C-8: Dryer Drain Channel, Guide channels and Guide Rod - Bottom View (Square Hood Dryer)

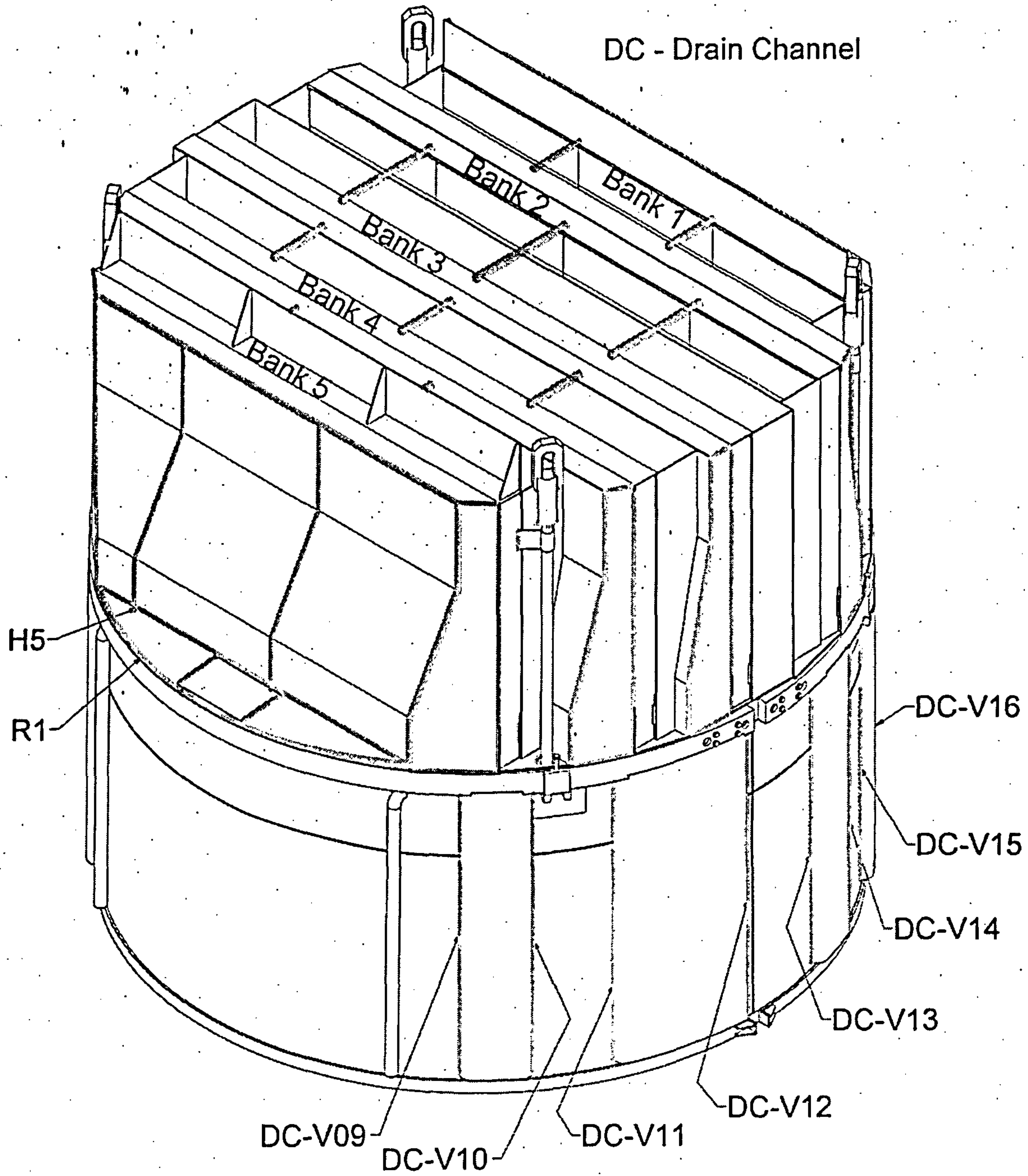


Figure C-9: Inspection Locations (Slanted Hood Dryer)

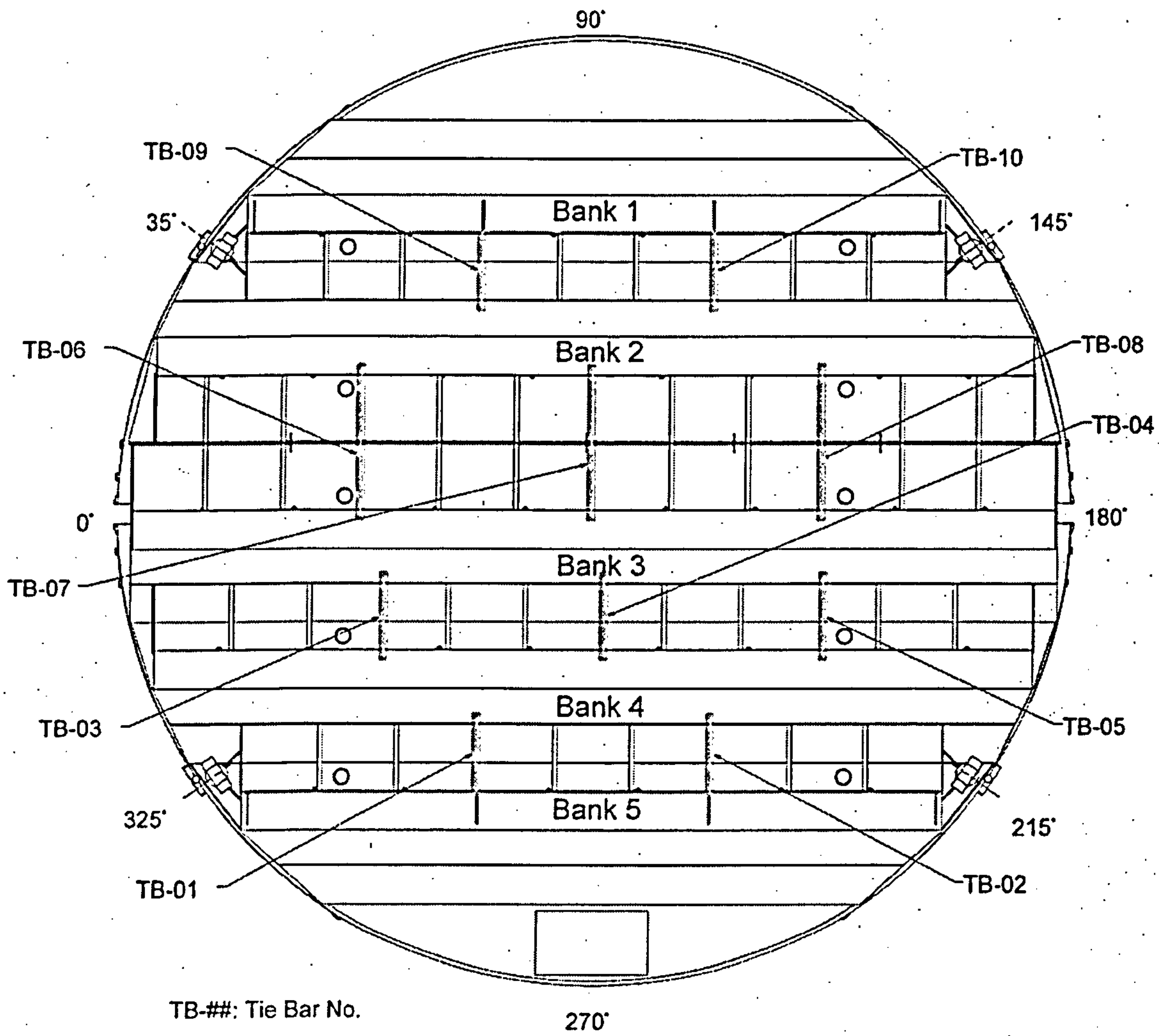


Figure C-10: Tie Bar Locations (Slanted Hood Dryers)

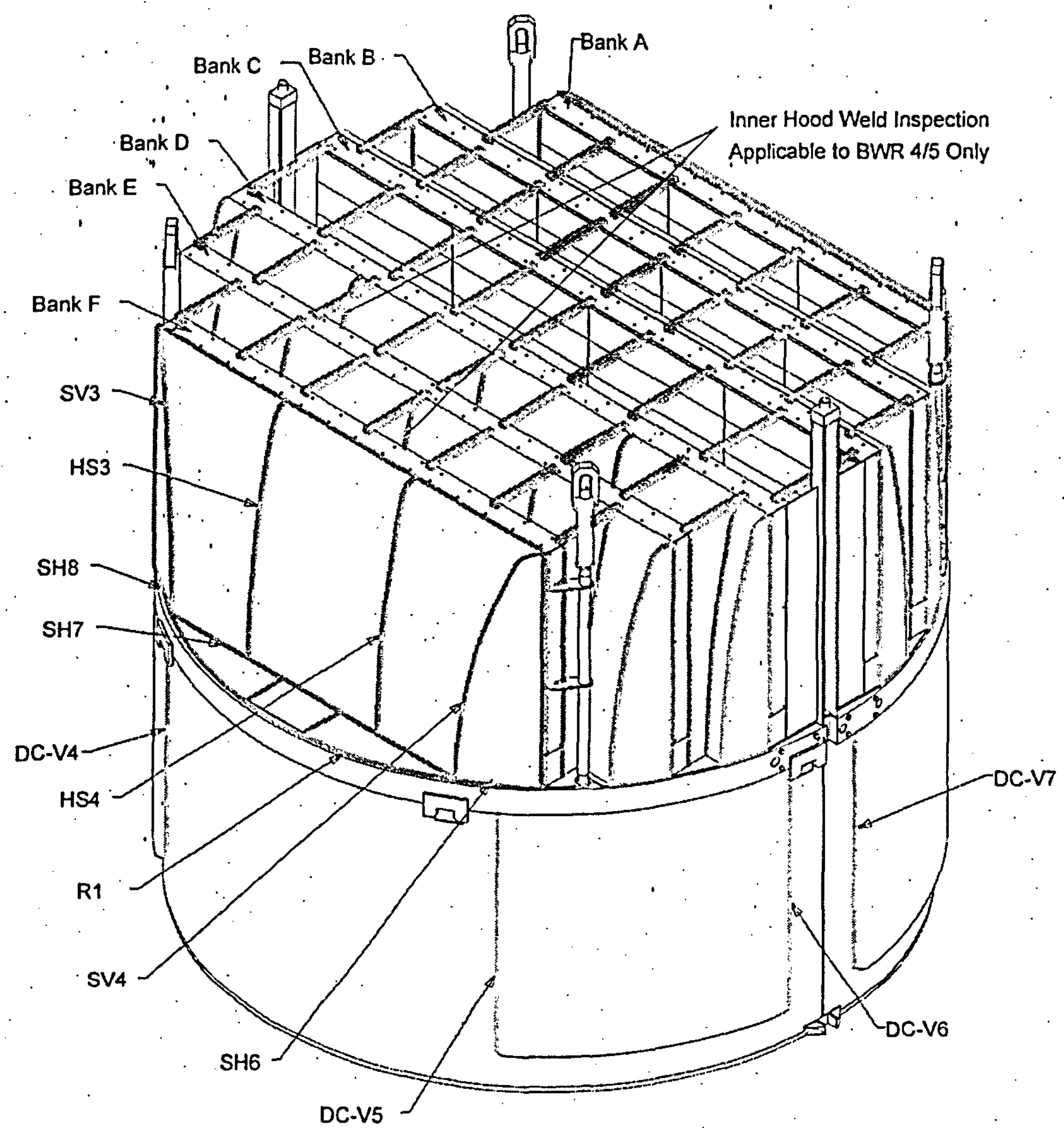


Figure C-11: Inspection Locations (Curved Hood Dryer)

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.