



UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
WASHINGTON, D.C. 20555-0001

June 24, 2016

Mr. Bryan C. Hanson  
President and Chief Nuclear Officer  
Exelon Nuclear  
Nine Mile Point Nuclear Station, LLC  
4300 Winfield Road  
Warrenville, IL 60555

SUBJECT: NINE MILE POINT NUCLEAR STATION, UNIT 2 – SUMMARY REPORT OF  
AUDIT REGARDING THE STEAM DRYER INSPECTION REPORT RESULTS  
(CAC NO. MF4559)

Dear Mr. Hanson:

By letter dated July 28, 2014 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML14216A347), Exelon Generation Company, LLC (the licensee), submitted the post-extended power uprate steam dryer inspection results for the Nine Mile Point Nuclear Station, Unit 2 (NMP2). The submittal was in accordance with operating license condition 2.C.(20)(f) of Renewed Facility Operating License No. NPF-69. In the review of the inspection results, the U.S. Nuclear Regulatory Commission (NRC) staff requested additional information from the licensee by letters dated August 13, 2014, and August 5, 2015 (ADAMS Accession Nos. ML14225A222 and ML15198A359, respectively). The licensee provided responses to those requests for additional information by letters dated January 14 and October 8, 2015 (ADAMS Accession Nos. ML15023A030 and ML15288A248, respectively). A clarification call was held on November 16, 2015, between the staff and the licensee to ensure staff understanding of the licensee's responses.

Portions of the letters dated January 14 and October 8, 2015, contain proprietary information and, accordingly, are withheld from public disclosure (ADAMS ML15027A258 and ML16153A007) pursuant to Section 2.390, "Public inspections, exemptions, requests for withholding," of Title 10 of the *Code of Federal Regulations* (10 CFR).

The NRC staff determined that an audit was necessary to support the staff assessment by providing greater understanding of vibration-induced loading as used in the NMP2 steam dryer stress analysis. The audit was conducted on February 18, 2016, at the facilities of Continuum Dynamics Inc., in Ewing Township, New Jersey, as described in the regulatory audit plan e-mailed to the licensee on February 12, 2016 (ADAMS Accession No. ML16147A087).

The NRC staff has determined that the enclosed audit summary contains proprietary information pursuant to 10 CFR 2.390. Accordingly, the NRC staff has also prepared a non-proprietary

Enclosure 2 contains Proprietary Information. When separated from Enclosure 2, this letter and Enclosure 1 is DECONTROLLED.
---

B. Hanson

- 2 -

version of the audit summary (Enclosure 1) that contains two open items for which the licensee agreed to provide a docketed response. The proprietary version of the audit summary is provided in Enclosure 2.

The NRC staff has determined that the licensee has met the reporting requirements in accordance with license condition 2.C.(20)(f). The staff has completed assessment of the inspection results and is closing CAC MF4559.

If you have any questions regarding this letter, I may be reached at 301-415-2020.

Sincerely,



Brenda L. Mozafari, Senior Project Manager  
Plant Licensing Branch I-1  
Division of Operating Reactor Licensing  
Office of Nuclear Reactor Regulation

Docket No. 50-410

Enclosures:

1. Regulatory Audit Summary (non-proprietary)
2. Regulatory Audit Summary (proprietary)

cc w/Enclosure 1: Distribution via Listserv

**OFFICIAL USE ONLY – PROPRIETARY INFORMATION**

STAFF AUDIT SUMMARY

EXELON GENERATION COMPANY, LLC

NINE MILE POINT NUCLEAR STATION, UNIT 2

POST-EXTENDED POWER UPRATE

STEAM DRYER INSPECTION RESULTS

DOCKET NO. 50-410

1.0 BACKGROUND

By letter dated July 28, 2014 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML14216A347), Exelon Generation Company, LLC (the licensee), submitted the post-extended power uprate steam dryer inspection results for the Nine Mile Point Nuclear Station, Unit 2 (NMP2). The submittal was in accordance with operating license conditions 2.C.(20)(f) and 2.C.(20)(g) of Renewed Facility Operating License No. NPF-69. In the review of the inspection results, the U.S. Nuclear Regulatory Commission (NRC) staff requested additional information from the licensee by letters dated August 13, 2014, and August 5, 2015 (ADAMS Accession Nos. ML14225A222 and ML15198A359, respectively). The licensee provided responses to those requests for additional information by letters dated January 14 and October 8, 2015 (ADAMS Accession Nos. ML15023A030 and ML15288A248, respectively). A clarification call was held on November 16, 2015, between the staff and the licensee to ensure staff understanding of the licensee's responses. The NRC staff conducted an audit on February 18, 2016, to support understanding of vibration-induced loading used in the steam dryer stress analysis.

Portions of the letters dated January 14 and October 8, 2015, contain proprietary information and, accordingly, are withheld from public disclosure (ADAMS ML15027A258 and ML16153A007) pursuant to Section 2.390, "Public inspections, exemptions, requests for withholding," of Title 10 of the *Code of Federal Regulations*.

1.1 Regulatory Audit Scope

In a note preceding its formal response to RAI-5 in its August 5, 2015, submittal, the licensee stated that the new [[ ]] coefficient that the NRC staff was requesting additional information about had been previously reviewed and accepted by the staff. The staff has reviewed the reports cited in the licensee's response, dated October 8, 2015, as clarified during a call on November 16, 2015, to include Report 07-11P. The staff found that theoretical estimates and test results in Report 07-11P only apply to areas where [[ ]]

]]. Additionally,

Enclosure 1

**OFFICIAL USE ONLY – PROPRIETARY INFORMATION**

the phenomenon that causes [[

]]. Report 07-17P describes the stress analysis for the Hope Creek (HC) dryer, but provides no discussion of [[ ]]. Report 07-27P includes in-air steam dryer damping measurements for the HC dryer, but again does not discuss [[ ]]. However, the HC dryer measurements show that in-air dryer damping is extremely small, much lower than the 1 percent (applied for in-service applications) recommended in Regulatory Guide (RG) 1.20, “Comprehensive Vibration Assessment Program for Reactor Internals During Preoperational and Initial Startup Testing,” for structural alternating stress evaluations.

The primary purpose of this audit, as described in the regulatory audit plan provided to the licensee by e-mail dated February 12, 2016 (ADAMS Accession No. ML16147A087), is to support the NRC staff assessment by providing greater understanding of [[

]] as used in the NMP2 steam dryer stress analysis. In Section 3.11 and Appendix A of Report 14-08P, Rev. 0, as provided by the licensee in its response dated January 14, 2015, a new [[ ]] loading component on the steam dryer was introduced, which was not considered in the original extended power uprate license amendment request. This loading, described in Appendix A, [[

]].

## 1.2 Audit Logistics

The audit was conducted on February 18, 2016, at the facilities of Continuum Dynamics Inc. (C.D.I.), in Ewing Township, New Jersey.

## 1.3 Audit Schedule

8:00 a.m. – 9:00 a.m.	Introductions and discussion of NRC staff concerns
9:00 a.m. – 10:30 a.m.	Licensee presentation
10:30 a.m. – 12:00 p.m.	NRC staff presentation
12:00 p.m. – 1:00 p.m.	Lunch
1:00 p.m. – 2:00 p.m.	Open discussion
2:30 p.m. – 3:00 p.m.	Closed discussion for NRC staff
3:00 p.m. – 4:30 p.m.	Discussion on proposed resolution and next steps

## 1.4 Team Assignments

The following NRC Staff members and consultants participated in the audit.

- Yong Li, NRC – Chief, Mechanical and Civil Engineering Branch
- Chakrapani Basavaraju, NRC – Technical Reviewer, Mechanical Engineer
- Ian Tseng, NRC – Technical Reviewer, Mechanical Engineer
- Vik Shah, Argonne National Laboratory – NRC Consultant (by teleconference)

- Steve Hambric, Penn State University – NRC Consultant
- Samir Ziada, McMaster University – NRC Consultant

2.0 TECHNICAL ISSUES REVIEWED AND DISCUSSED

2.1 Licensee Presentation

- After the C.D.I. Acoustic Circuit Model (ACM) error was corrected and updated, the code was rebenchmarked against Quad Cities Unit 2 (QC2) surface pressure data and reapplied to the NMP2 dryer. The updated loads led to significant alternating stress increases and reduced the corresponding Minimum Alternating Stress Ratios (MASRs) to below the required value of 2.0 for dryers where the fluctuating pressure loading on the dryer is inferred based on remote and indirect main steam line and steam generator data, and without end-to-end benchmarking.

- The licensee examined the QC2 data [[

]].

- The licensee claims this [[

]].

- The licensee assumes that the [[

]].

- When [[ ]] is applied, only the region near the top of the inner vane bank/side plate/tie-bar junction has MASRs less than the required 2.0. To address these low MASRs, the licensee installed U-brackets on the dryer to stiffen the structure, and to reduce those alternating stresses.

2.2 NRC Staff Presentation

- On-dryer strain gage spectra along with accompanying simulations assuming dryer damping of 1 percent, which show similar character, confirming the reasonableness of the RG 1.20 guidance.

- Operating on-dryer low-frequency strain gage spectra with narrow-frequency resolution, used to further confirm that individual resonance peaks have about 1 percent damping (estimated using the half-power bandwidth method).
- Estimates for actual radiation resistance (the same quantity postulated in the licensee's application of [[ ]]), using well-established methods, of panels with thicknesses, material properties, and dimensions similar to those of dryer panels, show values about an order of magnitude below the licensee's assumed values.

### 2.3 Open Discussion

- The NRC staff examined additional arguments and data presented by the licensee during the open discussion to attempt to justify the use of the originally proposed [[ ]] levels.
- The NRC staff noted that [[ ]], as provided in the licensee's presentation, is equivalent to increasing the structural damping well above the 1 percent allowable per RG 1.20, and significantly reduces the alternating stresses, thus increasing the MASRs. Based on information submitted by the licensee on October 8, 2015, when [[ ]] is not applied, approximately 50 percent of the reported peak dryer alternating stress regions have MASRs less than the required 2.0, and about 25 percent of the reported locations have MASRs less than 1.5.

### 3.0 OPEN ITEMS IDENTIFIED

- The staff found the information provided does not substantiate the application of [[ ]] as proposed by the licensee in its 2014 reports and 2015 RAI responses. Therefore, the MASRs computed without the use of [[ ]] are representative of the actual alternating stress state of the NMP2 dryer.
- In addition, the staff found that the reexamination of the NMP2 revised dryer loads presented in Appendix C of Report 14-09P, Rev. 1 show much lower than expected pressure loading spectra based on experience with similar sized plants and dryers. The licensee has agreed to check the accuracy of the plots provided in the report.

### 4.0 PROPOSED RESOLUTION OF OPEN ITEMS

The NRC staff and licensee discussed potential paths forward to ensure NMP2 steam dryer structural integrity in the future given that the current implementation of [[ ]] is not justified. Several options were considered, including:

**OFFICIAL USE ONLY – PROPRIETARY INFORMATION**

- 5 -

- Alternative approaches for accounting for [[ ]], including fully coupled analyses of the dryer structure and the internal and external steam. A fully coupled analysis would include the [[ ]] effects, including any [[ ]] on the dryer, along with [[ ]].
- An end-to-end on-dryer strain-based benchmarking, as used by Westinghouse Electric Company and General Electric-Hitachi (GEH) to qualify the dryers in other plants. The NRC staff and the licensee discussed the option of the licensee conducting a simulation of the QC2 surface strains, where end-to-end bias errors and uncertainties could be computed. The licensee noted that it is considering this option.
- The NMP2 dryer could be instrumented with strain gages and/or accelerometers, providing an optimal end-to-end benchmark. Benchmarking the NMP2 dryer would reduce the required MASR to 1.0. The licensee will examine this possibility, but stated that instrumenting existing dryers in operating plants with many years of service is challenging.
- The NMP2 dryer could be inspected for fatigue cracking beyond the current license condition, which requires one final inspection in April 2016, and beyond the inspection requirements of Boiling Water Reactor Vessel and Internals Project (BWRVIP)-139, “Steam Dryer Inspection and Flaw Evaluation Guidelines.” The NRC staff and licensee discussed the potential frequency and breadth of future dryer inspections at refueling outages. Since some of the fatigue loading acting on the dryer is low in excitation frequency (less than 1 Hertz), any fatigue cracking of dryer components is not expected to manifest until much later in the component’s operating life, thus future inspections may need to be carried out throughout the remaining life of the plant. The licensee noted it will consider additional inspections in the future, but proposes that a reduction in the frequency and breadth of inspections may be justified based on the following:
  - A mapping of current inspection locations compared with all dryer locations with alternating stress ratios (ASRs) less than 2.0 (to ensure all high-stress regions are covered in the inspections).
  - Histograms of alternating stresses based on 120 seconds of stress analysis for all dryer locations with ASRs less than 2.0 can be used to estimate the number of cycles and inspection frequency.

The licensee noted that the next steam dryer inspection is scheduled for April 2016, and that its path forward may depend on the outcome of that

**OFFICIAL USE ONLY – PROPRIETARY INFORMATION**

inspection. The licensee also noted that it will submit the list of targeted inspection locations of the dryer before the start of the steam dryer inspection.

- Additional inspections could be supplemented with more frequent moisture carryover checks. The licensee noted that current checks are performed monthly.

## 5.0 CONCLUSIONS

The audit provided a forum for focused discussion between the NRC staff and the licensee to discuss the theory and methodology behind [[ ]], and other aspects of the licensee's submittals. There was open communication throughout the audit and it was conducted in accordance with the audit plan. The staff identified two open items during this audit. First, the information submitted by the licensee in its 2014 reports and 2015 RAI responses and the licensee's presentation at the audit do not adequately substantiate the application of [[ ]] as proposed by the licensee. Therefore, at the current time, the staff recognizes the MASRs computed without the use of [[ ]] as representative of the actual alternating stress state of the NMP2 dryer. The acceptability of [[ ]] requires numerous additional analyses (e.g., coupled acoustic and structural analyses) and benchmarking. Second, discrepancies were found in plots of the steam dryer loads presented in a report the licensee submitted, which was reiterated during the licensee's presentation during the audit. After the identification of the open items, the discussion turned to the proposed resolution of open items, including a number of proposed additional analyses, plant modifications, or compensatory measures and actions that could offset the drop in analyzed margin.

The NRC staff has reviewed the two open items and determined that adequate assurance of the NMP2 steam dryer structural integrity is maintained despite the drop in stress margin that resulted from the licensee's revised analysis of the steam dryer. The staff's determination is based on the consideration that the MASRs in the licensee's updated steam dryer stress analysis still meet the American Society of Mechanical Engineers Section III Code requirements. The NRC staff has determined that the licensee has met the reporting requirements in accordance with license condition 2.C.(20)(f) for the first refueling outage post-extended power uprate implementation. As such, the staff has completed assessment of the inspection results and is closing CAC MF4559 with issuance of this summary. The staff is in the process of reviewing the inspection results submitted in accordance with license condition 2.C.(20)(g) for the second refueling outage. Resolution of the two open items identified is being addressed along with the staff review of the second inspection results under CAC MF7742.



~~OFFICIAL USE ONLY – PROPRIETARY INFORMATION~~

B. Hanson

- 2 -

version of the audit summary (Enclosure 1) that contains two open items for which the licensee agreed to provide a docketed response. The proprietary version of the audit summary is provided in Enclosure 2.

The NRC staff has determined that the licensee has met the reporting requirements in accordance with license condition 2.C.(20)(f). The staff has completed assessment of the inspection results and is closing CAC MF4559.

If you have any questions regarding this letter, I may be reached at 301-415-2020.

Sincerely,

*/RA/*

Brenda L. Mozafari, Senior Project Manager  
Plant Licensing Branch I-1  
Division of Operating Reactor Licensing  
Office of Nuclear Reactor Regulation

Docket No. 50-410

Enclosures:

1. Regulatory Audit Summary (non-proprietary)
2. Regulatory Audit Summary (proprietary)

cc w/Enclosure 1: Distribution via Listserv

DISTRIBUTION:

PUBLIC	RidsNrrDirRpb1	RidsRgn1MailCenter
LPL1-1 R/F	RidsNrrDorLPL1-1	DSchroeder, Region 1
RidsAcrs_MailCTR	RidsNrrLAKGoldstein	
RidsNrrDeEmcb	RidsNrrPMNineMilePoint	

ADAMS Accession Nos. Proprietary ML16146A208; Non-Proprietary ML16146A211 \*via email

OFFICE	NRR/DORL/LPL1-1/PM	NRR/DORL/LPL1-1/LA*	NRR/DE/EMCB/BC*
NAME	BMozafari	KGoldstein (JBurkhardt for)	YLi
DATE	5/27/16	5/26/16	5/25/16
OFFICE	NRR/DORL/LPL1-1/BC	NRR/DORL/LPL1-1/PM	
NAME	TTate	BMozafari	
DATE	6/24/16	6/24/16	

OFFICIAL AGENCY COPY