

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
ATOMIC SAFETY AND LICENSING BOARD

In the Matter of)	
)	Docket Nos.
)	50-247-LR
Entergy Nuclear Operations, Inc.)	and 50-286-LR
(Indian Point Nuclear Generating)	
Units 2 and 3))	June 9, 2015

**SUPPLEMENTAL PREFILED WRITTEN TESTIMONY OF DR.
JORAM HOPENFELD REGARDING CONTENTION NYS-38/RK-TC-5**

On behalf of Riverkeeper, Inc. (“Riverkeeper”), Dr. Joram Hopenfled submits the following supplemental testimony regarding the State of New York and Riverkeeper’s Joint Contention NYS-38/RK-TC-5, as amended.

Q. Please identify yourself.

My name is Dr. Joram Hopenfled and I am a nuclear engineer and currently the CEO and founder of Noverflo, Inc. I prepared prefiled direct written testimony on Contention NYS-38/RK-TC-5, which included my qualifications and was submitted in this proceeding on June 19, 2012.¹ I also prepared prefiled rebuttal written testimony on Contention NYS-38/RK-TC-5, which was submitted in this proceeding on November 9, 2012.² My *curriculum vitae*, which has previously been admitted as an exhibit in this proceeding (Exhibit RIV000004), fully describes my education, professional experience, and publications.

Q. Please state the purpose of your supplemental testimony.

A. Since the Atomic Safety and Licensing Board (“ASLB”) deferred Contention NYS-38/RK-TC-5 to hearing Track 2,³ and since the submission of my direct and rebuttal prefiled

¹ Prefiled Written Testimony of Dr. Joram Hopenfled Regarding NYS-38/RK-TC-5 (June 19, 2012) (Exhibit RIV000102).

² Prefiled Rebuttal Testimony of Dr. Joram Hopenfled Regarding NYS-38/RK-TC-5 (November 9, 2012) (Exhibit RIV000134).

³ See In the Matter of Entergy Nuclear Operations, Inc. (Indian Point Nuclear Generating Units 2 and 3), Docket Nos. 50-247-LR and 50-286-LR, ASLBP No. 07-858-03-LR-BD01, Order (Evidentiary Hearing Administrative Matters) (September 14, 2012), at 1.

1 testimonies in 2012, Entergy has undertaken certain additional analyses that are relevant to the
2 issues raised in Contention NYS-38/RK-TC-5. In addition, Riverkeeper and New York State
3 successfully raised additional bases to Contention NYS-38/RK-TC-5 after the issuance of
4 Supplement 2 to NUREG-1930, “Safety Evaluation Report Related to the License Renewal of
5 Indian Point Generating Unit Nos. 2 and 3” (Exhibit NYS000507) (“SSER2”) in November
6 2014.⁴ The purpose of this supplemental testimony is to respond to Entergy’s further analyses
7 and provide support for the recently admitted additional contention bases.

8
9 **Q. Please describe your understanding of what additional analyses Entergy undertook**
10 **after you submitted your prefiled direct and rebuttal testimonies related to Contention**
11 **NYS-38/RK-TC-5 in this proceeding.**

12 A. In connection with Entergy’s regulatory Commitment 43, Entergy’s vendor
13 Westinghouse conducted a screening analysis aimed to allegedly determine the most limiting
14 locations for fatigue evaluation purposes, as well as subsequent refined fatigue evaluations.⁵ In
15 addition, in connection with Entergy’s regulatory Commitment 49, the approval of which was
16 memorialized in the SSER2, Westinghouse conducted fatigue analyses related to reactor vessel
17 internal (RVI) components.⁶

18
19 **Q. Have you reviewed these additional analyses?**

20 A. Yes.

21
22 **Q. Have you reviewed anything else in connection with this supplemental testimony?**

23 A. Yes. In addition to the many documents I previously reviewed as described in my initial
24 and rebuttal testimonies related to Contention NYS-38/RK-TC-5, I have reviewed dozens of

⁴ See In the Matter of Entergy Nuclear Operations, Inc. (Indian Point Nuclear Generating Units 2 and 3), Docket Nos. 50-247-LR and 50-286-LR, ASLBP No. 07-858-03-LR-BD01, Memorandum and Order (Granting Motions for Leave to File Amendments to Contentions NYS-25 and NYS-38/RK-TC-5 (March 31, 2015).

⁵ Westinghouse, Indian Point Unit 2 and Unit 2 EAF Screening Evaluations, Calculation Note Number CN-PAFM-12-35 (November 2012), IPECPROP00072778 (Exhibit NYS000510); Westinghouse, Indian Point Unit 2 (IP2) and Unit 3 (IP3) Refined EAF Analyses and EAF Screening Evaluations, Calculation Note Number CN, PAFM-13-32 (August 2013), IPECPROP00078338 (Exhibit NYS000511).

⁶ See Westinghouse, Indian Point Unit 2 (IP2) and Unit 3 (IP3) Refined EAF Analyses and EAF Screening Evaluations, Calculation Note Number CN, PAFM-13-32 (August 2013), IPECPROP00078338 (Exhibit NYS000511).

1 documents identified and provided by Entergy as relevant to Contention NYS-38/RK-TC-5 that
2 were disclosed after the my initial submissions, NRC and Entergy correspondence, additional
3 NUREG reports, the SSER2, and additional scientific and scholarly reports, books, and articles.
4 I have used all these documents to inform me of the relevant facts and derive my conclusions.
5

6 **Q. Have you prepared an assessment relating to the additional analyses conducted by**
7 **Entergy described above?**

8 A. Yes, I have prepared a report related to Entergy's screening and refined fatigue analyses,
9 and the ongoing inadequacy of Entergy's aging management program; this report has been
10 marked and provided as Exhibit RIV000144, and reflects my analysis and opinions.
11

12 I relied on various documents in forming the opinions and conclusions in my report. Numerous
13 documents I have reviewed and relied upon in forming my opinions have been previously
14 submitted in this proceeding, and where discussed, are identified by their exhibit designations. I
15 have also relied on additional documents in forming my opinions; these documents have been
16 provided as Exhibits RIV000145 to RIV000160, or by New York State as NYS000490,
17 NYS000507, NYS000510, and NYS000511. To the best of my knowledge, these are all true and
18 accurate copies of each document that I used and/or relied upon in preparing this testimony.
19

20 **Q. Please describe how your supplemental report and analysis (RIV000144) relate to**
21 **your initial testimonies on Contention NYS-38/RK-TC-5.**

22 A. My initial testimonies on Contention NYS-38/RK-TC-5 related to Entergy's failure to
23 demonstrate that metal fatigue of reactor components will be adequately managed during the
24 proposed periods of extended operation at the plant as required by 10 C.F.R. § 54.21(c). In
25 particular, my testimony criticized Entergy's failure to expand the scope of its fatigue analysis,
26 and discussed Entergy's then-vague and inadequate commitment (regulatory Commitment 43) to
27 determine the most limiting locations for Indian Point Unit 2 (IP2) and Indian Point Unit 3 (IP3)
28 and to conduct environmentally corrected fatigue analyses for any such locations.⁷ My
29 testimony described what an analysis to determine the most limiting locations should entail, and

⁷ See Prefiled Written Testimony of Dr. Joram Hopenfeld Regarding NYS-38/RK-TC-5 (June 19, 2012), at 8-12 (Exhibit RIV000102).

1 I provided a list of components to be evaluated to determine whether they are the most limiting.⁸
2 After I submitted my earlier testimonies, Entergy did undertake a screening analysis in an
3 attempt to fulfill Commitment 43 and determine the most limiting locations at Indian Point, as
4 well as follow-up refined fatigue analyses.⁹ My report, RIV000144, assesses the adequacy of
5 those analyses and thereby builds upon and updates my previous testimony related to whether
6 Entergy has appropriately expanded the scope of its fatigue analysis for Indian Point.

7
8 **Q. What are your opinions on Entergy's additional fatigue evaluations, with respect to**
9 **Entergy's Commitment 43 to determine the most limiting locations and conduct refined**
10 **analysis for any such locations?**

11 A. In my supporting report, RIV000144, I conducted an extensive assessment of Entergy's
12 screening and refined fatigue evaluations. In brief summary, these analyses conducted on behalf
13 of Entergy for Indian Point were flawed in various respects. In particular, and as detailed in my
14 report, the screening and subsequent refined fatigue evaluations (1) failed to adequately consider
15 the impact of dissolved oxygen on fatigue life;¹⁰ (2) failed to consider synergistic aging effects
16 of radiation, thermal embrittlement, and stress corrosion cracking on fatigue life;¹¹ and (3)
17 improperly relied on CUF values of record without adequately accounting for changes in
18 geometry, surface finish, heat transfer, strain rate, and radiation.¹² Based on such a flawed
19 analysis, Entergy's efforts to expand the scope of its fatigue assessment was inadequate and
20 incomplete, and Entergy has continued to fail to conduct an appropriately expanded, bounding
21 analysis of the most limiting locations at Indian Point.¹³ Various components that are subject to
22 and may succumb to metal fatigue during the proposed periods of extended operation for Indian

⁸ *Id.* at 12-15.

⁹ Westinghouse, Indian Point Unit 2 and Unit 2 EAF Screening Evaluations, Calculation Note Number CN-PAFM-12-35 (November 2012), IPECPROP00072778 (Exhibit NYS000510); Westinghouse, Indian Point Unit 2 (IP2) and Unit 3 (IP3) Refined EAF Analyses and EAF Screening Evaluations, Calculation Note Number CN, PAFM-13-32 (August 2013), IPECPROP00078338 (Exhibit NYS000511).

¹⁰ Supplemental Report of Dr. Joram Hopenfeld in Support of Contention NYS-26/RK-TC-1B and Amended Contention NYS-38/RK-TC-5 (June 9, 2015), at § 2 (Exhibit RIV000144).

¹¹ *See id.* at § 3

¹² *Id.* at § 4.

¹³ *See id.* at § 5.

1 Point remain unanalyzed.¹⁴ And because the refined analyses that Entergy did conduct as a
2 follow-up to the screening assessment are so flawed, they fail to demonstrate that the
3 components Entergy *did* analyze will not exhaust their fatigue life— $CUF_{en} > 1.0$ —sometime
4 during the proposed extended periods of operation.¹⁵

5
6 **Q. What conclusions have you drawn related to Entergy’s additional fatigue**
7 **evaluations, with respect to Entergy’s Commitment 43 to determine the most limiting**
8 **locations and conduct refined analysis for any such locations?**

9 A. As discussed in my report, based on my review of Entergy’s screening and refined
10 fatigue analyses, Entergy has failed to adequately determine the most limiting locations for
11 Indian Point and to conduct the necessary expanded fatigue analysis for the plants.¹⁶ Also as I
12 discuss in my report, this failure represents a significant safety risk at Indian Point.¹⁷ It, thus,
13 remains my conclusion that Entergy has failed to demonstrate that metal fatigue will be
14 adequately managed at Indian Point during the proposed periods of extended operation.¹⁸

15
16 **Q. Have the opinions and conclusions you submitted in your earlier testimonies related**
17 **to Contention NYS-38/RK-TC-5 changed as a result of Entergy’s additional fatigue**
18 **evaluations?**

19 A. No, they have not. The analysis, opinions, and conclusions I discussed in my earlier
20 written testimonies remain valid and applicable, as Entergy has continued to fail to conduct an
21 appropriate expanded fatigue analysis.

22

¹⁴ *Id.*

¹⁵ *See id.* at §§ 2, 3, 4.

¹⁶ *See id.* at § 5, 6.

¹⁷ *Id.* at § 6.

¹⁸ *Id.* at 31-33.

1 **Q. Please describe how your supplemental report and analysis (RIV000144) relate to**
2 **the additional bases of Contention NYS-38/RK-TC-5 that were admitted by the ASLB on**
3 **March 31, 2015.¹⁹**

4 A. The amended bases of Contention NYS-38/RK-TC-5 that were advanced by the ASLB,
5 and for which I submitted an expert declaration, relate to Entergy's aging management plan for
6 RVI components. In particular, as memorialized in the SSER2, subsequent to the submission of
7 my earlier testimonies related to Contention NYS-38/RK-TC-5, Entergy expressed its intention
8 to rely on its Fatigue Monitoring Program (FMP) to manage the effects of fatigue on RVI
9 components at Indian Point during the periods of extended operation; in order to account for the
10 effects of the reactor coolant environment on the fatigue of RVI components as required under
11 the ASME Code Section III, Subsections NG-2160 and NG-3121, Entergy committed, in
12 regulatory Commitment 49, to recalculating CUF values for RVI components to include reactor
13 coolant environmental effects.²⁰ The supplemental bases of Contention NYS-38/RK-TC-5 that
14 were admitted into this proceeding contended, among other things, that Entergy's commitment to
15 recalculate the CUF values of RVI components to include reactor coolant environment effects
16 involved a flawed methodology that failed to accurately and fully account for environmental
17 effects, and, thus, assure that fatigue of such components will be adequately managed during the
18 period of extended operation.²¹ Entergy has conducted such fatigue evaluations for RVI
19 components,²² and my report, Exhibit RIV000144, assesses the adequacy of those analyses.

20
21 **Q. What are your opinions on Entergy's fatigue evaluations for RVI components, with**
22 **respect to Entergy's Commitment 49?**

23 A. In my supporting report, Exhibit RIV000144, I conducted an extensive assessment of
24 Entergy's fatigue evaluations related to RVI components. As discussed above, and detailed in

¹⁹ In the Matter of Entergy Nuclear Operations, Inc. (Indian Point Nuclear Generating Units 2 and 3), Docket Nos. 50-247-LR and 50-286-LR, ASLBP No. 07-858-03-LR-BD01, Memorandum and Order (Granting Motions for Leave to File Amendments to Contentions NYS-25 and NYS-38/RK-TC-5 (March 31, 2015).

²⁰ See NUREG-1930, Safety Evaluation Report Related to the License Renewal of Indian Point Nuclear Generating Unit Nos. 2 and 3, Supplement 2 (November 2014), at 3-51 to 3-52 (Exhibit NYS000507).

²¹ See Declaration of Dr. Joram Hopenfeld (February 12, 2015) at ¶¶ 10-18 (Exhibit RIV000148)

²² See Westinghouse, Indian Point Unit 2 (IP2) and Unit 3 (IP3) Refined EAF Analyses and EAF Screening Evaluations, Calculation Note Number CN, PAFM-13-32 (August 2013), IPECPROP00078338 (Exhibit NYS000511).

1 my expert report, these analyses conducted on behalf of Entergy for Indian Point were flawed in
2 various respects since they (1) failed to adequately consider the impact of dissolved oxygen on
3 fatigue life;²³ (2) failed to consider the effects of radiation and stress corrosion;²⁴ and (3)
4 improperly relied on CUF values of record without adequately accounting for changes in
5 geometry, surface finish, heat transfer, strain rate, and radiation.²⁵ Based on such a flawed
6 analysis, Entergy's evaluations related to RVI components are inaccurate and fail to demonstrate
7 that such components will not exhaust their fatigue life— $CUF_{en} > 1.0$ —sometime during the
8 proposed extended periods of operation.²⁶ Importantly, as I discuss in my report, Entergy's
9 flawed analysis represents a significant safety risk at Indian Point.²⁷

10
11 **Q. What conclusions have you drawn related to Entergy's fatigue evaluations for RVI**
12 **components?**

13 A. As discussed in my report, based on my review of Entergy's additional fatigue analyses
14 related to RVI components, it is my professional opinion that Entergy has failed to demonstrate
15 that the effects of metal fatigue on RVI components will be adequately managed at the Indian
16 Point facilities during the proposed period of extended operation.²⁸

17
18 **Q. Do you have any additional comments on Entergy's Commitment 49 for managing**
19 **the effects of fatigue on RVI components during the proposed periods of extended**
20 **operations?**

21 A. Yes. As I discussed in my supporting declaration to Riverkeeper and New York State's
22 amended contention, in Commitment 49 Entergy proposed (and NRC Staff agreed) that it need
23 not complete the calculation of CUFen values for IP3 RVI components until December 2015.²⁹
24 The schedule for Entergy's resolution of this issue extends beyond the time frame for the

²³ Supplemental Report of Dr. Joram Hopenfeld in Support of Contention NYS-26/RK-TC-1B and Amended Contention NYS-38/RK-TC-5 (June 9, 2015), at § 2 (Exhibit RIV000144).

²⁴ See *id.* at § 3.

²⁵ *Id.* at § 4.

²⁶ See *id.* at §§ 2, 3, 4, 6.

²⁷ *Id.* at § 6.

²⁸ *Id.* at 30-33.

²⁹ NUREG-1930, Safety Evaluation Report Related to the License Renewal of Indian Point Nuclear Generating Unit Nos. 2 and 3, Supplement 2 (November 2014), at A-15 (Exhibit NYS000507).

1 hearings in this ASLB proceeding and thus will not allow for a testing of the adequacy of the
2 proposed resolution of these issues in this proceeding. That timeline likely will prevent
3 Riverkeeper from playing any meaningful role in their development or resolution. Entergy's
4 commitment to complete CUFen evaluations for RVI components in the future, without review
5 by the public, the ASLB, and/or NRC Staff, is unacceptable. By merely making a future
6 commitment, it is not possible to fully determine the adequacy of the calculated CUFen values
7 and Entergy's AMP for RVI components. An adequate analysis must be performed *before* a
8 determination is made about license renewal. NRC Staff's acceptance of Entergy's commitment
9 49 in the SSER2 to conduct environmentally corrected metal fatigue evaluations for RVI
10 components at some time in the future is not warranted or acceptable. By failing to undertake
11 and complete an adequate CUFen analysis now and not in the future, Entergy has failed to
12 demonstrate that metal fatigue of RVI components will be adequately managed during the PEO.
13
14 Furthermore, Entergy has not yet developed inspection acceptance criteria for baffle former bolts
15 in either IP2 or IP3.³⁰ Instead, it has agreed to develop a technical justification including
16 acceptance criteria for baffle former bolts sometime prior to the first round of anticipated
17 inspections, which might not occur until 2019 for IP2 and 2021 for IP3 and would be after an
18 evidentiary hearing in this proceeding.³¹ The schedule for Entergy's resolution of this issue
19 extends beyond the time frame for the hearings in this ASLB proceeding and thus will not allow
20 for a testing of the adequacy of the proposed resolution of this issue in this proceeding. That
21 timeline likely will prevent Riverkeeper from playing any meaningful role in their development
22 or resolution.
23

24 **Q. Does this conclude your supplemental testimony regarding Contention NYS-38/RK-**
25 **TC-5?**

26 **A. Yes.**

³⁰ *Id.* at 3-20.

³¹ *Id.*

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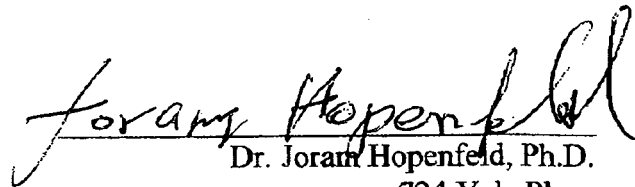
Entergy Nuclear Operations, Inc.)
(Indian Point Nuclear Generating)
Units 2 and 3))
_____)

Docket Nos.
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and 50-286-LR

DECLARATION OF DR. JORAM HOPENFELD

I, Joram Hopenfeld, do hereby declare under penalty of perjury that my statements in the foregoing testimony and my statement of professional qualifications are true and correct to the best of my knowledge and belief.

Executed in Accord with 10 C.F.R. § 2.304(d)


Dr. Joram Hopenfeld, Ph.D.

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June 8, 2015