

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-26B/RK-TC-1B**

On behalf of Riverkeeper, Inc. (“Riverkeeper”), Dr. Joram Hopenfeld submits the following supplemental testimony regarding the State of New York and Riverkeeper’s Joint Contention NYS-26B/RK-TC-1B.

1 **Q. Please identify yourself.**

2 My name is Dr. Joram Hopenfeld and I am a nuclear engineer and currently the CEO and
3 founder of Noverflo, Inc. I prepared prefiled direct written testimony on Contention NYS-
4 26B/RK-TC-1B, which included my qualifications and was submitted in this proceeding on
5 December 22, 2011.¹ I also prepared prefiled rebuttal written testimony on Contention NYS-
6 26B/RK-TC-1B, which was submitted in this proceeding on June 29, 2012, 2012.² My
7 *curriculum vitae*, which has previously been admitted as an exhibit in this proceeding (Exhibit
8 RIV000004), fully describes my education, professional experience, and publications.

9

10 **Q. Please state the purpose of your supplemental testimony.**

11 A. Since the Atomic Safety and Licensing Board (“ASLB”) deferred Contention NYS-
12 26B/RK-TC-1B to hearing Track 2,³ and since the submission of my direct and rebuttal prefiled

¹ Prefiled Written Testimony of Dr. Joram Hopenfeld Regarding NYS-26B/RK-TC-1B (December 22, 2011) (Exhibit RIV000034).

² Prefiled Rebuttal Testimony of Dr. Joram Hopenfeld Regarding NYS-26B/RK-TC-1B (June 29, 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 2011 and 2012, respectively, Entergy has undertaken certain additional analyses
2 that are relevant to the issues raised in Contention NYS-26B/RK-TC-1B. The purpose of this
3 supplemental testimony is to respond to Entergy's further analyses and update my previous
4 testimonies.

5
6 **Q. Please describe your understanding of what additional analyses Entergy undertook**
7 **after you submitted your prefiled direct and rebuttal testimonies related to Contention**
8 **NYS-26B/RK-TC-1B in this proceeding.**

9 A. In connection with Entergy's regulatory Commitment 43, Entergy's vendor
10 Westinghouse conducted a screening analysis aimed to allegedly determine the most limiting
11 locations for fatigue evaluation purposes, as well as subsequent refined fatigue evaluations.⁴ In
12 addition, in connection with Entergy's regulatory Commitment 49, the approval of which was
13 memorialized in the SSER2, Westinghouse conducted fatigue analyses related to reactor vessel
14 internal (RVI) components.⁵

15
16 **Q. Have you reviewed these additional analyses?**

17 A. Yes.

18
19 **Q. Have you reviewed anything else in connection with this supplemental testimony?**

20 A. Yes. In addition to the many documents I previously reviewed as described in my initial
21 and rebuttal testimonies related to Contention NYS-26B/RK-TC-1B, I have reviewed dozens of
22 documents identified and provided by Entergy as relevant to Contention NYS-26B/RK-TC-1B
23 that were disclosed after the my initial submissions, NRC and Entergy correspondence,
24 additional NUREG reports, the SSER2, and additional scientific and scholarly reports, books,
25 and articles. I have used all these documents to inform me of the relevant facts and derive my
26 conclusions.

⁴ 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).

⁵ 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

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

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

7

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

15

16 **Q. Please describe how your supplemental report and analysis (RIV000144) relate to**
17 **your initial testimonies on Contention NYS-26B/RK-TC-1B.**

18 A. My initial testimonies on Contention NYS-26B/RK-TC-1B related to Entergy's failure to
19 demonstrate that metal fatigue of reactor components will be adequately managed during the
20 proposed periods of extended operation at the plant as required by 10 C.F.R. § 54.21(c). In
21 particular, my testimony criticized Entergy's "refined" environmentally assisted fatigue (EAF)
22 evaluations conducted in 2010, which Entergy undertook due to results reported in its License
23 Renewal Application, in Tables 4.3-13 and 4.3-14, that the CUF_{en} values for four risk significant
24 reactor components would exceed unity during the proposed periods of extended operations; I
25 described various ways in which Entergy's refined 2010 analyses were highly flawed and
26 inaccurate, and not indicative of whether critical components would succumb to metal fatigue
27 during the proposed periods of extended operations.⁶ I further explained how Entergy does not
28 have an adequate program for managing the effects of metal fatigue during the proposed periods
29 of extended operation, since (1) its flawed 2010 fatigue calculations did not demonstrate that the

⁶ See Prefiled Written Testimony of Dr. Joram Hopenfeld Regarding NYS-26B/RK-TC-1B (December 22, 2011), at 6-20 (Exhibit RIV000034).

1 CUF_{enS} for the components evaluated will not exceed unity, (2) it failed to expand the scope of
2 the fatigue analysis beyond representative components, and (3) in the absence of a reliable and
3 complete assessment of CUF_{en} values for susceptible plant components, Entergy had failed to
4 define specific criteria concerning component inspection, monitoring, repair, and replacement.⁷
5

6 After I submitted my earlier testimonies, Entergy undertook additional fatigue analyses,
7 including a screening analysis aimed at determining the most limiting locations at Indian Point,
8 and follow-up refined fatigue analyses.⁸ My report, RIV000144, assesses the adequacy of those
9 analyses and thereby builds upon and updates my previous testimony related to the adequacy of
10 Entergy's program for managing metal fatigue at Indian Point during the proposed periods of
11 extended operation.
12

13 **Q. What are your opinions on Entergy's additional fatigue evaluations?**

14 A. In my supporting report, Exhibit RIV000144, I conducted an extensive assessment of
15 Entergy's screening and refined fatigue evaluations. In brief summary, these analyses conducted
16 on behalf of Entergy for Indian Point were flawed in various respects. In particular, and as
17 detailed in my report, the screening and subsequent refined fatigue evaluations (1) failed to
18 adequately consider the impact of dissolved oxygen on fatigue life;⁹ (2) failed to consider
19 synergistic aging effects of radiation, thermal embrittlement, and stress corrosion;¹⁰ and (3)
20 improperly relied on CUF values of record without adequately accounting for changes in
21 geometry, surface finish, heat transfer, strain rate, and radiation.¹¹ Based on such a flawed
22 analysis, Entergy's efforts to expand the scope of its fatigue assessment was inadequate and
23 incomplete, and Entergy has continued to fail to conduct an appropriately expanded, bounding

⁷ *Id.* at 20-22.

⁸ 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).

⁹ Supplemental Report of Dr. Joram Hopenfeld in Support of Contention NYS-26/RK-TC-1B and Amended Contention NYS-38/RK-TC-5 (June 8, 2015) at § 2 (Exhibit RIV000144).

¹⁰ *See id.* at § 3

¹¹ *Id.* at § 4.

1 analysis of the most limiting locations at Indian Point.¹² Various components that are subject to
2 and may succumb to metal fatigue during the proposed periods of extended operation for Indian
3 Point remain unanalyzed.¹³ And because the refined analyses that Entergy did conduct as a
4 follow-up to the screening assessment are so flawed, they fail to demonstrate that the
5 components Entergy *did* analyze will not exhaust their fatigue life— $CUF_{en} > 1.0$ —sometime
6 during the proposed extended periods of operation.¹⁴

7

8 **Q. What conclusions have you drawn related to Entergy's additional fatigue**
9 **evaluations?**

10 A. As discussed in my report, based on my review of Entergy's screening and refined
11 fatigue analyses, Entergy has continued to fail to demonstrate that metal fatigue will be
12 adequately managed at Indian Point during the proposed periods of extended operation. Entergy
13 has continued to employ a flawed methodology in calculating fatigue life and has produced
14 fatigue results that are not indicative and whether the CUF_{en} values for plant components will
15 actually exceed 1 during the proposed license renewal terms.¹⁵ Further, Entergy has failed to
16 adequately determine the most limiting locations for Indian Point and to conduct the necessary
17 expanded fatigue analysis for the plants.¹⁶ Moreover, Entergy's additional fatigue evaluations
18 included evaluations of fatigue of reactor vessel internal (RVI) components for the first time;
19 however, Entergy's deficient analysis extends equally to that analysis, and Entergy has failed to
20 demonstrate that the effects of metal fatigue on RVI components will be adequately managed at
21 the Indian Point facilities during the proposed period of extended operation.¹⁷ As I discuss in my
22 report, these various deficiencies represent a significant safety risk at Indian Point.¹⁸

23

¹² *See id.* at § 5.

¹³ *Id.*

¹⁴ *See id.* at §§ 2, 3, 4.

¹⁵ *See id. generally.*

¹⁶ *See id.* at § 5, 6.

¹⁷ *Id.* at §§ 2-6.

¹⁸ *Id.* at § 6.

1 **Q. Have the opinions and conclusions you submitted in your earlier testimonies related**
2 **to Contention NYS-26B/RK-TC-1B changed as a result of Entergy's additional fatigue**
3 **evaluations?**

4 A. No, they have not. The analysis, opinions, and conclusions I discussed in my earlier
5 written testimonies remain valid and applicable, as Entergy has continued to fail to conduct
6 appropriate fatigue analysis or demonstrate an adequate program for managing metal fatigue
7 during the proposed periods of extended operation. Based on my assessment, as detailed in my
8 accompanying report, I continue to conclude, as I did in my earlier testimony, that (1) Entergy's
9 fatigue calculations do not demonstrate that the CUF_{en} values for the components evaluated will
10 not exceed unity,¹⁹ (2) Entergy failed to appropriately expand the scope of the fatigue analysis,²⁰
11 and (3) in the absence of a reliable and complete assessment of CUF_{en} values for susceptible
12 plant components, Entergy had failed to define specific criteria concerning component
13 inspection, monitoring, repair, and replacement, or otherwise demonstrate that metal fatigue will
14 be sufficiently managed at Indian Point if the plant is relicensed.²¹

15

16 **Q. Does this conclude your supplemental testimony regarding Contention NYS-**
17 **26B/RK-TC-1B?**

18 A. Yes.

¹⁹ *Id.* at §§ 2-4.

²⁰ *Id.* at § 5.

²¹ *Id.* at § 6.

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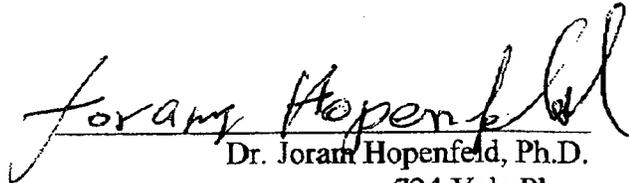
Entergy Nuclear Operations, Inc.)
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Units 2 and 3))
_____)

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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