

In the Matter of:

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



ASLBP #: 07-858-03-LR-BD01
Docket #: 05000247 | 05000286
Exhibit #: NYS000576-00-BD01
Admitted: 11/5/2015
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Stricken:

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UNITED STATES

NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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In re: Docket Nos. 50-247-LR; 50-286-LR
License Renewal Application Submitted by ASLBP No. 07-858-03-LR-BD01
Entergy Nuclear Indian Point 2, LLC, DPR-26, DPR-64
Entergy Nuclear Indian Point 3, LLC, and
Entergy Nuclear Operations, Inc. September 23, 2015
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PRE-FILED SUPPLEMENTAL TESTIMONY OF
DR. RICHARD T. LAHEY, JR.
REGARDING CONTENTIONS NYS-25,
NYS-26B/RK-TC-1B, AND NYS-38/RK-TC-5

On behalf of the State of New York ("NYS" or "the State"),
the Office of the Attorney General hereby submits the following
testimony by RICHARD T. LAHEY, JR., Ph.D. regarding Contention
NYS-25.

Q. Please state your full name.

A. Richard T. Lahey, Jr.

Q. Dr. Lahey, you have previously summarized your
educational and professional qualifications and submitted
testimony in this proceeding, correct?

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1 A. Yes. I previously have submitted testimony and
2 reports in this proceeding. My education and professional
3 qualifications and experience are described in my Curricula
4 Vitae and that testimony.

5 Q. I show you what has been marked as Exhibit NYS000574
6 and NYS000575. Do you recognize those documents?

7 A. Yes. These are copies of documents that Entergy
8 disclosed to the parties in this proceeding. The first document
9 is a report published by the USNRC and is entitled NUREG/CR-
10 7184, ANL-12/56, "Crack Growth Rate and Fracture Toughness Tests
11 on Irradiated Cast Stainless Steels," by Y. Chen, et al. The
12 second document is a report that is also published by the USNRC
13 entitled NUREG/CR-7185, ANL-14/10, entitled "Effects of Thermal
14 Aging and Neutron Irradiation on Crack Growth Rate and Fracture
15 Toughness of Cast Stainless Steels and Austenitic Stainless
16 Steel Welds," by O. K. Chopra, et al.

17 Q. In those titles, do you know what "ANL" signifies?

18 A. Yes. The abbreviation "ANL" stands for the Argonne
19 National Laboratories, and the designation "ANL-14/10" and "ANL-
20 12/56" signifies, in my experience, that the documents were
21 developed by Argonne National Laboratories for the USNRC.

22

1 Q. Does NUREG/CR-7184, ANL-12/56 (NYS000574) indicate
2 what the USNRC's role was, if any, in developing the document?

3 A. Yes. Among other things, the document's bibliographic
4 data sheet (frame 177) reports that the USNRC's Division of
5 Engineering was the "sponsoring organization."

6 Q. Does NUREG/CR-7185, ANL-14/10 (NYS000575) contain
7 similar information?

8 A. Yes, the cover page states that the document was
9 "prepared for" the USNRC's Division of Engineering, Office of
10 Nuclear Regulatory Research, and that A.S. Rao was the "USNRC
11 Technical Monitor and Project Manager."

12 Q. Have you now had an opportunity to review NYS000574
13 and NYS000575?

14 A. Yes.

15 Q. Have these documents caused you to change the
16 testimony and opinions that you have previously submitted in
17 this proceeding in connection with Contention NYS-25 and
18 Contention NYS-26B/RK-TC-1B or Contention NYS-38/RK-TC-5?

19 A. No. In fact, the documents support the concerns,
20 opinions, and testimony that I have presented in this
21 proceeding.

22 Q. Please explain.

1 A. The document, "Effects of Thermal Aging and Neutron
2 Irradiation on Crack Growth Rate and Fracture Toughness of Cast
3 Stainless Steels and Austenitic Stainless Steel Welds,"
4 [NUREG/CR-7185, ANL-14/10, NYS000575], contains analysis and
5 conclusions that are relevant to and supportive of the opinions
6 and testimony that I have presented. To briefly summarize,
7 among other things, the document reports that:

- 8 • Both CASS and austenitic stainless steel welds (but not the
9 heat affected zones (HAZ)) have a duplex structure (i.e.,
10 they contain both ferritic & austenite phases), and both
11 may experience thermal embrittlement (TE). This
12 degradation mechanism applies to CASS structures,
13 components and fittings and the stainless steel welds for
14 reactor vessel internals (RVIs);
- 15 • While thermal embrittlement (TE) may increase the hardness
16 and tensile strength of a material, it also decreases
17 ductility, fracture toughness (i.e., the resistance to
18 crack propagation), and, it decreases the impact strength
19 (i.e., due to significant shock loads) of CASS, its welds,
20 and the welds of austenitic stainless steel. In addition,
21 irradiation also causes embrittlement (IE) in these
22 components for fluences $> 2.0 \times 10^{20}$ n/cm² (i.e., material
23 damage > 10 dpa), and irradiation makes CASS, its welds,

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1 and the welds of austenitic stainless steel also more
2 susceptible to irradiation-assisted stress corrosion
3 cracking (IASCC);

- 4 • Significantly, IASCC increases the crack growth rate of
5 cracks induced by stress corrosion cracking. However, the
6 document also reports that there is virtually no data above
7 10 dpa -- even though during the period of extended
8 operation some of the reactor vessel internals may
9 experience several hundred dpa;
- 10 • Transgranular brittle cleavage was observed for embrittled
11 materials (and in particular for the CASS tests reported in
12 the other USNRC document, NUREG/CR-7184 [NYS000574];
- 13 • Possible synergy was noted between thermal embrittlement
14 and irradiation embrittlement, although the report stresses
15 the need for more information to develop reliable J-R
16 failure curves. The other USNRC document, NUREG/CR-7184,
17 also notes this same type of synergism.

18 Q. Do you believe that this report, NUREG/CR-7185, is
19 significant?

20 A. Yes, it is. As mentioned, this USNRC report supports
21 my opinions and testimony presented in this proceeding. In

1 addition, this report, which was prepared by Argonne National
2 Laboratories and the USNRC Staff, contains information that
3 I have not seen in previous USNRC reports. In particular, the
4 susceptibility of stainless steel welds to TE and, for the first
5 time ever, the detrimental effect of this embrittlement on
6 impact strength (i.e., for withstanding significant shock loads)
7 and the potential for brittle fracture due to various impulsive
8 loads.

9 Q. Can you summarize the other USNRC document, NUREG/CR-
10 7184, Exhibit NYS000574?

11 A. Yes. That document, "Crack Growth Rate and Fracture
12 Toughness Tests on Irradiated Cast Stainless Steels,"
13 [NYS000574], also contains analysis and conclusions that are
14 relevant to and supportive of the opinions and testimony that I
15 have presented. For example, as noted previously, the document
16 reports that for CASS materials, synergies exist between thermal
17 embrittlement (TE) and irradiation embrittlement (IE). Also, it
18 is significant that transgranular brittle cleavage was observed
19 for embrittled materials, as was ductile tearing (i.e.,
20 "dimpling").

21 Q. In your opinion, what is the significance of that
22 information?

1 A. The observation of both of these failure mechanisms
2 and the synergies between the various aging-related degradation
3 mechanisms is supportive of my previous opinions and testimony.
4 That is, realistic safety and fatigue analyses need to take into
5 account the age-related degradation of materials. For example,
6 the finding in NUREG/CR-7185 that CASS and austenitic stainless
7 steel welds are subject to thermal embrittlement (TE), and that
8 this reduces their impact strength, means that the welds
9 associated with the pressurizer spray nozzle, for example, are
10 particularly vulnerable to significant seismic and
11 thermal/pressure shock loads. Moreover, it appears that
12 vulnerability to early failure of the various RVI welds, which
13 are subject to TE, IE, IASCC, and shock loads, have not been
14 adequately analyzed.

15 Q. I show you what previously was marked as NYS00488A-B
16 and ask you to compare it to NYS000575.

17 A. NYS00488A-B is entitled "Crack Growth Rate and
18 Fracture Toughness Tests on Irradiated Cast Stainless Steels,"
19 NUREG/CR-7184, ANL-12/56 and it appears that this document is a
20 "revised manuscript" and it bears a manuscript date of December
21 2014. I referred to that earlier manuscript in my previous
22 testimony [e.g., NYS000482], and the State previously presented
23 the document as Exhibit 488. It appears that Argonne National

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1 Laboratory and the USNRC have subsequently made some edits and
2 republished the document, which is now NYS000574.

3 Q. It that the end of your supplementary testimony today?

4 A. Yes it is. However, I reserve the right to supplement
5 my testimony if new information is disclosed or introduced.

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11 **DECLARATION OF RICHARD T. LAHEY, JR.**

12 I, Richard T. Lahey, Jr., do hereby declare under penalty
13 of perjury that my statements in the foregoing testimony and my
14 statement of professional qualifications are true and correct to
15 the best of my knowledge and belief.

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



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18
19 Dr. Richard T. Lahey, Jr.

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