#### UNITED STATES OF AMERICA NUCLEAR REGULATORY COMMISSION

#### BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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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

March 22, 2013

#### ENTERGY'S PROPOSED FINDINGS OF FACT AND CONCLUSIONS OF LAW FOR CONSOLIDATED CONTENTION NYS-12C (SEVERE ACCIDENT MITIGATION ALTERNATIVES ANALYSIS)

William B. Glew, Jr., Esq.
William C. Dennis, Esq.
ENTERGY SERVICES, INC.
440 Hamilton Avenue
White Plains, NY 10601
Phone: (914) 272-3202
Fax: (914) 272-3205
E-mail: wglew@entergy.com
E-mail: wdennis@entergy.com

Kathryn M. Sutton, Esq. Paul M. Bessette, Esq. MORGAN, LEWIS & BOCKIUS LLP 1111 Pennsylvania Avenue, NW Washington, DC 20004 Phone: (202) 739-3000 Fax: (202) 739-3001 E-mail: ksutton@morganlewis.com E-mail: pbessette@morganlewis.com

Martin J. O'Neill, Esq. MORGAN, LEWIS & BOCKIUS LLP 1000 Louisiana Street Suite 4000 Houston, TX 77002 Phone: (713) 890-5710 Fax: (713) 890-5001 E-mail: martin.oneill@morganlewis.com

COUNSEL FOR ENTERGY NUCLEAR OPERATIONS, INC.

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Pursuant to 10 C.F.R. § 2.1209, and the Atomic Safety and Licensing Board's ("Board") February 28, 2013 Order,<sup>1</sup> Entergy Nuclear Operations, Inc. ("Entergy") submits its Proposed Findings of Fact and Conclusions of Law ("Proposed Findings and Conclusions") on New York State ("New York") Consolidated Contention NYS-12C ("NYS-12C").

The Proposed Findings and Conclusions are based on the evidentiary record in this proceeding, and are submitted in the form of a proposed Partial Initial Decision by the Board. The Proposed Findings and Conclusions are set out in numbered paragraphs, with corresponding citations to the record of this proceeding.

#### I. <u>INTRODUCTION</u>

1. This Partial Initial Decision presents the Board's Findings of Fact and Conclusions of Law on NYS-12C, which relates to Entergy's and the U.S. Nuclear Regulatory Commission's ("NRC" or "Commission") Staff's compliance with the National Environmental Policy Act ("NEPA"),<sup>2</sup> as implemented by the NRC's 10 C.F.R. Part 51 regulations. NYS-12C

<sup>&</sup>lt;sup>1</sup> Licensing Board Order (Granting Parties Joint Motion for Alteration of Filing Schedule) at 1 (Feb. 28, 2013) (unpublished).

<sup>&</sup>lt;sup>2</sup> 42 U.S.C. § 4321 *et seq.* (2006).

challenges the adequacy of Entergy's severe accident mitigation alternative ("SAMA") analysis for Indian Point Energy Center ("IPEC"), as reviewed and approved by NRC Staff in the December 2010 Final Supplemental Environmental Impact Statement ("FSEIS") for IPEC license renewal.<sup>3</sup> Specifically, NYS-12C alleges that Entergy and the NRC Staff have "significantly underestimated" the economic costs of a severe accident at IPEC by relying on computer code input values that are not specific to the uniquely urban area surrounding IPEC, and that do not sufficiently take into account the greater difficulty and costs of cleaning up "small-sized" radioactive particles released by a severe reactor accident.<sup>4</sup> As pursued at hearing, NYS-12C particularly focuses on the decontamination cost and decontamination time values (among other economic parameters) used by Entergy as inputs to the MELCOR Accident Consequence Code System Version 2 ("MACCS2"), the computer code which Entergy used to perform the offsite consequences portion of its SAMA analysis.<sup>5</sup>

2. Having considered all of the record evidence, the Board concludes that the contested SAMA analysis computer code inputs are reasonable and appropriate, as judged under NEPA's "rule of reason"<sup>6</sup> and given the NRC's and industry's current state of knowledge and practice regarding SAMA analyses and other severe accident consequence assessments. Moreover, the Board concludes that New York's criticisms of Entergy's MACCS2 inputs (including New York's proposed alternative input values) do not "credibly render the SAMA

<sup>&</sup>lt;sup>3</sup> NUREG-1437, Supp. 38, Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Regarding Indian Point Nuclear Generating Unit Nos. 2 and 3, Final Report (Dec. 2010) (NYS00133A-J) ("FSEIS").

<sup>&</sup>lt;sup>4</sup> State of New York Initial Statement of Position [on] Consolidated Contention NYS-12C at 3, 37 ("New York Position Statement") (NYS000240).

<sup>&</sup>lt;sup>5</sup> See Official Transcript of Proceedings, Indian Point Nuclear Generating Units 2 & 3 at 2054:23-2055:4 (Lemay) (Oct. 17, 2012) ("Oct. 17, 2012 Tr.").

<sup>&</sup>lt;sup>6</sup> Entergy Nuclear Generation Co. (Pilgrim Nuclear Power Station), CLI-10-22, 72 NRC 202, 208 (2010) (citing Communities, Inc. v. Busey, 956 F.2d 619, 626 (6th Cir. 1992)).

analysis altogether unreasonable under NEPA standards."<sup>7</sup> Nor, in the Board's view, do they support a finding that there are additional potentially cost-beneficial SAMA candidates beyond those identified in the Staff's FSEIS.<sup>8</sup>

3. Accordingly, the Board finds that the NRC Staff and Entergy have carried their respective burdens of proof on this contention, and resolves NYS-12C in their favor. The Board further finds that the NRC Staff's reliance upon Entergy's SAMA analysis in satisfaction of its obligations under NEPA and 10 C.F.R. Part 51 is reasonable. In accordance with well-established NRC adjudicatory practice, the FSEIS is deemed supplemented by this decision.<sup>9</sup>

#### II. PROCEDURAL HISTORY OF CONTENTION NYS-12C

#### A. The Indian Point License Renewal Application and Original Contention NYS-12

4. On April 23, 2007, Entergy applied to the NRC to renew the Indian Point Unit 2

and Unit 3 ("IP2" and "IP3") operating licenses for twenty years beyond their current expiration dates of September 28, 2013, and December 12, 2015, respectively.<sup>10</sup> As required by 10 C.F.R. § 51.53(c)(3)(ii)(L),<sup>11</sup> Entergy included in its associated Environmental Report ("ER") a SAMA

Entergy Nuclear Generation Co. (Pilgrim Nuclear Power Station), CLI-12-01, 75 NRC \_\_, slip op. at 25 (Feb. 9, 2012).

<sup>&</sup>lt;sup>8</sup> See NUREG-1437, Supp. 38, Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Regarding Indian Point Nuclear Generating Unit Nos. 2 and 3, Final Report, App. G at G-36 to G-38 (Dec. 2010) ("FSEIS") (NYS00133I).

<sup>&</sup>lt;sup>9</sup> Pilgrim, CLI-12-01, slip op. at 30 (citation omitted) ("In an NRC adjudicatory proceeding, the adjudicatory record, Board decision, and any Commission decision become effectively part of the environmental review document (here, a final supplemental EIS). Therefore, the SEIS is deemed supplemented by the Board's decision, and by this decision."). This issue is discussed further in Section III.D below.

<sup>&</sup>lt;sup>10</sup> Entergy Nuclear Operations, Inc., Indian Point Nuclear Generating Unit Nos. 2 and 3; Notice of Acceptance for Docketing of the Application and Notice of Opportunity for Hearing Regarding Renewal of Facility Operating License Nos. DPR-26 and DPR-64 for an Additional 20-Year Period, 72 Fed. Reg. 42,134 (Aug. 1, 2007) ("Hearing Notice").

<sup>&</sup>lt;sup>11</sup> 10 C.F.R. § 51.53(c)(3)(ii)(L) requires that an applicant's ER contain a SAMA analysis, "[i]f staff has not previously considered severe accident mitigation alternatives for the applicant's plant in an environmental impact statement or related supplement or in an environmental assessment." At the time the NRC imposed this requirements, only three facilities had considered severe accident mitigation alternatives in connection with their initial operating licenses (Limerick, Comanche Peak, and Watts Bar).

analysis for IP2 and IP3.<sup>12</sup> As discussed in Section II.B below, Entergy later submitted a revised SAMA analysis for IPEC in December 2009.<sup>13</sup>

5. In preparing the IPEC SAMA analysis, Entergy used methodologies that have been used by numerous other license renewal applicants and that are consistent with those described in NRC-approved guidance.<sup>14</sup> That guidance endorses using the MACCS2 computer code to estimate the offsite dose and economic impacts that result from postulated radioactive material releases to the environment.<sup>15</sup> The Commission has described MACCS2, which is commonly used by license renewal applicants, as the "most current, established code for NRC SAMA analysis."<sup>16</sup>

6. A SAMA analysis is part of the NRC's license renewal review under NEPA.<sup>17</sup>

SAMA analyses, however, do not represent the NRC's NEPA analysis of potential severe

accident *impacts*.<sup>18</sup> The NRC's GEIS for license renewal generically evaluates severe accident

impacts and provides the technical basis for the NRC's conclusion in 10 C.F.R. Part 51 that "the

probability-weighted consequences of atmospheric releases, fallout onto open bodies of water,

<sup>&</sup>lt;sup>12</sup> See generally Indian Point Energy Center License Renewal Application, App, E, Applicant's Environmental Report, Operating License Renewal Stage, Indian Point Energy Center at 4-47 to -78, E-I to E.4-82 (Apr. 2007) ("ER") (ENT000015B).

<sup>&</sup>lt;sup>13</sup> See NL-09-165, Letter from Fred Dacimo, Entergy, to NRC, License Renewal Application - SAMA Reanalysis Using Alternate Meteorological Tower Data, Indian Point Nuclear Generating Units Nos. 2 and 3 (Dec. 11, 2009) ("NL-09-165") (ENT000009).

<sup>&</sup>lt;sup>14</sup> See NEI 05-01, Rev. A, Severe Accident Mitigation Alternatives (SAMA) Analysis, Guidance Document (Nov. 2005) ("NEI 05-01") (NYS000287) (endorsed by the NRC Staff in Final License Renewal Interim Staff Guidance LR-ISG-2006-03: Staff Guidance for Preparing Severe Accident Mitigation Alternatives Analyses at 45467 (Aug. 2007 (ENT000451)).

<sup>&</sup>lt;sup>15</sup> See Entergy Nuclear Generation Co. (Pilgrim Nuclear Power Station), CLI-10-11, 71 NRC 287, 291(2010) (citing NEI 05-01 (NYS000287)).

<sup>&</sup>lt;sup>16</sup> *Pilgrim*, CLI-10-22, 72 NRC at 208.

<sup>&</sup>lt;sup>17</sup> *Pilgrim*, CLI-12-01, slip op. at 2 (citing 10 C.F.R. § 51.53(c)(3)(ii)(L)).

<sup>&</sup>lt;sup>18</sup> A severe accident is a beyond design-basis accident involving "multiple failures of equipment or function, whose likelihood is generally lower than that design-basis accidents but where consequences may be higher." NUREG-1437, Volumes 1 and 2, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants," at Vol. 1 at 5-1 (May 1996) ("GEIS") (NYS00131C).

releases to groundwater, and societal and economic impacts from severe accidents are *small* for all plants."<sup>19</sup> The GEIS thus addresses the impacts of severe accidents generically in bounding fashion.<sup>20</sup>

7. By way of comparison, a SAMA analysis is a *site-specific* environmental mitigation analysis performed under NEPA.<sup>21</sup> It is conducted to identify additional mitigation measures—procedure or hardware changes—that may be cost-beneficial to implement at a nuclear power plant to further reduce the already very low risk (probability or consequences) of a severe accident.<sup>22</sup> It also is a probabilistic risk assessment ("PRA") because it examines the probability of various hypothesized accident scenarios, spanning a spectrum of potential initiating events, accident sequences, and severity of consequences.<sup>23</sup> As a NEPA mitigation analysis, the SAMA analysis is judged under NEPA's "rule of reason."<sup>24</sup> As such, it is not based on best-case or worst-case accident scenarios.<sup>25</sup> Rather, a SAMA analysis estimates mean accident consequence values (both offsite population dose and economic costs), which are averaged over many hypothetical severe accident scenarios and over the examined 50-mile radius region surrounding the plant.<sup>26</sup>

<sup>21</sup> NextEra Energy Seabrook, LLC (Seabrook Station, Unit 1), CLI-12-05, 75 NRC \_\_, slip. op. at 27 (Mar. 8, 2012).

<sup>&</sup>lt;sup>19</sup> *Id.* at 5-115 (emphasis added).

<sup>&</sup>lt;sup>20</sup> Pilgrim, CLI-12-15, slip op. 5-6 ("SAMA analysis must also be understood against the backdrop of our Generic Environmental Impact Statement (GEIS), which contains a bounding, generic severe accident impacts analysis, applicable to all plants.").

<sup>&</sup>lt;sup>22</sup> *See id.* 

<sup>&</sup>lt;sup>23</sup> *Pilgrim*, CLI-12-15, slip op. at 3.

See Duke Energy Corp. (McGuire Nuclear Station, Units 1 & 2; Catawba Nuclear Station, Units 1 & 2), CLI-02-17, 56 NRC 1, 12 (2002) (citing Vt. Yankee Nuclear Power Corp v. Natural Res. Def. Council, Inc., 435 U.S. 519, 551 (1978); Citizens Against Burlington v. Busey, 938 F.2d 190, 195 (D.C. Cir. 1991)).

<sup>&</sup>lt;sup>25</sup> *Id.* at 5.

<sup>&</sup>lt;sup>26</sup> Pilgrim, CLI-12-01, slip op. at 20. Specifically, "[t]he analysis uses the 'mean values' of the accident consequence distributions for each accident category. These mean values 'are multiplied by the estimated frequency' of the accident 'to determine population dose risk and offsite economic cost risk for each release

8. On August 1, 2007, the NRC published a "Notice of Acceptance for Docketing of the Application and Notice of Opportunity for Hearing," in the *Federal Register*.<sup>27</sup> The Hearing Notice explicitly clarified that proposed contentions "shall be limited to matters within the scope of [license renewal]."<sup>28</sup> It also stated that any person whose interest would be affected by the proceeding and who wished to participate as a party in the proceeding must file a petition for leave to intervene within sixty days of the Notice (*i.e.*, October 1, 2007).<sup>29</sup> On October 1, 2007, the Commission extended the period for filing requests for hearing until November 30, 2007.<sup>30</sup>

9. In response to the Hearing Notice, New York filed a petition to intervene on November 30, 2007, in which it proposed various contentions, including NYS-12, the contention at issue here.<sup>31</sup> As originally proffered, NYS-12 alleged that Entergy's SAMA analysis is deficient because MACCS2 underestimates the costs of a severe accident due to its use of decontamination and clean-up costs that are based on "large-sized" radionuclides.<sup>32</sup> New York asserted that a nuclear power plant severe accident likely would result in the dispersion of "small-sized radionuclides" that are more expensive to clean-up than the large-sized radionuclide particles purportedly assumed in Entergy's SAMA analysis.<sup>33</sup> As principal support for this argument, New York cited the 1996 Site Restoration Report, which examined the potential

<sup>29</sup> *Id.* at 42,134.

<sup>32</sup> See id. at 140-45.

<sup>33</sup> See id. at 140-41.

category studied."" *Id.* (citation omitted). Section IV.B of this decision discusses the SAMA analysis methodology in further detail.

<sup>&</sup>lt;sup>27</sup> Hearing Notice, 72 Fed. Reg. at 42,134.

<sup>&</sup>lt;sup>28</sup> *Id.* at 42,135.

<sup>&</sup>lt;sup>30</sup> Entergy Nuclear Operations, Inc., Indian Point Nuclear Generating Unit Nos. 2 and 3; Notice of Opportunity for Hearing Regarding Renewal of Facility Operating License Nos. DPR-26 and DPR-64 for an Additional 20-Year Period: Extension of Time for Filing of Requests for Hearing or Petitions for Leave To Intervene in the License Renewal Proceeding, 72 Fed. Reg. 55,834 (Oct. 1, 2007).

<sup>&</sup>lt;sup>31</sup> *See* New York State Notice of Intention to Participate and Petition to Intervene (Nov. 30, 2007) ("New York Petition"), *available at* ADAMS Accession No. ML073400187.

economic costs that the federal government might face "if *weapons-related nuclear material* in its custody became involved in an accident culminating in the release of *plutonium* to the environment."<sup>34</sup> In particular, the report focused "on the directly attributable costs that might be faced by the government in compensating property owners for loss or damage and in restoring an accident site."<sup>35</sup>

10. New York argued that the IPEC SAMA analysis should incorporate the "analytical framework" contained in the Site Restoration Report as well as recent studies examining the cost consequences of accidents in the New York metropolitan area.<sup>36</sup> It claimed that the Site Restoration Report recognized that earlier estimates of decontamination costs are incorrect because they are based on studies of nuclear weapons that produce large particles.<sup>37</sup>

11. Entergy opposed the admission of NYS-12, arguing that it presented a generic challenge to the MACCS2 computer code used to perform the IPEC SAMA analysis, lacked adequate factual or expert opinion support, and failed to controvert specific portions of the license renewal application.<sup>38</sup> The NRC Staff also opposed the admission of NYS-12. The Staff contended that New York had not established the relevance of the Site Restoration Report, noting that the report relates to the dispersion of plutonium from a nuclear weapon as opposed to radionuclide releases from a nuclear power plant severe accident.<sup>39</sup> It also argued that New York

<sup>&</sup>lt;sup>34</sup> Site Restoration Report at viii (NYS000249) (emphasis added).

<sup>&</sup>lt;sup>35</sup> *Id*.

<sup>&</sup>lt;sup>36</sup> New York Petition at 142 (citing 1996 Site Restoration Report (NYS000249)).

<sup>&</sup>lt;sup>37</sup> See id. at 143.

<sup>&</sup>lt;sup>38</sup> Answer of Entergy Nuclear Operations, Inc. Opposing New York State's Petition to Intervene and Request for Hearing at 86-91 (Jan. 22, 2008) ("Entergy Answer"), *available at* ADAMS Accession No. ML080300149.

<sup>&</sup>lt;sup>39</sup> NRC Staff's Response to Petitions for Leave to Intervene Filed by (1) Connecticut Attorney General Richard Blumenthal, (2) Connecticut Residents Opposed to Relicensing of Indian Point, and Nancy Burton, (3) Hudson River Sloop Clearwater, Inc., (4) The State of New York, (5) Riverkeeper, Inc., (6) The Town of Cortlandt, and (7) Westchester County, at 50-51 (Jan. 22, 2008) ("NRC Staff Answer"), *available at* ADAMS Accession No. ML080230543.

had failed to show how the MACCS2 code is defective, or how the Site Restoration Report presents a superior alternative or methodology.<sup>40</sup>

12. In reply, New York acknowledged that the Site Restoration Report focuses on nuclear weapon plutonium dispersal events, but maintained that the report is still a relevant source of information on post-accident decontamination costs.<sup>41</sup> New York also disputed Entergy's claims that NYS-12 is a generalized attack on the MACCS2 code, arguing that it instead "focuses on particular aspects of the MACCS2 code that mis-represent the post-accident consequences of a severe accident, thus distorting the SAMA analysis of the damages such an accident would cause."<sup>42</sup>

13. The Board heard oral argument on whether NYS-12 and New York's other proposed contentions met the Commission's contention admissibility requirements on March 11, 2008, in White Plains, New York.<sup>43</sup> Thereafter, on July 31, 2008, the Board admitted NYS-12 to the extent that it "challenges the cost data for decontamination and cleanup used by MACCS2."<sup>44</sup> In doing so, we stated that NYS-12 is neither a challenge to the acceptability of using the MACCS2 computer program nor a direct challenge to MACCS2 itself.<sup>45</sup> Rather, we viewed the contention as questioning whether "specific inputs" and "assumptions" made in MACCS2 SAMA analyses are correct for the area surrounding Indian Point.<sup>46</sup>

<sup>&</sup>lt;sup>40</sup> *Id.* at 51.

<sup>&</sup>lt;sup>41</sup> New York State Reply in Support of Petition to Intervene at 78 (Feb. 22, 2008), *available at* ADAMS Accession No. ML080600444.

<sup>&</sup>lt;sup>42</sup> *Id.* at 79.

<sup>&</sup>lt;sup>43</sup> Official Transcript of Proceedings, Indian Point Nuclear Generating Units 2 & 3 (Mar. 11, 2008).

<sup>&</sup>lt;sup>44</sup> See Entergy Nuclear Operations, Inc. (Indian Point Nuclear Generating Units 2 & 3), LBP-08-13, 68 NRC 43, 102 (2008).

<sup>&</sup>lt;sup>45</sup> *Id*.

<sup>&</sup>lt;sup>46</sup> *Id.* The Board concluded that "[q]uestions raised in this contention relating to cleanup and decontamination costs based on the validity of assumptions used with the code should appropriately be resolved at the hearing." *Id.* 

#### B. <u>The NRC Staff's Environmental Review and Amended Contentions NYS-</u> <u>12A/12B/12C</u>

#### 1. Draft Supplemental Environmental Impact Statement and Amended Contention NYS-12A

14. As required by NEPA and 10 C.F.R. Part 51, the NRC Staff comprehensively reviewed Entergy's license renewal application. The NRC Staff initiated that process by publishing a notice of intent to prepare a plant-specific supplement to the GEIS (*i.e.*, a supplemental environmental impact statement or "SEIS") and to conduct related environmental scoping activities.<sup>47</sup>

15. As part of that process, the NRC Staff conducted environmental site audits at Indian Point from September 10-14, 2007, and from September 24-27, 2007, which allowed the NRC Staff to tour the site, examine the data Entergy used in preparing the ER, and meet with Entergy personnel and representatives from federal, state, and local government agencies to obtain relevant information.<sup>48</sup>

16. The NRC also invited the applicant, federal, state, local, and tribal government agencies, local organizations, and individuals to participate in the scoping process by providing oral comments at scheduled public meetings and/or submitting written suggestions and comments.<sup>49</sup> The scoping process included two public meetings held on September 19, 2007, in Cortlandt Manor, New York.<sup>50</sup> Following the NRC Staff's prepared statements, the meetings

<sup>50</sup> *See id.* 

<sup>&</sup>lt;sup>47</sup> Entergy Nuclear Operations, Inc., Indian Point Nuclear Generating Unit Nos 2 and 3; Notice of Intent to Prepare an Environmental Impact Statement and Conduct Scoping Process, 72 Fed. Reg. 45,075 (Aug. 10, 2007). 10 C.F.R. § 51.20(b)(2) requires the NRC to prepare an EIS or SEIS for renewal of a reactor operating license. In addition, Section 51.95(c) states that the EIS prepared at the operating license renewal stage will be a supplement to the GEIS (NYS00131A-I).

<sup>&</sup>lt;sup>48</sup> See FSEIS at xv (NYS00133A).

<sup>&</sup>lt;sup>49</sup> See Environmental Impact Statement Scoping Process Summary Report Indian Point Nuclear Generating Station Unit Nos. 2 and 3 Village of Buchanan, New York at 1 (Dec. 2008) (NRCR00139).

were open for public comments.<sup>51</sup> The Staff received hundreds of written and oral comments during the scoping process.<sup>52</sup>

17. In addition to its participation in the adjudicatory process, New York also participated in the environmental scoping process. On October 31, 2007, New York submitted numerous comments concerning the scope of the IPEC Draft Supplemental Environmental Impact Statement ("DSEIS") and various aspects of the NRC Staff's environmental review.<sup>53</sup> In one comment, New York stated that the Staff's NEPA review should address whether the plume model used in the SAMA analysis "is sufficiently accurate for use in computing the health and safety consequences of an accident, as an *environmental* issue."<sup>54</sup> New York did not mention issues related to decontamination costs, as assessed by MACCS2 or in a SAMA analysis.

18. A month later, on November 30, 2007, New York supplemented its scoping comments, generally echoing the issues raised in proposed Contention NYS-12.<sup>55</sup>

19. Concurrently, the NRC Staff proceeded with its NEPA review. In preparing its DSEIS for IP2 and IP3, the NRC Staff reviewed the IPEC ER and compared it to the GEIS; consulted with numerous federal, state, regional, and local agencies, and Native American Tribes agencies (as listed in Appendix D to the DSEIS); conducted an independent review of the issues in accordance with the guidance in NUREG-1555 (the Staff's Environmental Standard Review

<sup>&</sup>lt;sup>51</sup> See id.

<sup>&</sup>lt;sup>52</sup> See id. at 3-15.

<sup>&</sup>lt;sup>53</sup> See New York State Executive Agencies and the Department of Law Scoping Comments on the License Renewal of Indian Point Units 2 and 3, Buchanan, New York (Oct. 31, 2007) (NRC000135).

<sup>&</sup>lt;sup>54</sup> See *id.* at 16 (emphasis in original).

<sup>&</sup>lt;sup>55</sup> See New York State Supplemental Submission Concerning NEPA Scoping on the License Renewal of Indian Point Units 2 and 3, Buchanan, New York at 2-4 (Nov. 30, 2007) (NRC000145).

Plan for license renewal applications); issued to Entergy detailed requests for additional information ("RAIs"); and considered public comments received during the scoping process.<sup>56</sup>

20. Based on its initial review of the SAMA analysis, the Staff issued SAMA-specific RAIs to Entergy in December 2007<sup>57</sup> and April 2008.<sup>58</sup> Entergy responded to the Staff's RAIs in letters dated February 5, 2008, and May 22, 2008.<sup>59</sup> Entergy's responses resulted in the identification of several additional potentially cost-beneficial SAMAs as well as the elimination of one previously-identified cost-beneficial SAMA.<sup>60</sup>

21. Relevant here, in SAMA RAI 4, the Staff requested that Entergy briefly describe key MACCS2 input assumptions that contribute to the offsite economic cost risk, including the non-farm area decontamination cost input, and to "[j]ustify that the input values used for these parameters are reasonable for the Indian Point site/region."<sup>61</sup> As discussed further below,

<sup>&</sup>lt;sup>56</sup> See NUREG-1437, Supp. 38, Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Regarding Indian Point Nuclear Generating Unit Nos. 2 and 3, Draft Report for Comment at xiii (Dec. 2008) ("DSEIS") (NYS00132A-D).

<sup>&</sup>lt;sup>57</sup> Letter from Jill Caverly, Environmental Project Manager, NRC, to Michael A. Balduzzi, Sr. Vice President and COO, Entergy Nuclear Operations, Inc., Request for Additional Information Regarding Severe Accident Mitigation Alternatives for Indian Point Nuclear Generating Unit Nos. 2 and 3 License Renewal (Dec. 7, 2007), available at ADAMS Accession No. ML073110447.

<sup>&</sup>lt;sup>58</sup> Letter from Bo M. Pham, Senior Project Manager, NRC, to Vice President, Operations, Entergy Nuclear Operations, Inc., Requests for Additional Information Regarding the Review of License Renewal Application for Indian Point Nuclear Generating Unit Nos. 2 and 3 (TAC Nos. MD5411 and MD5412) (Apr. 9, 2008), *available at* ADAMS Accession No. ML080880104.

See NL-08-028, Letter from Fred Dacimo, Vice President, Entergy, to NRC, Reply to Request for Additional Information Regarding License Renewal Application – Severe Accident Mitigation Alternatives Analysis (Feb. 5, 2008) ("February 2008 RAI Response") (ENT000460); NL-08-086, Letter from Fred Dacimo, Vice President, Entergy, to NRC, Supplemental Reply to Request for Additional Information Regarding License Renewal Application – Severe Accident Mitigation Alternatives Analysis (May 22, 2008) ("May 2008 RAI Response") (ENT000477). Entergy provided clarification of the internal flooding analysis changes in each PRA model version; additional information regarding the peer review process and comment resolution; details regarding the MACCS2 input data, including results of a sensitivity analysis addressing loss of tourism and business; additional explanation and justification for the assumptions in each analysis case; descriptions of plant-specific features that account for differences in risk and SAMA benefits between units; and additional information regarding several specific SAMAs, including steam generator tube rupture-related SAMAs. *See* FSEIS, Vol. 3, App. G at G-1 (NYS00133I).

<sup>&</sup>lt;sup>60</sup> See FSEIS, Vol. 3, App. G at G-1 to G-2 (NYS00133I).

<sup>&</sup>lt;sup>61</sup> February 2008 RAI Response, Attach. 1 at 22 (ENT000460).

Entergy responded to the Staff's RAI in its February 2008 RAI Response.<sup>62</sup> Entergy explained that its MACCS2 decontamination inputs are reasonable for the IPEC SAMA analysis region, because they are derived from well-established, reliable values contained in NRC guidance documents (NUREG-1150 and NUREG/CR-4551), and are based upon various levels of contamination and site-specific population estimates.<sup>63</sup> Entergy further stated that some portions of the IPEC SAMA analysis region have relatively high population densities, whereas other areas have relatively low population densities (*e.g.*, due to the high proportions of local, state and federal parkland and other rural property).<sup>64</sup> Therefore, Entergy's MACCS2 input values actually reflect local conditions.

22. In December 2008, the Staff issued the DSEIS for public comment.<sup>65</sup> The Staff documented its initial review of Entergy's SAMA analysis in Section 5.2 and Appendix G of the DSEIS. Among other things, the Staff concluded that certain MACCS2 inputs, including the population relocation cost, daily cost for a person who is relocated, and cost of farm and nonfarm decontamination were obtained from the MACCS2 Code Manual and inflation-adjusted using the consumer price index corresponding to the year 2005.<sup>66</sup> The Staff also concluded that Entergy's MACCS2-based methodology provides an acceptable basis for assessing the risk reduction potential for candidate SAMAs because the key elements of the methodology are consistent with standard practice.<sup>67</sup>

<sup>66</sup> DSEIS, Vol. 2, App. G at G-18 (NYS00132D) (citing NUREG/CR-6613, "Code Manual for MACCS2," Vol. 1, User's Guide (May 1998) ("*MACCS2 User's Guide*" or "NUREG/CR-6613") (NYS000243)).

<sup>67</sup> *Id.* at G-19.

<sup>&</sup>lt;sup>62</sup> See id., Attach. 1 at 37-38 (ENT000460).

<sup>&</sup>lt;sup>63</sup> *Id.* 

<sup>&</sup>lt;sup>64</sup> *Id.* at 38.

<sup>&</sup>lt;sup>65</sup> Indian Point Nuclear Generating Unit Nos. 2 and 3; Notice of Availability of the Draft Supplement 38 to the Generic Environmental Impact Statement for License Renewal of Nuclear Plants and Public Meeting for the License Renewal of Indian Point Nuclear Generating Unit Nos. 2 and 3, 73 Fed. Reg. 80,440 (Dec. 31, 2008).

23. Subsequently, it held two public meetings in Cortlandt Manor, New York, on February 12, 2009. During those meetings, the Staff described the preliminary results of the NRC environmental review (as documented in the DSEIS), answered questions, and provided members of the public with information to assist them in formulating comments on the DSEIS.<sup>68</sup> During the DSEIS comment period, the Staff received comments from 183 individuals or groups, including New York, and 88 commenters spoke during the public meetings.<sup>69</sup> In a comment submitted on the DSEIS, New York asserted that as part of its analysis, the NRC Staff should consider the densely populated and developed New York City area, incorporate the region's property values, and ensure that the resulting financial costs are expressed in present value.<sup>70</sup> New York again asserted that the NRC Staff should use the analytical framework contained in the 1996 Site Restoration Report.<sup>71</sup>

24. After reviewing the DSEIS, New York submitted Contention NYS-12A, which asserted that the DSEIS adopted the same flawed modeling contained in the ER and, therefore, also underestimated the true cost of decontamination and cleanup in the event of a severe accident.<sup>72</sup> NYS-12A mirrored New York's above-described comments on the DSEIS.<sup>73</sup> Thus, New York again asserted that the Staff should consider the densely populated and developed New York City area, incorporate the region's property values, and use the analytical framework contained in the 1996 Site Restoration Report.<sup>74</sup>

<sup>&</sup>lt;sup>68</sup> See FSEIS, Vol. 1 at xvi (NYS00133A).

<sup>&</sup>lt;sup>69</sup> FSEIS, Vol. 1, App. A at A-2 (NYS000133C).

<sup>&</sup>lt;sup>70</sup> See id. at A-128-29.

<sup>&</sup>lt;sup>71</sup> *Id*.

<sup>&</sup>lt;sup>72</sup> State of New York Contentions Concerning NRC Staff's Draft Supplemental Environmental Impact Statement (Feb. 27, 2009) ("Feb. 27, 2009 Amended Contentions"), *available at* ADAMS Accession No. ML090690303.

<sup>&</sup>lt;sup>73</sup> Comments Submitted by the New York Office of the Attorney General on the DSEIS Prepared by Staff on the NRC for the Renewal of the Operating Licenses for Indian Point Units 2 and 3 at 43-47 (Mar. 18, 2009) (NYS000134).

<sup>&</sup>lt;sup>74</sup> See Feb. 27, 2009 Amended Contentions at 8-9.

25. In its Answer, Entergy asserted that New York had not met the requirements of 10 C.F.R. § 2.309(f)(2) for the admission of an amended contention, because it did not allege that the DSEIS contains data or conclusions that are significantly different from those in Entergy's ER.<sup>75</sup> The NRC Staff did not oppose the admission of the amended contention, insofar as it simply recast NYS-12 as challenge to the DSEIS.<sup>76</sup>

26. We admitted NYS-12A on June 16, 2009, and consolidated it with NYS-12,<sup>77</sup> finding "no issue with [New York] proactively asking the Board to recognize that an admitted contention relative to the ER challenges the same issue when included in the Draft SEIS."<sup>78</sup>

#### 2. Entergy's Revised SAMA Analysis and Amended Contention NYS-12B

27. Later, in November 2009, as part of its ongoing environmental review, the Staff sought clarification from Entergy regarding certain wind direction data as an input to the MACCS2 code.<sup>79</sup> In addressing the Staff's inquiry, Entergy determined that the 5-year averaged wind direction data used in the original SAMA analysis were not representative of the region's wind direction conditions for the five-year period (2000-2004) originally considered by Entergy.<sup>80</sup> Entergy submitted a revised SAMA analysis in December 2009 that addressed the Staff's concern by using a single, representative year of meteorological data; *i.e.*, 2000.<sup>81</sup>

<sup>&</sup>lt;sup>75</sup> Answer of Entergy Nuclear Operations, Inc. Opposing New and Amended Environmental Contentions of New York State at 13 (Mar. 24, 2009), *available at* ADAMS Accession No. ML090930204.

<sup>&</sup>lt;sup>76</sup> NRC Staff's Answer to Amended and New Contentions Filed by the State of New York and Riverkeeper, Inc., Concerning the Draft Supplemental Environmental Impact Statement at 12 (Mar. 24, 2009), *available at* ADAMS Accession No. ML090840116.

<sup>&</sup>lt;sup>77</sup> See Licensing Board Order (Ruling on New York State's New and Amended Contentions) at 3-4 (June 16, 2009) (unpublished).

<sup>&</sup>lt;sup>78</sup> *Id.* at 4.

<sup>&</sup>lt;sup>79</sup> See NL-09-165, at 1 (ENT000009).

<sup>&</sup>lt;sup>80</sup> See id. at Attach. 1 at 1.

See id. Entergy selected the year 2000 because, of the five years of data used in the original analysis, the year 2000 resulted in the most conservative (*i.e.*, largest) calculated population doses. *Id.* The use of one year of meteorological data is permitted by NEI 05-01. *See* NEI 05-01 at 15 (NYS000287) (stating that an applicant may use a "full year" of consecutive hourly values). In its revised SAMA analysis, Entergy used the same 2035 population estimate at issue in a separate New York contention, NYS-16B. *See* NL-09-065, Attach. 1 at

28. New York filed Amended Contention 12B as a challenge to Entergy's revised SAMA analysis.<sup>82</sup> NYS-12B contended that Entergy's revised SAMA analysis underestimated the likely decontamination and cleanup costs associated with a postulated severe accident at IPEC—the same allegation made in NYS-12 and NYS-12A.<sup>83</sup> New York reiterated its view that Entergy and the Staff should have used decontamination cost information contained in the Site Restoration Report.<sup>84</sup>

29. Entergy and the NRC Staff filed Answers. Entergy continued to assert its disagreement with NYS-12/12A on the merits, but did not oppose admission of NYS-12B insofar as the amended contention simply reasserted claims that the Board already admitted as NYS-12/12A, and NYS-12B relied on the same evidence as the previously admitted contention.<sup>85</sup> The NRC Staff also did not oppose the admission of NYS-12B.<sup>86</sup> It noted that New York's supporting bases were substantially identical to New York's supporting bases for NYS-12 and NYS-12A, albeit modified to refer specifically to Entergy's revised SAMA analysis.<sup>87</sup>

<sup>87</sup> See id.

<sup>5 (</sup>ENT000009). NYS-16B claims that the FSEIS improperly accepts Entergy's estimate of the 2035 population within 50 miles of IPEC, despite two alleged errors in Entergy's estimate: (1) failure to account for "census undercount" of minority and low-income groups in the 2000 U.S. Census data underlying the estimate, and (2) failure to account for the commuter population within the 50-mile radius region surrounding IPEC.

<sup>&</sup>lt;sup>82</sup> State of New York's Motion for Leave to File New and Amended Contentions Concerning the December 2009 Reanalysis of Severe Accident Mitigation Alternatives (Mar. 11, 2010), *available* at ADAMS Accession No. ML100780366.

<sup>&</sup>lt;sup>83</sup> See id. at 1.

<sup>&</sup>lt;sup>84</sup> See id. at 3-6.

<sup>&</sup>lt;sup>85</sup> Applicant's Answer to New York State's New and Amended Contentions Concerning Entergy's December 2009 Revised SAMA Analysis at 19 (Apr. 5, 2010), *available at* ADAMS Accession No. ML101450328.

<sup>&</sup>lt;sup>86</sup> NRC Staff's Answer to State of New York's New and Amended Contentions Concerning the December 2009 Severe Accident Mitigation Alternative Reanalysis at 11-12 (Apr. 5, 2010), *available at* ADAMS Accession No. ML100960165.

30. We admitted NYS-12B and consolidated it with NYS-12/12A as NYS-12/12A/12B.<sup>88</sup>

# **3.** Final Supplemental Environmental Impact Statement and Amended Contention NYS-12C

31. The NRC Staff issued its FSEIS in December 2010, which consists of three

volumes and over 2,000 pages.<sup>89</sup> In the FSEIS, the Staff considered and addressed all public comments on the scope of the Staff's NEPA review and its DSEIS.<sup>90</sup> Appendix A to the FSEIS documents the Staff's responses to those comments.<sup>91</sup>

32. New York's submission of the aforementioned comments and related contention

(as subsequently amended) is expressly reflected in Appendix A to the FSEIS:

A concern regarding the adequacy of the decontamination cost estimates used in the SAMA analysis was raised in a contention filed by the State of New York in the license renewal adjudicatory proceeding. The contention includes the criticisms mentioned above and has been admitted for litigation by the ASLB. *Additional discussion of the decontamination cost estimates and their impact on the SAMA analysis has been provided in Section G.2.3 of Appendix G to the FSEIS.*<sup>92</sup>

Thus, it is clear that in the FSEIS, the NRC Staff explicitly acknowledged and analyzed

Entergy's MACCS2 decontamination cost inputs and New York's criticism thereof, the same

overarching criticism raised in Contention NYS-12/12A/12B.

<sup>&</sup>lt;sup>88</sup> Entergy Nuclear Operations, Inc. (Indian Point Nuclear Generating Units 2 & 3), LBP-10-13, 71 NRC 673, 683-84 (2010).

<sup>&</sup>lt;sup>89</sup> See FSEIS (NYS00133A-J).

<sup>&</sup>lt;sup>90</sup> See *id.* at iv (stating that the Staff's recommendation regarding license renewals for IP2 and IP3 was based in part on consideration of public comments received during the scoping process and in response to the draft SEIS"); *id.*, App. A at A-2.

<sup>&</sup>lt;sup>91</sup> *Id.*, App. A at A-175.

<sup>&</sup>lt;sup>92</sup> *Id.*, App. A at A-129 (emphasis added).

33. FSEIS Section G.2.3 documents the NRC Staff's detailed evaluation of the IPEC SAMA analysis, including the methods used in those analyses and the results.<sup>93</sup> As stated therein, the Staff utilized the relevant technical expertise of Sandia MACCS2 and decontamination specialists (including Staff witnesses Dr. Bixler and Mr. Jones) in performing its review.<sup>94</sup>

34. The NRC Staff concluded in the FSEIS that Entergy's methodology "provides an acceptable basis from which to proceed with an assessment of candidate SAMAs."<sup>95</sup> It further concluded that Entergy's decontamination cost estimates are "reasonable and acceptable," and consistent with those used in SAMA analyses performed for other nuclear power plants and previously accepted by the NRC.<sup>96</sup>

35. As noted above, in FSEIS Section G.2.3, the NRC Staff also included a new technical analysis that directly addresses allegations made in New York's contention.<sup>97</sup> The Staff, addressing the Site Restoration Report, stated that it does not consider the methodology for clean-up of a nuclear weapons accident relevant to the decontamination and clean-up after a nuclear power plant severe accident.<sup>98</sup> Nonetheless, the Staff and its Sandia analysts reviewed the inputs and assumptions regarding particle size distribution and decontamination costs used in the IPEC SAMA analysis, and compared the decontamination cost factors derived from the 1996 Site Restoration Report cited by New York to those used in the IPEC SAMA analysis.<sup>99</sup>

<sup>&</sup>lt;sup>93</sup> *Id.* at 5-1 to 5-13; *Id.*, App. G at G-1 to G-51.

<sup>&</sup>lt;sup>94</sup> *Id.*, App. B at B-2.

<sup>&</sup>lt;sup>95</sup> *Id.* at G-21 to G-22.

<sup>&</sup>lt;sup>96</sup> *See id.* at G-24.

<sup>&</sup>lt;sup>97</sup> See id. at G-22 to -24.

<sup>&</sup>lt;sup>98</sup> See id. at G-23.

See id. The FSEIS states that the NRC Staff and Sandia performed a comprehensive review of relevant documents and references, including the ER, the DSEIS, the MACCS2 input decks for Indian Point and associated documentation, the New York contentions and supporting documents and references, the Board's rulings on the contentions, and other relevant filings in the adjudicatory proceeding. See id. at G-22.

36. As described in the FSEIS, the NRC Staff and Sandia identified the basic considerations of a nuclear weapons and a reactor accident (*e.g.*, contaminants, half life of contaminants, and health and safety considerations), identified the decontamination methods required to cleanup each type of accident, and compared the Site Restoration Report cost values (as applied to the urban area of New York City) to those used in the IPEC SAMA analysis.<sup>100</sup> Based on this review, the NRC Staff and Sandia concluded that Entergy's decontamination cost estimates are reasonable, acceptable, and consistent with the estimates used in prior NRC-approved SAMA analyses for other nuclear power plants.<sup>101</sup>

37. New York filed Amended Contention NYS-12C, the last amendment to its contention, in response to the December 2010 FSEIS.<sup>102</sup> In addition to "updating" its previously-admitted consolidated contentions (NYS-12/12A/12B), New York also sought to challenge the discussion in FSEIS Section G.2.3 insofar as it applies to those contentions.<sup>103</sup> In particular, New York, based on a report prepared by its former consultant, Mr. David Chanin,<sup>104</sup> argued that the FSEIS is inadequate because it: (1) accepts and applies cost data for "moderate" contamination events in lieu of cost data for "heavy" contamination events; and (2) fails to "scale up" the Site Restoration Report decontamination cost data, which New York alleged are based

<sup>&</sup>lt;sup>100</sup> *See id.* at G-23.

<sup>&</sup>lt;sup>101</sup> *Id.* 

<sup>&</sup>lt;sup>102</sup> State of New York's Motion for Leave to File New and Amended Contentions Concerning Chapter 8 of the December 3, 2010 Final Supplemental Environmental Impact Statement (Feb. 3, 2011), *available at* ADAMS Accession No. ML110680290; State of New York New Contention-12C Concerning NRC Staff's December 2010 Final Environmental Impact Statement and the Underestimation of Decontamination and Clean Up Costs Associated with a Severe Accident in the New York Metropolitan Area (Feb. 3, 2011) ("New York New Contention"), *available at* ADAMS Accession No. ML110680212.

<sup>&</sup>lt;sup>103</sup> See New York New Contention at 1-2.

See D. Chanin, Errors and Omissions in NRC Staff's Economic Cost Estimates of Severe Accident Mitigation Alternatives Analysis Contained in December 2010 Indian Point Final Supplemental Environmental Impact Statement (FSEIS), NUREG-1437, Supp. 38, (Feb. 2011) ("Feb. 2011 Chanin Report"), available at ADAMS Accession No. ML110680212.

on the population density of Albuquerque, New Mexico, to a "hyper-density" urban area such as New York City.<sup>105</sup>

38. In its Answer, Entergy did not oppose New York's characterization of NYS-12C as an "update" to NYS-12/12A/12B, or New York's incorporation by reference of supporting evidence previously identified by New York in support of those contentions.<sup>106</sup> However, Entergy opposed the admission of NYS-12C,<sup>107</sup> asserting that New York's then-consultant, Mr. Chanin, relied on several technical papers concerning the economic costs of "rad/nuc" attacks using nuclear weapons or "dirty" bombs.<sup>108</sup> According to Entergy, New York did not demonstrate the relevance of those papers to a nuclear power plant SAMA analysis.<sup>109</sup> Entergy further asserted that New York had not raised a genuine dispute of material fact with the FSEIS because: (1) the radionuclides postulated in the FSEIS are in fact small, and radionuclides similar to those used in the IPEC SAMA analysis have been found acceptable for other plants' SAMA analyses; (2) Mr. Chanin's report contradicted FSEIS conclusions regarding clean-up costs from plutonium and cesium dispersal; (3) there is no technical reason to require a higher

<sup>&</sup>lt;sup>105</sup> *See id.* at 7.

<sup>&</sup>lt;sup>106</sup> Applicant's Answer to New York State's Amended Contention 12C Concerning Severe Accident Mitigation Alternatives Analysis at 2-3 (Mar. 7, 2011) ("Entergy Answer to NYS-12C").

<sup>&</sup>lt;sup>107</sup> See *id.* at 17-24 (asserting that the contention did not meet the admissibility criteria of 10 C.F.R. § 2.309(f)(1)(v) and (vi)).

<sup>&</sup>lt;sup>108</sup> Those papers included E. Luna, H.R. Yoshimura, and M.S. Soo Hoo, Survey of Costs Arising from Potential Radionuclide Scattering Events, WM2008 Conference (Feb. 2008) ("Luna Paper") (NYS000255); Reichmuth, et al., Economic Consequences of a Rad/Nuc Attack: Cleanup Standards Significantly Affect Cost, Proceedings of Working Together R&D Partnerships in Homeland Security, Boston, MA (Apr. 2005) (Pacific Northwest National Laboratory, PNNL-SA-45256) ("Reichmuth Paper") (NYS000257); and OECD Nuclear Energy Agency, Pathway Parameter Evaluation, A Survey Conducted by an OECD/NEA Group of Experts (July 1987) (Committee on the Safety of Nuclear Installations, CSNI 87-139.

<sup>&</sup>lt;sup>109</sup> Entergy Answer to NYS-12C at 3. Entergy did not oppose NYS-12C on timeliness grounds, insofar as that contention sought to challenge the new discussion contained in Section G.2.3 of the FSEIS. However, Entergy expressly reserved any arguments or objections that might exist relative to the timeliness of New York's reliance on the three technical reports cited by Mr. Chanin, the most recent of which was published in February 2008. *Id.* at 17 n.90. Entergy asserted that New York could have identified those documents as supporting references for its contention as early as February 2009, when it filed NYS-12A in response to the DSEIS. *Id.* Dr. Lemay, who later replaced Mr. Chanin as New York's consultant, relied on the Luna and Reichmuth papers cited above in his hearing testimony on NYS-12C.

population density multiplier per-square-kilometer than that used in the FSEIS; (4) the FSEIS did include an analysis of severe accident impacts on local property values using site-specific data, and (5) New York's demands would transform the SAMA analysis into a worst-case analysis, contrary to the requirements of NEPA and 10 C.F.R. Part 51.<sup>110</sup>

39. The Staff did not oppose NYS-12C to the extent that it sought to apply Contention 12/12A/12B to the FSEIS discussion of the IPEC SAMA analysis.<sup>111</sup> The Staff, however, opposed the admission of NYS-12C in all other respects.<sup>112</sup> It argued that NYS-12C: (1) relies upon information which was available to New York before the issuance of the FSEIS, and fails to satisfy the timeliness requirements set forth in 10 C.F.R. §§ 2.309(c)(1) and 2.309(f)(2);<sup>113</sup> (2) is overly vague and lacking in basis, contrary to 10 C.F.R. § 2.309(f)(1)(ii);<sup>114</sup> and (3) fails to raise a genuine material issue in dispute, as required by 10 C.F.R. § 2.309(f)(1)(iv) and (vi).<sup>115</sup>

40. We admitted NYS-12C and consolidated it with NYS-12/12-A/12-B as Consolidated Contention NYS-12C.<sup>116</sup> In doing so, we emphasized that NYS-12C's claims regarding the sufficiency of Entergy's and the NRC Staff's SAMA reviews mirror the basic allegation found in the consolidated contention that NYS-12C seeks to amend; *i.e.*, that Entergy's and the NRC Staff's use of the MACCS2 code leads to an underestimation of the cleanup costs from a severe accident.<sup>117</sup> We further explained that this "overarching aspect" of

<sup>117</sup> *Id.* 

<sup>&</sup>lt;sup>110</sup> See id. at 22-25.

<sup>&</sup>lt;sup>111</sup> NRC Staff's Answer to State of New York Contention 12-C Concerning the Final SEIS Evaluation of Decontamination and Clean Up Costs in a Severe Accident at 10-25 (Mar. 7, 2011), *available at* ADAMS Accession No. ML110670302.

<sup>&</sup>lt;sup>112</sup> *See id.* at 8-9.

<sup>&</sup>lt;sup>113</sup> See id. at 10-11.

<sup>&</sup>lt;sup>114</sup> See id. at 19-20, 22-23.

<sup>&</sup>lt;sup>115</sup> See id. at 19-20, 22-24.

<sup>&</sup>lt;sup>116</sup> Licensing Board Memorandum and Order (Ruling on Pending Motions for Leave to File New and Amended Contentions) at 7-8 (July 6, 2011) (unpublished).

the contention, including its citation to the Site Restoration Report, has not differed significantly since New York filed its original contention.<sup>118</sup>

#### C. <u>New York's December 2011 Prefiled Testimony and Entergy's Related Motion in</u> <u>Limine</u>

41. On December 21, 2011, New York filed its Statement of Position<sup>119</sup>, written testimony<sup>120</sup>, and supporting exhibits for contention NYS-12C.<sup>121</sup> New York and its new expert, Dr. Francois J. Lemay, alleged that Entergy's SAMA analysis significantly underestimates the economic costs of a severe accident at IPEC by relying on MACCS2 code input values that purportedly are not IPEC-specific and do not account for the particle types released from such an accident.<sup>122</sup> In this regard, they principally asserted that: (1) the use of the MACCS2 User's Guide "Sample Problem A" inputs in lieu of site-specific inputs results in underestimated severe accident costs, because the Sample Problem A inputs are not current and are not appropriate for the dense population and buildings surrounding IPEC;<sup>123</sup> (2) the decontamination factors and times used by Entergy and accepted by the NRC Staff are not rationally related to IPEC;<sup>124</sup> and (3) the nonfarm decontamination cost input data used by Entergy and accepted by the Staff is not rationally related to IPEC.<sup>125</sup> As described in his testimony and associated expert report,<sup>126</sup> Dr.

<sup>&</sup>lt;sup>118</sup> *Id.* at 8.

<sup>&</sup>lt;sup>119</sup> New York Position Statement (NYS000240).

<sup>&</sup>lt;sup>120</sup> Pre-filed Written Testimony of Dr. Francois J. Lemay Regarding Consolidated NYS-12-C (NYS-12/12-A/12-B/12-C) (Dec. 21, 2011) ("New York Direct Testimony") (NYS000241).

<sup>&</sup>lt;sup>121</sup> Exhibits NYS000242-NYS000292.

 <sup>&</sup>lt;sup>122</sup> New York Position Statement at 2-3, 12-13, 19-20, 42 (NYS000240); New York Direct Testimony at 7:147-9:184, 23:496-511, 36:763-771, 61:1271-1283, 64:1346-65:1356, 70:1470-85 (NYS000241).

 <sup>&</sup>lt;sup>123</sup> New York Position Statement at 17-19, 33-40 (NYS000240); New York Testimony at 9:195-200, 21:466-23:511, 29:642-30:665, 63:1308-28, 70:1470-77 (NYS000241).

See New York Position Statement at 21-22, 31-32 (NYS000240); New York Testimony at 27:602-29:649, 51:1058-55:1134, 70:1470-77 (NYS000241).

<sup>&</sup>lt;sup>125</sup> See New York Position Statement at 23- 31 (NYS000240); New York Testimony 21:459-64, 30:651-55:1134 (NYS000241).

 <sup>&</sup>lt;sup>126</sup> ISR Report 13014-01-01, Review of Indian Point Severe Accident Off Site Consequence Analysis (Dec. 21, 2011) ("ISR Report") (NYS000242).

Lemay proposed alternative values for various MACCS2 input parameters that the Board discusses in detail below.

42. Entergy filed a Motion in Limine to exclude certain portions of Dr. Lemay's testimony, report, and supporting exhibits on the ground that New York's prefiled testimony discussed issues and challenged MACCS2 parameters beyond the scope of the admitted contention.<sup>127</sup> Entergy asserted that, as pled and admitted, NYS-12C challenged only the adequacy of Entergy's nonfarm decontamination cost value (MACCS2 input parameter "CDNFRM"), principally related to information contained in the Site Restoration Report and other studies cited by New York.<sup>128</sup> Entergy contended that Dr. Lemay's testimony improperly disputed numerous other Entergy MACCS2 inputs not previously challenged by New York.<sup>129</sup>

43. Entergy also viewed Dr. Lemay's objections to Entergy's use of MACCS2 User's Guide "Sample Problem A" values as a belated new argument.<sup>130</sup> Finally, Entergy moved to strike Dr. Lemay's testimony and report insofar as they relied on results generated using a modified version of the proprietary MACCS2 code.<sup>131</sup> Specifically, Dr. Lemay modified the MACCS2 source code to accept larger non-farm decontamination cost (CDNFRM) and decontamination time (TIMDEC) values than would otherwise be allowed by the code.<sup>132</sup>

<sup>&</sup>lt;sup>127</sup> Applicant's Motion in Limine to Exclude Portions of the Prefiled Testimony, Report, and Exhibits Filed by New York State and Dr. Francois Lemay in Support of Consolidated Contention NYS-12C (Jan. 30, 2012), *available at* ADAMS Accession No. ML12030A216.

<sup>&</sup>lt;sup>128</sup> *Id.* at 7.

<sup>&</sup>lt;sup>129</sup> Id. at 7-8. Those additional MACCS2 parameters include decontamination time (TIMDEC), value of nonfarm wealth (VALWNF), societal discount rate of property (DSRATE), fraction of nonfarm property due to improvements (FRNFIM), depreciation rate (DPRATE), and relocation costs (POPCST).

<sup>&</sup>lt;sup>130</sup> *Id.* at 8.

<sup>&</sup>lt;sup>131</sup> *Id.* at 14-15.

<sup>&</sup>lt;sup>132</sup> *Id*.

44. The NRC Staff supported Entergy's Motion in Limine.<sup>133</sup> In its Answer, the Staff asserted that New York and its original consultant (Mr. Chanin) had identified only two alleged errors in the FSEIS,<sup>134</sup> and that "Dr. Lemay's testimony, report and supporting exhibits "stray far from these two discrete issues."<sup>135</sup> The Staff also contended that the Dr. Lemay's "uncontrolled changes" to the MACCS2 code were not limited to the issue identified in New York's contention, such that the Board should exclude any related testimony.<sup>136</sup> New York opposed Entergy's Motion in Limine.<sup>137</sup>

45. We denied Entergy's Motion in Limine noting that licensing boards admit contentions, not bases, and finding that the additional contested MACCS2 inputs "go to the core of the question of property values and how they might be affected by a radionuclide-releasing accident at IPEC and the resulting decontamination process."<sup>138</sup> We further noted that Dr. Lemay's MACCS2 source code modifications illustrate the effect of varying the code's assumptions to address alternative inputs, as conceptualized by the original admitted contention.<sup>139</sup> Finally, the Board reiterated its prior ruling that the contention "is not challenging

<sup>135</sup> *Id.* 

<sup>136</sup> *Id.* at 6.

<sup>&</sup>lt;sup>133</sup> See NRC Staff's Answer to Applicant's Motion in Limine to Exclude Portions of the Prefiled Testimony, Report, and Exhibits Filed by New York State and Dr. Francois Lemay in Support of Consolidated Contention NYS-12C (Feb. 9, 2012), available at ADAMS Accession No. ML12040A239.

See id. at 5. According to the Staff, Mr. Chanin had asserted that in the FSEIS, the Staff (1) relied on cleanup costs estimates for a city with 1,344 person/km2 and made no adjustment to New York City, with its assumed 12,000 persons/km<sup>2</sup>; and (2) mistakenly claimed that cleanup costs for "moderate" contamination requiring a DF from 5 to 10 for plutonium is appropriate for achieving a DF of 15 for cesium. *Id.* (quoting Feb. 2011 Chanin Report at 3).

<sup>&</sup>lt;sup>137</sup> State of New York's Answer to Entergy's Motion in Limine to Exclude Portions of Pre-Filed Testimony and Exhibits for Consolidated Contention NYS-12C (Feb. 17, 2012), *available at* ADAMS Accession No. ML12048B412.

<sup>&</sup>lt;sup>138</sup> Licensing Board Order (Granting in Part and Denying in Part Applicant's Motions in Limine) at 6-7 (Mar. 6, 2012) (unpublished). We recognize that Entergy disagrees with the Board's statement that licensing boards admit contentions, not bases, citing the Commission's decision in *NextEra Energy Seabrook, LLC* (Seabrook Station, Unit 1), CLI-12-05, 75 NRC \_\_, slip op. at 11 n.50 (Mar. 8, 2012).

<sup>&</sup>lt;sup>139</sup> Licensing Board Order (Granting in Part and Denying in Part Applicant's Motions in Limine) at 7 (Mar. 6, 2012) (unpublished).

the use of MACCS2 itself, but is questioning whether 'specific inputs' and 'assumptions' made in MACCS2 SAMA analyses are correct for the area surrounding Indian Point."<sup>140</sup>

#### D. Entergy's and the NRC Staff's March 2012 Prefiled Testimony

46. Entergy filed its Statement of Position<sup>141</sup>, written testimony<sup>142</sup>, and supporting exhibits for contention NYS-12C on March 30, 2012.<sup>143</sup> Entergy submitted written testimony from a panel of three witnesses: Ms. Lori Potts, Dr. Kevin O'Kula, and Mr. Grant Teagarden.<sup>144</sup>

47. In response to New York's direct testimony, Entergy's experts testified that Entergy followed the NRC-approved, prescriptive guidance in NEI 05-01 to perform the SAMA analysis and appropriately used the NRC and industry standard code (MACCS2) in the analysis.<sup>145</sup> In addition, they testified that Entergy's MACCS2 decontamination cost and time inputs are reasonable and appropriate for use in a NEPA-based SAMA analysis.<sup>146</sup> They explained that Entergy's values, while coinciding with Sample Problem A values, are actually: (1) based on peer-reviewed NUREG-1150 values that have been well-vetted by the nuclear industry, the national laboratories, and the NRC;<sup>147</sup> (2) used in all NRC-approved SAMA analyses;<sup>148</sup> and (3) applied in the NRC's recent State-of-the-Art Reactor Consequence Analyses

<sup>&</sup>lt;sup>140</sup> *Id.* (quoting *Indian* Point, LBP-08-13, 68 NRC at 102).

<sup>&</sup>lt;sup>141</sup> Entergy's Statement of Position Regarding Consolidated Contention NYS-12C (Severe Accident Mitigation Alternatives Analysis) (Mar. 30, 2012) (ENT000449);

<sup>&</sup>lt;sup>142</sup> Testimony of Entergy Witnesses Lori Potts, Kevin O'Kula, and Grant Teagarden on Consolidated Contention NYS-12C (Severe Accident Mitigation Alternative Analysis) (Mar. 30, 2012) ("Entergy Testimony") (ENT000450).

<sup>&</sup>lt;sup>143</sup> Exhibits ENT000451-ENT000477.

<sup>&</sup>lt;sup>144</sup> See generally Entergy Testimony (ENT000450).

<sup>&</sup>lt;sup>145</sup> See id. at 17-19 (A29-30), 46 (A61).

<sup>&</sup>lt;sup>146</sup> See id. at 48-58 (A64-73), 72-88 (A93-109).

<sup>&</sup>lt;sup>147</sup> See id. at 52-58 (A71-72), 59 -62 (A76-78).

<sup>&</sup>lt;sup>148</sup> *See id.* at 14 (A26).

("SOARCA") project, which was just completed in November 2012.<sup>149</sup> Entergy's experts further asserted that Dr. Lemay's proposed decontamination cost and time values are neither technically justified nor reasonable and appropriate for use in a SAMA analysis.<sup>150</sup> They maintained that Dr. Lemay's proposed values are based on sources and data that have no relevance to a nuclear power plant SAMA analysis and/or on misapplications of those sources and data.<sup>151</sup> Entergy's experts also asserted that Dr. Lemay's methodologies and assumptions are inconsistent with established SAMA analysis practices and the decontamination modeling assumptions built into and applied by the MACCS2 code.<sup>152</sup>

48. The NRC Staff also filed its Statement of Position<sup>153</sup>, written testimony<sup>154</sup>, and supporting exhibits for contention NYS-12C on March 30, 2012.<sup>155</sup> The Staff filed testimony from a panel of four witnesses: Dr. Nathan Bixler, Dr. S. Tina Ghosh, Mr. Joseph Jones, and Mr. Donald Harrison.<sup>156</sup>

49. The Staff's witness Dr. Bixler and Dr. Ghosh testified that NYS-12C does not raise valid issues that would materially impact the IPEC SAMA analysis.<sup>157</sup> Among other things, they asserted that: (1) New York incorrectly claims that the SAMA analysis assumes unrealistically large particles, and that accounting for smaller particle sizes would result in

<sup>&</sup>lt;sup>149</sup> See id. at 13 (A26), 85-86 (A106). The NRC initiated the SOARCA project in 2006 to develop revised best estimates of the offsite radiological health consequences of severe reactor accidents by including significant plant improvements and updates not reflected in earlier NRC assessments. *Id.* at 26 (A41).

<sup>&</sup>lt;sup>150</sup> See id. at 92- 103 (A118-127), 104-123 (A130-151).

<sup>&</sup>lt;sup>151</sup> See, e.g., *id.* at 99-100 (A123), 112-13 (A136).

<sup>&</sup>lt;sup>152</sup> See id. at 73-76 (A96-100), 77-80 (A102-03), 122 (A149).

<sup>&</sup>lt;sup>153</sup> NRC Staff's Initial Statement of Position on Consolidated Contention NYS-12C (Mar. 30, 2012) ("NRC Staff Position Statement") (NRC000039).

<sup>&</sup>lt;sup>154</sup> NRC Staff Testimony of Nathan E. Bixler, S. Tina Ghosh, Joseph A. Jones and Donald G. Harrison Concerning NYS' Contentions NYS 12/16 (Mar. 30, 2012) ("NRC Staff Testimony") (NRC000041).

<sup>&</sup>lt;sup>155</sup> Exhibits NRC000042-NRC000061.

<sup>&</sup>lt;sup>156</sup> See NRC Staff Testimony at 1-2 (A1) (NRC000041).

<sup>&</sup>lt;sup>157</sup> See id. at 12-16 (A6).

greater cleanup costs;<sup>158</sup> (2) the Site Restoration Report is inappropriate for modeling the cleanup costs from a reactor severe accident given the significant differences between cleanup of plutonium dispersal accidents and the isotopes resulting from a severe nuclear reactor accident;<sup>159</sup> (3) MACCS2 provides a reasonable analytical framework to compute offsite economic costs in a SAMA analysis;<sup>160</sup> (4) Entergy used appropriate site-specific and standardized MACCS2 inputs in the SAMA analysis;<sup>161</sup> (5) the IPEC SAMA analysis accounted for the unique characteristics of New York City through the application of population-based cost parameters;<sup>162</sup> and (6) the decontamination costs and times used by Dr. Lemay tend to be biased toward the worst accident scenarios and for the worst environmental conditions.<sup>163</sup>

#### E. <u>New York's June 2012 Prefiled Rebuttal Testimony and Related Motions</u>

50. On June 29, 2012, New York filed its Revised Statement of Position<sup>164</sup>, written rebuttal testimony<sup>165</sup>, and several new exhibits referenced therein.<sup>166</sup> Therein, New York and Dr. Lemay asserted, in principal part, that the "central issue" raised by NYS-12C is whether it was reasonable for Entergy and NRC Staff to rely upon "Sample Problem A" inputs instead of developing site-specific inputs for IPEC.<sup>167</sup> They argued that NUREG-1150's technical "pedigree" does not justify the use of the MACCS inputs contested by New York, and that the

<sup>&</sup>lt;sup>158</sup> See id. at 48-51 (A41-45), 52-57 (A48-49).

<sup>&</sup>lt;sup>159</sup> See id. at 44-48 (A39-40).

<sup>&</sup>lt;sup>160</sup> See id. at 12-16 (A6), 38-40 (A34).

<sup>&</sup>lt;sup>161</sup> See id. at 12-16 (A6), 35-37 (A32), 89-90 (A81).

<sup>&</sup>lt;sup>162</sup> See id. at 15 (A6).

<sup>&</sup>lt;sup>163</sup> *See id.* at 31 (A25).

<sup>&</sup>lt;sup>164</sup> State of New York Revised Statement of Position [on] Consolidated Contention NYS-12C (June 29, 2012) ("New York Rebuttal Position Statement") (NYS000419).

<sup>&</sup>lt;sup>165</sup> Pre-Filed Written Rebuttal Testimony of Dr. François J. Lemay Regarding Consolidated Contention NYS-12C (NYS-12/12A/12B/12C) (June 29, 2012) ("New York Rebuttal Testimony") (NYS000420).

<sup>&</sup>lt;sup>166</sup> Exhibits NYS000421-NYS000432.

<sup>&</sup>lt;sup>167</sup> New York Rebuttal Position Statement at 7 (NYS000419); *see also* New York Rebuttal Testimony at 17:5-20:15 (NYS000420).

NUREG-1150 values appear to be based on a draft document that was never published.<sup>168</sup> New York and Dr. Lemay further claimed, for the first time, that in the 1980s the NRC commissioned a "site-specific case study" (*i.e.*, Chapter 5 of Draft NUREG/CR-5148) to estimate the costs associated with a severe accident at Indian Point.<sup>169</sup> According to New York, it was unreasonable for the NRC Staff to rely on NUREG-1150 values, given that a specific analysis was "eminently possible and had been completed in conjunction with [Draft] NUREG/CR-5148."<sup>170</sup>

51. Entergy filed a Motion seeking leave from the Board to file written surrebuttal testimony and a revised position statement on NYS-12C.<sup>171</sup> In support of its Motion, Entergy argued that it was prejudiced by New York's presentation of new arguments and evidence that exceeded the scope of rebuttal testimony, and to which Entergy did not have a fair opportunity to respond.<sup>172</sup> In particular, Entergy objected to New York's reliance on Draft NUREG/CR-5148, and its related new argument that the draft report documented an Indian Point-specific "case study."<sup>173</sup> The Staff did not oppose Entergy's Motion but did not file an Answer.<sup>174</sup>

52. The Board denied Entergy's motion for leave to file surrebuttal testimony on contention NYS-12C.<sup>175</sup> We ruled that the issues raised in the motion could be handled at the

<sup>172</sup> *Id.* at 1.

<sup>&</sup>lt;sup>168</sup> See New York Rebuttal Testimony at 19:16-25:4 (NYS000420).

See id. at 25:7-30:9 (citing Draft NUREG/CR-5148 (PNL-6350), Property-Related Costs of Radiological Accidents (Feb. 1990) ("Draft NUREG/CR-5148") (NYS00424A to BB)). New York and Dr. Lemay acknowledged that Draft NUREG/CR-5148 was "never published" as a final document.

<sup>&</sup>lt;sup>170</sup> New York Rebuttal Position Statement at 15 (NYS000419).

<sup>&</sup>lt;sup>171</sup> See Applicant's Motion for Leave to File Surrebuttal Testimony on Consolidated Contention NYS-12C (July 12, 2012) ("Entergy Motion for Surrebuttal"), *available at* ADAMS Accession No. ML12194A724. Entergy, nonetheless, reserved the right to file a motion in limine to strike the New York rebuttal testimony and evidence in question and, as discussed below, filed such a motion on July 30, 2012.

<sup>&</sup>lt;sup>173</sup> Entergy Motion for Surrebuttal at 4.

<sup>&</sup>lt;sup>174</sup> *Id.* at 7.

 <sup>&</sup>lt;sup>175</sup> Licensing Board Order (Denying Applicant's Motion for Leave to File Surrebuttal Testimony on NYS-12C) at 4 (Aug. 2, 2012) (unpublished).

evidentiary hearing, and that the submission of additional written testimony on NYS-12C would potentially delay the evidentiary hearing.<sup>176</sup> The Board, nonetheless, encouraged the parties to address the issues raised in New York's rebuttal testimony in their proposed questions for the Board to ask at the evidentiary hearing.<sup>177</sup>

53. In the interim, on July 30, 2012, Entergy and the NRC Staff filed separate Motions in Limine seeking to exclude portions of Dr. Lemay's rebuttal testimony (NYS000420), Exhibits NYS000424<sup>178</sup> and NYS000426,<sup>179</sup> and related portions of New York's Revised Position Statement (NYS000419).<sup>180</sup> They argued that the testimony and exhibits in question should be excluded from evidence because they belatedly advanced new arguments that Entergy and the Staff could not have reasonably anticipated when they prepared their prefiled direct testimony.<sup>181</sup> Entergy and the Staff also challenged the new testimony and evidence as unreliable and not relevant under the evidence admissibility standards in 10 C.F.R. § 2.337(a).<sup>182</sup> The Board later denied both Motions in Limine in a bench ruling issued on October 15, 2012, the first day of evidentiary hearings, opting instead to accord the challenged testimony and evidence its due weight after the hearing on the merits.<sup>183</sup>

<sup>&</sup>lt;sup>176</sup> *See id.* 

<sup>&</sup>lt;sup>177</sup> See id.

<sup>&</sup>lt;sup>178</sup> Draft NUREG/CR-5148 (NYS00424A-BB).

<sup>&</sup>lt;sup>179</sup> E-mail from J. Tawil, Research Enter., Inc., to M. Labriola, Indep. Safety Research, Inc., Re: The DECON Code from PNL (May 2, 2012) (NYS000426).

<sup>&</sup>lt;sup>180</sup> Entergy's Motion in Limine to Exclude Portions of New York State's Rebuttal Filings on Contention NYS-12C (July 30, 2012) ("Entergy Rebuttal Motion in Limine"), *available at* ADAMS Accession No. ML12212A403; NRC Staff's Motion in Limine to Exclude Portions of the Prefiled Rebuttal Testimony and Rebuttal Exhibits Filed by the State of New York Concerning Consolidated Contention NYS-12C (SAMAS) (July 30, 2012) ("NRC Staff Rebuttal Motion in Limine"), *available at* ADAMS Accession NO. ML12212A403.

<sup>&</sup>lt;sup>181</sup> Entergy Rebuttal Motion in Limine at 5-8; NRC Staff Rebuttal Motion in Limine at 5-7.

<sup>&</sup>lt;sup>182</sup> Entergy Rebuttal Motion in Limine at 8-11; NRC Staff Rebuttal Motion in Limine at 8-12.

<sup>&</sup>lt;sup>183</sup> Official Transcript of Proceedings, Indian Point Nuclear Generating Units 2 & 3 at 1265-66 (Oct. 15, 2012) (Judge McDade).

#### F. Other Prehearing Procedural Matters

54. On August 8, 2012, New York filed a motion with respect to its seven "Track 1" contentions,<sup>184</sup> seeking to invoke its purported statutorily-granted cross-examination rights under Section 274(*l*) of the Atomic Energy Act ("AEA"), 42 U.S.C. § 2021(l).<sup>185</sup> Specifically, New York claimed that as the host state to IPEC, Section 274(*l*) confers upon it expansive cross-examination rights that take precedence over the restrictive cross-examination rights allowed pursuant to 10 C.F.R. §§ 2.315(c) and 2.1204(b)(3).<sup>186</sup> It argued that the 2004 modifications to the NRC's Administrative Procedure Act-compliant regulations, which it contended generally restrict the use of cross-examination by most parties, do "not purport to address the rights preserved to the States in [Section 2021(*l*)]."<sup>187</sup> Thus, New York asserted, 10 C.F.R. §§ 2.135(c) and 2.1204(b)(3) do not apply to it as a host state and do not restrict its right to interrogate witnesses.<sup>188</sup>

55. Both Entergy and the NRC Staff opposed the motion as lacking a legal basis,<sup>189</sup> arguing that New York mischaracterized as an "absolute right" what is actually a "reasonable opportunity" to cross-examine witnesses.<sup>190</sup>

<sup>&</sup>lt;sup>184</sup> Track 1 contentions consist of Riverkeeper TC-2 (Flow-Accelerated Corrosion), NYS-12C (SAMA Analysis – Decontamination Costs), NYS-16B (SAMA Analysis – Population Estimate), NYS-17B (Land Values), NYS-37 (Energy Alternatives), Clearwater EC-3A (Environmental Justice), NYS-5 (Buried Piping), NYS-6/7 (Non-EQ Cables), and NYS-8 (Transformers). Prior to the October 2012 hearings, the parties settled another Track 1 contention, Riverkeeper EC-3/Clearwater EC-1 (Spent Fuel Pool Leaks to Groundwater). The Board approved that settlement agreement on October 17, 2012. Licensing Board Consent Order (Approving Settlement of Consolidated Contention Riverkeeper EC-3 and Clearwater EC-1) (Oct. 17, 2012) (unpublished).

<sup>&</sup>lt;sup>185</sup> State of New York Motion to Implement Statutorily-Granted Cross-Examination Rights Under Atomic Energy Act § 274(*l*) at 1 (Aug. 8, 2012), *available at* ADAMS Accession No. ML12221A483.

<sup>&</sup>lt;sup>186</sup> *Id.* at 14-15, 19.

<sup>&</sup>lt;sup>187</sup> *Id.* at 14.

<sup>&</sup>lt;sup>188</sup> *Id.* at 15.

<sup>&</sup>lt;sup>189</sup> Entergy's Answer Opposing New York State's Motion to Cross-Examine (Aug. 20, 2012) ("Entergy Answer Opposing New York Motion"), *available at* ADAMS Accession No. ML12233A371; NRC Staff's Answer to State of New York's "Motion to Implement Statutorily-Granted Cross-Examination Rights under Atomic Entergy Act § 274(*l*)" (Aug. 20, 2012) ("Staff Answer Opposing New York Motion"), *available at* ADAMS Accession No. ML12233A742.

56. On August 29, 2012, in accordance with 10 C.F.R. § 2.1207(a)(3) and the Board's Scheduling Order, Entergy (and the other parties) submitted *in camera* proposed questions for the Board to consider asking to the other parties' witnesses on Contention NYS-12C.<sup>191</sup>

57. In an Order issued on September 21, 2012, the Board granted, in part, New York's August 8, 2012 motion for cross-examination of witnesses during the evidentiary hearings.<sup>192</sup> The Board found that New York's opportunity to cross-examine witnesses is bound by the same 10 C.F.R. Part 2 regulations that govern all parties to this proceeding.<sup>193</sup> As a result, the Board found it unnecessary "to address whether and if so to what extent, in some theoretical sense, the right to cross-examination granted to host states by the AEA may be different from those provided to parties under 10 C.F.R. Part 2."<sup>194</sup> Citing 10 C.F.R. § 2.1204(b)(1), the Board noted that in any oral hearing held under Subpart L, a party may file a motion (accompanied by a cross-examination plan) seeking cross-examination by the parties on particular admitted contentions or issues.<sup>195</sup> Pursuant to 10 C.F.R. § 2.1204(b)(3), the presiding officer may allow cross-examination by the parties "only if the presiding officer determines that cross-examination by the parties is necessary to ensure the development of an adequate record for decision."<sup>196</sup>

58. The Board concluded that New York had complied with 10 C.F.R. § 2.1204(b) by filing the motion for cross-examination and proposed examination questions before the August

<sup>&</sup>lt;sup>190</sup> Entergy Answer Opposing New York Motion at 3-4, Staff Answer Opposing New York Motion at 9-10.

<sup>&</sup>lt;sup>191</sup> 10 C.F.R. § 2.1207(a)(3)(iii).

<sup>&</sup>lt;sup>192</sup> Licensing Board Order (Order Granting, in part, New York's Motion for Cross Examination) (Sept. 21, 2012) ("Sept. 21, 2012 Order") (unpublished); *see also* Licensing Board Errata (Regarding Order Granting, in part, New York's Motion for Cross Examination) (Sept. 25, 2012) (unpublished).

<sup>&</sup>lt;sup>193</sup> Sept. 21, 2012 Order at 5.

<sup>&</sup>lt;sup>194</sup> *Id.* at 5-6.

<sup>&</sup>lt;sup>195</sup> *Id.* at 6.

<sup>&</sup>lt;sup>196</sup> *Id.* (quoting 10 C.F.R. § 2.1204(b)(3)).

29, 2012, deadline for those submittals.<sup>197</sup> Citing the "voluminous and technical" nature of the parties' evidentiary submissions, the Board determined that granting New York's request for cross-examination was necessary to ensure development of an adequate record for this proceeding.<sup>198</sup> It thus ruled that during the hearing, New York could examine witnesses following the Board's examination, as long as its questions were "relevant, reasonable, and non-repetitive."<sup>199</sup>

59. On September 24, 2012, the Board discussed its Order in a pre-hearing conference call in response to questions from the NRC Staff and Entergy.<sup>200</sup> During that conference, Chairman McDade confirmed that New York would have the opportunity to examine witnesses on "areas that the Board missed" in its own witness examinations.<sup>201</sup> He also suggested that the Board might limit New York's questioning if it becomes repetitive<sup>202</sup> and stated that other parties would have a reasonable opportunity to interrogate witness on discrete issues through oral motions at the hearing if they made a "sufficiently compelling request" and avoided repetitive questions.<sup>203</sup>

60. Subsequently, on September 28, 2012, Entergy filed an emergency petition for interlocutory review of the Board's order with the Commission.<sup>204</sup> Entergy requested, and was

<sup>&</sup>lt;sup>197</sup> *Id.* 

<sup>&</sup>lt;sup>198</sup> *Id.* 

<sup>&</sup>lt;sup>199</sup> *Id.* at 6-7.

Official Transcript of Proceedings, Indian Point Nuclear Generating Units 1 & 2 [sic—2 & 3] (Sept. 24, 2012).
 *Id.* at 1238:1-6 (Judge McDade).

<sup>&</sup>lt;sup>202</sup> Id.

<sup>&</sup>lt;sup>203</sup> *Id.* at 1239:21-1241:8 (Judge McDade).

<sup>&</sup>lt;sup>204</sup> Entergy's Emergency Petition for Interlocutory Review of Board Order Granting Cross-Examination to New York State and Request for Expedited Briefing (Sept. 28, 2012), *available at* ADAMS Accession No. ML12272A363.

granted, expedited briefing on its petition.<sup>205</sup> New York opposed Entergy's petition<sup>206</sup> and the Staff supported it.<sup>207</sup>

61. On October 12, 2012, the Commission issued an Order denying Entergy's request for interlocutory review, noting that the Board has the responsibility in the first instance to oversee the development of an adequate case record.<sup>208</sup> In so ruling, the Commission cited Chairman McDade's assurances, made during the September 24, 2012 prehearing conference call, that the Board would prohibit open-ended, lengthy, repetitive, and immaterial crossexamination, and allow all parties a full and fair opportunity to request cross-examination.<sup>209</sup> The Commission further stated its expectation that the Board would act on cross-examination requests fairly and evenhandedly, rigorously oversee any cross-examination it allowed, and limit the cross-examination to "supplemental and genuinely material inquiries, necessary to develop an adequate and fair record."<sup>210</sup>

62. During the hearing on the first contention (Riverkeeper TC-2), the Board indicated that it would allow questioning of the witnesses by the petitioner (there, Riverkeeper, Inc. ("Riverkeeper")), Entergy, and the NRC Staff.<sup>211</sup> Entergy objected to examination of witnesses by any party, and requested that the Board close the record on that contention.<sup>212</sup> In

<sup>&</sup>lt;sup>205</sup> *Id.*; Commission Order (Oct. 2, 2012) (unpublished).

<sup>&</sup>lt;sup>206</sup> State of New York Combined Opposition to Entergy's Requests for Emergency Stay and Interlocutory Review of the Board Order Granting Limited Cross Examination (Oct. 1, 2012), *available at* ADAMS Accession No. ML12275A327. Entergy replied in opposition to New York's answer. *See* Entergy's Reply to New York State's Opposition to Entergy's Emergency Petition for Interlocutory Review (Oct. 8, 2012), *available at* ADAMS Accession No. ML12282A002.

<sup>&</sup>lt;sup>207</sup> NRC Staff's Answer to Entergy's Emergency Petition for Interlocutory Review, and Application for Stay, of the Board's Order of September 21, 2012 (Oct. 5, 2012), *available at* ADAMS Accession No. ML12279A309.

<sup>&</sup>lt;sup>208</sup> Entergy Nuclear Generation Co. (Indian Point Nuclear Generating Units 2 & 3) CLI-12-18, 76 NRC \_\_\_\_\_ slip op. at 6 (Oct. 12, 2012).

<sup>&</sup>lt;sup>209</sup> *Id.* at 3-4.

<sup>&</sup>lt;sup>210</sup> *Id.* at 7.

<sup>&</sup>lt;sup>211</sup> Oct. 17, 2012 Tr. at 1797:16-24 (Judge McDade).

<sup>&</sup>lt;sup>212</sup> *Id.* at 1794:11-1797:15 (Fagg).

support, Entergy: (a) noted that Riverkeeper had not made, nor been required to make, the sort of showing contemplated by the Subpart L regulations, which was a circumstance that the Commission had found "troubling"; (b) argued that no sufficient constraints had been placed on examination by parties; (c) noted that the procedure, rather than constituting the "rare occurrence" contemplated by the Commission, was apparently being undertaken as the norm for these proceedings; and (d) argued that, with two full days of Board questioning, additional questioning by the parties was not "truly necessary," as mandated by the Commission.<sup>213</sup> In the alternative, Entergy requested reciprocal treatment; *i.e.*, that it be afforded the same direct and cross-examination rights as the other parties.<sup>214</sup>

63. The Board denied Entergy's motion to preclude party examination of witnesses, stating any additional showing need not be articulated, and that the Board envisioned allowing Riverkeeper, then Entergy, and then the Staff brief opportunities to conduct limited interrogation of the witnesses.<sup>215</sup> During hearing on NYS-12C (the second contention), Entergy reiterated its objection, which was again denied by the Board, and Entergy asked that the Board recognize Entergy's standing objection on such grounds with respect to all remaining contentions.<sup>216</sup> Upon that basis, Entergy rested upon its standing objection, and did not repeat its procedural arguments in connection with subsequent contentions.

<sup>&</sup>lt;sup>213</sup> *Id.* 

<sup>&</sup>lt;sup>214</sup> *Id.* at 1797:8-14 (Fagg).

<sup>&</sup>lt;sup>215</sup> *Id.* at 1797:16-1800:10 (Judge McDade).

<sup>&</sup>lt;sup>216</sup> Official Transcript of Proceedings, Indian Point Nuclear Generating Units 2 & 3 at 2315:17-2316:2 (Oct. 18, 2012) (Bessette) ("Oct. 18, 2012 Tr.").
# G. <u>The October 17-18, 2012 Evidentiary Hearings</u>

64. On October 15, 2012, the Board commenced evidentiary hearings on the Track 1 contentions and admitted into evidence the exhibits proffered by the parties.<sup>217</sup> The Board held evidentiary hearings on Contention NYS-12C on October 17-18, 2012 at the DoubleTree Hotel in Tarrytown, NY, located at 455 South Broadway, Tarrytown, NY 10591.<sup>218</sup>

65. The Board conducted the hearing in accordance with the provisions of 10 C.F.R. Part 2, Subpart L. In accordance with our September 21, 2012 Order, and the Commission's related guidance in CLI-12-18, the Board permitted limited cross-examination and redirect examination by all parties. Specifically, after the Board completed its questioning of the parties' witnesses, it afforded all parties the opportunity to ask relevant, non-repetitive redirect and crossexamination questions to the witnesses.<sup>219</sup> New York questioned the witnesses first, followed by Entergy and then the NRC Staff.<sup>220</sup>

66. After the conclusion of the hearing, the parties jointly submitted proposed corrections to the hearing transcripts on December 5, 2012.<sup>221</sup> The Board issued an Order on December 27, 2012, adopting the parties' proposed transcript corrections with some minor revisions.<sup>222</sup>

67. On March 22, 2013, the parties submitted proposed findings of fact and conclusions of law in the form of a proposed Initial Decision by the Board.

<sup>&</sup>lt;sup>217</sup> Official Transcript of Proceedings, Indian Point Nuclear Generating Units 2 & 3 at 1268:21-1270:6 (Oct. 15, 2012) (Judge McDade).

<sup>&</sup>lt;sup>218</sup> Official Transcript of Proceedings, Indian Point Nuclear Generating Units 2 & 3 at 1895:22 (Oct. 22, 2012).

<sup>&</sup>lt;sup>219</sup> See supra Section II.F.

<sup>&</sup>lt;sup>220</sup> See generally Oct. 18, 2012 Tr.

<sup>&</sup>lt;sup>221</sup> Letter from Counsel for Entergy Nuclear Operations, Inc., Counsel for Riverkeeper, Inc., Counsel for the State of New York, Counsel for the NRC Staff, and Counsel for Hudson [River] Sloop Clearwater, Inc., to Lawrence G. McDade, Chairman, Dr. Michael F. Kennedy, and Dr. Richard Wardwell, Atomic Safety and Licensing Board (Dec. 5, 2012), *available at* ADAMS Accession No. ML12340A546.

<sup>&</sup>lt;sup>222</sup> Licensing Board Order (Adopting Proposed Transcript Corrections with Minor Edits) (Dec. 27, 2012) (unpublished).

# III. <u>APPLICABLE LEGAL AND REGULATORY STANDARDS</u>

#### A. Law Governing Environmental Evaluations and SAMA Analyses Under NEPA

68. Two sets of regulatory requirements govern the NRC's review of license renewal applications. Under 10 C.F.R. Part 54, the NRC conducts a health and safety review focused on "the detrimental effects of aging" on the plant.<sup>223</sup> Under 10 C.F.R. Part 51, the NRC completes a NEPA-based environmental review, focusing on the potential impacts of twenty additional years of operation. As explained above, the contention at issue here—NYS-12C—arises under NEPA and the NRC's NEPA-implementing regulations in 10 C.F.R. Part 51.<sup>224</sup>

69. NEPA requires that federal agencies, such as the NRC, prepare an EIS for "major Federal actions significantly affecting the quality of the human environment."<sup>225</sup> NEPA is a procedural statute that does not mandate particular substantive results.<sup>226</sup> Rather, it is designed "to insure a fully informed and well-considered decision" in the examination of potential environmental impacts of a proposed agency action.<sup>227</sup> NEPA "merely prohibits uninformed rather than unwise—agency action."<sup>228</sup>

70. Under NEPA, the Board must apply a "rule of reason" in determining whether the NRC took the requisite "hard look" at the proposed actions' environmental impacts and alternatives.<sup>229</sup> Under the rule of reason, an EIS need not "be so all-encompassing in scope that the task of preparing it would become either fruitless or well nigh impossible."<sup>230</sup> An EIS must

<sup>&</sup>lt;sup>223</sup> See Nuclear Power Plant License Renewal: Revisions, 60 Fed. Reg. 22,461, 22,464 (May 8, 1995).

<sup>&</sup>lt;sup>224</sup> *Indian Point,* LBP-08-13, 68 NRC at 100-02.

<sup>&</sup>lt;sup>225</sup> 42 U.S.C. § 4332(2)(C) (2006).

<sup>&</sup>lt;sup>226</sup> Robertson v. Methow Valley Citizens Council, 490 U.S. 332, 350–51 (1989).

<sup>&</sup>lt;sup>227</sup> Vermont Yankee, 435 U.S. at 558.

<sup>&</sup>lt;sup>228</sup> *Robertson*, 490 U.S. at 351.

New York v. Kleppe, 429 U.S. 1307, 1311 (1976); see U. S. also Dep't of Transp. v. Pub. Citizen, 541 U.S. 752, 767-69 (2004) (rule of reason is inherent in NEPA and its implementing regulations).

<sup>&</sup>lt;sup>230</sup> *Kleppe*, 429 U.S. at 1311 (citing *Natural Res. Def. Council v. Callaway*, 524 F.2d 79, 88 (2d Cir. 1975)).

only furnish such information as appears to be reasonably necessary under the circumstances for evaluation of the project.<sup>231</sup>

71. As the Commission explained in *Pilgrim*, NEPA does not require agencies to use "the best scientific methodology," and NEPA "should be construed in the light of reason if it is not to demand' virtually infinite study and resources."<sup>232</sup> The Commission clarified that an EIS is not intended to be a "'research document,' reflecting the frontiers of scientific methodology, studies and data."<sup>233</sup> Nor does NEPA require agencies "to use technologies and methodologies that are still 'emerging' and under development, or to study phenomena 'for which there are not yet standard methods of measurement or analysis."<sup>234</sup> Moreover, "while there 'will always be more data that could be gathered,' agencies 'must have some discretion to draw the line and move forward with decisionmaking."<sup>235</sup> In short, the Commission explained, "NEPA allows agencies 'to select their own methodology as long as that methodology is reasonable."<sup>236</sup>

72. "[N]or does NEPA require [resolution of] disagreements among various scientists as to methodology."<sup>237</sup> "When specialists express conflicting views, an agency must have discretion to rely on the reasonable opinions of its own qualified experts."<sup>238</sup>

# B. Legal Principles Applicable to SAMA Contentions

73. In the past several years, the Commission has issued a series of rulings that bear directly on the issue of adjudicatory challenges to SAMA analyses. For example, in the *Pilgrim* 

<sup>236</sup> Id.

<sup>&</sup>lt;sup>231</sup> Lee v. U.S. Air Force, 354 F.3d 1229, 1245 (10th Cir. 2004).

<sup>&</sup>lt;sup>232</sup> *Pilgrim*, CLI-10-11, 71 NRC at 315-16 (citation omitted).

<sup>&</sup>lt;sup>233</sup> *Id*.

<sup>&</sup>lt;sup>234</sup> *Id*.

<sup>&</sup>lt;sup>235</sup> *Id*.

 <sup>&</sup>lt;sup>237</sup> Pac. Gas & Elec. Co. (Diablo Canyon Power Plant Indep. Spent Fuel Storage Installation), CLI-08-26, 68
NRC 509, 518 n.51 (2008) (quoting Friends of Endangered Species, Inc. v. Jantzen, 760 F.2d 976, 986 (1985)).

<sup>&</sup>lt;sup>238</sup> Id. at 518 n. 50 (quoting Marsh v. Or. Natural Res. Council, 490 U.S. 360, 378 (1989)).

proceeding (CLI-12-01), the Commission recently stated that, "unless a contention, submitted with adequate factual, documentary, or expert support, raises a potentially significant deficiency in the SAMA analysis—that is, a deficiency that could credibly render the SAMA analysis altogether unreasonable under NEPA standards—a SAMA-related dispute will not be material to the licensing decision, and is not appropriate for litigation in an NRC proceeding."<sup>239</sup>

74. In addition, the Commission stated in *Seabrook* (CLI-12-05) that, "[g]iven the quantitative nature of the SAMA analysis, where the analysis rests largely on selected inputs, it may always be possible to conceive of alternative and more conservative inputs, whose use in the analysis could result in greater estimated accident consequences."<sup>240</sup> As the Commission noted, however, "the proper question is not whether there are plausible alternative choices for use in the analysis, but whether the analysis that was done is reasonable under NEPA."<sup>241</sup> That is because "SAMA adjudications would prove endless if hearings were triggered merely by suggested alternative inputs and methodologies that conceivably could alter the cost-benefit conclusions."<sup>242</sup> Significantly, the Commission held that "[a] contention proposing alternative inputs or methodologies must present some factual or expert basis for why the proposed changes in the analysis are warranted (*e.g.*, why the inputs or methodology used is unreasonable, and the proposed changes or methodology would be more appropriate)."<sup>243</sup> Otherwise, as the

<sup>243</sup> *Id*.

<sup>&</sup>lt;sup>239</sup> Pilgrim, CLI-12-01, slip op. at 25; see also id. ("There is questionable benefit to spending considerable agency resources in an attempt fine tune a NEPA mitigation analysis. Ultimately, we hold adjudicatory proceedings on issues that are material to licensing decisions.").

<sup>&</sup>lt;sup>240</sup> *Seabrook*, CLI-12-05. slip op. at 28.

<sup>&</sup>lt;sup>241</sup> *Id.* at 29.

<sup>&</sup>lt;sup>242</sup> *Id*.

done, only a proposal for an alternate NEPA analysis that may be no more accurate or meaningful."<sup>244</sup>

75. Thus, the fact that a computer model (MACCS2 in this case) could have been run with alternate inputs (*e.g.*, nonfarm decontamination cost values) does not, by itself, suggest that the inputs used were unreasonable.<sup>245</sup> As the Commission recently held in *Pilgrim* (CLI-12-15), "contentions challenging a SAMA analysis must identify a deficiency that plausibly could alter the overall results"—*i.e.*, the conclusions as to which SAMAs may be cost-beneficial—in a material way.<sup>246</sup>

# C. Standard of Review and Burden of Proof

76. The Board reviews contested issues *de novo*.<sup>247</sup> According to the Commission: "[W]hen resolving contentions litigated through the adversary process, [boards must] bring their own "*de novo*" judgment to bear. In such cases, boards must decide, based on governing regulatory standards and the evidence submitted, whether the applicant has met its burden of proof (except where the NRC Staff has the burden)."<sup>248</sup>

77. With respect to NYS-12C, New York has the initial "burden of going forward"; *i.e.*, it must provide sufficient evidence to support the claims made in the admitted contention.<sup>249</sup>

<sup>&</sup>lt;sup>244</sup> *Id.* 

<sup>&</sup>lt;sup>245</sup> *Id.* at 17.

<sup>&</sup>lt;sup>246</sup> *Pilgrim*, CLI-12-15, slip op. at 13.

<sup>&</sup>lt;sup>247</sup> Exelon Generation Co., LLC (Early Site Permit for Clinton ESP Site), CLI-05-17, 62 NRC 5, 39 (2005); La. Energy Serv., L.P. (Claiborne Enrichment Ctr.), CLI-98-3, 47 NRC 77, 84 (1998).

<sup>&</sup>lt;sup>248</sup> *Clinton*, CLI-05-17, 62 NRC at 39.

<sup>&</sup>lt;sup>249</sup> Oyster Creek, CLI-09-7, 69 NRC at 269 (quoting Consumers Power Co. (Midland Plant, Units 1 & 2), ALAB-123, 6 AEC 331, 345 (1973)) ("The ultimate burden of proof on the question of whether the permit or license should be issued is . . . upon the applicant. But where . . . one of the other parties contends that, for a specific reason . . . the permit or license should be denied, that party has the *burden of going forward* with evidence to buttress that contention. Once he has introduced sufficient evidence to establish a *prima facie* case, the burden then shifts to the applicant who, as part of his overall burden of proof, must provide a sufficient rebuttal to satisfy the Board that it should reject the contention as a basis for denial of the permit or license.") (emphasis in original); see also Vt. Yankee, 435 U.S. at 554 (upholding this threshold test for intervenor participation in licensing proceedings); *Phila. Elec. Co.* (Limerick Generating Station, Units 1 & 2), ALAB-262, 1 NRC 163,

As a general matter, an intervenor cannot meet its burden by relying on unsupported allegations and speculation.<sup>250</sup> It must introduce sufficient evidence during the hearing phase to establish a *prima facie* case. If it does so, then the burden shifts to the applicant and the NRC Staff to provide sufficient evidence to rebut the intervenor's contention.<sup>251</sup> In challenging the NRC Staff's SAMA evaluation, it is the petitioner's "burden to provide support for why the further 'analyses' or new computer modeling it seeks credibly could make a material difference to the SAMA analysis conclusions, not simply that the analysis might change in some fashion."<sup>252</sup>

78. An applicant generally has the burden of proof in a licensing proceeding.<sup>253</sup> In

cases involving NEPA contentions, the burden shifts to the NRC Staff, because it has the burden

of complying with NEPA.<sup>254</sup> The Commission has described that burden as follows:

Ultimately, NEPA requires the NRC to provide a "reasonable" mitigation alternatives analysis, containing "reasonable" estimates, including, where appropriate, full disclosures of any known shortcomings in available methodology, disclosure of incomplete or unavailable information and significant uncertainties, and a reasoned evaluation of whether and to what extent these or other considerations credibly could or would alter the [applicant's] SAMA analysis conclusions on which SAMAs are cost-beneficial to implement.<sup>255</sup>

- <sup>252</sup> *Pilgrim*, CLI-12-15, slip op. at 20.
- <sup>253</sup> 10 C.F.R. § 2.325.

<sup>191 (1975) (</sup>holding that the intervenors had the burden of introducing evidence to demonstrate that the basis for their contention was more than theoretical).

See Oyster Creek, CLI-09-07, 69 NRC at 268-70; see also Phila. Elec. Co. (Limerick Generating Station, Units 1 & 2), ALAB-857, 25 NRC 7, 13 (1987) (stating that an intervenor may not merely assert a need for more current information without having raised any questions concerning the accuracy of the applicant's submitted facts).

<sup>&</sup>lt;sup>251</sup> See, e.g., 10 C.F.R. § 2.325; La. Power & Light Co. (Waterford Steam Electric Station, Unit 3), ALAB-732, 17 NRC 1076, 1093 (1983) (citing *Midland*, ALAB-123, 6 AEC at 345); see also Pilgrim, CLI-12-15, slip op. at 13 ("Contentions challenging a SAMA analysis therefore must identify a deficiency that plausibly could alter the overall result of the analysis in a material way.").

See, e.g., Duke Power Co. (Catawba Nuclear Station, Units 1 & 2), CLI-83-19, 17 NRC 1041, 1049 (1983); Pilgrim, CLI-12-01, slip op. at 29-30 ("NEPA compliance is determined by the adequacy of the SEIS, not the applicant's Environmental Report. Therefore, the ultimate issue in determining NEPA compliance is the adequacy of the Staff's environmental review, not the Applicant's Environmental Report.").

<sup>&</sup>lt;sup>255</sup> *Pilgrim*, CLI-10-22, 72 NRC at 208.

79. Although the Staff must perform an independent review under NEPA, the Staff understandably relies upon the applicant's ER in preparing the SEIS.<sup>256</sup> Therefore, "should the Applicant become a proponent of a particular challenged position set forth in the EIS, the Applicant, as such a proponent, also has the burden on that matter."<sup>257</sup>

80. From an evidentiary standpoint, the Applicant's and NRC Staff's positions must be supported by a preponderance of the evidence.<sup>258</sup> If the preponderance of the evidence shows that the Applicant's and Staff's positions with respect to the contested issues are reasonable, then the Board will rule in their favor.

#### D. The Board's Decision Supplements and Amends the FSEIS

81. In accordance with these NEPA and administrative law principles, NRC hearings must focus on whether the NRC Staff has taken the required "hard look" at relevant, non-speculative environmental impacts.<sup>259</sup> Thus, NRC hearings must focus on whether Staff has "unduly ignored or minimized pertinent environmental effects."<sup>260</sup> But it is not a game of

See 10 C.F.R. § 51.45(c) ("The environmental report should contain sufficient data to aid the Commission in its development of an independent analysis."); *id.* § 51.70(b) ("The NRC staff will independently evaluate and be responsible for the reliability of all information used in the draft environmental impact statement."). *See also Curators of the University of Missouri*, CLI-95-8, 41 NRC 386, 396 (1995) (stating that the purpose of an environmental report is to inform the Staff's preparation of an EIS).

<sup>&</sup>lt;sup>257</sup> La. Energy Servs., L.P. (Claiborne Enrichment Ctr.), LBP-96-25, 44 NRC 331, 338-39 (1996) (citing Pub. Serv. Co. of N.H. (Seabrook Station, Units 1 & 2), ALAB-471, 7 NRC 477, 489 n.8 (1978), rev'd on other grounds, CLI-97-15, 46 NRC 294 (1997)). As a practical matter, we note that Entergy and the NRC Staff are generally aligned in their positions; *i.e.*, they both view Entergy's SAMA analysis as reasonable under NEPA and Intervenors' criticisms of that analysis as technically unjustified.

See Diablo Canyon, CLI-08-26, 68 NRC at 521 (ruling in favor of the NRC Staff and applicant because the record (which included written submissions and oral argument) "by a preponderance of the evidence," indicated that the intervenor's contention lacked merit); *Pac. Gas & Elec. Co.* (Diablo Canyon Nuclear Power Plant, Units 1 & 2), ALAB-763, 19 NRC 571, 577 (1984) ("In order to prevail . . . , the applicant's position must be supported by a preponderance of the evidence."). A preponderance of the evidence "requires the trier of fact to believe that the existence of a fact is more probable than its nonexistence." *Concrete Pipe & Products of Cal., Inc. v. Constr. Laborers Pension Trust for S. Cal.*, 508 U.S. 602 (1993) (internal quotation marks omitted).

<sup>&</sup>lt;sup>259</sup> See Balt. Gas & Elec. Co. v. Natural Res. Def. Council, 462 U.S. 87, 97-98 (1983).

Duke Energy Corp. (McGuire Nuclear Station, Units 1 & 2; Catawba Nuclear Station, Units 1 & 2), CLI-03-17, 58 NRC 419, 431 (2003); see also Exelon Generating Co., LLC (Early Site Permit for Clinton ESP Site), CLI-05-29, 62 NRC 801, 811 (2005) ("There may, of course, be mistakes in the [EIS], but in an NRC

"gotcha," in which the Staff's work can be rejected based on trivial, speculative, regulatorilyforeclosed, or irrelevant considerations.<sup>261</sup>

82. In determining whether the environmental record in this proceeding is sufficient under NEPA and 10 C.F.R. Part 51, the Board considers the record as a whole, including the FSEIS and the evidentiary record for the hearing, as developed by the Board and the parties.<sup>262</sup> As the Commission has explained:

Boards frequently hold hearings on contentions challenging the staff's final environmental review documents. In such cases, "[t]he adjudicatory record and Board decision (and . . . any Commission appellate decisions) become, in effect, part of the FEIS." Put another way, under our longstanding practice, the Staff's review (the FEIS itself) and the adjudicatory record will become part of the environmental record of the decision.<sup>263</sup>

83. Thus, after the Board considers the entire record of this proceeding, the FSEIS

will be "deemed supplemented" by the Board's decisions on NEPA contentions and by any

subsequent Commission decision.<sup>264</sup> Likewise, the NRC's record of decision ultimately will

include the Board and Commission decisions, which are based on the adjudicatory record.<sup>265</sup>

This process is codified at 10 C.F.R. § 51.102(c), which specifies:

When a hearing is held on the proposed action under the regulations in part 2 of this chapter or when the action can only be taken by the Commissioners acting as a collegial body, the initial decision of the

adjudication, it is Intervenors' burden to show their significance and materiality. Our boards do not sit to flyspeck environmental documents or to add details or nuances.") (internal quotes omitted).

<sup>&</sup>lt;sup>261</sup> See, e.g., Clinton, CLI-05-29, 62 NRC at 811.

<sup>&</sup>lt;sup>262</sup> See, e.g., Nuclear Innovation North America LLC (South Texas Project, Units 3 & 4), CLI-11-6, 74 NRC \_\_, slip op. at 7-8 (Sept. 9, 2011).

<sup>&</sup>lt;sup>263</sup> Id. (quoting La. Energy Servs., L.P. (Claiborne Enrichment Center), CLI-98-3, 47 NRC 77, 89 (1998)).

Pilgrim, CLI-12-01, slip op. at 30 (citing La. Energy Servs., L.P. (National Enrichment Facility), CLI-05-28, 62 NRC 721, 731 (2005).

See, e.g., La. Energy Servs., L.P. (Nat'l Enrichment Facility), CLI-06-15, 63 NRC 687, 707 n.91 ("Adjudicatory findings on NEPA issues, including our own in this decision, become part of the environmental 'record of decision' and in effect supplement the FEIS."); *Claiborne*, CLI-98-3, 47 NRC at 89.

presiding officer or the final decision of the Commissioners acting as a collegial body will constitute the record of decision.<sup>266</sup>

84. The Commission and its Boards have followed this process routinely and without exception, not only in the relatively-recent decisions cited above, but also in many more cases dating back decades.<sup>267</sup> Under this well-established process, the presiding officer may modify NRC Staff conclusions and, if warranted, remedy an otherwise deficient EIS through its adjudicatory decision.<sup>268</sup> The Commission may also do so on appeal.<sup>269</sup> This process applies to all NEPA issues, including SAMA issues.<sup>270</sup>

85. The U.S. Courts of Appeals, across multiple circuits, have consistently upheld the

NRC's practice as consistent with the AEA<sup>271</sup> and NEPA.<sup>272</sup> Supplementation through public

<sup>&</sup>lt;sup>266</sup> Final Rule, Amendments to Adjudicatory Process Rules and Related Requirements, 77 Fed. Reg. 46,562, 46,600 (Aug. 3, 2012).

See, e.g., Diablo Canyon, CLI-08-26, 68 NRC at 526; Hydro Res., Inc. (P.O. Box 15910, Rio Rancho, NM 87174), CLI-01-04, 53 NRC 31, 53 (2001) ("[T]he Presiding Officer's incorporation into LBP-99-30 of a staff affidavit on costs and benefits also does not require FEIS supplementation . . . in an adjudicatory hearing, to the extent that any environmental findings by the Presiding Officer (or the Commission) differ from those in the FEIS, the FEIS is deemed modified by the decision."); *Phila. Elec. Co.* (Limerick Generating Station, Units 1 & 2), ALAB–819, 22 NRC 681, 705-07 (1985), aff'd in part and review otherwise declined, CLI–86–5, 23 NRC 125 (1986), remanded in part on other grounds sub nom. Limerick Ecology Action, Inc. v. NRC, 869 F.2d 719 (3d Cir. 1989); Niagara Mohawk Power Corp. (Nine Mile Point Nuclear Station, Unit 2), ALAB-264, 1 NRC 347 (1975).

<sup>&</sup>lt;sup>268</sup> S. Nuclear Operating Co. (Early Site Permit for Vogtle ESP Site), LBP-09-7, 69 NRC 613 (2009) ("[T]he record *now contains* sufficient evidence on dry cooling to support a conclusion that dry cooling would not be preferable to the proposed wet cooling system at the Vogtle site. We thus conclude that the agency's NEPA obligations relative to the discussion of design alternatives have been satisfied with regard to dry cooling, and contention EC 1.3 is resolved on the merits in favor of the staff and SNC.") (emphasis added).

See Dominion Nuclear N. Anna, LLC (Early Site Permit for North Anna ESP Site), CLI-07-27, 66 NRC 215, 230 (2007) ("But our own examination of the entire administrative record leads us to conclude that the Staff's underlying review was sufficiently detailed to qualify as "reasonable" and a "hard look" under NEPA – even if the Staff's description of that review in the FEIS was not. Our explanation below provides an additional detailed discussion as part of the record on the alternative site review. We direct the Staff to include a similar level of detail in future FEIS analyses of alternative sites.") (emphasis in original).

See Pilgrim, CLI-12-1, slip op. at 30 (upholding the Board's merits decision on a SAMA contention and stating "[i]n an NRC adjudicatory proceeding, the adjudicatory record, Board decision, and any Commission decision become effectively part of the environmental review document (here, a final supplemental EIS). Therefore, the SEIS is deemed supplemented by the Board's decision, and by this decision.") (footnote omitted).

<sup>&</sup>lt;sup>271</sup> Nuclear Info. & Res. Serv. v. NRC, 509 F.3d 562 (D.C. Cir. 2007).

<sup>&</sup>lt;sup>272</sup> Citizens for Safe Power, Inc. v. NRC, 524 F.2d 1291 1294 n.5 (D.C. Cir. 1975) (holding that the "deemed modified" principled did not depart "from either the letter or the spirit" of NEPA); Ecology Action v. AEC, 492

hearings, moreover, is not confined to the NRC.<sup>273</sup> The rationale for allowing supplementation through the hearing process is straightforward—the NRC's hearing process allows for *greater* public participation than NEPA otherwise requires.<sup>274</sup>

86. The Commission has repeatedly authorized supplementation through the hearing record, most recently last year, when it revised and clarified 10 C.F.R. § 51.102(c).<sup>275</sup> The well-established process in Section 51.102(c), which governs the resolution of environmental issues following an adjudicatory hearing, requires the Board to consider the adjudicatory record as a whole when evaluating the environmental impacts of the proposed action, to supplement the FSEIS as necessary, and to modify the NEPA analysis and conclusions, if warranted.<sup>276</sup>

87. Despite this definitive governing precedent, New York argues that the process of

supplementing a final EIS with the hearing record is inconsistent with another regulation,

10 C.F.R. § 51.92, which requires that the Staff prepare a supplemental EIS when there are

F.2d 998, 1001–02 (2nd Cir. 1974) (omissions from an FEIS can be cured by subsequent consideration of the issue in an agency hearing); *New England Coalition on Nuclear Pollution v. NRC*, 582 F.2d 87, 94 (1st Cir. 1978) (having "no trouble finding" that the NRC's supplementation process satisfies NEPA); *see also Public Service Co. of N.H.* (Seabrook Station, Units 1 & 2), CLI-78-1, 7 NRC 1 (1978).

<sup>&</sup>lt;sup>273</sup> See, e.g., Pacific Alaska LNG Company, et al., 9 FERC ¶ 61,334, 61,709 (1979) ("[T]he CEQ General Counsel suggests that the matter should also be considered in the FEIS because the Commission proceeding does not provide the broad public review and comment required by NEPA. We disagree. Our final decision will address this issue in detail, based on the record in the proceeding. All interested parties have had an opportunity to contribute to that record, and our decision will therefore be based on full information. This procedure fully comports with the letter and spirit of NEPA.") (citing Aberdeen & Rockfish R.R. v. SCRAP, 422 U.S. 289, 320-21 (1975); Citizens For Safe Power, Inc. v. NRC, 582 F.2d 87 (1st Cir. 1978)).

<sup>&</sup>lt;sup>274</sup> Hydro Resources, Inc. (P.O. Box 15910, Rio Rancho, NM 87174), CLI-01-04, 53 NRC 31, 53 (2001) ("the hearing process itself "allows for additional and *more rigorous* public scrutiny of the FES than does the usual 'circulation for comment.") (quoting *Limerick*, 22 NRC at 707) (emphasis added).

See Final Rule, Amendments to Adjudicatory Process Rules and Related Requirements, 77 Fed. Reg. at 46,586, 46,600 (amending 10 C.F.R. § 52.102(c) to cover all hearings under 10 C.F.R. Part 2, without altering the meaning or intent of the regulation).

<sup>&</sup>lt;sup>276</sup> See, e.g., Diablo Canyon, CLI-08-26, 68 NRC at 526; Hydro Res., Inc., CLI-01-04, 53 NRC at 53 ("[T]he Presiding Officer's incorporation into LBP-99-30 of a staff affidavit on costs and benefits also does not require FEIS supplementation . . . in an adjudicatory hearing, to the extent that any environmental findings by the Presiding Officer (or the Commission) differ from those in the FEIS, the FEIS is deemed modified by the decision."); Limerick, ALAB–819, 22 NRC at 705-07.

substantial changes to the proposed action or new and significant information.<sup>277</sup> According to New York, this regulation requires an FSEIS supplement to address any new and significant information brought to light during the hearing if that information was not addressed in the FSEIS.<sup>278</sup>

88. New York's argument is incorrect for two reasons. First, despite Section 51.92's longstanding existence, the Commission has repeatedly authorized supplementation through the hearing record, most recently in reaffirming and clarifying 10 C.F.R. § 51.102(c) last year.<sup>279</sup> Second, "[a] basic tenet of statutory construction, equally applicable to regulatory construction, [is] that a statute should be construed so that effect is given to all its provisions . . . .<sup>9280</sup> New York's claim that Section 51.92—a more general regulation governing all EISs prepared by the NRC Staff—forbids the supplementation of an EIS through the hearing record would render meaningless the more specific provisions in Section 51.102(c), which governs the resolution of environmental issues following an adjudicatory hearing. Because New York's argument would give no effect to Section 51.102(c), it cannot be correct.<sup>281</sup>

89. None of the federal cases on which New York relies is relevant to interpreting the NRC's regulations in Part 51, nor do these cases establish that those regulations somehow undermine the NEPA public participation process. The only two arguably pertinent cases cited

<sup>&</sup>lt;sup>277</sup> See, e.g., New York Rebuttal Position Statement at 31 (NYS000419) ("NRC Staff may cure its NEPA deficiencies only by supplementing the FSEIS and circulating the supplement for public review and comment."); State of New York's Revised Statement of Position Regarding Contention NYS-17B at 7-8 (June 29, 2012) ("New York Rebuttal Position Statement for 17B") (NYS000433).

<sup>&</sup>lt;sup>278</sup> See New York Rebuttal Position Statement for NYS-17B at 7-8 (NYS000433).

<sup>&</sup>lt;sup>279</sup> See Final Rule, Amendments to Adjudicatory Process Rules and Related Requirements, 77 Fed. Reg. at 46,586, 46,600.

<sup>&</sup>lt;sup>280</sup> Hydro Res., Inc. (P.O. Box 777, Crownpoint, New Mexico 87313), CLI-06-11, 63 NRC 483, 491 (2006).

<sup>&</sup>lt;sup>281</sup> Nor does the supplementation of an EIS through the hearing process necessarily mean that there is new and significant information. On the contrary, supplementation of the record through the Section 51.102 process is appropriate when the record of hearing shows no significant new picture of the environmental impacts of the proposed action. *See Hydro Res, Inc.*, CLI-01-04, 53 NRC at 53.

by New York are readily distinguished from the NRC's hearing process by the NRC's Appeal Board decades ago, in decisions that remain binding in this proceeding and thus mandate rejecting New York's theory.<sup>282</sup>

90. First, in the *I-291 Why*? case, the court invalidated an agency decision because subsequent studies—which were not circulated for review and comment and were available only to agency officials and not the public—showed the EIS to be inadequate.<sup>283</sup> In ALAB-262, the *Limerick* Appeal Bound readily distinguished the NRC's public hearing supplementation process from this situation.<sup>284</sup> The Appeal Board found significant distinctions between the unpublished supplemental studies that the courts invalidated in *I-291 Why*? and any supplemental NEPA analysis that may result from the NRC's contested, public adjudicatory proceeding.<sup>285</sup> This NRC proceeding is no different, in that the environmental issues have been thoroughly tested through a public, adversarial adjudicatory proceeding.

91. Second, ten years later, the Appeal Board considered the claim that *Grazing Fields Farms v. Goldschmidt* forbids the amendment of a final environmental statement through the hearing record, but again it found that case to be "easily distinguished" from the NRC hearing process.<sup>286</sup> In *Grazing Fields*, the First Circuit held that the Federal Highway Administration's reliance on certain studies and memoranda that were in the administrative

<sup>&</sup>lt;sup>282</sup> New York's remaining authorities stand for the general principles that NEPA requires public participation in agency decisionmaking and the publication of relevant environmental information. See Minn. Public Interest Research Group v. Butz, 541 F2d 1292 (8th Cir. 1976); Ohio Valley Envt'l Coalition v. Hurst, 604 F.Supp.2d 860 (S.D.W.Va. 2009); Custer Cnty. Action Ass'n v. Garvey, 256 F.3d 1024 (10th Cir. 2001); 40 C.F.R. § 1500.1(b); Natural Res. Def Council v. Callaway, 527 F.2d 79 (2d Cir. 1975). These principles are not violated by 10 C.F.R. § 51.102(c) or the application of that regulation in this proceeding.

<sup>&</sup>lt;sup>283</sup> See I-291 Why? Association v. Burns, 517 F.2d 1077, 1081 (2d Cir. 1975).

<sup>&</sup>lt;sup>284</sup> *Limerick*, ALAB-262, 1 NRC at 163.

<sup>&</sup>lt;sup>285</sup> See id. at 197, n. 54.

<sup>&</sup>lt;sup>286</sup> *Limerick*, ALAB–819, 22 NRC at 706, n. 33.

record but not incorporated into the EIS was inappropriate.<sup>287</sup> Noting that the *Grazing Fields* decision did not even cite to the First Circuit's earlier *New England Coalition* opinion upholding the NRC's hearing supplementation rule, the Appeal Board approved the licensing board's application of Section 51.102 to explicitly amend the Limerick final environmental statement through its decision.<sup>288</sup>

92. Once again, this hearing is no different, in that the relevant environmental issues have been fully and rigorously ventilated through a public adjudicatory hearing.<sup>289</sup> Certainly, New York, as a full participant in this proceeding, can claim no prejudice to its own interests.<sup>290</sup> ALAB-819 therefore controls, and mandates the rejection of New York's argument.

93. In summary, Section 51.102(c), which governs the resolution of environmental issues following an adjudicatory hearing, requires the Board to consider the adjudicatory record as a whole when evaluating the environmental impacts of the proposed action, to supplement the FSEIS as necessary, and to modify the NEPA analysis and conclusions, if warranted.<sup>291</sup>

<sup>&</sup>lt;sup>287</sup> Grazing Fields Farm v. Goldschmidt, 626 F.2d 1068 (1st Cir. 1980).

See Limerick, ALAB-819, 22 NRC at 705-07 & n.33 (citing New England Coalition on Nuclear Pollution v. NRC, 582 F.2d at 94). The Appeal Board also rejected the argument that certain changes made to Part 51 in 1984 required the recirculation of NEPA documents following a hearing, holding that "section 51.102 serves the same purpose as its differently worded predecessor," incorporating the adjudicatory decision into the environmental record of decision. See id. As detailed above, the Commission and its Boards have uniformly followed this interpretation of Section 51.102 ever since.

<sup>&</sup>lt;sup>289</sup> See id. at 707.

<sup>&</sup>lt;sup>290</sup> See id.

<sup>&</sup>lt;sup>291</sup> See Final Rule, Amendments to Adjudicatory Process Rules and Related Requirements, 77 Fed. Reg. at 46,586, 46,600.

### IV. FACTUAL FINDINGS AND LEGAL CONCLUSIONS

#### A. Witnesses and Evidence Presented

#### 1. Entergy's Expert Witnesses

94. Entergy presented testimony by a panel of three witnesses: Ms. Potts, Dr. O'Kula, and Mr. Teagarden. These witnesses submitted written direct testimony and gave oral testimony at the evidentiary hearing.

95. Ms. Potts is a senior consulting engineer to Entergy in the areas of SAMA analysis and fire probabilistic risk assessment in Russellville, Arkansas.<sup>292</sup> She holds a Bachelor of Science ("B.S.") degree in Nuclear Engineering from Pennsylvania State University. She has over thirty years of experience as a technical professional in the nuclear industry in the areas of safety analysis, PRA, deterministic and probabilistic accident and consequence analysis, materials aging management, reactor engineering, and systems engineering. Ms. Potts' experience includes performing PRA and severe accident analysis of reactor, emergency system, and containment phenomena under accident conditions. She has participated directly in the preparation of SAMA analyses for eight nuclear plants, including the IPEC SAMA analysis, and has peer reviewed the SAMA analyses for three additional nuclear plants. Ms. Potts also is a co-author of NEI 05-01 (NYS000287), the NRC-approved industry guidance document for performing SAMA analyses.

96. Dr. O'Kula is an Advisory Engineer with URS Safety Management Solutions LLC in Aiken, South Carolina.<sup>293</sup> He obtained his B.S. degree in Applied and Engineering Physics from Cornell University in 1975, and his Master of Science ("M.S.") and Doctorate (Ph.D.) degrees in Nuclear Engineering from the University of Wisconsin in 1977 and 1984,

<sup>&</sup>lt;sup>292</sup> Ms. Potts' professional qualifications are provided in her curriculum vitae (ENT000004) and summarized in her testimony. *See* Entergy Testimony at 1-3 (A1-4) (ENT000450).

<sup>&</sup>lt;sup>293</sup> Dr. O'Kula's professional qualifications are provided in his curriculum vitae (ENT000005) and summarized in his testimony. *See* Entergy Testimony at 3-5 (A5-9) (ENT000450).

respectively. Dr. O'Kula has over thirty years of experience as a technical professional and manager in the areas of safety analysis methods and guidance development, computer code validation and verification, PRA, deterministic and probabilistic accident and consequence analysis applications for reactor and non-reactor nuclear facilities, source term evaluation, risk management, software quality assurance, and shielding. He is a past Chair of the Nuclear Installation Safety Division of the American Nuclear Society ("ANS"). In addition, he has over twenty years of experience using, applying, and providing training on the MACCS and MACCS2 computer codes, which are used to evaluate the potential impacts of nuclear power plants severe accidents on the public. Dr. O'Kula also was a member of the Peer Review Committee for the NRC's SOARCA project, which sought to develop updated and more realistic severe accident analyses through improved computer modeling and including significant plant improvements and updates not reflected in earlier NRC assessments.

97. Mr. Teagarden is the Manager for Consequence Analysis for ERIN Engineering & Research, Inc. in Campbell, California.<sup>294</sup> Mr. Teagarden obtained his B.S. degree in Mechanical Engineering from University of Miami in 1990 and completed the Bettis Reactor Engineering School at the Bettis Atomic Power Laboratory as part of his training in the U.S. Navy nuclear program. He has fourteen years of experience in the nuclear field, including ten years as a manager and technical professional in the areas of PRA, source term analysis, consequence analysis, and nuclear power plant security risk assessment. He also is a member of the ANS and Vice Chair of the writing committee for ANSI/ANS-58.25, Standard for Radiological Accident Offsite Consequence Analysis (Level 3 PRA) to Support Nuclear Installation Applications. Mr. Teagarden has substantial experience using MACCS2 and

<sup>&</sup>lt;sup>294</sup> Mr. Teagarden's professional qualifications are provided in his curriculum vitae (ENT000007) and summarized in his testimony. *See* Entergy Testimony at 5-7 (A10-13) (ENT000450).

developing MACCS2 models for nuclear power plants in the United States. He has developed or managed the development of MACCS2 models in support of SAMA analyses for ten nuclear power plant sites.

98. Based on the foregoing, and the respective backgrounds and experience of Ms. Potts, Dr. O'Kula, and Mr. Teagarden, the Board finds that all three Entergy witnesses are qualified to testify as expert witnesses relative to the issues raised in NYS-12C.

# 2. NRC Staff's Expert Witnesses

99. The NRC Staff presented testimony from a panel of four witnesses: Dr. Bixler, Dr. Ghosh, Mr. Jones, and Mr. Harrison. These witnesses submitted written direct testimony and gave oral testimony at the evidentiary hearing.

100. Dr. Bixler holds a Ph.D. in Chemical Engineering from the University of Minnesota (1982) and a B.S. in Chemical Engineering from the University of Toledo (1976).<sup>295</sup> He has been employed by Sandia National Laboratories for more than twenty-eight years as an engineer and computer software researcher in the areas of accident analysis and fluid mechanics. Since 1998, Dr. Bixler has been the principal investigator for code development and analysis of nuclear accident consequences for the NRC for multiple codes, including MACCS2,

RADTRAD, WinMACCS, SECPOP2000, and MELMACCS. From 2003 to 2009, he was the principal instructor for a weekly NRC training program on accident consequence analysis, which emphasized (among other things) the use of the WinMACCS/MACCS2 code system for estimating health and economic consequences. He has authored or co-authored over four dozen publications including, for example, "MACCS2 Consequence Calculations for a Postulated Short-Term Station Blackout at a Pressurized Water Reactor with an Ice Condenser Containment and a Boiling Water Reactor with a Mark III Containment," SAND2006-0632 (2006).

<sup>&</sup>lt;sup>295</sup> Dr. Bixler's professional qualifications are provided in his statement of qualifications (NRC000042) and summarized in his testimony. *See* NRC Staff Testimony at 1-3 (A1-2) (NRC000041).

101. Dr. Ghosh holds a Ph.D. in Nuclear Engineering and an M.S. in Technology & Policy from the Massachusetts Institute of Technology (2004 and 2000, respectively), as well as a B.S. in Civil Engineering and Operations Research from Princeton University (1995).<sup>296</sup> When completing her doctorate, she was a fission engineering major, specializing in probabilistic risk assessment. She has worked for the NRC for over six years in multiple roles, most recently as the NRC lead for the uncertainty analysis component of the SOARCA project. While serving as a Reactor Engineer in the Division of Risk Assessment, Dr. Ghosh reviewed SAMA analyses for nuclear power plant license renewal applications. As a Systems Performance Analyst in the Division of High-Level Waste Repository Safety, Dr. Ghosh also evaluated performance assessments and risk analyses in a license application for a proposed high-level waste/spent nuclear fuel repository. Dr. Ghosh has published several papers, including one entitled "Perspectives on Severe Accident Mitigation Alternatives for U.S. Plant License Renewal" (2009).

102. Mr. Jones has been employed by Sandia National Laboratories since 1989 and been named a Distinguished Member of the Technical Staff.<sup>297</sup> He holds a B.S. degree in Civil Engineering from New Mexico State University and is a Registered Professional Engineer in New Mexico. Mr. Jones has nearly thirty years of experience in engineering and analysis, and has been involved in radiological emergency preparedness, consequence management, and radioactive materials cleanup activities both nationally and internationally. He is the Sandia project manager for the NRC's SOARCA project, and the Sandia emergency preparedness technical lead for that same project. Mr. Jones also has managed project teams in the

<sup>&</sup>lt;sup>296</sup> Dr. Ghosh's professional qualifications are provided in her statement of qualifications (NRC000043) and summarized in her testimony. *See* NRC Staff Testimony at 1-3 (A1-2) (NRC000041).

<sup>&</sup>lt;sup>297</sup> Mr. Jones' professional qualifications are provided in his statement of qualifications (NRC000044) and summarized in his testimony. *See* NRC Staff Testimony at 1-4 (A1-2) (NRC000041).

decontamination and decommissioning of radioactively-contaminated facilities at Sandia and the development of advanced decontamination techniques for radioactive materials. In that capacity, he served as project manager for a U.S. Department of Homeland Security project involving the development of removable coatings for use in containing contamination from radiological dispersal devices. Mr. Jones also served as project manager for a Defense Advanced Research Projects Agency ("DARPA") project that involved the development of strippable coatings for decontamination of cesium, strontium, and cobalt. He holds a patent for a strippable coating technology designed to contain the spread of radioactive contamination and facilitate decontamination efforts.

103. Mr. Harrison is the Branch Chief for Probabilistic Risk Assessment Licensing Branch ("APLA") of the Division of Risk Assessment within the Office of Nuclear Reactor Regulation ("NRR") at the NRC.<sup>298</sup> APLA had the responsibility for the license renewal SAMA reviews and associated development of this aspect of the EIS (as well as most risk-informed rulemaking and license application reviews that involved the use of probabilistic risk assessments) when Entergy submitted the IPEC license renewal application in April 2007.<sup>299</sup> Mr. Harrison holds a B.S. degree in Nuclear Engineering from the University of Missouri – Rolla. He has over twenty-five years of technical expertise in PRA and risk-related activities. Mr. Harrison served as a Senior Reliability and Risk Analyst in the NRC's PRA Licensing Branch for seven years before becoming Branch Chief in 2007. Before joining the NRC in 2000, he held numerous engineering, consulting, and project management positions with private sector

<sup>&</sup>lt;sup>298</sup> Mr. Harrison's professional qualifications are provided in his statement of qualifications (NRC000045) and summarized in his testimony. *See* NRC Staff Testimony at 2-4 (A1-2) (NRC000041).

<sup>&</sup>lt;sup>299</sup> Due to an internal reallocation of review responsibilities and associated staff resources within the Division of Risk Assessment, the license renewal SAMA reviews were recently reassigned to another branch, the Accident Dose Branch. NRC Staff Testimony at 4 (A2) (NRC000041). However, Mr. Harrison has retained responsibility for those SAMA reviews that were performed under APLA, including the IPEC SAMA analysis review. *Id.* 

companies providing various services to the U.S. Department of Energy and national laboratories. Mr. Harrison also worked as a Research Engineer at the Battelle – Pacific Northwest Laboratory in Richland, Washington.

104. Based on the foregoing, and the respective backgrounds and experience of Dr. Bixler, Dr. Ghosh, Mr. Jones, and Mr. Harrison, the Board finds that all four Staff witnesses are qualified to testify as expert witnesses relative to the issues raised in NYS-12C.

# 3. New York's Expert Witness

105. New York presented testimony from one witness, Dr. Lemay. Dr. Lemay submitted written direct and rebuttal testimony and gave oral testimony at the hearing.

106. Dr. Lemay is Vice President of ISR.<sup>300</sup> He holds a Ph.D. in Physics of Nuclear Reactors from the University of Birmingham, United Kingdom and is a professional engineer in the provinces of Ontario and Quebec, Canada. He has twenty-seven years of experience in safety analysis, emergency response plans, procedures and systems, radiation protection, radiation transport, risk assessment, environmental impact assessment, standards and guidelines. He also has performed or participated in audits and evaluations, emergency exercises, courses and training exercises, and international projects. Dr. Lemay teaches an advanced-level course on the COSYMA and MACCS2 computer codes for health physicists and engineers.

107. Based on the foregoing, and Dr. Lemay's background and experience, the Board finds that Dr. Lemay is qualified to testify as an expert witness on issues raised in NYS-12C.

<sup>&</sup>lt;sup>300</sup> Dr. Lemay's professional qualifications are provided in his curriculum vitae (NYS000291) and summarized in his testimony. *See* New York Direct Testimony at 1:21-3:49 (NYS000241).

### B. <u>The SAMA Analysis Methodology</u>

108. Before addressing New York's specific claims, we discuss the IPEC SAMA analysis methodology, including the MACCS2 inputs challenged by New York.<sup>301</sup> As stated above, a SAMA analysis is intended to identify potential changes to a nuclear power plant, or its operations, that could reduce the already-low risk (the likelihood and/or the impact) of a severe accident, for which the benefit of implementing the change outweighs the cost of implementation.<sup>302</sup> Changes to the plant that could reduce the risk of a severe accident include hardware modifications or operational changes (*e.g.*, improved procedures and augmented training of control room and plant personnel).<sup>303</sup> These potential changes are called SAMAs or SAMA candidates.<sup>304</sup>

109. A SAMA analysis models numerous accident release conditions that could, based on probabilistic analysis, occur at any time under varying weather conditions during a one-year period to calculate the mean annual consequences of a severe accident for the entire 50-mile radius area of interest.<sup>305</sup> As such, a SAMA analysis makes use of "best estimate" values and

<sup>&</sup>lt;sup>301</sup> The parties' prefiled testimony on NYS-12C contains extensive discussions of the SAMA analysis methodology. *See* Entergy Testimony at 16-46 (A27-A60) (ENT000450); NRC Staff Testimony at 19-31 (A8-A25) (NRC000041); New York Direct Testimony at 10:204-19:511 (NYS000241). Also, during the evidentiary hearing on NYS-12C, the Board requested an overview of the SAMA analysis methodology to lay the groundwork for further questions. The parties' witnesses provided that overview on the first hearing day. *See generally* Oct. 17, 2012 Tr. at 1899:14-1919:14.

<sup>&</sup>lt;sup>302</sup> Oct. 17, 2012 Tr. at 1900:9-23 (Teagarden); Entergy Testimony at 17 (A28) (ENT000450); NRC Staff Testimony at 19 (A8) (NRC000041).

<sup>&</sup>lt;sup>303</sup> Oct. 17, 2012 Tr. at 1900:9-23 (Teagarden); Entergy Testimony at 17 (A28) (ENT000450); NRC Staff Testimony at 20 (A11) (NRC000041).

<sup>&</sup>lt;sup>304</sup> Oct. 17, 2012 Tr. at 1910:3-23 (Teagarden); Entergy Testimony at 17 (A28) (ENT000450); NRC Staff Testimony at 19 (A9) (NRC000041).

<sup>&</sup>lt;sup>305</sup> Oct. 17, 2012 Tr. at 1927:16-24 (Teagarden) ("It's important to recognize that a SAMA analysis is a spatially average[d] and time averaged analysis [that] ... looks at a range, a spectrum, of postulated releases that could occur using meteorology, a whole year of meteorology, looking at different weather sequences and determining an average result from all of those."). *See also* Entergy Testimony at 18 (A31) (ENT000450); NRC Staff Testimony at 25-26 (A19) (NRC000041).

involves an averaging of potential consequences.<sup>306</sup> The parties' experts all agreed on this point.<sup>307</sup>

110. The industry has developed a guidance document, NEI 05-01, Rev. A ("NEI 05-01") to facilitate the preparation of complete SAMA analyses.<sup>308</sup> NEI 05-01 was developed by several SAMA experts, including Ms. Potts, and was issued by NEI in November 2005.<sup>309</sup> It identifies the information an applicant should include in a SAMA analysis supporting a license renewal application.<sup>310</sup> NEI 05-01 draws from experience gained from prior SAMA analyses and NRC Staff reviews thereof.<sup>311</sup> The Staff has specifically endorsed NEI 05-01 and recommended that applicants for license renewal follow the guidance provided in NEI 05-01, Revision A when preparing their SAMA analyses.<sup>312</sup>

111. A SAMA analysis involves four major sequential steps.<sup>313</sup> In brief, the first step of a SAMA evaluation is to identify and characterize the leading contributors to core damage

<sup>&</sup>lt;sup>306</sup> Oct. 17, 2012 Tr. at 1907:3-7 (Teagarden) ("A SAMA analysis is designed to be what we say [is] a best estimate analysis, a representative average basis. And to present that average basis you need to look at both ends of the spectrum.").

<sup>&</sup>lt;sup>307</sup> See Oct. 17, 2012 Tr. at 1937:1-21 (Teagarden, Bixler, and Lemay); see also Oct. 18, 2012 Tr. at 2272:7-10 (Bixler) ("It's intended to be best estimate, whether you interpret that as a median or a mean. But something in the middle of the range certainly.").

<sup>&</sup>lt;sup>308</sup> Oct. 17, 2012 Tr. at 1926:5-8 (Teagarden); Entergy Testimony at 17 (A29) (ENT000450) (citing NEI 05-01 (NYS000287)).

<sup>&</sup>lt;sup>309</sup> Oct. 17, 2012 Tr. at 1926:8-9 (Teagarden); Entergy Testimony at 17 (A29) (ENT000450).

<sup>&</sup>lt;sup>310</sup> Oct. 17, 2012 Tr. at 1926:10-14 (Teagarden); Entergy Testimony at 17 (A29) (ENT000450).

<sup>&</sup>lt;sup>311</sup> Entergy Testimony at 17 (A29) (ENT000450).

Oct. 17, 2012 Tr. at 1926:10 (Teagarden); Entergy Testimony at 18 (A30) (citing Notice of Availability of the Final License Renewal Interim Staff Guidance LR-ISG-2006-03: Staff Guidance for Preparing Severe Accident Mitigation Alternatives Analyses, 72 Fed. Reg. 45,466, 45,467 (Aug. 14, 2007) ("NEI 05-01, Revision A, describes existing NRC regulations, and facilitates complete preparation of SAMA analysis submittals.")). In reviewing a license renewal applicant's SAMA analysis, the NRC Staff uses the guidance contained in NUREG-1555, Standard Review Plan for Environmental Reviews for Nuclear Power Plants – Supplement 1: Operating License Renewal, Sec. 5.1.1 (Severe Accident Mitigation Alternatives) (Oct. 1999) (ENT00019B).

<sup>&</sup>lt;sup>313</sup> See October 17, 2012 Tr. at 1900:24-1919:14 (Teagarden). See also Entergy Testimony at 18 (A31) (ENT000450); NRC Staff Testimony at 19 (A9) (NRC000041); NEI 05-01 at 2 (NYS000287).

frequency ("CDF") and offsite risk based on a plant-specific risk study.<sup>314</sup> The second step in the process is to identify candidate SAMAs to mitigate these risk contributors.<sup>315</sup> In the third step, an initial screening is performed to determine which SAMAs cannot be cost-beneficial.<sup>316</sup> For example, if the cost of implementing a SAMA is higher than the elimination of all risk from operating the plant (called the "maximum attainable benefit"), then that SAMA is screened out.<sup>317</sup> In the final step, a benefit assessment is performed for each SAMA that survives the initial screening to address how the change would affect relevant risk measures (*i.e.*, the reduction gained in core damage frequency, offsite population dose risk, and offsite economic cost risk).<sup>318</sup> An implementation cost assessment also is performed for each SAMA is estimated and compared to its estimated implementation cost.<sup>320</sup>

112. As described further below, Entergy followed the four-step approach described above in performing both its original April 2007 SAMA analysis and December 2009 revised SAMA analysis (in which it used corrected meteorological data).<sup>321</sup> The Staff's detailed review

<sup>&</sup>lt;sup>314</sup> See Oct. 17, 2012 Tr. at 1900:25-1910:2 (Teagarden); Entergy Testimony at 18-19 (A31) (ENT000450); NRC Staff Testimony at 19 (A9), 21 (A12) (NRC000041).

<sup>&</sup>lt;sup>315</sup> See Oct. 17, 2012 Tr. at 1910:3-15 (Teagarden); Entergy Testimony at 18-19 (A31) (ENT000450); NRC Staff Testimony at 19-20 (A9-10) (NRC000041).

<sup>&</sup>lt;sup>316</sup> See Oct. 17, 2012 Tr. at 1910:16-1911:3 (Teagarden); Entergy Testimony at 18-19 (A31) (ENT000450); NRC Staff Testimony at 19-20 (A9-11) (NRC000041).

<sup>&</sup>lt;sup>317</sup> See Oct. 17, 2012 Tr. at 1911:4-12 (Teagarden); Entergy Testimony at 18-19 (A31) (ENT000450); NRC Staff Testimony at 19 (A9) (NRC000041).

<sup>&</sup>lt;sup>318</sup> Entergy Testimony at 18-19 (A31) (ENT000450); NRC Staff Testimony at 19 (A9), 21-22 (A13-14) (NRC000041).

<sup>&</sup>lt;sup>319</sup> Entergy Testimony at 18-19 (A31) (ENT000450); NRC Staff Testimony at 19 (A9), 23 (A15) (NRC000041).

<sup>&</sup>lt;sup>320</sup> Entergy Testimony at 18-19 (A31) (ENT000450); NRC Staff Testimony at 19 (A9) (NRC000041).

<sup>&</sup>lt;sup>321</sup> See Indian Point Energy Center License Renewal Application, App. E, at 4-48 to 4-50 (Apr. 2007) ("ER") (ENT00015B); NL-09-165, Attach. 1 at 3-9 (ENT000009). NEI 05-01 also recommends that applicants perform sensitivity analyses that evaluate how changes to certain assumptions and uncertainties in the SAMA analysis would affect the cost-benefit analysis outcome. See Entergy Testimony at 47 (A62) (ENT000450); NEI 05-01 at 30-32 (NYS000287). As documented in the FSEIS, Entergy performed a number of sensitivity analyses. See FSEIS, Vol. 3, App. G at G-18, G-21, G-40, G-45 to G-47, G-49 (NYS00133I) (discussing Entergy's various sensitivity analyses, including cases addressing use of a 3 percent discount rate (instead of 7)

of Entergy's SAMA analysis is summarized in Section 5.2 of the FSEIS and documented in full in Appendix G of the FSEIS.<sup>322</sup>

### 1. Characterization of Plant Risk (Step 1)

113. Three PRA steps are required to perform the first step of a SAMA analysis.<sup>323</sup> The Level 1 PRA analyzes initiating events (*e.g.*, equipment failures, operator actions) and ensuing accident sequences leading to core damage, and the results of that analysis are used as inputs to the Level 2 PRA, which evaluates accident progression leading to containment failure (or bypass) and release of radionuclides to the environment.<sup>324</sup> The Level 3 PRA combines the Level 2 PRA results (source terms and frequencies) with site-specific parameters (*e.g.*, population distribution, meteorological data, land use data, and economic data) to estimate offsite public dose and offsite economic consequences of the postulated releases to the environment.<sup>325</sup>

114. Entergy quantified the level of risk associated with potential reactor accidents using plant-specific PRAs and other risk models.<sup>326</sup> Specifically, Entergy used the most recent probabilistic safety assessments for IP2 and IP3 available at the time it performed the SAMA analysis as well as insights from the Individual Plant Examination ("IPE") and the Individual Plant Examination of External Events ("IPEEE") for each unit.<sup>327</sup> Entergy used the MACCS2

percent), use of a longer plant life, tourism and business losses, and an increased probability of a thermally induced steam generator tube rupture ("TI-SGTR")).

<sup>&</sup>lt;sup>322</sup> See FSEIS, Vol. 1 at 5-1 to 5-13 (NYS00133B); FSEIS, Vol. 3, App. G at G-1 to G-51 (NYS00133I).

<sup>&</sup>lt;sup>323</sup> Oct. 17, 2012 Tr. at 1901:6-1902:25, 1907:17-1908:24 (Teagarden); NRC Staff Testimony at 21 (A12) (NRC000041).

<sup>&</sup>lt;sup>324</sup> Oct. 17, 2012 Tr. at 1901:13-1902:8 (Teagarden); NRC Staff Testimony at 21 (A12) (NRC000041).

<sup>&</sup>lt;sup>325</sup> Oct. 17, 2012 Tr. at 1902:14-25 (Teagarden); NRC Staff Testimony at 21 (A12), 25 (A19) (NRC000041).

<sup>&</sup>lt;sup>326</sup> See FSEIS, Vo. 3, App. G at G-1 to G-2 (NYS00133I).

<sup>&</sup>lt;sup>327</sup> *See id.* 

code to perform the plant-specific offsite consequence analysis (*i.e.*, the Level 3 PRA portion of the analysis).<sup>328</sup>

115. The MACCS2 code is the standard tool used in the U.S. to perform the offsite consequence analysis in the Level 3 portion of the PRA.<sup>329</sup> MACCS2 performs its calculations based on plant- and site-specific, regional, and industry-standardized regulatory inputs (*e.g.*, dose conversion factors, breathing rates).<sup>330</sup> Plant-specific inputs to MACCS2 include, for example, the PRA-based source terms for each source term release category and the reactor core radionuclide inventory, site-specific meteorological data, projected population distribution, and economic data.<sup>331</sup> The source term is the amount and radionuclide composition of material postulated to be released from the core of the analyzed nuclear power reactor during an accident scenario.<sup>332</sup>

116. MACCS2 is divided into three primary modules—ATMOS, EARLY, and CHRONC.<sup>333</sup> ATMOS performs all calculations pertaining to atmospheric transport, dispersion, and deposition of radioactive material, and to radioactive decay of that material both before and

<sup>&</sup>lt;sup>328</sup> See id. at G-4, G-19 to G-22.

<sup>&</sup>lt;sup>329</sup> NRC Staff Testimony at 21 (A12) (NRC00041); Entergy Testimony at 24 (A39), 77 (A101) (ENT000450). See also Pilgrim, CLI-12-01, slip op. at 3 ("NRC-endorsed guidance on SAMA analysis endorses use of the MACCS2 code.") (citing Pilgrim, CLI-10-11, 71 NRC 287, 291 & n.11).

<sup>&</sup>lt;sup>330</sup> Oct. 17, 2012 Tr. at 1938:4-9 (Teagarden), 1944:11-1945:4 (O'Kula). See also NEI 05-01 at 13-15 (NYS000287).

<sup>&</sup>lt;sup>331</sup> Oct. 17, 2012 Tr. at 1947:16-1950:8 (Teagarden). See also NEI 05-01 at 13-15 (NYS000287).

<sup>&</sup>lt;sup>332</sup> NRC Staff Testimony at 23-24 (A17-18) (NRC000041). The information in the source term description includes the quantity of each important radionuclide released into the atmosphere, the initial time of the release relative to the start of the accident, the duration of the release, the elevation of the release, the buoyancy of the plume released, and the particle size of the released material. Source terms generally depend on how rapidly the accident progresses, the path by which the radionuclides escape from the reactor into containment, the path through containment (or possibly bypassing containment altogether), and the effectiveness of both passive and active safety features, especially pools and sprays, that are intended to mitigate releases by, for example, "scrubbing" the radionuclides and/or reducing containment internal pressure driving the release. *See id.* 

<sup>&</sup>lt;sup>333</sup> Oct. 17, 2012 Tr. at 2056:22-2057:25 (O'Kula); Entergy Testimony at 28-29 (A44 & Fig. 2) (ENT000450) (citing NUREG/CR-6613, Vol. 1 at 2-1 to 2-3 (NYS000243)); NRC Staff Testimony at 25 (A19) (NRC000041).

after its release into the atmosphere.<sup>334</sup> It calculates air and ground concentrations, plume size, and timing information for all plume segments as a function of downwind distance.<sup>335</sup>

117. The results of the ATMOS calculations are then used by the other MACCS2 modules.<sup>336</sup> Specifically, EARLY uses the calculated air and ground concentrations, plume size, and timing information for all plume segments calculated by ATMOS and other inputs (*e.g.*, population) to calculate consequences due to radiation exposure in the emergency phase (*i.e.*, in the first seven days from the time of release in the IPEC SAMA analysis).<sup>337</sup>

118. CHRONC uses the radioactivity concentrations determined by ATMOS, as well as extensive economic cost data inputs and parameters, to determine long-term offsite population dose and long-term economic costs.<sup>338</sup> Long-term consequences are calculated for the period starting after the seven-day emergency phase and extending approximately 30 years.<sup>339</sup>

119. There are numerous economic cost inputs to CHRONC including, for example, average county-wide value of farm wealth and of non-farm wealth, average cost of labor to perform decontamination, population relocation costs, and daily cost for an evacuated person.<sup>340</sup> Consistent with NEI 05-01 guidance, the economic inputs to the SAMA analysis are expressed in dollars for the year in which the SAMA analysis is being performed.<sup>341</sup> This enables SAMA

<sup>&</sup>lt;sup>334</sup> Oct. 17, 2012 Tr. at 2057:8-12 (O'Kula); Entergy Testimony at 28 (A44) (ENT000450); NRC Staff Testimony at 25-26 (A19) (NRC000041).

<sup>&</sup>lt;sup>335</sup> Entergy Testimony at 28 (A44) (ENT000450); NRC Staff Testimony at 26 (A19) (NRC000041).

<sup>&</sup>lt;sup>336</sup> Entergy Testimony at 28 (A44) (ENT000450); NRC Staff Testimony at 26 (A19) (NRC000041).

<sup>&</sup>lt;sup>337</sup> Oct. 17, 2012 Tr. at 2057:13-16 (O'Kula); Entergy Testimony at 28 (A44) (ENT000450); NRC Staff Testimony at 26 (A19), 35-36 (A32) (NRC000041).

<sup>&</sup>lt;sup>338</sup> Entergy Testimony at 28 (A44) (ENT000450); NRC Staff Testimony at 36-37 (A32) (NRC000041).

<sup>&</sup>lt;sup>339</sup> Oct. 17, 2012 Tr. at 1983:11-17 (Teagarden); Entergy Testimony at 28 (A44), 40 (A53) (ENT000450); NRC Staff Testimony at 36 (A32) (NRC000041).

<sup>&</sup>lt;sup>340</sup> Oct. 17, 2012 Tr. at 1978:12-1981:8 (Teagarden); Entergy Testimony at 40-43 (A53-A54) (ENT000450); NRC Staff Testimony at 37-38 (A33) (NRC000041).

<sup>&</sup>lt;sup>341</sup> NRC Staff Testimony at 21 (A12) (NRC000041); Entergy Testimony at 45 (A58) (ENT000450) (citing NEI 05-01 at 13 (NYS000287)).

economic costs to be compared to SAMA mitigation costs in current day dollars.<sup>342</sup> To scale available economic data from a past census or survey to current conditions, NEI 05-01 recommends the use of the ratio of the consumer price indices ("CPIs").<sup>343</sup>

120. MACCS2 provides results in terms of offsite population dose and offsite economic cost that are used to compute the offsite risk measures; *i.e.*, population dose risk ("PDR") expressed in units of person-rem/year, and offsite economic cost risk ("OECR") expressed in dollars/year.<sup>344</sup> The individual PDRs and OECRs for the spectrum of different accident release categories are summed to determine the overall PDR and overall OECR for the SAMA analysis.<sup>345</sup> The PDR and OECR are the mean annual risk metrics and represent the mean cumulative impacts from postulated severe accidents (*i.e.*, dose or economic costs) to all individuals and land within a 50-mile radius of the plant.<sup>346</sup> Entergy calculated mean PDRs of 87.4 person-rem/year and 94.8 person-rem/year for IP2 and IP3, respectively.<sup>347</sup> It calculated mean OECRs of 2.12 x 10<sup>5</sup> dollars/year and 2.61 x 10<sup>5</sup> dollars/year for IP2 and IP3, respectively.<sup>348</sup>

<sup>&</sup>lt;sup>342</sup> Entergy Testimony at 45 (A58) (ENT000450).

<sup>&</sup>lt;sup>343</sup> *Id.* at 45 (A58), 53 (A71); NEI 05-01 at 13 (NYS000287).

<sup>&</sup>lt;sup>344</sup> Oct. 17, 2012 Tr. at 1907:17-22, 1913:3-14, 1918:1-22 (Teagarden); Entergy Testimony at 45 (A59) (ENT000450).

<sup>&</sup>lt;sup>345</sup> Entergy Testimony at 45 (A59) (ENT000450). Specifically, the analysis uses the mean values of the accident consequence distributions for each accident category. These mean values (which are obtained from the MACCS2 Level 3 PRA) are multiplied by the estimated frequency of the accident (obtained from the Level 1 and Level 2 PRAs) to determine population dose risk and offsite economic cost risk for each release category studied. *See* Oct. 18, 2012 Tr. at 2191:22-25 (Teagarden) ("MACCS develops the conditional results and you multiply it by the frequency in a spreadsheet or some other fashion and can total them up."); *see also id.* at 2194:17-24 (Lemay).

<sup>&</sup>lt;sup>346</sup> See Entergy Testimony at 45 (A59) (ENT000450).

<sup>&</sup>lt;sup>347</sup> NL-09-165, Attach. 1 at 7 (ENT000009).

<sup>&</sup>lt;sup>348</sup> *Id.* at 6.

# 2. Identification of Potential SAMA Candidates (Step 2)

121. Entergy identified possible SAMAs for reducing the risk associated with the major risk contributors for each unit.<sup>349</sup> In evaluating potential SAMAs, Entergy followed standard industry guidance and considered SAMAs that addressed the major contributors to the CDF and large early release frequency ("LERF") at IP2 and IP3, as well as SAMA candidates for other plants that have submitted license renewal applications.<sup>350</sup> Entergy identified 231 candidate SAMAs for IP2 and 237 SAMAs for IP3 (*i.e.*, "Phase I" SAMAs).<sup>351</sup> It then performed an initial screening in which it removed Phase I SAMAs that (1) were not applicable to IP2 and IP3 for design-related reasons, (2) were already implemented at IPEC, or (3) could be combined with other, similar SAMA candidates.<sup>352</sup> This screening process reduced the list of potential SAMAs to 68 for IP2 and 62 for IP3 (*i.e.*, "Phase II" SAMAs).<sup>353</sup>

## 3. Quantification of Risk Reduction Potential and Implementation Cost (Step 3)

122. Entergy next performed more detailed evaluations of the Phase II SAMAs. Specifically, it evaluated each Phase II SAMA's benefit by modifying the baseline PRA to account for the effect of the plant improvement being evaluated, and then compared the risk results of the baseline and modified PRAs.<sup>354</sup> The "baseline" PRA for a plant evaluates the risk of operating the plant based on its current state; *i.e.*, without implementing any of the proposed improvements or procedures.<sup>355</sup> For comparison purposes, all calculated consequences were

<sup>&</sup>lt;sup>349</sup> FSEIS, Vol. 3, App. G at G-30 to G-33 (NYS00133I).

<sup>&</sup>lt;sup>350</sup> *Id.* at G-1, G-31.

<sup>&</sup>lt;sup>351</sup> *Id.* at G-30, G-49.

<sup>&</sup>lt;sup>352</sup> *Id.* at G-30 to G-33.

<sup>&</sup>lt;sup>353</sup> *Id.* at G-30, G-33, G-49.

<sup>&</sup>lt;sup>354</sup> Oct. 18, 2012 Tr. at 2219:3-7 (Potts); NRC Staff Testimony at 21-22 (A13) (NRC000041).

<sup>&</sup>lt;sup>355</sup> NRC Staff Testimony at 21 (A12) (NRC000041).

expressed in dollars.<sup>356</sup> The economic risk (in dollars) is reevaluated, assuming that one of the SAMAs was implemented.<sup>357</sup> The benefit is the reduction in economic risk (in dollars) after implementing the SAMA compared with the baseline.<sup>358</sup>

123. Entergy evaluated each Phase II SAMA candidate individually.<sup>359</sup> It performed a benefit assessment to address how the mitigation measure would affect relevant risk measures (*i.e.*, CDF, PDR, and OECR).<sup>360</sup> Entergy also developed cost estimates for implementing each SAMA candidate.<sup>361</sup> This process included reviewing cost estimates for similar improvements considered in prior NRC-approved SAMA analyses.<sup>362</sup>

# 4. Identification of Potentially Cost-Beneficial SAMAs (Step 4)

124. Finally, Entergy compared the costs and benefits of each of the remaining

SAMAs to determine whether the SAMA was cost-beneficial.<sup>363</sup> To account for uncertainties

<sup>357</sup> *Id*.

<sup>358</sup> Id.

<sup>&</sup>lt;sup>356</sup> *Id.* at 22 (A13).

<sup>&</sup>lt;sup>359</sup> Id. In reality, if a given SAMA were to be implemented at the plant, then the baseline risk would decrease, such that incremental benefit of implementing additional SAMAs would decrease, particularly when the additional SAMAs are acting on the same accident sequences. See Oct. 18, 2012 Tr. at 2165:21-25, 2342:9-21 (Ghosh); see also id. at 2343:8-12 (Ghosh) ("So there are essentially diminishing returns. As you -- if you were to do it in a sequential manner, you have increasing diminishing returns for implementing subsequent SAMA candidates.").

<sup>&</sup>lt;sup>360</sup> NRC Staff Testimony at 19 (A9), 22 (A13) (NRC000041). The benefit calculated for an individual SAMA is a fraction of the maximum attainable benefit, because an individual SAMA will not eliminate all possible accident initiators or mitigate all kinds of possible accidents. *Id.* at 22 (A13). Further, a given SAMA candidate does not necessarily have the same effect across all release categories (*id.*); *i.e.*, the impact depends on the risk significance of the specific system that is being influenced in the PRA model. *Id.* at 19 (A9), 21-22 (A13) (NRC000041); Oct. 17, 2012 Tr. at 1912:19-1913:14 (Teagarden). For example, the effect of the plant improvement might be to decrease the likelihood of an accident or group of accidents calculated in the Level 1 PRA. Other plant improvements might have no effect on accident frequencies, but might diminish the outcome of some of the accidents, leading to smaller consequences. These would affect the magnitude of the source term predicted in the Level 2 PRA and result in lower consequences in the Level 3 PRA. Some plant improvements would reduce both accident frequencies and consequences; *i.e.*, they would be both "preventers" and "mitigators." Oct. 17, 2012 Tr. at 1915:17-1916:10 (O'Kula).

<sup>&</sup>lt;sup>361</sup> Oct. 17, 2012 Tr. at 1910:16-18; FSEIS, Vol. 3, App. G at G-34 to G-38 (NYS00133I).

<sup>&</sup>lt;sup>362</sup> FSEIS, Vol. 3, App. G at G-34 (NYS00133I).

<sup>&</sup>lt;sup>363</sup> Oct. 17, 2012 Tr. at 1911:8-12 (Teagarden); Entergy Testimony at 46 (A60) (ENT000450); FSEIS, Vol. 3, App G. at G-36 to G-38 (Tbl. G-6), G-41 to G-44 (NYS00133I).

associated with the internal events CDF calculations, Entergy also compared the cost of SAMA implementation with a benefit value estimated by applying an uncertainty multiplier to the internal and external events estimated benefit.<sup>364</sup> This value is defined as the baseline benefit with uncertainty.<sup>365</sup> Entergy included any additional SAMAs identified as potentially costbeneficial in the uncertainty analysis within the set of potentially cost-beneficial SAMAs.<sup>366</sup> As documented in the FSEIS, Entergy identified a total of 22 IP2 and IP3 SAMA candidates as potentially cost-beneficial to implement in its final, revised SAMA analysis.<sup>367</sup>

### C. <u>Summary of Contested MACCS2 Input Values</u>

125. As discussed above, Entergy used MACCS2 to provide plant-specific offsite consequence information as part of the first step in the SAMA analysis. Entergy thus used numerous site-specific inputs, such as IPEC-specific meteorological data (year 2000 data from the IPEC meteorological tower), the projected year 2035 population distribution within the 50-mile SAMA analysis region (based on year 2000 census data and state and county-level population projections), the IP2 and IP3 core radionuclide inventories, IP2 and IP3 source term and release characteristics, and region-specific economic data (*i.e.*, for value of farm and nonfarm wealth).<sup>368</sup> Consistent with NEI 05-01 guidance and prior SAMA analyses, Entergy also used certain standardized values as inputs to the MACCS2 code.

126. With the exception of Entergy's 2035 population projection and the VALWNF region-specific economic discussed below (*see infra* Section IV.I.1), New York did not

<sup>&</sup>lt;sup>364</sup> FSEIS, Vol. 3, App G. at G-36 to G-38 (Tbl. G-6), G-42, G-45 (NYS00133I).

<sup>&</sup>lt;sup>365</sup> Id. at G-36 to G-38; NL-09-165, Attach. 1 at 7 (ENT000009). For purposes of this assessment, Entergy applied a multiplier of 8 to the internal-event benefits for each unit to account for both internal and external events, with analysis uncertainty. The multiplier of 8 slightly exceeds the product of the external-event multiplier and the uncertainty factor for each unit (*i.e.*, 3.80 x 2.10=7.98 for IP2, and 5.53 x 1.40=7.73 for IP3) and adds some additional conservatism. FSEIS, Vol. 3, App. G at G-45 (NYS00133I).

<sup>&</sup>lt;sup>366</sup> FSEIS, Vol. 3, App. G at G-45 (NYS00133I).

<sup>&</sup>lt;sup>367</sup> *Id.* at G-49.

<sup>&</sup>lt;sup>368</sup> See Oct. 17, 2012 Tr. at 1947:15-1950:8, 2064:12-2066:23 (Teagarden).

challenge Entergy's numerous site-specific MACCS2 inputs.<sup>369</sup> It principally took exception with Entergy's use of several standardized decontamination cost-related inputs that are derived from NUREG-1150 and used in MACCS2 User's Guide Sample Problem A (see Table 1 below).<sup>370</sup>

127. As set forth in Dr. Lemay's prefiled testimony and the ISR Report, New York

proposed alternative values for the following IPEC-specific and standardized MACCS2 inputs:

- <u>CDNFRM</u>, which defines the nonfarmland decontamination cost per individual for each level of decontamination. This input value was derived from NUREG-1150.
- <u>TIMDEC</u>, which defines the time required for completion of each of the decontamination levels. This input value was derived from NUREG-1150.
- <u>VALWNF</u>, which defines the value of the per capita nonfarm wealth in the region. Nonfarm wealth includes all public and private property not associated with farming that would be unusable if the region was rendered either temporarily or permanently uninhabitable (*e.g.*, the cost of land, buildings, infrastructure, and non-recoverable equipment or machinery). This input value was developed using economic data specific to the IPEC region.
- <u>POPCST</u>, which defines the per capita removal cost for temporary or permanent relocation of population and businesses in a region rendered uninhabitable during the long-term phase time period. This cost is assessed if any of the following actions are required: decontamination alone, decontamination followed by interdiction, or condemnation. This value is derived in a way that takes account of both personal and corporate income losses for a transitional period as well as moving expenses. This input value was derived from NUREG-1150.
- <u>DSRATE</u>, which defines the expected rate of return from land, buildings, equipment, etc. (*e.g.*, the inflation-adjusted real mortgage rate for land and buildings could be used). This input value was derived from NUREG-1150.

<sup>&</sup>lt;sup>369</sup> The details associated with Entergy's 2035 population estimate, which New York challenged in a separate contention, NYS-16B, are presented in Entergy's expert witness testimony on that contention. *See* Testimony of Entergy Witnesses Lori Potts, Kevin O'Kula, Grant Teagarden, and Jerry Riggs on Consolidated Contention NYS-16B (Severe Accident Mitigation Alternatives Analysis) (Mar. 28, 2012) (ENT000003).

<sup>&</sup>lt;sup>370</sup> *See, e.g.*, New York Direct Testimony at 23:498-511, 71:1490 tbl. 13 (NYS000241), ISR Report at 7, 16-32 (NYS000242).

# • <u>FRNFIM</u>, which defines the nonfarm wealth improvements fraction. This input value was derived from NUREG-1150.<sup>371</sup>

128. In the IPEC SAMA analysis, Entergy used two CDNFRM values (as well as two TIMDEC values), one corresponding to a dose reduction factor ("DRF") of 3 and the other corresponding to a DRF of 15.<sup>372</sup> As Dr. O'Kula and Mr. Teagarden explained, in MACCS2, the relevant code input parameter is "DSRFCT," which is defined as "the effectiveness of the various decontamination levels in reducing dose."<sup>373</sup>

129. Table 1 below shows Entergy's input parameter values, along with the corresponding values from NUREG-1150, for the six CHRONC parameters for which New York proposed alternative values. It also shows New York's proposed alternative values, as developed by Dr. Lemay and later revised in his June 2012 prefiled rebuttal testimony in response to Entergy and NRC Staff criticisms of his methodologies.<sup>374</sup>

<sup>&</sup>lt;sup>371</sup> *See* Entergy Testimony at 42 (A54, Tbl. 1), 65 (A84) (identifying and defining CHRONC parameter inputs for which Dr. Lemay proposed alternative values).

<sup>&</sup>lt;sup>372</sup> Entergy Testimony at 49 (A66) (ENT000450); NRC Staff Testimony at 38-39 (A34) (NRC000041).

<sup>&</sup>lt;sup>373</sup> Id. at 66 (A86) (quoting NUREG/CR-6613, Vol. 1 at 7-11 (ENT000243)). The inputs applied in the MACCS2 code to evaluate decontamination, countermeasures such as interdiction, and economic consequences are termed dose reduction factors, or DRFs, rather than decontamination factors and are represented by the code parameter DSRFCT. *Id.* (citing NUREG/CR-6613, Vol. 1 at 7-9 to 7-11 (ENT000243)). A similar term, decontamination factor ("DF"), generally is defined as the ratio between the contamination levels before and after decontamination has been performed. *Id.* at 65 (A85). Thus, the DF is a measure of the efficiency of removing radioactivity from a surface, whereas the DRF generally refers to the reduction in dose levels following an application of a countermeasure. *Id.* at 66 (A86); *see also* Oct. 18, 2012 Tr. at 2295:15-2296:12, 2296:16-2297:4 (Teagarden). As a matter of convenience, we use the term decontamination factor or DF below.

See New York Rebuttal Testimony at 36:1-38:6 (NYS000420); Revisions to Tables in ISR Report 13014-01-01: Review of Indian Point Severe Accident Off Site Consequence Analysis (21 Dec 2011), Tbl. 13: Summary of ISR proposed inputs and calculated OECRs (costs in 2005 USD) (NYS000430).

Index	MACCS2 Parameter	Parameter Description	Entergy's IP2 and IP3 Values (MACCS2)	NUREG-1150 (MACCS)	New York's (Dr. Lemay's) Proposed Values (MACCS2)
-	CDNFRM	Non-Farmland	Non-Farmland	Non-Farmland	Non-Farmland
		decontamination cost	decontamination cost	decontamination cost	decontamination cost
		(\$/person), given DSRFCT as			
		defined below	defined below	defined below	defined below
	Dose	DSRFCT=3	\$5,184	\$3,000	\$15,000 – \$184,000
	Reduction				
	Factor				
	(DSRFCT)				
	Dose	DSRFCT=15	\$13,824	\$8,000	\$71,000 – \$418,000
	Reduction				
	Factor (DSRFCT)				
,					
7	TIMDEC	Time required tor	Time required tor	Time required tor	Time required tor
		decontamination (days), for each DSRFCT defined below	decontamination (days), for each DSRFCT defined below	decontamination (days), for each DSRFCT defined below	decontamination (years), for each DSRFCT defined below
	Dose	DSRFCT=3	60 days	60 days	1 year – 15 years
	Reduction				
	Factor				
	(DSRFCT)				
	Dose	DSRFCT=15	120 days	120 days	2 years – 30 years
	Reduction				
	Factor				
	(DSRFCT)				
ŝ	VALWNF	Regional Average Value of	\$208,838 (IPEC-specific value)	\$84,000 (for Surry)	\$284,189
		Non-Farm Wealth (\$/person)			
4	POPCST	Per capita cost of long-term	\$8,640	\$5,000	\$10,640 – \$49,857
		relocation (\$/person)			
ъ	DSRATE	Societal Discount Rate for	12%	12%	5% – 7%
		Property (%)			
9	FRNFIM	Nonfarm wealth	80%	80%	80%
		improvements fraction (%)			

<u>Table 1 – Comparison of Selected CHRONC Parameter Values</u>

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130. The Board discusses each of these input parameters below. However, as at the hearing, we focus primarily on the CDNFRM and TIMDEC values (as reflected in Approaches A-D in the ISR Report), given the parties' agreement that these values have the most significant impact of the MACCS2 parameters at issue here.<sup>375</sup> Indeed, during the hearing, Dr. Lemay stated: "It was our assessment that CDNFRM and TIMDEC were the most important ones, and the rest had minimal impact on the calculation of the offsite economic cost."<sup>376</sup>

131. Thus, at its core, Contention NYS-12C relates to the reasonableness of the CDNFRM and TIMDEC values used as inputs to MACCS2 in the IPEC SAMA analysis. In the Board's view, New York's position devolves into three primary claims. New York and its expert, Dr. Lemay, allege that: (1) Entergy's and the NRC Staff's use of NUREG-1150 inputs (which, as discussed below, also are used in MACCS2 User's Guide Sample Problem A) in lieu of site-specific inputs is inappropriate because the challenged inputs were developed decades ago and are not appropriate for the dense population and buildings surrounding IPEC;<sup>377</sup> (2) the nonfarm decontamination cost values used in the SAMA analysis are also not "rationally related" to the area surrounding IPEC;<sup>378</sup> and (3) the decontamination factors and decontamination time values used in the SAMA analysis are not "rationally related" to the area surrounding IPEC.<sup>379</sup>

132. Accordingly, the balance of our decision is framed principally by the three issues set forth above. In addressing these issues, we are guided by the Commission's recent SAMA-related jurisprudence. In particular, we consider (1) whether the alleged deficiencies in

<sup>&</sup>lt;sup>375</sup> See Oct. 17, 2012 Tr. at 2053:18-2055:8 (Teagarden, Lemay).

<sup>&</sup>lt;sup>376</sup> *Id.* at 2054:23-2055:1 (Lemay) (emphasis added); *id.* at 2055:1-4 ("So if you're limited by time and you want to get to the crux of the matter, CDNFRM and TIMDEC are the two parameters that are really at play here.")

<sup>&</sup>lt;sup>377</sup> New York Position Statement at 17-19, 33-36 (NYS000240); New York Direct Testimony at 9:196-200, 21:458-23:511, 29:642-30:672, 63:1318-28, 70:1470-77 (NYS000241).

<sup>&</sup>lt;sup>378</sup> New York Position Statement 23-30 (NYS000240); New York Direct Testimony at 30:651-51:1056 (NYS000241).

<sup>&</sup>lt;sup>379</sup> New York Position Statement at 21-23, 31-33 (NYS000240); New York Direct Testimony 27:593-29:649, 51:1057-55:1134, 70:1470-77 (NYS000241).

Entergy's SAMA analysis inputs are valid and so significant that they render the SAMA analysis altogether unreasonable under NEPA standards;<sup>380</sup> and (2) whether the alleged deficiencies plausibly could alter NRC Staff's conclusions as to which SAMAs are cost-beneficial.<sup>381</sup>

# D. <u>Entergy's Use of Economic Cost Inputs From NUREG-1150/MACCS2 Sample</u> <u>Problem A is Reasonable Under NEPA Standards</u>

133. The Board first considers New York's claim that Entergy and the NRC Staff arbitrarily relied on "default" input values derived from MACCS2 "Sample Problem A" (as taken from NUREG-1150).<sup>382</sup> New York claimed that these values are inappropriate because they are not specific to the area surrounding IPEC, including the "hyper-urban" New York City with its "very high population density" and high-rise buildings.<sup>383</sup> In particular, Dr. Lemay asserted that the MACCS2 Sample Problem A inputs used by Entergy are based on data that are specific to the Surry nuclear power plant in Virginia, which he claimed is largely surrounded by farmland.<sup>384</sup> New York also argued that the IPEC SAMA analysis inputs do not properly account for the size of particles released by a nuclear power reactor severe accident.<sup>385</sup>

134. Accordingly, in this portion of our decision, we discuss (1) the origin and purpose of the MACCS2 Sample Problem A values cited by New York (including their relationship to the Surry site); (2) Entergy's justification for using values derived from NUREG-1150/MACCS2 Sample Problem A; (3) and New York's concern about the size of radionuclide particles that are

<sup>&</sup>lt;sup>380</sup> *Pilgrim*, CLI-12-01, slip op. at 25.

<sup>&</sup>lt;sup>381</sup> *Pilgrim*, CLI-12-15, slip op. at 13-14.

 <sup>&</sup>lt;sup>382</sup> See New York Position Statement at 17-18, 35 (NYS000240); New York Direct Testimony at 22:483-23:511, 61:1271-77 (NYS000241).

<sup>&</sup>lt;sup>383</sup> New York Direct Testimony at 20:441-443 (NYS000241).

<sup>&</sup>lt;sup>384</sup> *Id.* at 19:421-20:444, 21:470-22:480, 61:1271-63:1328.

<sup>&</sup>lt;sup>385</sup> See New York Position Statement at 2-5, 19-20, 26, 36-37, 42 (NYS000240); New York Direct Testimony at 36:752-37:777, 64:1346-66:1381 (NYS000241); ISR Report at 13, 36-39 (NYS000242).

released to the atmosphere (*i.e.*, postulated severe accident source terms) determined from the IPEC Level 2 PRAs.

# 1. Entergy reasonably relied on Sample Problem A input values insofar as those values are based on, and coincide with, the relevant values in NUREG-1150

135. By way of background, Dr. O'Kula and Mr. Teagarden explained the purpose of Sample Problem A and its relationship to the IPEC SAMA analysis.<sup>386</sup> Specifically, they explained that Section 4.0 of the MACCS2 User's Guide (NUREG/CR-6613) contains six sample problems, Sample Problems A through F.<sup>387</sup> The MACCS2 User's Guide uses these sample problems to compare MACCS and MACCS2 (*e.g.*, the dose algorithms) and to show different aspects of code functionality.<sup>388</sup> They also noted that Sample Problem A provides "one of the more complete" sample problems,<sup>389</sup> and "offers a full exercise of the code in all of its modules."<sup>390</sup>

136. The MACCS2 User's Guide states that Sample Problem A is based on input data obtained from NUREG-1150.<sup>391</sup> NUREG-1150 is a seminal PRA study that presented population dose results for a 50-mile radial region around each of five representative nuclear power plants (including Surry Unit 1), as well as population dose results for a broader region (*i.e.*, greater than 50 miles) that is typically referred to as the "entire region."<sup>392</sup>

137. The NUREG-1150 study used the MACCS code (MACCS2's predecessor) and applied the same CHRONC economic inputs for each of the five study sites, except for the variables related to farm and nonfarm wealth (VALWF and VALWNF), which are based on

<sup>388</sup> Id.

<sup>&</sup>lt;sup>386</sup> See Entergy Testimony at 59 (A75), 60-61 (A77) (ENT000450).

<sup>&</sup>lt;sup>387</sup> *Id.* at 59 (A75) (citing NUREG/CR-6613, Vol. 1 at 4-1 to 4-9 (NYS000243)).

<sup>&</sup>lt;sup>389</sup> Oct. 17, 2012 Tr. at 2058:18-19 (Teagarden).

<sup>&</sup>lt;sup>390</sup> *Id.* at 2060:15-16 (O'Kula).

<sup>&</sup>lt;sup>391</sup> Entergy Testimony at 59 (A75) (ENT000450) (citing NUREG/CR-6613, Vol. 1 at 4-3 (NYS000243)).

<sup>&</sup>lt;sup>392</sup> *Id.* at 22 (A35) (citing NUREG-1150, Vol. 1 at 2-3, 2-20 (NYS00252A)).

region-specific inputs.<sup>393</sup> NUREG-1150 thus applied the same CDNFRM and TIMDEC values used in Sample Problem A to *all* five of the NUREG-1150 study sites.<sup>394</sup> Therefore, contrary to New York's claim, the NUREG-1150 authors did not view those values as being applicable only to the Surry site.<sup>395</sup> And, as discussed further below, use of the NUREG-1150 CDNFRM values is reasonable under NEPA because in SAMA analysis, the values are multiplied by regionspecific population densities.

138. Entergy relied on certain Sample Problem A values insofar as those values are based on, and coincide with, the relevant values in NUREG-1150.<sup>396</sup> Specifically, Entergy applied inputs that were based on the NUREG-1150 study, and it updated those input values using the CPI ratio for 1986 to 2005 (the basis year for the IPEC SAMA analysis), consistent with NEI 05-01 guidance.<sup>397</sup> Mr. Teagarden emphasized that Entergy did not rely on Surry land use information, but instead used "site-specific, regional-specific economic data for the value of land and property."<sup>398</sup>

139. Dr. O'Kula and Mr. Teagarden further stated that the use of the challengedNUREG-1150/Sample Problem A values is standard for Level 3 PRA-type analyses (including

<sup>&</sup>lt;sup>393</sup> *Id.* at 52 (A71).

<sup>&</sup>lt;sup>394</sup> Id. at 61 (A77) ("Furthermore, with respect to the specific CHRONC economic and decontamination input parameters in question here, NUREG-1150 used the same values for those parameters for each of the five study sites.").

<sup>&</sup>lt;sup>395</sup> Oct. 17, 2012 Tr. at 1951:9-10 (Teagarden) ("In NUREG-1150, those same values were applied at all five plants."); *id.* at 2070:7-10 (Teagarden) ("But the values for NUREG-1150 … applied to all five of the NUREG-1150 sites. So you know, it wasn't viewed as specific to a rural environment.").

<sup>&</sup>lt;sup>396</sup> See Oct. 17, 2012 Tr. at 2058:20-22 (Teagarden); *id.* at 2059:14-16 (Teagarden) ("The sample problem reflects values from NUREG-1150. The Entergy analysis used values from NUREG-1150.").

<sup>&</sup>lt;sup>397</sup> See Entergy Testimony at 53 (A71) (ENT000450) (citing February 2008 RAI Response, Attach. 1 at 38 (ENT000460)). The CPI for 1986 was 109.6, and the CPI for 2005 was 195.3, so Entergy applied an escalation factor of 1.7. Entergy Testimony at 53 (A71) (ENT000450) (citing Consumer Price Index History Table: Table Containing History of CPI-U U.S. All Items Indexes and Annual Percent Changes From 1913 to Present (ENT000461)); Oct. 17, 2012 Tr. at 1962:20-22 (Teagarden).

<sup>&</sup>lt;sup>398</sup> Oct. 17, 2012 Tr. at 2065:24-2066:3 (Teagarden).
SAMA analyses) performed in the U.S.<sup>399</sup> They further stated that, to their knowledge, all prior NRC license renewal applicants have used these same values (as appropriately escalated) in their SAMA analyses.<sup>400</sup>

140. In summary, the Board disagrees with New York that the Sample Problem A values are inapplicable "default" values originally developed for the Surry site. As Entergy's witnesses explained, the contested Sample Problem A values are derived from the NUREG-1150 study, which applied them to all five plants examined in that study. The Board finds that the challenged values (including the NUREG-1150 values for CDNFRM and TIMDEC) are consistently used in license renewal SAMA analyses and are appropriate for that purpose.

# 2. Entergy and the NRC Staff appropriately considered the applicability of NUREG-1150 input values to the IPEC site-specific SAMA analysis

141. Ms. Potts, who helped prepare the IPEC SAMA analysis, testified that she and other Entergy technical reviewers considered the applicability of the NUREG-1150 values (as escalated) and concluded that they are reasonable values for IPEC.<sup>401</sup> She noted that Entergy described the bases for this conclusion in its February 2008 RAI Response.<sup>402</sup> That response addressed the Staff's request that Entergy describe the key MACCS2 input parameters that contribute to the offsite economic cost risk, and justify the applicability of Entergy's selected input values to the IPEC site and region.<sup>403</sup> The February 2008 RAI Response states that the

<sup>&</sup>lt;sup>399</sup> Id. at 61 (A78) (ENT000450). NRC guidance states that "[s]tandard MACCS2 modeling for NRC assessments uses the parameters in Sample Problem A." NUREG/CR-6953, Vol. 1, "Review of NUREG-0654, Supplement 3, Criteria for Protective Action Recommendations for Severe Accidents," at 32 (Dec. 2007) (ENT000291).

<sup>&</sup>lt;sup>400</sup> Oct. 17, 2012 Tr. at 1951:13-16 (Teagarden) ("And those values to our knowledge have been used in every SAMA analysis of the Entergy panel's knowledge being based in NUREG-1150 and then escalated for time.").

<sup>&</sup>lt;sup>401</sup> Oct. 17, 2012 Tr. at 2067:14-2069:3 (Potts); *id.* at 2080:17-19 (Potts) ("[T]he key input data from NUREG-1150 [were] judged by us to be applicable to the Indian Point SAMA analysis.").

<sup>&</sup>lt;sup>402</sup> Oct. 17, 2012 Tr. at 2079:21-25 (Potts).

<sup>&</sup>lt;sup>403</sup> *Id.* at 2079:19-2080:19 (Potts) (citing February 2008 RAI Response, Attach. 1 at 37-38 (ENT000460)).

NUREG-1150 values, as adjusted to 2005 dollars using the CPI ratio method, are reasonable for the IPEC region for three principal reasons that the Board and parties discussed at hearing.<sup>404</sup>

142. First, the NUREG-1150 economic and decontamination-related values are viewed as the most reasonable values currently available based on industry-reviewed studies.<sup>405</sup> Dr. O'Kula and Mr. Teagarden testified that standard MACCS2 modeling for NRC assessments uses NUREG-1150 input values due to their well-established pedigree within the PRA community.<sup>406</sup> Dr. O'Kula emphasized that NUREG-1150 was made available for public comment and subjected to multiple peer reviews that involved an "unprecedented" level of technical scrutiny.<sup>407</sup>

143. Dr. O'Kula and Mr. Teagarden stated that NRC and industry technical staff vetted

key economic inputs before their inclusion in NUREG-1150, as reflected in NUREG/CR-

4551:<sup>408</sup>

Estimation of offsite accident consequences is the customary final step in a probabilistic assessment of the risks of severe nuclear reactor accidents. Recently, the Nuclear Regulatory Commission reassessed the risks of severe accidents at five U.S. Power reactors (NUREG-1150). Offsite accident consequences for NUREG-1150 source terms were estimated using the MELCOR Accident Consequence Code

<sup>&</sup>lt;sup>404</sup> See February 2008 RAI Response, Attach. 1 at 38 (ENT000460).

<sup>&</sup>lt;sup>405</sup> *Id.*, Attach. 1 at 37.

<sup>&</sup>lt;sup>406</sup> Entergy Testimony at 72 (A95) (ENT000450); Oct. 17, 2012 Tr. at 1951:21-1952:1 (Teagarden) ("So Entergy used values that are per person values, have been well vetted in the PRA community, have been used consistently through time, used in the latest study [SOARCA] and then those values are applied to the population distribution.").

<sup>&</sup>lt;sup>407</sup> Oct. 18, 2012 Tr. at 2370:2-2372:9 (O'Kula). See also Entergy Testimony at 21-22 (A35), 55 (A72) (ENT000450); NRC Staff Testimony at 46 (A39) (NRC000041) ("NUREG-1150 included an economic analysis and was subjected to an extensive peer review and public comment. Two peer reviews were conducted on the second version of NUREG-1150, one of which was NRC sponsored, and the second was sponsored by the American Nuclear Society."); NUREG-1150, Vol. 1 at 1-2 (NYS000252A) (summarizing the public comment and peer review processes for NUREG-1150).

<sup>&</sup>lt;sup>408</sup> Entergy Testimony at 60 (A76) (ENT000450). NUREG/CR-4551, which was published in December 1990, is a seven-volume report that was prepared to support the development of NUREG-1150. NUREG/CR-4551, Vol. 2, Rev. 1, Part 7, "Evaluation of Severe Accident Risks: Quantification of Major Input Parameters" (December 1990) ("NUREG/CR-4551") (NYS000248) specifically discusses major MACCS input parameters used in the NUREG-1150 study. *See* Entergy Testimony at 22-23 (A36) (ENT00450).

System (MACCS). Before these calculations were performed, most *MACCS input parameters were reviewed, and for each parameter reviewed, a best-estimate value was recommended.* This report presents the results of these reviews. Specifically, *recommended values* and the basis for their selection are presented for MACCS atmospheric and biospheric transport, emergency response, food pathway, and economic input parameters.<sup>409</sup>

144. Entergy's experts further testified that there is no NRC- and industry-accepted alternative to the NUREG-1150 values, and that to their knowledge, all license renewal applicants have used these NUREG-1150 values (as escalated) in their SAMA analyses.<sup>410</sup> Mr. Teagarden explicitly stated that "we believe these values represent the best values that are available for a SAMA analysis. We know of no technically superior values to use for the MACCS code input for these [parameters]."<sup>411</sup> Dr. O'Kula and Mr. Teagarden also cited the NRC's use of the NUREG-1150 values in the recently-completed SOARCA project as further evidence of their continued applicability and suitability for use in SAMA analyses.<sup>412</sup>

145. Second, as stated in Entergy's February 2008 RAI Response, the NUREG-1150 economic cost parameters were developed based on information obtained for the five plant regions studied by the NRC in NUREG-1150<sup>413</sup> and are reasonable for the Indian Point region because the initial development included "heavily populated regions."<sup>414</sup> Mr. Jones elaborated on this point at the hearing, stating that two of the five sites studied in NUREG-150 are not unlike IPEC with respect to the population density within the 10-mile radius Emergency

<sup>&</sup>lt;sup>409</sup> NUREG/CR-4551, Vol. 2, Rev. 1, Part 7 at iii/iv (NYS000248) (emphasis added).

<sup>&</sup>lt;sup>410</sup> Oct. 17, 2012 Tr. at 1951:13-16 (Teagarden).

<sup>&</sup>lt;sup>411</sup> Oct. 17, 2012 Tr. at 2040:2-5 (Teagarden). *See also id.* at 2043:24-2044:4 (Ms. Potts) ("As Mr. Teagarden said, these are the best values that we know of, the only values that are available, and its irrational to think that the authors of [NUREG-]1150 would have used them for all five of the plants in that study if they were not applicable.").

<sup>&</sup>lt;sup>412</sup> Entergy Testimony at 62 (A78) (ENT000450) (citing NUREG-1935, State-of-the-Art Reactor Consequence Analyses (SOARCA) Report, Draft Report for Public Comment, at 61, 63 (Jan. 2012) ("Draft NUREG-1935") (ENT000455)); Oct. 17, 2012 Tr. at 1951:17-21 (Teagarden).

<sup>&</sup>lt;sup>413</sup> February 2008 RAI Response, Attach. 1 at 37 (ENT000460).

<sup>&</sup>lt;sup>414</sup> *Id.*, Attach. 1 at 38.

Planning Zone ("EPZ").<sup>415</sup> He stated that the IPEC EPZ has about 300,000 people,<sup>416</sup> and that the Surry EPZ (which includes the northern and eastern side of the James River) has a very comparable population density.<sup>417</sup> He also noted that the now-decommissioned Zion plant located just north of Chicago had an EPZ population density comparable to that of IPEC.<sup>418</sup>

146. Third, as stated in Entergy's February 2008 RAI Response, the NUREG-1150 decontamination cost values are reasonable for the IPEC region because they are based upon levels of contamination and population rather than upon the region in which the contamination occurs.<sup>419</sup> In other words, MACCS2 applies the nonfarm economic inputs, including the nonfarm decontamination cost (*i.e.*, CDNFRM), on a *per person* basis.<sup>420</sup> This approach thus accounts for areas with high population densities and low population densities (*e.g.*, due to the high proportions parkland and other rural property) within the 50-mile IPEC SAMA analysis region.<sup>421</sup>

147. Accordingly, in MACCS2, the populations within the IPEC SAMA analysis region are multiplied by these per person decontamination cost values, as appropriate, making

<sup>&</sup>lt;sup>415</sup> Oct. 17, 2012 Tr. at 1968:11-24 (Jones).

<sup>&</sup>lt;sup>416</sup> *Id.* at 1968:15-16 (Jones).

<sup>&</sup>lt;sup>417</sup> *Id.* at 1968:16-19 (Jones).

<sup>&</sup>lt;sup>418</sup> Id. at 1968:19-21 (Jones). On redirect examination, Mr. Jones clarified that the Zion plant was located on the shore of Lake Michigan, so that roughly half of the SAMA analysis area is effectively water. Oct. 18, 2012 Tr. at 2379:11-20 (Jones) ("So if you have eight and a half million people in half of a SAMA area, you can look at that as 17 million people in a whole SAMA area. Population density-wise, it is not dissimilar from the Indian Point SAMA area.").

<sup>&</sup>lt;sup>419</sup> February 2008 RAI Response, Attach. 1 at 38 (ENT000460).

<sup>&</sup>lt;sup>420</sup> See, e.g., NRC Staff Testimony at 41 (A35) (NRC00041); Entergy Testimony at 55-58 (A72) (ENT000450); Oct. 17, 2012 Tr. at 1949:23-1950:8 (Teagarden) ("And it's important to note the decontamination costs are developed on a per capita basis. It's a per person basis.... Those values are multiplied by the number of individuals in that region that are being impacted by the postulated release. So how those values are applied at the end of the day represents a site-specific analysis.").

<sup>&</sup>lt;sup>421</sup> Entergy Testimony at 58 (A72) (ENT000450).

the resulting decontamination cost estimate site-specific.<sup>422</sup> For the IPEC SAMA analysis, Entergy developed a year 2035 population estimate based on census data and population projections that are specific to the IPEC SAMA analysis region.<sup>423</sup> Therefore, the large population centers (including the New York City metropolitan area) within the SAMA analysis region were multiplied by the CDNFRM values.<sup>424</sup> As Mr. Jones and Dr. Bixler stated: "By using a per-person basis, this approach takes into account the site-specific high population density of New York City and the correspondingly high density of buildings."<sup>425</sup> Dr. Lemay agreed that the application of decontamination costs on a per person basis, as is done in MACCS2, is a valid approach.<sup>426</sup>

148. In summary, the Board finds that applying appropriately-escalated NUREG-1150 (and hence MACCS2 Sample Problem A) economic and decontamination cost values on a perperson basis—as was done in the IPEC SAMA analysis—is a reasonable method under NEPA standards. Contrary to New York's claim, Entergy and the NRC Staff have fully justified their reliance on the NUREG-1150 economic and decontamination inputs. It is clear that those values have a long-established technical basis and continue to be used in state-of-the-art severe accident consequence analyses, including other SAMA analyses and the recent SOARCA project.<sup>427</sup>

<sup>&</sup>lt;sup>422</sup> See Oct. 17, 2012 Tr. at 1949:23-1950:8 (Teagarden); Entergy Testimony at 55-58 (A72) (ENT000450). For example, when Entergy's CDNFRM value of \$13,824 per person (for a DF of 15) is applied to an apartment building housing 200 people, the resulting decontamination cost would \$2.7 million. Oct. 17, 2012 Tr. at 2040:8-14 (Teagarden).

<sup>&</sup>lt;sup>423</sup> Entergy Testimony at 48 (A65) (ENT000450); Oct. 18, 2012 Tr. at 2139:18-2140:15 (Teagarden).

<sup>&</sup>lt;sup>424</sup> NRC Staff Testimony at 69 (A61) (NRC00041); Oct. 17, 2012 Tr. at 1950:4-8 (Teagarden).

<sup>&</sup>lt;sup>425</sup> NRC Staff Testimony at 41 (A35) (NRC00041). *See also id.* at 69 (A61) (NRC00041) ("The detailed methodology described in NUREG/CR-4551 and applied at the per-person level provides a reasonable and tested approach for use in the SAMA analysis.").

<sup>&</sup>lt;sup>426</sup> Oct. 18, 2012 Tr. at 2136:2-10 (Dr. Lemay) ("I think that whoever came up with the decontamination cost per person it's a brilliant insight . . . .").

<sup>&</sup>lt;sup>427</sup> Oct. 17, 2012 Tr. at 2059:4-5 (Teagarden) ("We believe those are the best inputs. We know of no technically superior inputs to use.").

# **3.** Entergy's MACCS2 inputs appropriately account for the types of particles released during a postulated severe accident

149. New York also contended that Entergy's MACCS2 decontamination parameter inputs, as derived from NUREG-1150, reflect a faulty assumption that "large" radionuclide particles would be released by a severe reactor accident,<sup>428</sup> and that accounting for "smaller" particle sizes that would actually be released in such an accident would increase offsite decontamination costs.<sup>429</sup> With respect to this issue, Dr. Lemay asserted that small-sized, soluble cesium is more difficult to remove from porous surfaces than the large-sized, insoluble radionuclides, such as plutonium.<sup>430</sup>

150. As a threshold matter, the basis for New York's arguments related to particle size is unclear, given that the NUREG-1150/MACCS2 Sample Problem A values challenged by New York do not specify a particle size.<sup>431</sup> Rather, the MACCS2 code user must specify a deposition velocity (a parameter not challenged by New York in NYS-12C).<sup>432</sup> As explained by Dr. Bixler, the deposition velocity and surface roughness inputs to the MACCS2 code can be used in tandem to estimate the particle size considered in the SAMA analysis.<sup>433</sup>

151. Dr. Bixler reviewed Entergy's deposition velocity and surface roughness inputs to the MACCS2 code.<sup>434</sup> Based on the analysis described in his prefiled testimony—which Dr. Lemay did not dispute—he determined that the IPEC SAMA analysis effectively assumed

<sup>&</sup>lt;sup>428</sup> See New York Position Statement at 4-9, 36-37 (NYS000240) (summarizing contentions NYS-12, 12A, 12B, and 12C and asserting that the FSEIS "underestimate[s] the costs associated with the dispersion of small particle radiation from a nuclear power facility accident"). Although New York and Dr. Lemay raised this issue in their filings, it was not the subject of significant discussion during the two-day evidentiary hearing.

<sup>&</sup>lt;sup>429</sup> *See id.* at 2, 13.

<sup>&</sup>lt;sup>430</sup> New York Direct Testimony at 36:758-60 (NYS000241).

<sup>&</sup>lt;sup>431</sup> NRC Staff Testimony at 54 (A49) (NRC000041).

<sup>&</sup>lt;sup>432</sup> *Id.* 

<sup>&</sup>lt;sup>433</sup> *See id.* at 55-56 (A49) (including Fig. 2, "Effect of aerodynamic particle diameter on deposition velocity for selected values of surface roughness").

<sup>&</sup>lt;sup>434</sup> See id. at 54-57 (A49).

the release of radionuclide particles having an aerodynamic diameter of 6 micrometers or microns (which corresponds to a physical diameter of 3 micrometers and about a specific density of 4).<sup>435</sup> Dr. Bixler stated that this particle size is representative of the aerosols that would be released into the atmosphere during a severe reactor accident.<sup>436</sup> As he further noted, this conclusion refutes New York's claim that Entergy's MACCS2 decontamination cost estimates are based on large-sized radionuclide particles, which New York itself defined as "particles ranging in size from *tens to hundreds* of microns."<sup>437</sup>

152. Furthermore, Mr. Jones explained that decontamination of "small" particles is not necessarily more difficult or more costly than for "large" particles,<sup>438</sup> and that there is no evidence that decontamination costs depend on particle sizes when they are in the range of 1 to 10 micrometers.<sup>439</sup> He stated that particle size is only one of many factors affecting decontamination cost,<sup>440</sup> an observation with which Entergy's experts agreed and Dr. Lemay did not dispute.<sup>441</sup>

<sup>438</sup> NRC Staff Testimony at 57 (A50) (NRC000041) (citing ISR Report at 17 (NYS000242) as showing that smaller particles were equal to or easier to decontaminate than large particles).

<sup>&</sup>lt;sup>435</sup> *See id.* 

<sup>&</sup>lt;sup>436</sup> Id. at 57 (A49). Dr. Bixler stated that Entergy's assumed deposition velocity (1 cm/s) is conservative because it produces more deposition and thus requires more decontamination within the 50-mile SAMA analysis region. Id. at 49 (A41), 50 (A43).

<sup>&</sup>lt;sup>437</sup> Id. at 54 (A49); New York Position Statement at 37 (NYS000240); New York Petition at 141, 143; see also New York Direct Testimony at 64:1346-51 (NYS000241). New York's definition of "large" radioactive particles" is based on the Site Restoration Report. See New York Petition at 143 (citing Site Restoration Report at 2-9 to 2-10, 5-7 (NYS000249)). Notably, in the Seabrook proceeding, the Commission rejected another intervenor's reliance on the Site Restoration Report in overruling the admission of a SAMA contention similar to NYS-12C. The Commission stated that the Site Restoration Report is "focused on plutonium dispersal events" and contains "no suggestion that the MACCS2 code assumes inapplicable radionuclide particle sizes." Seabrook, CLI-12-05, slip op. at 40. It further noted that the report predates issuance of the MACCS2 User's Guide and does not appear to discuss the MACCS2 code at all. Id.

<sup>&</sup>lt;sup>439</sup> *Id.* at 50 (A42).

<sup>&</sup>lt;sup>440</sup> Id. at 57 (A50). Other factors include the amount of contamination and the length of time since its deposition, the dose to the decontamination worker at the beginning of the effort, the surface of the substrate being decontaminated, the decontamination technology selected, and the achievable decontamination factor. Id.

<sup>&</sup>lt;sup>441</sup> Entergy Testimony at 101-02 (A125) (ENT000450) (citing EPA Technology Reference Guide for Radiologically Contaminated Surfaces, EPA-402-R-06-003 (Apr. 2006) (ENT000475)).

153. Based on the above findings, the Board concludes that there is no evidentiary support for New York's claim that the IPEC SAMA analysis, whether through its use of NUREG-1150 values or other inputs to the MACCS2 code, considers inapplicable radionuclide particle sizes.

## E. <u>The CDNFRM Values Used As Inputs to the IPEC SAMA Analysis Have an</u> Established Technical Basis and Are "Rationally Related" to the IPEC Site

154. As stated above, New York and Dr. Lemay focused heavily on Entergy's CDNFRM values. They claimed that support for the NUREG-1150 values "simply does not exist,"<sup>442</sup> and that the values are not "rationally related" to the IPEC site.<sup>443</sup>

155. In support of these claims, Dr. Lemay asserted that neither NUREG-1150 nor NUREG/CR-4551 provides a detailed explanation of decontamination costs.<sup>444</sup> He further contended that another document cited by the NRC Staff and Entergy in support of the NUREG-1150 CDNFRM values, NUREG/CR-3673, "Economic Risks of Nuclear Power Reactor Accidents" (Apr. 1984) ("NUREG/CR-3673") (ENT000466), is not a reliable source.<sup>445</sup>

156. As Dr. O'Kula and Mr. Teagarden testified, Entergy selected values of \$5,184/person and \$13,824/person for dose reduction factors ("DRFs") of 3 and 15, respectively.<sup>446</sup> Entergy obtained these values by using the values from NUREG-1150, which were \$3,000/person for DRF of 3 and \$8,000/person for DRF of 15, and then adjusting them by the CPI method in accordance with NEI 05-01 (NYS000287).<sup>447</sup> The NUREG-1150 CDNFRM

<sup>&</sup>lt;sup>442</sup> New York Rebuttal Position Statement at 10 (NYS000419).

<sup>&</sup>lt;sup>443</sup> New York Position Statement at 23 (NYS000240).

<sup>&</sup>lt;sup>444</sup> New York Rebuttal Testimony at 21:15-16 (NYS000420).

<sup>&</sup>lt;sup>445</sup> *See id.* at 21:20-24:20.

Entergy Testimony at 89 (A111) (ENT000450). The DRF is the ratio of the radiological dose (typically 1 meter above the surface) before the remediation activity to the dose after the remediation activity. *Id.* at 67 (A86). A dose reduction factor of 3 means that the resulting population dose at that location will be reduced to one-third of what it would be without decontamination activity. *Id.*

<sup>&</sup>lt;sup>447</sup> *Id.* at 89 (A111).

values can be traced to NUREG/CR-3673 (also referred to as "Burke").<sup>448</sup> NUREG/CR-3673 states that it developed and employed "improved models to estimate the economic risks from unanticipated events which occur during U.S. LWR operation."<sup>449</sup> As part of this effort, the study estimated the offsite costs of post-accident population protective measures and public health impacts for severe LWR accidents that result in a release of radioactive material to the environment.<sup>450</sup> Those costs include non-farm area decontamination costs for three decontamination factors (DF = 3, 15, and 20). NUREG/CR-3673 states that "[t]he cost estimates used in this study for various levels of decontamination effort in an area are taken from a detailed review of decontamination effectiveness and costs performed at Sandia National Laboratories (SNL)."<sup>451</sup> The "detailed review" apparently was documented in an unpublished report by Robert Ostmeyer and Gene Runkle entitled "An Assessment of Decontamination Costs and Effectiveness for Accident Radiological Releases" ("Ostmeyer report").<sup>452</sup> Despite their best efforts, none of the parties or their experts could locate a copy of the report, even in the Sandia library.<sup>453</sup>

<sup>&</sup>lt;sup>448</sup> See id. at 57 (A72) (ENT000450). See also NUREG/CR-4691, MELCOR Accident Consequence Code System (MACCS) Model Description, Vol. 2 at 1-9, 4-1 (NYS000288) ("The economic effect models in MACCS are intended to estimate the offsite costs resulting from a reactor accident. The models used were assessed and selected by Burke [Bu84]... The following costs are treated in the economic models implemented in the MACCS code: ... decontamination costs for property that can be returned to use if decontaminated.") (emphasis added).

<sup>&</sup>lt;sup>449</sup> NUREG/CR-3673 at EX-1 (ENT000466).

<sup>&</sup>lt;sup>450</sup> NUREG/CR-3673 states that offsite costs associated with population evacuation and temporary relocation, agricultural product disposal, land and property decontamination, land interdiction, and public health impacts and medical care costs are included in the new economic consequence models. *Id*.

<sup>&</sup>lt;sup>451</sup> New York Rebuttal Testimony at 23:17-22 (NYS000420) (quoting NUREG/CR-3673 at 4-15 (ENT000466)). *See also* Oct. 17, 2012 Tr. at 2005:2-24 (Lemay).

<sup>&</sup>lt;sup>452</sup> See NUREG/CR-3673 at 4-15, 8-8 (ENT000466).

<sup>&</sup>lt;sup>453</sup> Oct. 17, 2012 Tr. at 2005:16-17 (Lemay), 2009:24-2011:5 (Jones, Ghosh).

157. Dr. Lemay contended that the unavailability of the Ostmeyer report renders NUREG/CR-3673 unreliable and leaves a "gaping hole" in the record.<sup>454</sup> Given the apparent link between the NUREG-1150 non-farm decontamination cost values and the Ostmeyer report (via NUREG/CR-3673), the Board does not disagree that the unavailable document might have proven helpful. However, the Board does not find that the document's unavailability renders the NRC Staff's or Entergy's reliance on the NUREG-1150 decontamination cost values "altogether unreasonable" under NEPA.<sup>455</sup> As Dr. Ghosh observed, the NUREG/CR-3673 authors presumably had access to the Ostmeyer report when they prepared NUREG/CR-3673.<sup>456</sup> Therefore, we can reasonably presume that they reviewed the Ostmeyer report's contents in preparing NUREG/CR-3673, which was published as a final, NRC-approved document. Moreover, NUREG/CR-3673 expressly states that Dr. Robert Ostmeyer, co-author of the referenced report, provided technical assistance and advice during the preparation of NUREG/CR-3673.<sup>457</sup> Thus, we do not agree with New York that NUREG/CR-3673 is an unreliable source.<sup>458</sup>

158. As discussed above, the NUREG-1150 CDNFRM values have long been used in severe accident consequence analyses—including all SAMA analyses performed to date.<sup>459</sup> The PRA community continues to view them as acceptable values.<sup>460</sup> In the Board's view, the

<sup>&</sup>lt;sup>454</sup> New York Rebuttal Testimony at 24:12-17 (NYS000420); New York Rebuttal Position Statement at 10 (NYS000419); Oct. 17, 2012 Tr. at 2043:5-10 (Lemay).

<sup>&</sup>lt;sup>455</sup> *Pilgrim*, CLI-12-01, slip op. at 25.

<sup>&</sup>lt;sup>456</sup> Oct. 17, 2012 Tr. at 2010:17-25 (Ghosh).

<sup>&</sup>lt;sup>457</sup> See NUREG/CR-3673 at xix (ENT000466).

<sup>&</sup>lt;sup>458</sup> New York Rebuttal Testimony at 24:16-17 (NYS000420 (stating that NUREG/CR-3673 "is not a reliable source upon which experts in this field would base any findings").

 $<sup>^{459}</sup>$  See Oct. 17, 2012 Tr. at 1951:6-16 (Teagarden) (stating that the CDNFRM values used in the IPEC SAMA analysis for the two decontamination factors (DF = 3 and 15) are derived from NUREG-1150 and, to the knowledge of Entergy's witnesses, have been used in all prior NRC license renewal SAMA analyses).

<sup>&</sup>lt;sup>460</sup> See Oct. 17, 2012 Tr. at 1951:17-25 (Teagarden).

unavailability of the Ostmeyer report does not negate over two decades of established regulatory and probabilistic risk assessment practice. Consistent with NEPA's rule of reason, the NRC Staff has acted "based on the best available information and analysis" in completing its SAMA evaluation.<sup>461</sup> NEPA does not require agencies to resolve all uncertainties, including, in this case, uncertainties associated with the ultimate provenance of the time-tested NUREG-1150 values used in the IPEC SAMA analysis.<sup>462</sup>

159. In any event, we find that NUREG/CR-3673 contains useful insights into the nonfarm decontamination cost estimates included in NUREG-1150 (as CDNFRM values of 33,000 and 88,000 per person for DF =3 and DF =15, respectively). NUREG/CR-3673 states that these nonfarm decontamination cost estimates and decontamination factors reflect consideration of different decontamination methods, land uses, and accident magnitudes.

The cost estimates used in this study for various levels of decontamination effort in an area are taken from a detailed review of decontamination effectiveness and costs performed at Sandia National Laboratories (SNL). Cleanup cost estimates were provided for farmland and residential, business, and public property based on decontamination techniques which are currently feasible. *The study also considered the large areas which may require decontamination after the worst accidents* in defining the variety of decontamination techniques which could be employed.

The non-farm area decontamination costs and effectiveness values used in the new economic model are shown in Table 4.4. *The decontamination cost estimates incorporate information on a multitude of possible methods to be used in the decontamination of non-farm areas*, and have been weighted to account for residential, commercial and industrial, and public use land areas based on national average statistics. *The methods to be employed for each level of effort and each type of area include combinations of decontamination techniques*.<sup>463</sup>

<sup>&</sup>lt;sup>461</sup> Baltimore Gas & Elec. Co., 462 U.S. at 102.

<sup>&</sup>lt;sup>462</sup> See Izaak Walton League of Am. v. Marsh, 655 F.2d 346, 377 (D.C. Cir. 1981) ("Where adverse impacts are not likely, expensive and time-consuming studies are unnecessary. So long as the environmental impact statement identifies areas of uncertainty, the agency has fulfilled its mission under NEPA.").

<sup>&</sup>lt;sup>463</sup> NUREG/CR-3673 at 4-15, 4-17 (ENT000466) (emphasis added).

160. Consistent with the above statements, Mr. Teagarden testified that the CDNFRM values ultimately incorporated into NUREG-1150 reflect a mixture of land uses.<sup>464</sup> He also noted that the NUREG-1150 nonfarm decontamination cost value was applied universally across the five different sites examined in that study, suggesting that "in the developer's minds, those values were sufficiently applicable to each of the sites."<sup>465</sup> Mr. Teagarden also asserted that the CDNFRM value was intended to be a "global value" given that the NUREG-1150 study, like a SAMA analysis, examined regions encompassing approximately 7,800 square miles and multiple land uses.<sup>466</sup>

161. During the hearing, Dr. Lemay pointed to a passage in NUREG/CR-3673 stating that "[t]he cost and effectiveness estimates for decontamination contain large uncertainties, and results of future experimentation with decontamination techniques should be used to update models for decontamination."<sup>467</sup> However, as Mr. Harrison testified in response, NUREG/CR-3673 also recognizes that the use of standardized decontamination cost values is reasonable when evaluating the potential decontamination costs for non-farm areas impacted by a postulated severe accident, as is done in a SAMA analysis, especially given the uncertainties inherent in such estimates.<sup>468</sup> NUREG/CR-3673 states that detailed decontamination cost estimates based on land usage mapping or specific area types is not justified for risk models "because areas requiring decontamination are large enough that *average values provide reasonable cost estimates*."<sup>469</sup> It also notes that the large uncertainties inherent in estimates of reactor accident

<sup>&</sup>lt;sup>464</sup> Oct. 18, 2012 Tr. at 2169:24-2170:9 (Teagarden); *see also id.* at 2142:2-9 (Teagarden).

<sup>&</sup>lt;sup>465</sup> *Id.* at 2246:13-14 (Teagarden).

<sup>&</sup>lt;sup>466</sup> *Id.* at 2246:17-20 (Teagarden).

<sup>&</sup>lt;sup>467</sup> Oct. 17, 2012 Tr. at 2017:14-18 (Lemay) (quoting NUREG/CR-3673 at 4-15 (ENT000466)).

<sup>&</sup>lt;sup>468</sup> See id. at 2044:22-2045:10 (Harrison) (citing NUREG/CR-3673 at 4-17 (ENT000466)).

<sup>&</sup>lt;sup>469</sup> NUREG/CR-3673 at 4-17 (ENT000466) (emphasis added).

radionuclide release processes (*e.g.*, source terms), atmospheric transport and deposition, decontamination effectiveness, and decontamination costs limit the usefulness of more detailed analyses.<sup>470</sup> The upshot, as the Board sees it, is that more detailed or localized decontamination cost estimates (even assuming they could be developed) are not necessarily better suited for use in a time-averaged and spatially-averaged SAMA analysis.

162. Given the unavailability of the referenced Ostmeyer report, the Board queried whether the decontamination cost estimates presented in NUREG/CR-3673 (and later in NUREG-1150) might be based on a non-reactor (*e.g.*, plutonium) source term, as suggested in New York's contention.<sup>471</sup> Mr. Jones and Dr. Ghosh testified that they had no reason to believe that NUREG/CR-3673 authors had considered anything other than nuclear power plant severe accident source terms in their report.<sup>472</sup> Dr. O'Kula also stated his expert opinion that NUREG/CR-3673 is concerned with decontamination costs for a reactor-type source term, as evidenced by the document's explicit focus on "providing cost figures that implicitly include contamination over broad areas, such as would be expected with those associated with a reactor-type source term."<sup>473</sup>

163. The NUREG-1150 decontamination values clearly have withstood the test of time, as evidenced by their use in the NRC's recently-completed SOARCA project, a state-of-the-art assessment of the accident progression, radiological releases, and offsite consequences associated with a severe accident.<sup>474</sup> NUREG-1935, which discusses the SOARCA project methodology and result, expressly states that "[v]alues from NUREG-1150 provide the basis for

<sup>&</sup>lt;sup>470</sup> *Id.* 

<sup>&</sup>lt;sup>471</sup> See Oct. 17, 2012 Tr. at 2011:6-10 (Judge McDade).

<sup>&</sup>lt;sup>472</sup> See id. at 2011:11-17 (Jones); id. at 2011:18-25 (Ghosh).

<sup>&</sup>lt;sup>473</sup> *Id.* at 2015:7-10 (O'Kula).

<sup>&</sup>lt;sup>474</sup> See Oct. 18, 2012 Tr. at 2374:1-9, 2374:20-2375:1 (O'Kula).

decontamination parameters, which consist of two levels of decontamination, just as in NUREG-1150."<sup>475</sup>

164. It bears emphasis that three of the experts testifying in this proceeding— Dr. Bixler, Mr. Jones, and Dr. O'Kula—were directly involved in the SOARCA project and, in their expert opinions, the NUREG-1150 values are broadly accepted by the PRA community and reasonable for use in a SAMA analysis.<sup>476</sup> It is well established that under NEPA, "an agency must have discretion to rely on the reasonable opinions of its own qualified experts."<sup>477</sup> Therefore, for purposes of its NEPA-based inquiry, the Board gives significant weight to the fact that the NRC currently relies on the same NUREG-1150 values for its state-of-the-art severe accident analyses.<sup>478</sup> There also is no evidence in the record that the NRC Staff or the Commission expects licensees to rely on values other than those in NUREG-1150. There is certainly no evidence that the NRC expects licensees to engage in an extensive, world-wide research project to find alternate MACCS2 input values not previously reviewed or approved by

<sup>&</sup>lt;sup>475</sup> Draft NUREG-1935, at 63 (ENT000455) (emphasis added). We note that the final version of NUREG-1935 was published in November 2012, after the hearing on NYS-12C was held. The final report does not reflect any significant substantive changes from the draft report. *See* NUREG-1935, State-of-the-Art Reactor Consequence Analyses (SOARCA) Report (Nov. 2012), *available at* ADAMS Accession Nos. ML12332A057 and ML12332A058.

<sup>&</sup>lt;sup>476</sup> See, e.g., Oct. 17, 2012 Tr. at 2039:4-14 (O'Kula); Oct. 18, 2012 Tr. at 2251:20-24 (Jones).

<sup>&</sup>lt;sup>477</sup> See Diablo Canyon, CLI-08-26, 68 NRC at 518.

<sup>&</sup>lt;sup>478</sup> New York's reference to an NRC internal e-mail does not alter our conclusion that the NUREG-1150 values are reasonable under NEPA standards. *See* E-mail from C. Ader, Office of new Reactors ("NRO") to M. Johnson, NRO: Subject: FW: Action YT-2011-0003: Request Parallel Concurrence on Document: Agency Long-Term Research Activities for Fiscal Year 2013 (Jan. 19, 2011) (NYS000441). The e-mail contains a statement by an NRC Staff member that the pedigree of some Sample Problem A inputs values "is not known." As Dr. Ghosh explained at the hearing and in a September 28, 2012 affidavit, the referenced e-mail related to a research proposal submitted by a now-deceased NRC Staff member in late 2010 as part of the NRC's FY 13 Long-Term Research Program ("LTRP"). *See* Affidavit of S. Tina Ghosh Concerning State Of New York Motion For Leave To File An Additional Exhibit And Additional Cross-Examination Questions Concerning Consolidated Contention NYS-12C (Sept. 28, 2012) ("Ghosh Affidavit") (NRC000164); Oct. 18, 2012 Tr. at 2328:11-24 (Ghosh). A review committee comprising senior NRC Staff members evaluated the proposal and excluded it from the FY 13 LTRP. The committee assigned one of the lowest score in the "technical gap" element, indicating the members' expert judgment that the proposal identified no important technical gap in NRC's existing regulatory tools and practices. Ghosh Affidavit at 4 (NRC000164).

the NRC.<sup>479</sup> Nor is such action required under NEPA. In fact, it is not at all clear that the NRC would even accept such alternate values for the purposes of a license renewal SAMA analysis given the long-established pedigree of the NUREG-1150 values.

165. Before discussing Dr. Lemay's proposed CDNFRM values, we address two more arguments related to Entergy's use of values derived from NUREG-1150. First, Dr. Lemay cited two NRC responses to public comments on a draft version of NUREG-1150 as purported evidence that the NUREG-1150 authors "expected NRC Staff to require site-specific assessments of the costs of decontamination 'in the context of specific regulatory activities,' such as those currently being conducted at [IPEC]."<sup>480</sup> Dr. Lemay claimed that the NRC's comment responses "do not justify the use of the Sample Problem A inputs at [IPEC] or any other particular reactor."<sup>481</sup>

166. The Board is not persuaded by Dr. Lemay's argument. As Dr. O'Kula explained during the hearing, the first NRC public comment response cited by Dr. Lemay relates to the first (February 1987) *draft* of NUREG-1150.<sup>482</sup> And, in stating that the 1987 draft "does not assess the costs of these or other improvements," the NRC was referring specifically to "potential benefits of accident management strategies in reducing core damage frequency;"<sup>483</sup> *viz.*, the effects of plant operational procedures to provide water and cooling to a reactor core to prevent

<sup>&</sup>lt;sup>479</sup> See Pilgrim, CLI-10-11, 71 NRC at 315-16 ("There is no NEPA requirement to use the best scientific methodology, and NEPA should be construed in the light of reason if it is not to demand virtually infinite study and resources. Nor is an environmental impact statement intended to be a research document.") (internal citations and quotation marks omitted).

<sup>&</sup>lt;sup>480</sup> See New York Rebuttal Testimony at 18:3-19:20 (NYS000420) (citing NUREG-1150, Vol. 3, App. D at D-31 to D-32 (NYS00252D)).

<sup>&</sup>lt;sup>481</sup> *Id.* at 19:21-20:2.

<sup>&</sup>lt;sup>482</sup> See Oct. 17, 2012 Tr. at 2034:8-13 (O'Kula).

<sup>&</sup>lt;sup>483</sup> *Id.* at 2034:24-2035:5 (O'Kula).

damage.<sup>484</sup> The comment response, therefore, does *not* speak to the adequacy of the NUREG-1150 economic or decontamination cost values or their applicability to a site-specific SAMA analysis.<sup>485</sup>

167. The second comment response quoted by Dr. Lemay indicates that the *first* draft of NUREG-1150 followed conventional NRC methods for cost and benefit analyses, and that those analyses were not included in the second draft (and, subsequently, the final) NUREG-1150 report, because cost/benefit analyses of that type are more properly conducted in the context of specific regulatory activities (such as proposed rule changes).<sup>486</sup> So again, the comment response does not relate to the final NUREG-1150 report or to the CDNFRM values incorporated therein.

168. In its rebuttal filings, New York also argued that Entergy's reliance on the NUREG-1150 CDNFRM values is unreasonable because a "site-specific" analysis of decontamination costs is "eminently possible and had been completed in conjunction with [Draft] NUREG/CR-5148."<sup>487</sup> Dr. Lemay stated that in further reviewing NUREG-1150, he learned that, in the 1980s, the NRC Staff contracted with Battelle Pacific Northwest Laboratory ("PNL")<sup>488</sup> to "conduct a case study of the economic costs associated with severe accidents at [Indian Point]."<sup>489</sup> According to Dr. Lemay, this "site-specific case study" is described in Chapter 5 of Draft NUREG/CR-5148.<sup>490</sup> Dr. Lemay contended that it was unreasonable for

<sup>&</sup>lt;sup>484</sup> See NUREG-1150, Vol. 3, App. D at D-6 (NYS00252C) (stating that NUREG-1150 considers the effects of plant operational procedures to provide water and cooling to a reactor core to prevent its damage and on mitigating the consequences of core damage accidents).

<sup>&</sup>lt;sup>485</sup> Oct. 17, 2012 Tr. at 2034:20-23 (O'Kula).

<sup>&</sup>lt;sup>486</sup> *Id.* at 2035:10-22 (O'Kula).

<sup>&</sup>lt;sup>487</sup> New York Rebuttal Position Statement at 15 (NYS000419).

<sup>&</sup>lt;sup>488</sup> Pacific Northwest Laboratory is now Pacific Northwest National Laboratory (PNNL).

<sup>&</sup>lt;sup>489</sup> New York Rebuttal Testimony at 25:14-15 (ENT000420).

<sup>&</sup>lt;sup>490</sup> *Id.* at 25:16. There is no indication that the document was ever reviewed, approved, and published by the NRC as a final document. Unlike other NUREG series reports, including the contemporaneously-prepared NUREG-

Entergy and the NRC Staff to "ignore" the Draft NUREG/CR-5148 case study given its purported nexus to IPEC.<sup>491</sup>

169. But, as discussed at hearing, Draft NUREG/CR-5148 is not the "site-specific" analysis New York and Dr. Lemay first claimed it to be. As the draft report itself states:

The results that are reported should not be considered as representative of reactor accident consequences either for pressurized water reactors (PWR) in general or for the Indian Point reactors, since the plume direction was selected to maximize the offsite consequences in an area having a particularly high population density.<sup>492</sup>

Further, the source terms implemented in the IPEC "case study" were generic source terms used in a 1982 Sandia reactor siting study.<sup>493</sup> They are not plant-specific source terms based on a plant-specific PRA analysis, like the source terms used in the IPEC SAMA analysis.<sup>494</sup>

170. Thus, the analyses presented in Draft NUREG/CR-5148 are not representative of

the IPEC site and cannot be accurately characterized as "site-specific."<sup>495</sup> Nor are they

consistent with the SAMA analysis objective, which is to estimate the mean annual offsite

population dose and economic costs over the entire SAMA analysis region based on plant-

specific information. Dr. Lemay conceded this fact, stating that "many of the parameters that are

in [Draft NUREG/CR-5148] are wrong," and that "I'm not advocating this particular example as

a NEPA-type and site-specific analysis for Indian Point."496 In any case, Dr. Lemay did not

<sup>1150,</sup> Draft NUREG/CR-5148 contains no manuscript completion date or the publication date in the front matter of the report. The inclusion of those dates on final NUREG series reports is standard NRC practice.

<sup>&</sup>lt;sup>491</sup> *Id.* at 29:1-6.

<sup>&</sup>lt;sup>492</sup> Draft NUREG/CR-5148 at 1.11 (NYS00424B)

<sup>&</sup>lt;sup>493</sup> Oct. 18, 2012 Tr. at 2258:21-24 (Teagarden).

<sup>&</sup>lt;sup>494</sup> See NRC Staff Testimony at 24 (A18) (NRC000041).

<sup>&</sup>lt;sup>495</sup> Mr. Teagarden described Draft NUREG/CR-5148 as a "stylized assessment" performed to demonstrate the functionality of a code (DECON) that, to his knowledge, is no longer available or operable. Oct. 18, 2012 Tr. at 2258:9-12 (Teagarden); *see also* Draft NUREG/CR-5148 at 1.11 (NYS000424B) ("The purpose of this chapter is to illustrate the uses of DECON and the interpretation of its output.").

<sup>&</sup>lt;sup>496</sup> Oct. 18, 2012 Tr. at 2257:8-14 (Lemay).

explain how this "example" study or the since-retired DECON code described therein could be used to develop a site-specific decontamination cost estimate, and in a form suitable for use in MACCS2.<sup>497</sup>

171. For all of the above reasons, the Board disagrees with New York that the CDNFRM values used in the IPEC SAMA analysis lack a technical basis or a rational relationship to the IPEC site. The Board also rejects the notion that more detailed or "localized" decontamination cost estimates—even if it were feasible to develop for use here—would be superior to the NUREG-1150 values used in the IPEC SAMA analysis. NUREG-1150's supporting technical documentation indicates that the CDNFRM values reflect consideration of multiple land uses and decontamination methods. It also establishes that NUREG-1150's "average" values are reasonable for estimating decontamination costs for the very large and varied geographic region considered in a SAMA analysis. And, as discussed earlier, the CDNFRM values are applied on a per-person basis by MACCS2. Therefore, they allow for sitespecific decontamination cost estimates that reflect the high-population areas with the IPEC SAMA analysis region, including New York City. Accordingly, the Board finds that Entergy's and the NRC Staff's reliance on the NUREG-1150 CDNFRM values (as escalated for time) is reasonable under NEPA standards.

#### F. <u>New York's Proposed Alternative CDNFRM Values Are Not Reasonable or</u> <u>Appropriate for Use in a SAMA Analysis</u>

172. Claiming that Entergy's CDNFRM values are too low, Dr. Lemay proposed his own values.<sup>498</sup> Dr. Lemay's methodology is described in his direct testimony and the ISR

<sup>&</sup>lt;sup>497</sup> See id. at 2299:2-5 (Teagarden) ("What we're talking about is what gets rolled up into the cost for non-farm decontamination, CDNFRM, and the associated dose reduction factor."); *id.* at 2303:18-21 (Lemay) ("MACCS2 has no way of specifying techniques or anything at that level of detail. It has only one aggregate value, the cost of decontamination per person.").

<sup>&</sup>lt;sup>498</sup> *See* New York Direct Testimony at 30:668-31:676 (NYS000241).

Report.<sup>499</sup> For purposes of his analysis, Dr. Lemay divided the spatial grid defined in the IPEC MACCS2 site input file into two discrete areas within the 50-mile radius SAMA analysis region for purposes of evaluation: (1) the "NYC metropolitan area" and (2) "the areas outside of the NYC metropolitan area."<sup>500</sup> For each of the areas, he calculated the costs of "light" and/or "heavy" decontamination (equating light decontamination to a DF of 3 and heavy decontamination to a DF of 15)<sup>501</sup> using the per square kilometer decontamination costs obtained

from four sources:

- <u>Approach A</u> is based on data from the *Site Restoration Report* as modified by R.E. Luna, H.R. Yoshimura, and M.S. Soo Hoo, *Survey of Costs Arising from Potential Radionuclide Scattering Events*, WM2008 Conference (Feb. 2008) ("Luna Paper") (NYS000255);
- <u>Approach B</u> relies upon data from Barbara Reichmuth's presentation of results from radiological dispersal device economic consequence analysis in the U.S. (Reichmuth, et al., *Economic Consequences of a Rad/Nuc Attack: Cleanup Standards Significantly Affect Cost*, Proceedings of Working Together R&D Partnerships in Homeland Security, Boston, MA (Apr. 2005) (Pacific Northwest National Laboratory, PNNL-SA-45256) ("Reichmuth Paper") (NYS000257);
- <u>Approach C</u> uses information from the CONDO Report (NYS000250), which relates to a decontamination cost estimation tool from the United Kingdom's National Radiological Protection Board, and its database; and
- <u>Approach D</u> relies upon data from Chernobyl-related decontamination analyses completed by the Risø National Laboratory in Denmark.<sup>502</sup>
  - 173. For each approach, Dr. Lemay calculated a single total cost for light and/or heavy

decontamination within the 50-mile radius area.<sup>503</sup> He then divided the total cost by the total

population, as reported by Entergy, in the 50-mile radius area to obtain a per capita cost for light

<sup>&</sup>lt;sup>499</sup> See generally New York Direct Testimony at 30:668-51:1056 (NYS000241); ISR Report at 13-24 (NYS000242).

<sup>&</sup>lt;sup>500</sup> New York Direct Testimony at 31:679-81 (NYS000241).

<sup>&</sup>lt;sup>501</sup> *Id.* at 31:682-83; Oct. 18, 2012 Tr. at 2106:10-15 (Lemay).

<sup>&</sup>lt;sup>502</sup> New York Direct Testimony at 31:686-33:711 (NYS000241).

<sup>&</sup>lt;sup>503</sup> *Id.* at 32:698-700.

and/or heavy decontamination.<sup>504</sup> Finally, Dr. Lemay updated the per capita cost for each approach to 2005 values, using the same CPI method used by Entergy.<sup>505</sup>

174. The Board discusses each of Dr. Lemay's four methodologies below, and concludes that none of them yields a CDNFRM value that is appropriate for use in SAMA analysis. As explained below, Dr. Lemay's CDNFRM values are based on references and assumptions that are inapplicable to a nuclear power plant severe accident or SAMA analysis.

#### 1. Site Restoration Report/Luna Paper (ISR Approach A)

175. In ISR Approach A, Dr. Lemay relied on data contained in the 1996 Site Restoration Report to develop alternative decontamination cost estimates.<sup>506</sup> Entergy and the Staff contended that the Site Restoration Report is inapplicable to a nuclear power plant SAMA analysis because it developed cost estimates for remediation of a *plutonium* dispersal event.<sup>507</sup> During the hearing, Dr. Lemay conceded that the Site Restoration Report is "not ideal" because it relates to plutonium dispersal events, *not* to reactor severe accidents.<sup>508</sup> In fact, he admitted that the report's focus on plutonium decontamination costs "is a weakness of the method."<sup>509</sup>

176. Based on the record evidence, the Board finds that the Site Restoration Report has little, if any, relevance to a nuclear power plant SAMA analysis given its focus on plutonium cleanup.<sup>510</sup> Cleanup of a plutonium dispersal event differs in significant respects from cleanup

<sup>&</sup>lt;sup>504</sup> *Id.* at 32:702-04.

<sup>&</sup>lt;sup>505</sup> *Id.* at 32:705-06.

<sup>&</sup>lt;sup>506</sup> New York Direct Testimony at 31:686 (NYS000241).

<sup>&</sup>lt;sup>507</sup> Entergy Testimony at 68 (A90) (ENT000450); NRC Staff Testimony at 13 (A6a) (NRC000041).

<sup>&</sup>lt;sup>508</sup> Oct. 17, 2012 Tr. at 2012:11-13 (Lemay).

<sup>&</sup>lt;sup>509</sup> Oct. 18, 2012 Tr. at 2108:5-8 (Lemay).

<sup>&</sup>lt;sup>510</sup> As stated earlier, the Commission has expressly confirmed this fact in a decision overruling a licensing board's admission of contention that relied on the Site Restoration Report as a supporting reference. *See Seabrook*, CLI-12-05, slip op. at 40 ("The Sandia Study is a lengthy report focused on plutonium dispersal events.").

of fission products from a severe reactor accident.<sup>511</sup> In contrast, the decontamination required for a major reactor accident is primarily concerned with dose reduction of Cesium-137 (Cs-137).<sup>512</sup>

177. The Site Restoration Report's focus on plutonium significantly increases the decontamination costs estimated therein, because the report's authors assumed that any area requiring a DF greater than 10 would require complete demolition of contaminated structures.<sup>513</sup> As the record evidence shows, this runs counter to actual remediation experience, where DFs of up to 15 have been achieved without resorting to complete demolition.<sup>514</sup>

178. The Site Restoration Report focused on relatively small areas for remediation and did not fully investigate attributes that would be pursued for a significantly larger-scale cleanup effort where complete demolition of all structures is not a viable option; *e.g.*, segregating non-radiological waste from radiological waste, employing waste volume reduction techniques, and

<sup>&</sup>lt;sup>511</sup> Entergy Testimony at 68 (A90) (ENT000450). For example, Pu-239 is primarily an alpha emitter, the presence of which can be difficult to identify in the field. U.S. Environmental Protection Agency, OSC Radiological Response Guideline at 101 (Oct. 2006) (ENT000463).

<sup>&</sup>lt;sup>512</sup> NRC Staff Testimony at 13 (A6a), 15 (A6c) (NRC000041). Cs-137 is a gamma emitter, so it is primarily an external health hazard. OSC Radiological Response Guideline at 83-86 (ENT000463). As a gamma emitter, identification in the field is more readily performed. *Id.* at 84-85. The Site Restoration Report specifically recognizes this fact:

<sup>[</sup>T]he high-energy gamma radiations emitted from deposited radioactive cesium are easily detected with simple field instruments, even if the material migrates below surfaces. In contrast, plutonium measurement in the field might be very difficult, particularly if some of the material was lodged in crevices, under vegetation, or inside buildings. *Decontamination [for plutonium] would probably be useless unless the post-cleanup level of residual contamination could be reliably quantified*.

Site Restoration Report, App. E at E-12 (NYS000249) (emphasis added).

<sup>&</sup>lt;sup>513</sup> Entergy Testimony at 68-69 (A90) (ENT000450). *See also* Site Restoration Report at App. F at F-18 ("It would be impossible to ensure that particles of plutonium had not lodged within the structure, from which they could be dislodged by later housecleaning or remodeling. Complete demolition, although not the only possible strategy, appears to be the most reliable.").

<sup>&</sup>lt;sup>514</sup> Entergy Testimony at 70-72 (A92) (ENT000450).

minimizing the costs associated with on-site disposal.<sup>515</sup> The report explicitly recognizes this fact in stating that "[o]ur choice of the potential size of the affected area should not be used to predict the costs of accidents."<sup>516</sup>

179. As discussed in Entergy's and the NRC Staff's prefiled testimony, the ISR Approach A cost estimates also rest on a number of other technically unsupported assumptions. For example, Dr. Lemay inappropriately considered "compensation" costs in the decontamination cost values developed from the Site Restoration Report. Per the *Site Restoration Report*, the compensation category addresses "compensation to private and business property owners for damage to or disposal of property, and to business firms for lost income."<sup>517</sup> As Dr. O'Kula and Mr. Teagarden explained, such costs are not included in the MACCS2 parameter CDNFRM.<sup>518</sup> Rather, they are captured in other MACCS2 parameters, namely the variable POPCST, which addresses temporary or permanent relocation of residents and businesses in the region, including moving expenses and personal and corporate income losses

<sup>&</sup>lt;sup>515</sup> *Id.* at 130 (A160). *See also* Site Restoration Report at 7-1 (NYS000249) ("In order to derive the cost estimates presented, we assumed that the size of the affected area could range from a few hundred square meters to a few square kilometers.").

<sup>&</sup>lt;sup>516</sup> Site Restoration Report at 7-1 (NYS000249). As part of ISR Approach A, Dr. Lemay also relied on data contained in a brief technical paper by Luna et al. (Luna Paper) that purports to survey efforts to estimate the clean-up costs for radiological dispersion events associated with radiological dispersion devices ("RDDs") or "dirty bombs." *See* ISR Report at 16-18 (NYS000242) (citing R.E. Luna, H.R. Yoshimura, and M.S. Soo Hoo, Survey of Costs Arising from Potential Radionuclide Scattering Events, WM2008 Conference (Feb. 2008) (NYS000255)). Like the Site Restoration Report, the Luna Paper concerns small-scale dispersion events and, therefore, lacks applicability in the present context. *See* Entergy Testimony at 92-93 (A119) (ENT000450). Further, most of the data sets surveyed by Luna implicitly incorporate the Site Restoration Report economic model and, for that reason alone, lack applicability to a nuclear power plant SAMA analysis. *See id.* 

<sup>&</sup>lt;sup>517</sup> Site Restoration Report, App. F at F-27 (NYS000249). For moderately to heavily-contaminated residential properties, these costs include replacement cost for personal property, including motor vehicles and all household furnishing and appliances. *Id.* at F-8. For heavy contamination, compensation "also includes the cost of acquisition of property." *Id.* at F-27. The *Site Restoration Report* notes that "[c]ompensation is one of the major determinants of total cost." *Id.* For the heavy contamination case, the compensation contributes approximately 58% and 59% of the total cost for residential and commercial property. *Id.* at G-30.

<sup>&</sup>lt;sup>518</sup> Entergy Testimony at 97 (A121) (ENT000450).

for a transitional period.<sup>519</sup> Incorporating such costs into the variable CDNFRM results in double counting of costs, and also skews the internal cost-benefit determinations made within MACCS2 related to application of decontamination strategies.<sup>520</sup>

180. Also, in developing cost estimates for "light" and "heavy" decontamination based on the Site Restoration Report, Dr. Lemay assumed that the cost of cesium decontamination always equals or exceeds the cost of plutonium decontamination.<sup>521</sup> But neither of the two references cited by Dr. Lemay supports that assumption. The first document cited by Dr. Lemay, the "Holt" study,<sup>522</sup> documents Sandia's efforts to remove both cesium and plutonium from concrete using a decontamination technique called "strippable coatings."<sup>523</sup> Dr. Lemay pointed to one result in which Sandia achieved a DF of 1.2 for cesium and a DF of 5.8 for plutonium, which ostensibly suggests that cesium is about five times more difficult to remove than plutonium.<sup>524</sup>

<sup>&</sup>lt;sup>519</sup> NUREG/CR-6613, Vol. 1 at 7-13 to 7-14 (NYS000243).

<sup>&</sup>lt;sup>520</sup> Entergy Testimony at 97 (A121) (ENT000450). In his rebuttal testimony, Dr. Lemay acknowledged this error, and removed the compensation costs and re-calculated CDNFRM for ISR Approaches A and B, as shown in the tables contained in Exhibit NYS000430. Dr. Lemay's original ISR Approach A decontamination cost values were \$135,927 to \$271,854 per person for light decontamination, and \$448,889 to \$897,778 per person for heavy decontamination. As a result of correcting only one of the errors identified by Entergy's experts, those values changed dramatically to \$91,936 - \$183,871 per person for light decontamination, and to \$208,780 to \$417,561 for heavy decontamination. As Mr. Jones noted, "[t]hat's a very sensitive number." Oct. 18, 2012 Tr. at 2116:19 (Jones). Dr. Lemay's original ISR Approach B decontamination cost values \$200,000 to \$252,000 per person for heavy decontamination. He revised those values to be \$97,000 to \$150,720 per person.

<sup>&</sup>lt;sup>521</sup> See New York Direct Testimony at 39:822-25 (NYS000241). Using the data from the Site Restoration Report, Dr. Lemay concluded that an appropriate "multiplicative factor" for the overall costs shown for plutonium in Table 2 of the ISR Report is necessary to estimate the costs of cesium decontamination. *Id.* at 37:792-95. Dr. Lemay considered two cases: (1) the cost of cesium decontamination *equals* that of plutonium, and (2) the cost of cesium decontamination is *twice that* of plutonium. *Id.* at 39:822-25.

<sup>&</sup>lt;sup>522</sup> See Letter from K. Holt, Sandia National Laboratories to M. O'Neill, Cellular Engineering, with encl., Testing for Radiological Decontamination Strippable Coating for Cellular Bioengineering, Inc. (Cs-137, Pu-239, Am-241) (Oct. 7, 2007) ("Holt Study") (NYS000259).

<sup>&</sup>lt;sup>523</sup> New York Direct Testimony at 38:800-06 (NYS000241).

<sup>&</sup>lt;sup>524</sup> *Id.* 

181. As noted by the other parties' experts, however, Dr. Lemay's conclusion is incorrectly based on a single coupon test comparison for concrete.<sup>525</sup> The Holt study actually included twenty-four test data sets. Review of the complete body of data reveals cases in which a much larger DF was achieved for cesium than for plutonium. This fact contravenes to Dr. Lemay's assumption that "the cost of cesium decontamination is twice that of plutonium," and invalidates his decision to multiply the CDNFRM input value used in MACCS2 by a factor of two.<sup>526</sup>

182. Dr. Lemay's second supporting reference includes several datasets from the CONDO software tool. Specifically, Dr. Lemay referenced Table A7, "Decontamination factors" from a document associated with the CONDO software.<sup>527</sup> Table A7 lists a series of decontamination techniques, the surface type being decontaminated, the time over which the DF is applicable, and the DFs.<sup>528</sup> Of the 61 decontamination technique/surface pairings listed in the CONDO Report, only seven of them can be differentiated as resulting in a higher DF for plutonium than for cesium.<sup>529</sup> Further, 52 of the remaining 54 sets of results are numerically identical and, in two cases, the DF reported for cesium was marginally *higher* than that reported for plutonium.<sup>530</sup> Thus, the referenced data clearly do not support Dr. Lemay's assertion that the DFs for cesium are "always less or equal to the DFs for plutonium in the CONDO dataset."<sup>531</sup>

<sup>&</sup>lt;sup>525</sup> Entergy Testimony at 106 (A131) (ENT000450); NRC Staff Testimony at 50-61 (A52) (NRC000041).

<sup>&</sup>lt;sup>526</sup> ISR Report at 17 (NYS000242).

<sup>&</sup>lt;sup>527</sup> See T. Charnock, J. Brown, A.L. Jones, W. Oatway and M. Morrey, CONDO: Software for Estimating the Consequences of Decontamination Options, Report for CONDO Version 2.1. (with Associated Database Version 2.1), National Radiological Protection Board, Chilton, Didcot, UK (May 2003) ("CONDO Report") (NYS000250).

<sup>&</sup>lt;sup>528</sup> *Id.* at 45-47.

<sup>&</sup>lt;sup>529</sup> See id.

<sup>&</sup>lt;sup>530</sup> *See id* at 47.

<sup>&</sup>lt;sup>531</sup> NRC Staff Testimony at 62 (A54) (NRC000041).

183. For the foregoing reasons, the Board finds that the ISR Approach A decontamination cost values are not appropriate for use in a SAMA analysis. The principal source of information on which Dr. Lemay relied—the Site Restoration Report—concerns nuclear weapon-related plutonium dispersal events and has no demonstrated relevance to a nuclear power plant severe accident. Furthermore, Dr. Lemay made unsupported technical assumptions that are integral to his cost estimates, including the assumption that cesium decontamination costs always equal or exceed plutonium decontamination costs. The net result are CDNFRM values that, even after revision by Dr. Lemay to remove double counted "compensation" costs, are two to four times the *maximum* value of \$100,000 per person allowed by MACCS2. Indeed, only by modifying the MACCS2 source code could Dr. Lemay even run the altered MACCS2 software using his proposed values.<sup>532</sup> To our knowledge, there is no evidence of an independent review having been performed of the altered software.

#### 2. Reichmuth Paper (ISR Approach B)

184. ISR Approach B is based principally on the Reichmuth Paper (NYS000257), which purports to compare the economic costs associated with nuclear weapon and RDD detonations for several U.S. cities, including New York City.<sup>533</sup> Reichmuth developed economic cost estimates based on two sources: (1) the economic model provided as a companion to the RADTRAN 5 computer code; and (2) a Federal Reserve Bank of New York ("FRBNY") study of the economic effects of the 9/11 terrorist attack on the World Trade Center ("WTC") in New York City.<sup>534</sup>

<sup>&</sup>lt;sup>532</sup> New York Direct Testimony at 50:1030-32 (NYS000241).

<sup>&</sup>lt;sup>533</sup> See Reichmuth Paper (NYS000257). Specifically, the Reichmuth Paper estimates economic consequences associated with three nuclear weapon detonations of varying sizes and a Cs-137 RDD in the New York City area.

<sup>&</sup>lt;sup>534</sup> *Id.* at 5-7.

185. The Board finds that both sources relied upon by Reichmuth are irrelevant to the analysis of nuclear power plant severe accident costs. The first source, the economic companion model to RADTRAN 5, is based on the Site Restoration Report methodology.<sup>535</sup> For the reasons stated above, the Site Restoration Report is not applicable to a SAMA analysis.

186. The second source identified above, the FRBNY WTC-related study, also has no apparent relevance to a nuclear power plant SAMA analysis. <sup>536</sup> Specifically, we can discern no sound basis for using a non-radiological event involving enormous structural damage (*i.e.*, the 9/11 WTC attacks) to estimate cleanup for a radiological event (*i.e.*, an RDD detonation), in which the structural damage is essentially non-existent.<sup>537</sup> And, as Mr. Jones noted, the chosen location for the postulated RDD detonation (New York City) would result in the deposition of the most contamination in the immediate city area.<sup>538</sup> This clearly is a worst-case scenario (involving a terrorist attack) that is not representative of a severe accident at a nuclear power plant located 24 to 40 miles from New York City, as postulated in the IPEC SAMA analysis.

187. Dr. Lemay also referenced a second paper by Reichmuth that is briefly discussed in a Congressional Research Services ("CRS") report but is not available to the Board and parties. Specifically, he relied on a graphical presentation of cost estimates for a postulated Cs-137 RDD attack on Vancouver that apparently was extracted from the second Reichmuth paper

<sup>&</sup>lt;sup>535</sup> Entergy Testimony at 112 (A136) (ENT000450).

<sup>&</sup>lt;sup>536</sup> *Id.* at 112-13 (A136).

<sup>&</sup>lt;sup>537</sup> As Dr. O'Kula, Mr. Teagarden, and Mr. Jones noted, there is no algorithm provided to demonstrate how the WTC data were used to derive costs, no process explaining how the WTC data were used, and no technical discussion of the approach to extend the WTC cleanup costs to represent cesium decontamination. *See* Entergy Testimony at 113 (A136) (ENT000450); NRC Staff Testimony at 77 (A69) (NRC000041).

<sup>&</sup>lt;sup>538</sup> NRC Staff Testimony at 77 (A69) (NRC000041). Indeed, the Reichmuth Paper states that "the WTC site is not representative of New York City in general or any other major population center in the United States because of the unique and very high value buildings that stood on this site and which will be replaced with equally high value buildings." Reichmuth Paper at 7 (NYS000257). It also acknowledges that the replacement value reported in the FRBNY study is thus likely to be much higher than would be expected for the average high density urban area. *Id*.

and presented in the CRS report.<sup>539</sup> Even putting aside the second Reichmuth paper's unavailability, Dr. Lemay again failed to explain how a RDD attack in a major metropolitan area is relevant to the severe accident scenarios postulated to occur in the IPEC SAMA analysis. Further, as Dr. O'Kula and Mr. Teagarden noted, approximately 85% of costs contained in the CRS report graphic are outside the scope of the MACCS2 parameter CDNFRM (*i.e.*, they are unrelated to radiological cleanup costs), and the basis for the other 15% of the costs is unknown.<sup>540</sup> The CRS report also provides no details regarding the cleanup cost estimate reported in the second, non-public Reichmuth paper.

188. Accordingly, the Board finds that the alternative CDNFRM values developed by Dr. Lemay in ISR Approach B are not reasonable or appropriate for use in a SAMA analysis. The values have no relevant or reliable technical basis. The cited Reichmuth papers (the second of which is not in evidence) do not involve nuclear power reactors and lack sufficient information to allow a reasonable and reliable comparison to the costs of a nuclear power plant severe accident.

#### **3.** CONDO Report (ISR Approach C)

189. In ISR Approach C, Dr. Lemay used data related to the European CONDO software tool for estimating decontamination costs in the United Kingdom.<sup>541</sup> He claimed that the CONDO user can enter site-specific inputs such as population and building density and use this information to develop site-specific decontamination cost estimates.<sup>542</sup> However, he later

See Entergy Testimony at 113-15 (A137) (ENT000450). The CRS Report briefly describes this additional paper by Reichmuth, noting that it considers the economic impacts of a postulated explosive-driven RDD containing 1,000 curies of cesium-137 that is detonated at BC Place Stadium in Vancouver, British Columbia. CRS Report at 15 (NYS000262). It also includes two figures from Reichmuth's paper. See id. at 16-17 (Figs. 2 & 3).

<sup>&</sup>lt;sup>540</sup> Entergy Testimony at 114 (A137) (ENT000450).

<sup>&</sup>lt;sup>541</sup> See ISR Report at 19-21 (NYS000242).

<sup>&</sup>lt;sup>542</sup> Oct. 18, 2012 Tr. at 2111:6-18 (Lemay).

conceded that he did not actually run the CONDO computer code, but instead manipulated data contained in CONDO code documentation in self-generated spreadsheets.<sup>543</sup> As discussed below, the Board finds that Dr. Lemay's use of the CONDO dataset is not technically sound.

190. CONDO provides unit cost estimates for different decontamination techniques and applications of those technologies.<sup>544</sup> However, for reasons explained by the NRC Staff's and Entergy's witnesses, Dr. Lemay did not apply these unit costs appropriately in developing his cost estimates.<sup>545</sup> Specifically, he did not consider the manner in which MACCS2 calculates contamination levels and assesses the decontamination efforts needed to return an area to habitability. As a result, Dr. Lemay failed to account for the mass balance of contamination that is accounted for in the modeling within the MACCS2 code.<sup>546</sup> This is a significant error in his analysis.

191. Mr. Jones explained that mass balance is important because MACCS2 calculates an amount of contamination per unit area as if the contamination is being deposited on a flat plane, such as a perfectly horizontal surface.<sup>547</sup> Applying additional multipliers that effectively increase the base areas used in MACCS2—without equally reducing the amount of contamination in this area—results in artificially high decontamination cost estimates.<sup>548</sup> Mr. Jones explained the disconnect between the MACCS2 mass balance model and the CONDO "fragmentation" model:

<sup>&</sup>lt;sup>543</sup> *Id.* at 2376:14-20 (Lemay).

<sup>&</sup>lt;sup>544</sup> NRC Staff Testimony at 78 (A69) (NRC000041). Dr. Lemay referenced Table A7, "Decontamination factors" of the CONDO Report (NYS000250). The table lists a series of decontamination techniques, the type of surface being decontaminated, the time over which the DF is applicable, and the DFs. The DFs are provided for "cesium" to represent the cesium and ruthenium element classes (*i.e.*, beta/gamma emitters), and for "plutonium" to represent the plutonium element class (*i.e.*, all alpha emitters).

<sup>&</sup>lt;sup>545</sup> See Oct. 18, 2012 Tr. at 2116:20-2117:1, 2117:25-2118:12 (Jones); *id.* at 2143:19-2145:2 (Bixler); *id.* at 2152:14-2156:15 (O'Kula); *id.* at 2167:19-2169:3 (Teagarden).

<sup>&</sup>lt;sup>546</sup> See NRC Staff Testimony at 78 (A69) (NRC000041); Oct. 18, 2012 Tr. at 2116:20-2117:1 (Jones).

<sup>&</sup>lt;sup>547</sup> NRC Staff Testimony at 78 (A69) (NRC000041).

<sup>&</sup>lt;sup>548</sup> Id.

CONDO allows you to include decontamination of the walls, decontamination of the interior and exterior. So if you put a building on this flat plane where MACCS calculates 100 curies, now you've got four walls and a roof. And you've got four interior walls, a floor and a ceiling. You have 11 surfaces. In Dr. Lemay's analysis, he applies the heavy decontamination activities towards all of those surfaces. So he's removing effectively 100 curies from each of those surfaces to reduce this below habitability [dose threshold]. So 1,100 curies of cesium are being removed when only 100 is present.<sup>549</sup>

In other words, Dr. Lemay's methodology assumes the decontamination of more cesium than is postulated to exist by MACCS2 based on the plant-specific source term inputs to the code.

192. Dr. Lemay initially disagreed with Mr. Jones, asserting that "MACCS2 is not a

mass conservation code."550 He claimed that the code "contaminate[s] the surfaces" and then

"decontaminate[s] them depending on how many surfaces we have to decontaminate."<sup>551</sup>

Dr. Lemay also said that MACCS2 assumes that the contaminant plume is continually

replenished.552

193. Dr. Bixler agreed with Mr. Jones that MACCS2 conserves mass through a source

depletion model.<sup>553</sup> He explained that the simulated plume is depleted through various

mechanisms modeled in MACCS2, including deposition on the ground, rainfall, and radioactive

decay.<sup>554</sup> He also clarified that plume depletion is accounted for through a "transfer coefficient

<sup>&</sup>lt;sup>549</sup> Oct. 18, 2012 Tr. at 2117:25-2118:12 (Jones). See also NRC Staff Position Statement at 12 (NRC000039) ("The MACCS2 code uses a mass balance for determining the clean-up requirements, while the CONDO code uses a fragmentation method."); NRC Staff Testimony at 79-80 (A71) (NRC000041).

<sup>&</sup>lt;sup>550</sup> Oct. 18, 2012 Tr. at 2134:25 (Lemay).

<sup>&</sup>lt;sup>551</sup> *Id.* at 2133:6-12 (Lemay).

<sup>&</sup>lt;sup>552</sup> *Id.* at 2131:21-2132:1 (Lemay) ("[A] source depletion model assumes that there is enough contamination in the cloud that what you remove will not appreciably disturb the cloud's shape. And the contamination will get replenished by the eddies in the cloud.").

<sup>&</sup>lt;sup>553</sup> *Id.* at 2143:19-2145:2 (Bixler); *see id.* at 2147:8-12 (Bixler) ("So you start out with a certain amount of activity. And that amount stays in the plume unless it decays and turns into something else or unless it's deposited. So it conserves that quantity as the plume moves down wind.").

<sup>&</sup>lt;sup>554</sup> *Id.* at 2143:19-2145:2 (Bixler).

times a unit surface area that just represents [a] flat plane area."<sup>555</sup> Dr. O'Kula and Mr. Teagarden agreed that the MACCS2 plume model is mass conservative.<sup>556</sup> In this regard, they noted that the MACCS2-simulated plumes contain a finite amount of radioactivity,<sup>557</sup> and that it is impossible to "decontaminate more than you start with."<sup>558</sup>

194. After hearing the testimony of the NRC Staff's and Entergy's experts, Dr. Lemay stated that "I would like to concede to Dr. Bixler that indeed MACCS has mass conservation between the plume and the contamination deposited on the ground. So what goes on the ground is taken off from the plume. That is absolutely correct."<sup>559</sup> In the Board's view, this concession casts significant doubt on the reliability of Dr. Lemay's Approach C (CONDO) for decontamination cost estimates.

195. Moreover, Dr. O'Kula and Mr. Teagarden identified another significant flaw in the ISR Approach C methodology. Despite the availability of 61 decontamination techniques in the CONDO database, Dr. Lemay weighted his results predominantly on decontamination of internal walls in buildings, and relied on a single decontamination technique in all of his spreadsheet calculations.<sup>560</sup> Specifically, one technique ("vacuuming, cleaning and washing") is the dominant cost contributor for the semi-urban, urban and "hyper-urban" population densities

<sup>&</sup>lt;sup>555</sup> *Id.* at 2144:16-17 (Bixler).

<sup>&</sup>lt;sup>556</sup> *Id.* at 2152:14-2156:15 (O'Kula); *id.* at 2167:19-2169:3 (Teagarden).

<sup>&</sup>lt;sup>557</sup> *Id.* at 2152:22-2153:11 (O'Kula) ("A finite amount of radioactivity is emitted over time into the atmosphere, constitutes the plume, travels downwind . . . . If it's not in the cloud, if it's not still remaining in the atmosphere, then it's deposited out on the ground.").

<sup>&</sup>lt;sup>558</sup> Id. at 2167:7-8 (Teagarden); see also id. at 2168:23-2169:3 (Teagarden) ("When it comes to decontaminating, certain surfaces will have higher deposition, higher contaminant levels. And when the costs are evaluated and rolled together, mass conservation just has to be viewed as a fundamental principle in my professional judgment.").

<sup>&</sup>lt;sup>559</sup> *Id.* at 2176:24-2177:3 (Lemay).

<sup>&</sup>lt;sup>560</sup> See Entergy Testimony at 118-20 (A143-44) (ENT000450).

areas described in the ISR Report.<sup>561</sup> Dr. O'Kula and Mr. Teagarden explained that this approach is not reasonable because building interiors are expected to be less contaminated than the building exteriors in the event of a nuclear power plant severe accident,<sup>562</sup> and that any decontamination effort would proceed through a "highly prioritized process."<sup>563</sup> Dr. Bixler and Mr. Jones agreed, explaining that all surfaces would not be decontaminated equally. Rather, decontamination efforts would focus on the most contaminated surfaces (*e.g.*, on the ground floor of a building and near ventilation systems, where contamination is more likely to enter the building) with the goal of restoring habitability.<sup>564</sup>

196. Notably, Mr. Jones testified that if appropriate corrections are made to Dr. Lemay's ISR Approach C decontamination cost estimates, the resulting CDNFRM values are much more in line with those used in the IPEC SAMA analysis. Mr. Jones stated that he redid the CONDO-related calculation provided by Dr. Lemay in Annex C of the ISR Report for heavy decontamination (where the New York City metropolitan area is considered urban and the remainder of the region is considered semi-urban).<sup>565</sup> His objectives were to account for mass

<sup>&</sup>lt;sup>561</sup> Id. at 119 (A144). The CONDO datasets present data for three different population category ranges; *i.e.*, rural (< 25 persons/km2), semi-urban (> 25 but ≤ 1,000 persons/km2), and urban (> 1,000 persons/km2). See id. at 119-20 (A144-45). Dr. Lemay created a fourth population category called "hyper-urban" to account for a population density exceeding 10,000 persons/km2 for the New York City region. He then characterized the New York City metropolitan area as either urban or hyper-urban by population density, and the area outside the New York City metropolitan area (but still within the 50-mile SAMA analysis region) as either semi-urban or urban. New York Direct Testimony at 43:899-44:943 (NYS000241). The Board agrees with Dr. O'Kula and Mr. Teagarden that Dr. Lemay's characterization is inconsistent with the actual population densities in the SAMA analysis region and leads to inflated cost estimates. Entergy Testimony at 118-21 (A143-45), 131 (A160) (ENT000450). The 50-mile (80-km) SAMA analysis polar grid indicates that only *one* of eighty 22.5-degree sector elements (1.8% of the total SAMA grid area) meets Dr. Lemay's definition of *hyper-urban* (10,000 persons per km<sup>2</sup>), and that 68 of the remaining grid elements (81.5% of the total SAMA grid area) would not meet the definition of an urban area. *Id.* at 120 (A145).

<sup>&</sup>lt;sup>562</sup> Id. at 119 (A144); Oct. 18, 2012 Tr. at 2125:17-21 (O'Kula) ("The reality is that if an area is contaminated with[in] a building that the building would be monitored or surveyed first so that the priorities would be set for the clean-up. All surfaces would not be bulk decontaminated blindly.").

<sup>&</sup>lt;sup>563</sup> Oct. 18, 2012 Tr. at 2126:14 (O'Kula).

<sup>&</sup>lt;sup>564</sup> *Id.* at 2130:8-15 (Bixler); NRC Staff Testimony at 83 (A74) (NRC000041).

<sup>&</sup>lt;sup>565</sup> NRC Staff Testimony at 82 (A73) (NRC000041).

balance of the MACCS2 estimate of contamination and to evaluate the effect of the two largest multipliers (for building walls and building interiors) used by Dr. Lemay in his calculation.<sup>566</sup> The ISR values for this estimate are shown in Table 7 of the ISR Report.<sup>567</sup>

197. When Mr. Jones input his adjusted values into Table 7 of the ISR Report, he obtained an estimated decontamination cost \$23,631 per person for heavy decontamination (DF = 15), which is nearly *four times* less than Dr. Lemay's original value of \$89,734.<sup>568</sup> He reduced that number by another 29 percent based on the fact that 29 percent of the land area is not urban or semi-urban.<sup>569</sup> The final value of \$16,778 per person, which Mr. Jones calculated using the CONDO data but accounting for mass conservation, is reasonably close to Entergy's decontamination value of \$13,824 per person for a DF of 15.<sup>570</sup>

198. Based on his review of Dr. Lemay's spreadsheets and Mr. Jones' testimony, Dr. O'Kula concurred that if Dr. Lemay's values are correctly "renormalized" to account for mass conservation and the non-uniform nature of contamination within a building, then those values would be much closer in value to the CDNFRM values used in the IPEC SAMA analysis.<sup>571</sup>

<sup>566</sup> *Id.* 

<sup>569</sup> *Id.* 

<sup>&</sup>lt;sup>567</sup> ISR Report at 21 (NYS000242).

<sup>&</sup>lt;sup>568</sup> NRC Staff Testimony at 82 (A73) (NRC000041)

<sup>&</sup>lt;sup>570</sup> *Id.* at 82-83 (A73).

<sup>&</sup>lt;sup>571</sup> Oct. 18, 2012 Tr. at 2365:7-16 (O'Kula). Dr. O'Kula stated that he had taken an "informal look" at Dr. Lemay's CONDO and Risø decontamination cost values, and that when he renormalized the surface factors for internal walls and exterior walls to make them more realistic, the values "became much like those applied in the Entergy SAMA analysis." *Id.* at 2366:5-12 (O'Kula). At the hearing, New York counsel requested that Entergy disclose any spreadsheets or analyses documenting Dr. O'Kula's aforementioned review. Oct. 18, 2012 Tr. at 2384:9-18 (Liberatore). Entergy disclosed and produced a copy of a spreadsheet prepared by Dr. O'Kula as an interim disclosure on November 30, 2012. *See* Entergy Disclosure No. 9432, CONDO and RISO Spreadsheet, prepared by Dr. Kevin O'Kula (Oct. 2012). Entergy also listed Dr. O'Kula's spreadsheet in its Forty-Sixth Supplemental Disclosure Log transmitted to the parties on December 5, 2012.

199. In summary, the Board finds that the ISR Approach C decontamination cost estimation methodology is fundamentally flawed because it overlooks the use of mass balance principles in the MACCS2 code. As a result, Dr. Lemay's proposed CDFRM values are neither reliable nor appropriate for use in the IPEC SAMA analysis.

### 4. Risø Report (ISR Approach D)

200. In ISR Approach D, Dr. Lemay repeated the methodology used in ISR Approach C, but substituted decontamination cost values obtained from a 1995 report prepared by Denmark's Risø National Laboratory for the costs reported in the CONDO dataset.<sup>572</sup> For this approach, Dr. Lemay chose decontamination techniques from the Risø Report that most closely correlated to those selected in the CONDO analysis.<sup>573</sup> For each type of area (hyper-urban, urban, semi-urban), the fraction of land covered by a given type of surface was taken from the CONDO spreadsheet, and the cost per km<sup>2</sup> was calculated using the Risø values.<sup>574</sup> The rest of the cost evaluation used the same methodology as the CONDO analysis described above.<sup>575</sup> Claiming that the Risø techniques are recommended only for "light" decontamination, Dr. Lemay did not use the Risø data to calculate a CDNFRM value for heavy decontamination.<sup>576</sup>

201. The Board finds that ISR Approach D does not provide CDNFRM values that are appropriate for use in a SAMA analysis. Regardless, it is clear that Dr. Lemay simply

<sup>&</sup>lt;sup>572</sup> New York Direct Testimony at 46:963-67 (NYS000241). The RISO report provides a catalog of feasible techniques for reduction of dose 9 years after the Chernobyl accident. NRC Staff Testimony at 88 (A79) (NRC000041). The report was based on experimental work that was followed by field trials in contaminated areas of Russia, Belarus, and the Ukraine and lists strippable (peelable) coatings with a DF up to 30. *Id*.

<sup>&</sup>lt;sup>573</sup> New York Direct Testimony at 46:970-72 (NYS000241).

<sup>&</sup>lt;sup>574</sup> *Id.* at 46:972-75.

<sup>&</sup>lt;sup>575</sup> *Id.* at 46:976-77.

<sup>&</sup>lt;sup>576</sup> Id. at 46:978-80. As Dr. O'Kula and Mr. Teagarden noted, the Risø Report does list a DF greater than 100 for the vacuum cleaning and changing of wall paper process, and a DF = 28 for the cutting or removal of the soil layer. Entergy Testimony at 122 (A149) (citing Risø Report at 24, 32 (NYS000251)). These DFs correspond to heavy decontamination, as defined in the ISR Report. *Id.* 

substituted Risø cost data for CONDO cost data and maintained the area-specific values derived from the CONDO study.<sup>577</sup> As such, ISR Approach D is based on the same flawed methodology and assumptions underlying the ISR Approach C (CONDO) cost estimate.<sup>578</sup> Dr. Lemay thus again failed to account for mass conservation principles (as applied in MACCS2) and the non-uniform nature of contamination within a building.<sup>579</sup> For that reason alone, the ISR Approach D decontamination cost values cannot be deemed reliable as a technical matter or more appropriate than Entergy's CDNFRM values.

### G. <u>The TIMDEC Values Used as Inputs to the IPEC SAMA Analysis Have an</u> Established Technical Basis and Are "Rationally Related" to the IPEC Site

202. New York also asserted that Entergy's TIMDEC values (60 days for a DF of 3 and 120 days for DF of 15) are not "rationally related" to the IPEC site.<sup>580</sup> Dr. Lemay asserted that those values are "unreasonable" in view of the Chernobyl and Fukushima accidents.<sup>581</sup> He stated that decontamination of the area affected by the Chernobyl accident took four years and included the decontamination of tens of thousands of buildings in the most contaminated cities and villages of the former USSR.<sup>582</sup> With respect to Fukushima, Dr. Lemay noted that "some estimates suggest that the decontamination could last for decades."<sup>583</sup>

203. The Board recognizes the severity of the Chernobyl and Fukushima accidents and the magnitude of the resulting cleanup efforts.<sup>584</sup> However, our task is to assess the

<sup>&</sup>lt;sup>577</sup> Entergy Testimony at 122 (A149) (ENT000450).

<sup>&</sup>lt;sup>578</sup> *Id*.

<sup>&</sup>lt;sup>579</sup> NRC Staff Testimony at 78 (A69), 83 (A74) (NRC000041).

<sup>&</sup>lt;sup>580</sup> New York Position Statement at 31 (NYS000240).

<sup>&</sup>lt;sup>581</sup> New York Direct Testimony at 54:1123-27 (NYS000241).

<sup>&</sup>lt;sup>582</sup> *Id.* at 52:1080-84, 54:1117-22.

<sup>&</sup>lt;sup>583</sup> *Id.* at 53:1089-90.

<sup>&</sup>lt;sup>584</sup> As Mr. Teagarden noted, the Fukushima accident was extraordinary event that resulted from the fourth largest earthquake in the last 100 years and a resultant tsunami that impacted a large region. It a severe reactor accident caused by an external event. Oct. 18, 2012 Tr. at 2210:1-5 (Teagarden).

reasonableness of Entergy's decontamination time and cost assumptions under NEPA, as reflected in specific inputs to the MACCS2 code and within the well-established framework of a SAMA analysis and applicable NRC guidance. The SAMA analysis examines the mean annual consequences of various hypothesized accident scenarios, spanning a spectrum of potential initiating events, accident sequences, and severity of consequences—and for the entire 50-mile radius region surrounding a plant.<sup>585</sup> It does not endeavor to "exactly mimic a real-life scenario."<sup>586</sup> Nor does a SAMA analysis attempt to model highly localized and variable decontamination activities or provide highly detailed cleanup costs associated with a single, specific accident such as Chernobyl or Fukushima.<sup>587</sup>

204. In MACCS2, the decontamination time variable—TIMDEC—represents the time period during which persons are temporarily interdicted (*i.e.*, kept away from their residences) while decontamination activities are completed to reduce the dose by the specified dose reduction factor.<sup>588</sup> Following the expiration of the TIMDEC period, and upon satisfaction of the specified habitability criteria, MACCS2 models the relocation of persons back to their residences.<sup>589</sup> Thus, TIMDEC establishes the minimum time that an individual is relocated due to dose constraints.<sup>590</sup>

<sup>&</sup>lt;sup>585</sup> See Entergy Testimony at 18 (A31) (ENT000450).

<sup>&</sup>lt;sup>586</sup> Oct. 18, 2012 Tr. at 2189:13-20 (Teagarden) ("So there's this element of MACCS [that] looks at these strategies together in the time frames that are represented are not meant to exactly mimic or the order is not meant to exactly mimic a real-life scenario. It's meant to put these strategies together in a way that can computationally be addressed in a manner for -- in a probabilistic manner where averages are in view.").

<sup>&</sup>lt;sup>587</sup> See NRC Staff Testimony at 90 (A81) ("As with any modeling effort, it is likely that an actual decontamination effort would depart from the modeled inputs based on the extent of the accident, environmental conditions during the clean-up, and actual resources expended during the clean-up.").

<sup>&</sup>lt;sup>588</sup> Entergy Testimony at 77 (A102) (ENT000450); Oct. 17, 2013 Tr. at 2240:10-15 (Teagarden) ("TIMDEC represents the time that individuals are maintained away from their residence while decontamination activities are occurring. The costs accrue during this time while the individuals are away, such that it establishes a cost basis.").

<sup>&</sup>lt;sup>589</sup> Entergy Testimony at 77 (A102) (ENT000450).

<sup>&</sup>lt;sup>590</sup> *Id.* 

205. MACCS2 requires users to input a decontamination time for each level of decontamination effectiveness modeled.<sup>591</sup> The TIMDEC parameter defines the time required for completion of each of the user-selected decontamination levels.<sup>592</sup> Thus, with two levels modeled in the IPEC SAMA analysis, two decontamination times are required: one for the lower DF, and one for the higher DF.<sup>593</sup> As noted above, Entergy used an input of 60 days for a DF of 3, and 120 days for DF of 15.<sup>594</sup> These values are the same values used in NUREG-1150.<sup>595</sup>

206. Entergy's and the NRC Staff's experts discussed the historical and technical bases for the DF and TIMDEC values used in NUREG-1150, as well as in the IPEC SAMA analysis.<sup>596</sup> Mr. Harrison and Dr. Ghosh noted that the NRC has been examining the decontamination times for over 37 years, beginning in 1975 with the Reactor Safety Study, which discussed decontamination activities that are capable of restoring areas to habitability quickly given sufficient resources.<sup>597</sup> They further stated (as did Dr. O'Kula and Mr. Teagarden) that the genesis of the values used by Entergy can be traced back to NUREG/CR-3673.<sup>598</sup>

207. NUREG/CR-3673 identified an average effort required to restore habitability to an area after the most severe type of reactor accident; *i.e.*, an "SST1" accident source term as defined in the 1982 Sandia Siting Study (ENT000453).<sup>599</sup> It states an average clean-up was

<sup>&</sup>lt;sup>591</sup> *Id.* at 72 (A94).

<sup>&</sup>lt;sup>592</sup> *Id.* at 72 (A93) (citing NUREG/CR-6613, Vol. 1 at 7-10 (NYS000243)).

<sup>&</sup>lt;sup>593</sup> *Id.* at 72 (A94).

<sup>&</sup>lt;sup>594</sup> Id. (citing Entergy Calculation No. IP-CALC-09-00265, Rev. 0, Re-analysis of MACCS2 Models for IPEC, Attach. A.1 at 38 & Attach. A.2 at 38 (Dec. 2, 2009) (ENT000464)).

<sup>&</sup>lt;sup>595</sup> *Id.* at 72 (A95).

<sup>&</sup>lt;sup>596</sup> See id at 80-88 (A105-A109); NRC Staff Testimony at 89-90 (A81) (NRC000041).

<sup>&</sup>lt;sup>597</sup> NRC Staff Testimony at 89 (A81) (NRC000041).

<sup>&</sup>lt;sup>598</sup> *Id.* at 90 (A81); Entergy Testimony at 80 (A105) (ENT000450).

<sup>&</sup>lt;sup>599</sup> NRC Staff Testimony at 90 (A81) (NRC000041) (citing NUREG/CR-3673 at 6-24 to 6-25 (NRC000058)). NUREG/CR-3673 states that the SST1 – SST3 accident source terms were defined in the 1982 Sandia Siting Study to represent the range of potential release of radioactive materials resulting from core-melt sequences with containment failure. The SST1 release category included accidents that result in containment failure due
expected to take 90 days with approximately 46,000 workers (11,000 person-years of effort) for this most severe type of reactor accident.<sup>600</sup> Thus, the report cites this period as an *average* time to complete decontamination efforts following the most severe type of reactor accident.<sup>601</sup> Less severe accidents, including ones that may result in little clean-up being required, may take less time or involve fewer resources.<sup>602</sup> In either situation, NUREG/CR-3673 identified the average time to complete decontamination efforts to be about 90 days or less for severe reactor accidents.<sup>603</sup> NUREG-1150 adopted 60-day and 120-day values for DF = 3 and DF = 15, respectively.<sup>604</sup>

208. Mr. Harrison and Dr. Ghosh testified that to provide a reliable and reasonable analysis, the decontamination time inputs to MACCS2 must represent *all* of the modeled severe accidents, including ones that require little decontamination.<sup>605</sup> This is a reasonable approach, especially in the context of a SAMA analysis, which is a probabilistic, time- and spatially-averaged analysis that considers "a multitude of clean-up scenarios."<sup>606</sup>

209. In his rebuttal testimony, Dr. Lemay argued that "the assumptions made in NUREG/CR-3673 are unreasonable for a severe accident at [IPEC]."<sup>607</sup> According to Dr. Lemay's calculations, applying the NUREG/CR-3673 methodology to the decontamination cost calculated by Entergy for the "Early High" release category at IP2 led him to conclude that

<sup>602</sup> NRC Staff Testimony at 90 (A81) (NRC000041).

<sup>603</sup> *Id.* 

- <sup>604</sup> See Entergy Testimony at 80-85 (A105) (ENT000450).
- <sup>605</sup> NRC Staff Testimony at 90 (A81) (NRC000041).

to rapid overpressurization and release of a large fraction of the core inventory to the environment. NUREG/CR-3673 at 2-10 (NRC000058).

<sup>&</sup>lt;sup>600</sup> NRC Staff Testimony at 90 (A81) (NRC000041).

<sup>&</sup>lt;sup>601</sup> Id. Dr. Lemay agreed that the TIMDEC value is intended to be average value. See Oct. 18, 2012 Tr. at 2181:8-9 (Lemay) ("At the end of this average decontamination period, people are allowed back to their homes.").

<sup>&</sup>lt;sup>606</sup> See Oct. 18, 2012 Tr. at 2139:11-12 (Teagarden); NRC Staff Testimony at 90 (A81) (NRC000041).

<sup>&</sup>lt;sup>607</sup> New York Rebuttal Testimony at 22:11-12 (NYS000420).

1.5 million workers (363,000 worker-years) would be required to decontaminate the affected area in 90 days.<sup>608</sup> Dr. Lemay further asserted that even assuming decontamination occurred over a full year, 363,000 workers would still be required to complete decontamination within that period.<sup>609</sup> Therefore, he claimed, "the assumptions regarding the timeline in NUREG/CR-3673 are invalid,<sup>610</sup> because a decontamination effort requiring "anything over 100,000 to 150,000 people is not reasonable."<sup>611</sup>

210. However, as Dr. O'Kula explained, a SAMA analysis considers a broad spectrum of release categories, including those that involve minimal or no failure of the containment (and thus lower accident source terms).<sup>612</sup> It is not concerned only with the most severe release category; *i.e.*, the "Early High" release category singled out by Dr. Lemay in his testimony.<sup>613</sup>

211. Moreover, there are frequencies associated with each release category, and the lower release categories make up a significant portion of the overall release frequency.<sup>614</sup> In effect, by focusing on the "Early High" release category in his decontamination worker calculation, Dr. Lemay applied a worst-case assumption.<sup>615</sup> Accounting for the full spectrum of release categories and frequencies considered in the IPEC SAMA analysis, Mr. Teagarden and Dr. O'Kula estimated that the "average" number of decontamination workers would be

<sup>&</sup>lt;sup>608</sup> See id. at 22:17-21; see also Oct. 18, 2012 Tr. at 2112:19-2114:14, 2186:4-12 (Lemay).

<sup>&</sup>lt;sup>609</sup> New York Rebuttal Testimony at 23:4-7 (NYS000420); *see also* Oct. 18, 2012 Tr. at 2112:19-2113:15 (Lemay).

<sup>&</sup>lt;sup>610</sup> New York Rebuttal Testimony at 23:2-3 (NYS000420); *see also* Oct. 18, 2012 Tr. at 2186:4-12 (Lemay).

<sup>&</sup>lt;sup>611</sup> Oct. 18, 2012 Tr. at 2114:6-9 (Lemay).

<sup>&</sup>lt;sup>612</sup> *Id.* at 2153:24-2155:3 (O'Kula) ("So the basis of the SAMA analysis is to reflect on a spectrum of potential source terms, model each one randomly in terms of the meteorological conditions. . . . A minor, small portion of those may make it as far as the New York City metropolitan area. Many others would not.").

<sup>&</sup>lt;sup>613</sup> See id. at 2196:21-24 (Lemay) ("So I would argue that we can't average the time it takes to decontaminate a trivial or benign accident with the time it takes to decontaminate these more severe accidents.").

<sup>&</sup>lt;sup>614</sup> *Id.* at 2190:23-2191:2 (Teagarden).

<sup>&</sup>lt;sup>615</sup> See id. at 2184:23-24 (Lemay) ("What I would like you to note is that early high is worse than Fukushima."). See also id. at 2196:14-16 (Lemay) (noting that the "Early High" release category accounts for over 60 percent of the calculated OECR).

approximately 60,000 to 80,000 people, the number of people "that would fill Yankee Stadium on any given Sunday."<sup>616</sup>

212. In further defending Entergy's TIMDEC values, Dr. O'Kula and Mr. Teagarden explained that NUREG/CR-3673 focused on the need to restore areas to habitability quickly and cost-effectively.<sup>617</sup> They explained that the MACCS2 decontamination/economic models are based on a "staged implementation" of offsite population protective measures in post-accident situations (*i.e.*, relocation, decontamination, interdiction, condemnation), and focus on achieving a decontamination level that is both cost-effective and feasible.<sup>618</sup> This is reflected in NUREG/CR-3673, which states that "the most effective approach is to complete decontamination of those areas which can be restored to acceptable levels as quickly as possible."<sup>619</sup>

213. Dr. O'Kula and Mr. Teagarden further explained that this staged approach to decontamination and re-habitation of interdicted areas always has been part of the MACCS/MACCS2 code logic,<sup>620</sup> and that the NUREG-3673/CR authors viewed the staged implementation of post-accident protective measures as providing more reasonable cost

<sup>&</sup>lt;sup>616</sup> *Id.* at 2191:2-6 (Teagarden).

<sup>&</sup>lt;sup>617</sup> Entergy Testimony at 86-87 (A107) (ENT000450). In MACCS2, habitability decisionmaking can result in four possible outcomes: (1) land is immediately habitable; (2) land is habitable after decontamination; (3) land is habitable after decontamination and interdiction ; or (4) land is not deemed habitable after 30 years of interdiction (*i.e.*, it is condemned). Land also is condemned if the cost of decontamination exceeds the value of the land. *See id.* at 37-40 (A51).

<sup>&</sup>lt;sup>618</sup> See id. at 80-87 (A105-06).

<sup>&</sup>lt;sup>619</sup> NUREG/CR-3673 at 4-19 (ENT000466).

<sup>&</sup>lt;sup>620</sup> See Entergy Testimony at 85-86 (A106) (ENT000450) (citing NUREG/CR-4691, Vol. 1, MELCOR Accident Consequence Code System (MACCS Version 1.4), Volume I, User's Guide (Draft Version) (July 15, 1987) (ENT000467); Allonso and Gallego, Cost-Effectiveness Analysis of Countermeasures Using Accident Consequence Assessment Models, 21 *Rad. Prot. Dosimetry* 151-58 (1987) (ENT000468)).

estimates.<sup>621</sup> Thus, the assumption that decontamination activities will be performed in an expedited manner is integral to the MACCS2 decontamination and interdiction model.<sup>622</sup>

214. For these reasons, Dr. O'Kula and Mr. Teagarden concluded that NUREG/CR-3673 and NUREG-1150 (including its supporting technical bases in NUREG/CR-4551) support the conclusion that the two decontamination levels (DFs) and times (TIMDEC) defined in the IPEC SAMA analysis are appropriate to model early efforts within days to weeks after plume deposition, and before weathering and human activities (planned and inadvertent) affect the distribution of the contamination.<sup>623</sup> They explained that the decontamination levels and times applied in the IPEC SAMA analysis are consistent with the limited time available for effective use of decontamination techniques and, and are technically justified within the context of a SAMA analysis, which uses probabilistic methods and cost-benefit analysis techniques.<sup>624</sup> Dr. O'Kula and Mr. Teagarden recognized that in the event of an actual severe accident, decontamination activities could extend over longer periods, and noted that the TIMDEC variable is not intended to represent the physical cessation of all decontamination activities following a severe accident.<sup>625</sup>

<sup>&</sup>lt;sup>621</sup> NUREG/CR-3673 at 4-6 (ENT000466).

<sup>&</sup>lt;sup>622</sup> Entergy Testimony at 15 (A26), 88 (A109) (ENT000450).

<sup>&</sup>lt;sup>623</sup> See Oct. 18, 2012 Tr. at 2186:20-2187:7 (Teagarden) ("The Indian Point analysis used the values used in NUREG-1150 and the justification would be that they were used in the seminal document of NUREG-1150 and also in recognition of how MACCS2 looks at TIMDEC in comparison with other mitigating strategies such as extended interdiction, which is another means of achieving a dose reduction that can be implemented within MACCS ...."); see also id. at 2211:1-2 (Teagarden) ("[T]he values Entergy chose were consistent with NUREG-1150."); id. at 2240:20-2241:1 (Teagarden) ("[W]e used the NUREG-1150 basis for those values. We believe that's appropriate because of the way that MACCS models TIMDEC in conjunction with evaluating the potential for extended interdiction, for the more severe cases where there could be contamination.").

<sup>&</sup>lt;sup>624</sup> Entergy Testimony at 86-87 (A107) (ENT000450).

<sup>&</sup>lt;sup>625</sup> *Id.* at 88 (A109). In this regard, Dr. O'Kula and Mr. Teagarden noted that continued decontamination activities following population resettlement as modeled by TIMDEC is not incongruous with other code assumptions or actual post-accident decontamination experience. *Id.* at 77-78 (A102).

215. Further, we assume that if the Commission expected licensees to use new values in their SAMA analyses as a result of Fukushima or Chernobyl, it would have issued such guidance on a generic basis, but it has not. The Chernobyl accident occurred in 1986, over 25 years ago, and the NRC has not issued any guidance on decontamination time frames since then. Nor has the Commission issued any NEPA-related guidance as a result of Fukushima, which leads the Board to believe that values consistent with NUREG-1150 are acceptable.<sup>626</sup>

216. In conclusion, based on the parties' testimony and evidence, and our understanding of how the TIMDEC input is used in MACCS2, the Board finds that Entergy's two decontamination factors (DF = 3 and DF = 15) and the associated decontamination times (60 and 120 days) are reasonable under NEPA standards. These values are consistent with the NUREG-1150 values and have been applied in Level-3 type PRA analyses (including SAMA analyses and the SOARCA project) for many years. The TIMDEC values used in the IPEC SAMA analysis were designed to be "average" values that reflect the entire spectrum of severe accident scenarios examined in a SAMA analysis, which ultimately calculates mean average offsite dose and economic consequences over an approximately 7,800 square mile region.

# H. <u>New York's Proposed Alternative TIMDEC Values Are Not Reasonable or</u> <u>Appropriate for Use in a SAMA Analysis</u>

217. In addition to alternative CDNFRM values, Dr. Lemay proposed TIMDEC values

ranging from 2 to 30 years, which are substantially larger than the values used in NUREG-1150

<sup>&</sup>lt;sup>626</sup> In contrast, the Commission has issued safety-related directives in response to Fukushima. As noted in a recent First Circuit decision concerning the Pilgrim nuclear power plant, in March 2012, the NRC issued three orders to the industry implementing the recommendations of a task force chartered by the NRC to conduct a methodical and systematic review of the NRC's processes and regulations to determine whether the agency should make additional improvements to its regulatory system in light of the events at Fukushima. *Massachusetts v. NRC*, 708 F.3d 63, slip op. at 13-14 (1st Cir. 2013). In addition, the court rejected the petitioner's argument that the NRC had acted arbitrarily and capriciously by failing to supplement the Pilgrim FSEIS as a result of Fukushima, concluding that the NRC had taken the requisite "hard look" at the lessons from Fukushima. *Id.* at 17-18.

and the IPEC SAMA analysis.<sup>627</sup> As an initial matter, his proposed values are so large that they are outside the accepted input range of the MACCS2 code, which allows a maximum TIMDEC value of one year.<sup>628</sup> Consequently, Dr. Lemay again needed to alter the MACCS2 source code to accept his much larger TIMDEC values.<sup>629</sup> Dr. O'Kula and Mr. Teagarden maintained that altering the MACCS2 source code without an independent verification of proper code functionality is ill-advised and counter to standard industry configuration control and software quality assurance practices.<sup>630</sup> Even putting that concern aside, the Board finds it unreasonable to expect applicants like Entergy to self-modify the MACCS2 code, particularly given the Commission's recent characterization of MACCS2 as the standard, NRC-endorsed tool for SAMA analyses.<sup>631</sup>

218. The Board also agrees with Entergy's witnesses (Dr. O'Kula and Mr. Teagarden) and the NRC Staff's witnesses (Mr. Harrison and Dr. Ghosh) that alternative decontamination times proposed by Dr. Lemay are inconsistent with the MACCS2 code's integral decontamination and interdiction modeling assumptions.<sup>632</sup> Dr. O'Kula and Mr. Teagarden convincingly testified that forcing a long decontamination period (*e.g.*, beyond a year) in the MACCS2 analysis via the TIMDEC variable—as done by Dr. Lemay—distorts the code's "dose reduction resettlement optimization strategy."<sup>633</sup> By design, MACCS2 will not model the relocation of persons back to their residences until TIMDEC expires. Therefore, an artificially

<sup>632</sup> Entergy Testimony at 77-80 (A102-03) (ENT000450); NRC Staff Testimony at 89-90 (A81) (NRC000041).

<sup>&</sup>lt;sup>627</sup> See New York Direct Testimony at 54:1123-55:1134 (NYS000241); ISR Report at 24-25 (NYS000242).

<sup>&</sup>lt;sup>628</sup> Entergy Testimony at 73 (A97-98) (ENT000450).

<sup>&</sup>lt;sup>629</sup> *Id.* at 73 (A98).

<sup>&</sup>lt;sup>630</sup> *Id.* at 74-75 (A99-100).

<sup>&</sup>lt;sup>631</sup> See Pilgrim, CLI-12-15, slip op. at 3 ("The NRC has endorsed use of the MACCS2 Accident Consequence Analysis (MACCS2) code to calculate estimated offsite consequences"); see also Pilgrim, CLI-12-01, slip op. at 3 ("The NRC uses MACCS2 to evaluate the potential offsite consequences of severe nuclear reactor accidents, and NRC-endorsed guidance on SAMA analysis endorses use of the MACCS2 code.").

<sup>&</sup>lt;sup>633</sup> Entergy Testimony at 78 (A102) (ENT000450).

long TIMDEC period precludes proper modeling of the resettlement of interdicted persons following the cessation of decontamination activities. For example, if a value of 10 years is used for TIMDEC, then MACCS2 will not model the return of any affected individuals to their residences until 10 years have passed.<sup>634</sup> In reality, many individuals within the 50-mile radius SAMA analysis region would be able to return to their homes relatively quickly; *i.e.*, within days to months.<sup>635</sup>

219. Dr. Bixler agreed, and stated that using TIMDEC values exceeding the one-year maximum allowed by MACCS2 "defeats the logic in the code."<sup>636</sup> He reiterated that "one year was set as the upper bound, because the framework of the code was based on one year, not more than a year."<sup>637</sup> Dr. Bixler explained that, within the MACCS framework, applying TIMDEC values as large as 15 or 30 years causes property values to decrease to zero or almost zero.<sup>638</sup> This, in turn, precludes MACCS2 from modeling the successful decontamination of those properties (particularly for a DF of 15) and instead results in condemnation of the properties.

220. Dr. Bixler also explained that the TIMDEC and CDNFRM parameters are interrelated, and that MACCS2 analysts must consider that nexus in selecting input values.<sup>639</sup> Mr. Teagarden agreed, stating that the decontamination factor, cost, and time form a "suite of variables" that reflect how MACCS2 models decontamination,<sup>640</sup> and that the code user should not arbitrarily alter one of these variables without evaluating the impact of the change on the

<sup>&</sup>lt;sup>634</sup> *Id*.

<sup>&</sup>lt;sup>635</sup> *Id*.

<sup>&</sup>lt;sup>636</sup> Oct. 18, 2012 Tr. at 2201:17-20 (Bixler).

<sup>&</sup>lt;sup>637</sup> *Id.* at 2273:6-8 (Bixler).

<sup>&</sup>lt;sup>638</sup> *Id.* at 2201:6-20 (Bixler); *see also id.* at 2273:9-13 (Bixler).

<sup>&</sup>lt;sup>639</sup> *Id.* at 2200:15-2201:5, 2209:6-20 (Bixler).

<sup>&</sup>lt;sup>640</sup> See id. at 2227:8-16 (Teagarden) ("CDNFRM and TIMDEC are related to one another."); see also id. at 2247:10-14 (Teagarden) ("So [] the cost is linked to the time, which is linked to the dose reduction factor achieved.").

other, related variables.<sup>641</sup> As discussed above, it is clear that the DF, CDNFRM, and TIMDEC values used in NUREG-1150, the IPEC SAMA analysis, and the SOARCA study were, in fact, developed as a "suite" of parameters and designed to be consistent with the MACCS2 habitability decisionmaking model. The same cannot be said of Dr. Lemay's proposed CDNFRM and TIMDEC values, which are based on a "mixed bag" of sources and assumptions.

221. In summary, the Board finds that the challenged NUREG-1150 decontamination time (TIMDEC) values have an established technical pedigree and a long history of use in severe accident analyses applying the MACCS2 code. In contrast, Dr. Lemay's proposed decontamination time values are inconsistent with the MACCS2 code's internal logic, outside the accepted input range of the MACCS2 code, and at odds with actual decontamination experience. As Dr. O'Kula and Mr. Teagarden testified, the out-of-range values could be input only with modification of the MACCS2 code itself, and because the software was not independently verified, this questionable practice in itself renders any new output as highly suspect.<sup>642</sup> Furthermore, the Board concludes that it is not reasonable to expect license renewal applicants to modify the MACCS2 source code, especially for purposes of a NEPA assessment, especially given the testimony from the NRC and Entergy experts regarding the inter-related complexity of the code.

# I. <u>Entergy's Values for Other MACCS2 Economic Inputs Are Reasonable and</u> <u>Appropriate for Use in the IPEC SAMA Analysis</u>

222. As noted above, the evidentiary hearing focused on Entergy's CDNFRM and TIMDEC values given their acknowledged, much larger effect on the SAMA analysis results. However, the parties' testimony also discussed values for several other MACCS2 economic parameters: value of nonfarm wealth (VALWNF), relocation costs (POPCST), investment rate

<sup>&</sup>lt;sup>641</sup> *Id.* at 2248:5-9 (Teagarden); *see also id.* at 2269:15-22 (Teagarden).

<sup>&</sup>lt;sup>642</sup> Entergy Testimony at 75-76 (A100) (ENT000450).

of return (DSRATE), and fraction of nonfarm property due to improvements (FRNFIM). We briefly discuss each of these MACCS2 parameters below and conclude that Entergy's associated input values are reasonable under NEPA standards.

# 1. Value of Nonfarm Wealth (VALWNF)

223. Dr. Lemay asserted that Entergy's calculations of nonfarm wealth were "outdated since the values obtained from SECPOP2000 were not scaled up from 1997 values to 2004 values."<sup>643</sup> VALWNF defines the value of per capita nonfarm wealth in the region (expressed in dollars per person).<sup>644</sup> Nonfarm wealth includes all public and private property not associated with farming that would be unusable if it was rendered temporarily or permanently uninhabitable.<sup>645</sup>

224. Entergy developed estimates of the nonfarm wealth value for each county based upon fixed reproducible tangible wealth, a measure of the durable goods that are owned in an area.<sup>646</sup> It obtained county-specific values for nonfarm wealth data from the data set of the SECPOP2000 computer software.<sup>647</sup> SECPOP2000 was previously developed by Sandia for the NRC and calculates estimated population and economic data about any point (specified by longitude and latitude) that lies within the continental United States.<sup>648</sup>

225. To ensure that economic information pertaining to New York City was included in the analysis, Entergy combined the nonfarm property values for four counties within the metropolitan New York City region as a weighted average (weighted by population) and

<sup>&</sup>lt;sup>643</sup> New York Direct Testimony at 58:1208-09 (NYS000241).

<sup>&</sup>lt;sup>644</sup> Entergy Testimony at 50 (A68) (ENT000450).

<sup>&</sup>lt;sup>645</sup> *Id*.

<sup>&</sup>lt;sup>646</sup> *Id.* (citing Enercon MACCS2 Input Report at 5-5 to 5-6 (NYS00270A)).

<sup>&</sup>lt;sup>647</sup> Id.

<sup>&</sup>lt;sup>648</sup> NUREG/CR-6525, Rev. 1, SECPOP2000: Sector Population, Land Fraction, and Economic Estimation Program at iii, 5 (Aug. 2003) ("NUREG/CR-6525") (NYS000271).

assigned it to the Queens economic region.<sup>649</sup> Entergy then computed an average regional value of nonfarm wealth for the 50-mile radius area for use in the MACCS2 analysis.<sup>650</sup> This value was calculated as VNFRM weighted by the area that each of the twenty-eight counties has in the IPEC 50-mile radius area.<sup>651</sup> The original calculated baseline VALWNF value was \$163,631/person.<sup>652</sup>

226. Entergy later modified its original baseline VALWNF value. Specifically, after the initial analysis described above, Entergy estimated the impact of lost tourism and business as a sensitivity case in response to an NRC Staff RAL<sup>653</sup> To assess lost business, Entergy obtained measures of total economic activity by examining a suite of products related to the national Gross Domestic Product ("GDP"), which is a measure of the total value of goods and services produced in an area.<sup>654</sup> Mr. Teagarden testified that this calculation is not customarily done by NRC license renewal applicants and represents a conservatism in Entergy's SAMA analysis.<sup>655</sup>

227. The GDP per person values for 2004 were developed to estimate the total value of goods and services produced in the 50-mile radius area.<sup>656</sup> This essentially is all the items that were manufactured or produced in the area in 2004, plus "services" that produce economic

<sup>&</sup>lt;sup>649</sup> Entergy Testimony at 50 (A68) (ENT000450) (citing Enercon MACCS2 Input Report at 5-5 to 5-6 (NYS00270A)).

<sup>&</sup>lt;sup>650</sup> *Id*.

<sup>&</sup>lt;sup>651</sup> *Id.* (citing Enercon MACCS2 Input Report at 5-6 (NYS00270A)).

<sup>&</sup>lt;sup>652</sup> *Id.* (citing Enercon MACCS2 Input Report at 5-6 (NYS00270A)).

<sup>&</sup>lt;sup>653</sup> See February 2008 RAI Response, Attach. 1 at 25-26 (ENT000460); see also May 2008 RAI Response (ENT000477); FSEIS, Vol. 3, App. G at G-21, G-43, G-45 to G-46 (NYS00133I).

<sup>&</sup>lt;sup>654</sup> February 2008 RAI Response, Attach. 1 at 25 (ENT000460).

<sup>&</sup>lt;sup>655</sup> See Oct. 17, 2012 Tr. at 2030:15-22 (Teagarden).

<sup>&</sup>lt;sup>656</sup> Entergy Testimony at 51 (A69) (ENT000450).

activity in that year.<sup>657</sup> The modified VALWNF values, therefore, were a measure of the people's nonfarm wealth as well as a measure of their economic output.<sup>658</sup>

228. The average value of nonfarm wealth thus was developed based upon the most recent and complete economic dataset available at the time of the SAMA analysis for the counties within the 50-mile radius using the modified nonfarm wealth values.<sup>659</sup> The revised estimate of average nonfarm wealth value for the full 50-mile radius region was quantified as \$208,838/person, a factor of 1.28 increase from the original estimated value of \$163,631.<sup>660</sup>

229. Dr. Lemay correctly noted that Entergy did not scale up the 1997 SECPOP2000 values to 2005 values.<sup>661</sup> However, the Board finds that this omission is not material. As Entergy's experts explained, if the VALWNF value of \$163,631/person was escalated from 1997 to 2005 using the CPI as suggested in NEI 05-01, the increase factor would be 1.22 (*i.e.*, CPI value of 195.3 for 2005/CPI value of 160.5 for 1997).<sup>662</sup> The increase factor (1.28) associated with lost tourism and business applied by Entergy in its updated SAMA base case bounds that associated with escalating the VALWNF value from 1997 to 2005.<sup>663</sup> Therefore, we find that Entergy's VALWNF value is reasonable under NEPA and appropriate for use in the SAMA analysis.

# 2. Per Capita Costs of Relocation (POPCST)

230. POPCST represents the per capita removal cost for temporary or permanent relocation of population and businesses in a region rendered uninhabitable during the long-term

<sup>&</sup>lt;sup>657</sup> *Id.* at 51-52 (A69).

<sup>&</sup>lt;sup>658</sup> *Id.* at 52 (A69)

<sup>&</sup>lt;sup>659</sup> *Id.* (citing February 2008 RAI Response, Attach. 1 at 26 (ENT000460)).

<sup>&</sup>lt;sup>660</sup> *Id.*; Oct. 17, 2012 Tr. at 2030:12-13 (Teagarden).

<sup>&</sup>lt;sup>661</sup> New York Direct Testimony at 58:1207-09 (NYS000241).

<sup>&</sup>lt;sup>662</sup> See Entergy Testimony at 124 (A153) (ENT000450).

<sup>&</sup>lt;sup>663</sup> *Id*.

phase.<sup>664</sup> POPCST was developed in NUREG/CR-4551 with a value of \$5,000/person on the basis of per capita lost wages (\$14,600/person-year, national value) for 140 days (*i.e.*, twenty weeks).<sup>665</sup> Entergy escalated the POPCST value using the CPI to a value of \$8,640/person, which reflects per capita lost income of \$61.70/person-day (*i.e.*, \$8,640/person divided by 140 days).<sup>666</sup> MACCS2 applies this value to each individual relocated after a postulated severe accident, whether he or she is an adult or child, or is employed or unemployed. <sup>667</sup>

231. Dr. Lemay agreed with Entergy that the moving expenses would contribute very little to the cost of long-term relocation (because the majority of the personal belongings would be contaminated), but "felt that given current unemployment benefits policies in the State of New York, it seemed that 140 days of lost wages was too low."<sup>668</sup> He noted that New York State unemployment benefits normally last twenty-six weeks (182 days) and have recently been extended to ninety-three weeks (651 days).<sup>669</sup> Based on those assumptions, Dr. Lemay calculated the cost of long-term relocation by multiplying the 2005 average income per capita (\$76/day) by a range of durations for the lost wages. The resulting costs were \$10,640/person (for 140 days of lost wages) to \$49,857/person (for 93 weeks of lost wages).<sup>670</sup>

232. Mr. Teagarden and Dr. O'Kula viewed use of the New York State value rather than the national value as reasonable.<sup>671</sup> (Dr. Lemay's daily rate is approximately 23% higher

<sup>&</sup>lt;sup>664</sup> *Id.* at 97 (A121), 125 (A154).

<sup>&</sup>lt;sup>665</sup> *Id.* at 125 (A155) (citing NUREG/CR-4551, Vol. 2, Rev. 1, Pt. 7 at 5-3 (NYS000248)).

<sup>&</sup>lt;sup>666</sup> *Id.* Thus, for a household of three, the POPCST would provide \$25,920 (*i.e.*, \$8,640/person times three persons), reflecting a per-household lost income of \$185.10/day (*i.e.*, \$25,920 divided by 140 days).

<sup>&</sup>lt;sup>667</sup> Id.

<sup>&</sup>lt;sup>668</sup> New York Direct Testimony at 60:1247-49 (NRC000241).

<sup>&</sup>lt;sup>669</sup> *Id.* at 60:1250-52.

<sup>&</sup>lt;sup>670</sup> *Id.* at 60:1254-58.

<sup>&</sup>lt;sup>671</sup> Entergy Testimony at 126 (A157) (ENT000450).

than the value used by Entergy.)<sup>672</sup> However, with regard to the length of time that the workers are assumed out of work, they disagreed that the current, temporary term of unemployment benefits in New York State is an appropriate basis for comparison.<sup>673</sup> They testified that, in their expert opinions, historical unemployment durations provide a more reasonable basis.<sup>674</sup>

233. According to the Bureau of Labor Statistics ("BLS"), the median and average duration of unemployment in the U.S. in 2005 (the reference year for the SAMA economic inputs) was 8.9 weeks and 18.4 weeks, respectively.<sup>675</sup> Although these 2005 values may be lower than current values associated with the recession, these 2005 values are still higher than broader historical unemployment durations.<sup>676</sup> Based on BLS data from 1970 through 2010, the average unemployment duration over this 41-year time period is 15.5 weeks, with the average median duration being 7.9 weeks (approximately fifty-five days).<sup>677</sup>

234. Based on the BLS data, the Board agrees that Entergy's assumption of 20 weeks (*i.e.*, 140 days) is reasonable and, in fact, somewhat conservative. Further, based on the 41-year historical average, the duration value of twenty weeks used by the Entergy is 29% higher than the average value of 15.5 weeks.<sup>678</sup> As Mr. Teagarden and Dr. O'Kula explained, this conservatism in the loss of work duration appears to offset the regional lost income variation cited by Dr. Lemay.<sup>679</sup> Thus, the Board finds that Entergy's POPCST value reasonable under NEPA.

<sup>679</sup> *Id*.

<sup>&</sup>lt;sup>672</sup> Id.

<sup>&</sup>lt;sup>673</sup> *Id*.

<sup>&</sup>lt;sup>674</sup> *Id.* 

<sup>&</sup>lt;sup>675</sup> See Grant Teagarden, Unemployment Duration Calculation (Feb. 2012) (ENT000476).

<sup>&</sup>lt;sup>676</sup> Entergy Testimony at 126 (A157) (ENT000450).

<sup>&</sup>lt;sup>677</sup> *Id.* at 126-27 (A157).

<sup>&</sup>lt;sup>678</sup> *Id.* at 127 (A157).

# **3.** Investment Rate of Return (DSRATE) and Fraction of Nonfarm Property Due to Improvements (FRNFIM)

235. Entergy used NUREG-1150 values for the DSRATE and FRNFIM inputs to MACCS2.<sup>680</sup> As explained earlier in our decision, we view Entergy's reliance on NUREG-1150 values as reasonable. Furthermore, Dr. Lemay noted that the overall effect of using allegedly "more appropriate values" for the remaining sensitive parameters "was negligible" on the final cost calculation.<sup>681</sup> This is reflected in that fact Dr. Lemay's proposed values for DSRATE and FRNFIM (5-7%, and 90%, respectively) are comparable to those used by Entergy (12%, and 80%, respectively).<sup>682</sup> Therefore, the Board finds that Entergy's DSRATE and FRNFIM values are reasonable under NEPA and appropriate for use in the IPEC SAMA analysis.

# J. <u>New York Has Not Provided Sufficient Evidence to Conclude That There Are</u> <u>Additional Potentially Cost-Beneficial SAMAs, Especially In View of the</u> <u>Conservatisms Inherent in the IPEC SAMA Analysis</u>

236. The Board has thoroughly evaluated the technical bases for New York's claims and examined them through the lens of NEPA's "rule of reason." For the reasons set forth in Sections IV.D through IV.I above, New York has not identified a significant deficiency in the IPEC SAMA analysis that renders the analysis "altogether unreasonable under NEPA standards."<sup>683</sup> New York also has not proposed reasonable alternative inputs or methodologies that, if adopted, would lead to a "more accurate or meaningful" SAMA analysis.<sup>684</sup> Indeed, New York's proposed CDNFRM and TIMDEC values lack sufficient technical justification and significantly exceed the maximum values allowed by the MACCS2 code for those parameters.

<sup>&</sup>lt;sup>680</sup> *Id.* at 127 (158).

<sup>&</sup>lt;sup>681</sup> New York Direct Testimony at 61:1283-62:1286 (NYS000241).

<sup>&</sup>lt;sup>682</sup> Entergy Testimony at 128 (A159) (ENT000450).

<sup>&</sup>lt;sup>683</sup> *Pilgrim*, CLI-12-01, slip op. at 25.

<sup>&</sup>lt;sup>684</sup> *Seabrook*, CLI-12-05, slip op. at 28-29.

237. The Board also finds that New York has not identified a deficiency in the IPEC SAMA analysis that plausibly could alter the overall results in a material way.<sup>685</sup> This finding is bolstered by the significant conservatisms undergirding the SAMA analysis, as explained by the NRC Staff's and Entergy's experts. For example, as Dr. Ghosh explained, SAMA analyses typically use two multipliers on the internal benefit quantification in order to account for (1) external events and (2) analysis uncertainties.<sup>686</sup> The analysis uncertainties multiplier is typically based on the ratio of the 95th percentile CDF to the mean or point estimate CDF.<sup>687</sup> Any SAMAs that become cost beneficial after the use of these two multipliers are included as cost-beneficial.<sup>688</sup>

238. Entergy's use of mean consequence values also adds conservatism to the analysis, As Dr. Bixler explained, the distribution of Entergy's MACCS2 offsite consequence results is roughly a lognormal distribution; *i.e.*, the "mean value" is well above the median of the distribution.<sup>689</sup> The median is defined as the value for which the outcome is lower half of the time and for which it is greater half of the time, whereas the mean is simply the arithmetic average of all the outcomes.<sup>690</sup> Dr. Bixler testified that he evaluated Entergy's MACCS2 results and estimated that the mean results were generally between the 66th and 72nd percentiles.<sup>691</sup>

<sup>&</sup>lt;sup>685</sup> *Pilgrim*, CLI-12-15, slip op. at 13.

<sup>&</sup>lt;sup>686</sup> See NRC Staff Testimony at 22 (A14), 93 (A84) (NRC000041).

<sup>&</sup>lt;sup>687</sup> Id. at 22 (A14). Although the analysis uncertainties multiplier is typically estimated as the ratio of the 95th percentile CDF to the mean or point estimate CDF, this multiplier is meant to account for analysis uncertainties generally, not just uncertainties in the level 1 PRA. Id. at 93-94 (A84).

<sup>&</sup>lt;sup>688</sup> See id.

<sup>&</sup>lt;sup>689</sup> *Id.* at 29 (A23).

<sup>&</sup>lt;sup>690</sup> Id.

<sup>&</sup>lt;sup>691</sup> *Id.* A seventieth percentile result is one for which seventy percent of the outcomes are lower and thirty percent of the outcomes are higher. *Id.* 

This means that the SAMA analysis results are skewed in the direction of greater offsite dose and economic consequences.<sup>692</sup>

239. In their prefiled and oral testimony, Entergy and NRC Staff witnesses identified other conservatisms that we briefly mention here. They include Entergy's use of: (1) a deposition velocity that results in greater radionuclide deposition within the 50-mile SAMA analysis region;<sup>693</sup> (2) the projected population in year 2035, which is the last year of the IP3 period of extended operation and two years after the end of the IP2 period of extended operation;<sup>694</sup> (3) a "no-evacuation" assumption, which overestimates doses incurred in the early phase of potential accidents;<sup>695</sup> (4) two decontamination factors instead of the three permitted by MACCS2;<sup>696</sup> and (5) the results of a sensitivity case for lost tourism and business in the base case analysis.<sup>697</sup>

240. The significant conservatisms discussed above are manifest in the final SAMA analysis cost-benefit results. As Dr. Ghosh explained during the hearing, the theoretical benefit of actually implementing all of the IP2 and IP3 SAMAs identified by Entergy as potentially cost-beneficial would exceed the maximum attainable benefit (*i.e.*, eliminate the baseline risks of plant operation) for IP2 and IP3, and, in the case of IP2, eliminate the baseline risks twice over.<sup>698</sup> This reflects the fact that SAMA analysis is done on a per SAMA candidate basis, and

<sup>697</sup> Entergy Testimony at 124-25 (A153) (ENT000450).

<sup>&</sup>lt;sup>692</sup> See Oct. 18, 2012 Tr. at 2290:21-2291:23, 2293:6-21 (Ghosh).

<sup>&</sup>lt;sup>693</sup> See NRC Staff Testimony at 50 (A42-43) (NRC00041).

<sup>&</sup>lt;sup>694</sup> See Entergy Testimony at 48 (A65) (ENT000450); Oct. 17, 2012 Tr. at 1963:5-9 (Teagarden) ("[T]he industry guidance document, NEI 05-01, specifies that economic impacts should be baselined to the year of the analysis which is [2005]. Population is projected to a further date, 2035.")

<sup>&</sup>lt;sup>695</sup> Entergy Testimony at 35 (A49) (ENT000450) (citing FSEIS, Vol. 3, App. G at G-21 (NYS00133I)).

<sup>&</sup>lt;sup>696</sup> NRC Staff Testimony at 41 (A36) (NRC000041). MACCS2 allows the use of three DF values. *Id.* However, by using only two DFs, the IPEC SAMA analysis provides a level of conservatism, because for any area where a DF of 3 is not sufficient, the model jumps to a much higher DF of 15 (which costs much more to implement than a DF of 3). *Id. See also* Oct. 17, 2012 Tr. at 1988:20-89:8 (Teagarden).

<sup>&</sup>lt;sup>698</sup> Oct. 18, 2012 Tr. at 2163:10-2166:8 (Ghosh).

that many of the SAMA candidates are acting on the same accident sequences.<sup>699</sup> Therefore, as the lower-cost alternatives for mitigating the dominant accident sequences (*e.g.*, steam generator tube rupture) are implemented, the baseline risk, as recalculated, is reduced.<sup>700</sup> This reduces the likelihood that other SAMA candidates acting on the same accident sequences will remain, or become, potentially cost-beneficial.<sup>701</sup> Dr. Ghosh opined that the "existing margin" in the IPEC SAMA analysis can accommodate uncertainties of the type posited by New York relative to decontamination cost estimates.<sup>702</sup>

241. Dr. Ghosh's testimony is compelling, and provides further support for the Board's conclusion that New York has not shown that the IPEC SAMA analysis is unreasonable under NEPA standards, or that the alleged deficiencies in Entergy's decontamination-related inputs have masked the existence of additional cost-beneficial SAMAs.<sup>703</sup>

<sup>&</sup>lt;sup>699</sup> *Id.* at 2164:24-2165:1 ("There are multiple SAMAs that are already identified to mitigate the same types of accidents."); *id.* at 2223:11-21 (Ghosh).

<sup>&</sup>lt;sup>700</sup> Id. at 2165:21-2166:2 (Ghosh) ("The point I'm trying to make is that if you look at the existing list of candidates that are there and if you actually started to implement some of them, the incremental benefit of implementing additional SAMAs just goes down. And we can't completely eliminate the plant risk twice over.")

<sup>&</sup>lt;sup>701</sup> Id. at 2224:22-2225:2 (Ghosh) ("[W]e don't believe we're going to come up with any more SAMAs that would be potentially cost beneficial and that they would be cheaper alternatives to mitigating the same types of accidents that were already looking at mitigating with the list that we have."); see also id. at 2235:19-2236:8 (Ghosh) ("[I]t's hard to imagine that they would really become cost beneficial since there is already alternatives on the table to mitigate those same types of accident sequences.").

<sup>&</sup>lt;sup>702</sup> *Id.* at 2235:5-10 (Ghosh) ("You're right that my fundamental point is that the ISR New York State analysis introduces some uncertainty and into particular elements of the benefit calculation. And I believe that the existing margin in the analysis can accommodate this uncertainty already.").

<sup>&</sup>lt;sup>703</sup> In establishing the SAMA analysis requirement in 1996, the Commission concluded that it is unlikely that site-specific SAMA evaluations would identify major plant design changes or modifications as being cost-beneficial. *See* Final Rule, Environmental Review for Renewal of Nuclear Power Plant Operating Licenses, 61 Fed. Reg. 28,467, 28,481 (June 5, 1996) (NYS000127). In view of plant enhancements identified and implemented as part of the NRC's industry-wide IPE program, the Commission expected that any additional plant enhancements identified by license renewal SAMA analyses as cost-beneficial "generally would be procedural and programmatic fixes, with any hardware changes being only minor in nature and few in number." *Id.* Entergy has identified a substantial number of SAMA candidates—some involving major plant modifications—as potentially cost-beneficial. This further reflects the conservatisms inherent in the IPEC SAMA analysis and supports our conclusion that the analysis is reasonable under NEPA standards.

#### V. <u>SUMMARY FINDINGS OF FACT AND CONCLUSIONS OF LAW</u>

242. Based upon a review of the entire record of this proceeding and the parties' proposed findings of fact and conclusions of law, and based upon the findings set forth above, which are supported by reliable, probative, and substantive evidence in the record, the Board has decided all matters in controversy in NYS-12C in favor of Entergy and the NRC Staff.

243. Regarding the Staff's obligations under NEPA, the Board finds that the NRC Staff has independently reviewed Entergy's SAMA analysis, including Entergy's economic inputs to the MACCS2 code. The Board concludes that the Staff is justified in relying upon Entergy's data, modeling assumptions, and SAMA analysis results in meeting its obligation under NEPA to provide a reasonably complete discussion of possible mitigation measures.<sup>704</sup>

244. The Board also concludes that the NRC Staff has provided a reasoned evaluation of whether and to what extent the issues raised in NYS-12C credibly could or would alter the Entergy's SAMA analysis conclusions on which SAMAs are cost-beneficial to implement.<sup>705</sup> With respect to New York's challenge to Entergy's MACCS2 economic and decontamination cost inputs, we find that the overwhelming preponderance of the evidence demonstrates:

245. Entergy's SAMA analysis is principally based on plant-, site-, and region-specific data. Entergy's use of certain standardized economic and decontamination cost inputs found in MACCS2 Sample Problem A is not arbitrary or unreasonable. The challenged inputs are derived from the NRC's landmark NUREG-1150 study and have been subject to extensive peer reviews. The NUREG-1150 values thus have a well-established technical pedigree that is widely recognized and accepted by the PRA community and continue to be used in licensee PRA and

<sup>&</sup>lt;sup>704</sup> *Robertson*, 490 U.S. at 352.

<sup>&</sup>lt;sup>705</sup> *Pilgrim*, CLI-10-22, 72 NRC at 208.

SAMA analyses and state-of-the-art NRC severe accident analyses. Accordingly, use of the values in the IPEC SAMA analysis is reasonable under NEPA standards.

246. There is no technical justification for New York's claim that the IPEC SAMA analysis assumed unrealistically large radionuclide particles and that accounting for smaller particle sizes would have resulted in greater cleanup costs. To the contrary, the record evidence shows that Entergy used a conservative deposition velocity value that results in greater modeled deposition, and thus, higher assumed cleanup costs within the 50-mile radius SAMA analysis region.

247. The nonfarm decontamination cost (CDNFRM) inputs used in the IPEC SAMA analysis are reasonable for the IPEC region because they are based on levels of contamination and population rather than upon the region in which the contamination occurs. By applying the CDNFRM values on a per-person basis, MACCS2 accounts for the region-specific population, including the high population density of New York City and its correspondingly higher building density. These values are consistent with the NUREG-1150 values and have been applied in Level 3-type PRA analyses (including SAMA analyses and the SOARCA project) for many years.

248. The two decontamination factors (DF = 3 and DF = 15) and the associated decontamination time (TIMDEC) values (60 and 120 days) used in the IPEC SAMA analysis are reasonable for use in a SAMA analysis because they are, by design, "average" values intended to reflect the full spectrum of severe accident scenarios examined in a SAMA analysis. They also reflect the objective, as integral to the MACCS2 code logic, of restoring areas to habitability quickly and cost-effectively through a staged implementation of offsite population protective measures, including decontamination in post-accident situations. The challenged TIMDEC

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values also are consistent with the NUREG-1150 values and have been applied in Level-3 PRA analyses (including SAMA analyses and the SOARCA project) for many years.

249. New York has not provided alternative nonfarm decontamination cost and decontamination values that are more appropriate than those used in the IPEC SAMA analysis. Dr. Lemay's proposed values for the CDNFRM and TIMDEC variables, as reflected in ISR Approaches A-D, are inappropriate because they are derived from cost data that have no applicability to a nuclear power plant SAMA analysis, are based on selective and incorrect use of the data, and lack adequate technical justification. Moreover, because New York's proposed values generally exceed the maximum values allowed by MACCS2, their use in a SAMA analysis would require modification of the NRC-recommended MACCS2 source code, and as such, is an inappropriate, unauthorized software quality assurance practice for a licensee. Thus, the Board finds that New York's values are not reasonable for use in a SAMA analysis.

250. We find that the contested decontamination-related inputs to the IPEC SAMA analysis are reasonable and appropriate, and that New York has not provided any basis to conclude that there are additional potentially cost-beneficial SAMAs, particularly in view of the numerous demonstrated conservatisms in the IPEC SAMA analysis. Accordingly, we conclude that the modeling and data used in the IPEC SAMA analysis are reasonable and adequate for use by the NRC in satisfaction of its obligations under NEPA. Issues, motions, and arguments presented by the parties but not addressed herein have been found to be without merit, unnecessary, or not relevant to the Board's findings on NYS-12C.

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#### VI. <u>ORDER</u>

WHEREFORE, IT IS ORDERED, pursuant to 10 C.F.R. §§ 2.1210 and 51.104(a)(3), that the Consolidated Contention NYS-12C is resolved on the merits in favor of the NRC Staff and Entergy.

IT IS FURTHER ORDERED, this Partial Initial Decision will constitute a final decision of the Commission forty (40) days from the date of issuance (or the first agency business day following that date if it is a Saturday, Sunday, or federal holiday, *see* 10 C.F.R. § 2.306(a)), unless a petition for review is filed in accordance with 10 C.F.R. § 2.1212, or the Commission directs otherwise.

IT IS FURTHER ORDERED that any party wishing to file a petition for review on the grounds specified in 10 C.F.R. § 2.341(b)(1) must do so within twenty-five (25) days after service of this Partial Initial Decision. The filing of a petition for review is mandatory for a party to have exhausted its administrative remedies before seeking judicial review. Within twenty-five (25) days after service of a petition for review, parties to the proceeding may file an answer supporting or opposing Commission review. Any petition for review and any answer shall conform to the requirements of 10 C.F.R. § 2.341(b)(2)-(3).

Although this ruling resolves all matters before the Board in connection with Consolidated Contention NYS-12C, NRC Staff issuance of the renewed operating licenses under 10 C.F.R. Part 54 must abide, among other things, the resolution of the remaining admitted contentions, including those contentions designated for future hearings.

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Respectfully submitted,

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

Kathryn M. Sutton, Esq. Paul M. Bessette, Esq. MORGAN, LEWIS & BOCKIUS LLP 1111 Pennsylvania Avenue, NW Washington, DC 20004 Phone: (202) 739-3000 Fax: (202) 739-3001 E-mail: ksutton@morganlewis.com E-mail: pbessette@morganlewis.com

Martin J. O'Neill, Esq. MORGAN, LEWIS & BOCKIUS LLP 1000 Louisiana Street Suite 4000 Houston, TX 77002 Phone: (713) 890-5710 Fax: (713) 890-5001 E-mail: martin.oneill@morganlewis.com

COUNSEL FOR ENTERGY NUCLEAR OPERATIONS, INC.

William B. Glew, Jr., Esq.
William C. Dennis, Esq.
ENTERGY SERVICES, INC.
440 Hamilton Avenue
White Plains, NY 10601
Phone: (914) 272-3202
Fax: (914) 272-3205
E-mail: wglew@entergy.com
E-mail: wdennis@entergy.com

Dated in Washington, D.C. this 22nd day of March 2013

# UNITED STATES OF AMERICA NUCLEAR REGULATORY COMMISSION

# **BEFORE THE ATOMIC SAFETY AND LICENSING BOARD**

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In the Matter of

ENTERGY NUCLEAR OPERATIONS, INC.

Docket Nos. 50-247-LR and 50-286-LR

(Indian Point Nuclear Generating Units 2 and 3)

March 22, 2013

# **CERTIFICATE OF SERVICE**

Pursuant to 10 C.F.R. § 2.305 (as revised), I certify that, on this date, copies of "Entergy's Proposed Findings of Fact and Conclusions for Law For Consolidated Contention NYS-12C (Severe Accident Mitigation Alternatives Analysis)" were served upon the Electronic Information Exchange (the NRC's E-Filing System), in the above-captioned proceeding.

Signed (electronically) by Lance A. Escher

Lance A. Escher, Esq. MORGAN, LEWIS & BOCKIUS LLP 1111 Pennsylvania Ave. NW Washington, DC 20004 Phone: (202) 739-5080 Fax: (202) 739-3001 E-mail: lescher@morganlewis.com

COUNSEL FOR ENTERGY NUCLEAR OPERATIONS, INC.

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