UNITED STATES
NUCLEAR REGULATORY COMMISSION

BEFORE COMMISSIONERS
KRISTINE L. SVINICKI,
WILLIAM C. OSTENDORFF, AND
JEFF BARAN AND
CHAIRMAN STEPHEN G. BURNS

ON PETITION FOR REVIEW OF
LBP-13-13 PURSUANT TO 10 C.F.R. § 2.341

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In re:	Docket Nos. 50-247-LR; 50-286-LR
License Renewal Application Submitted by	ASLBP No. 07-858-03-LR-BD01
Entergy Nuclear Indian Point 2, LLC, Entergy Nuclear Indian Point 3, LLC, and Entergy Nuclear Operations, Inc.	DPR-26, DPR-64 March 30, 2015
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STATE OF NEW YORK RESPONSE TO COMMISSION ORDER CLI-15-2 REQUESTING FURTHER BRIEFING ON CONTENTION NYS-12C CONCERNING SITE-SPECIFIC SEVERE ACCIDENT MITIGATION ALTERNATIVES

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GLOSSARY OF TERMS, ACRONYMS, & ABBREVIATIONS

Board	Atomic Safety and Licensing Board
CDNFRM	MACCS2 input parameter for the nonfarmland decontamination cost
Entergy Test.	Ex. ENT000450, Pre-filed Testimony of Entergy Witnesses Potts, O'Kula, and Teagarden on Consolidated Contention NYS-12C (Mar. 30, 2012)
FSEIS	Ex. NYS00133A-J, Ex. NRC000004[1] Final Supplemental Environmental Impact Statement NUREG-1437, *Volumes 1-3: Supplement 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)
ISR	International Safety Research, Inc.
LBP-13-13	Partial Initial Decision, *Entergy Nuclear Operations, Inc.* (Indian Point Nuclear Generating, Units 2 and 3), LBP-13-13, 78 N.R.C. 246 (Nov. 27, 2013) (ML13331B465).
Lemay Decl.	Declaration of François Lemay in Support of the State's Motion to Reopen the Record and for Reconsideration of NYS-12C (Jan. 22, 2014) (ML14022A273)
Lemay Initial Test.	Ex. NYS000241, Pre-filed Testimony of NYS Expert François Lemay on Contention NYS-12C (Dec. 21, 2011)
Lemay Rebuttal Test.	Ex. NYS000420, Pre-filed Rebuttal Testimony of NYS Expert François Lemay on Contention NYS-12C (Jun. 29, 2012)
MACCS2	MELCOR Accident Consequence Code Systems Version 2
MELCOR	Methods for Estimation of Leakages and Consequences of Releases
NCF	Non-Containment Failure
NRC	Nuclear Regulatory Commission
NUREG/CR-3673 or the 1984 report	Ex. NRC000058, NUREG/CR-3673, *Economic Risks of Nuclear Power Reactors Accidents* (May 1984)

[1] NRC000004 is a one-page exhibit that "[i]ncorporates New York Exhibit NYS000133A-J."

GLOSSARY OF TERMS, ACRONYMS, & ABBREVIATIONS

NUREG-1150	Ex. NYS00252A-D, NUREG-1150, *Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants* (Dec. 1990)
NYS-12C	Consolidated Contention NYS-12/12A/12B/12C
OECR	Offsite Economic Cost Risk
Os84	"Ostmeyer, R.M., and G.E. Runkle, An Assessment of Decontamination Costs and Effectiveness for Accident Radiological Releases, Albuquerque, N.M.: Sandia National Laboratories, to be published"
PRA	Probabilistic Risk Assessment
SAMA	Severe Accident Mitigation Alternatives
Sandia	Sandia National Laboratories
Sandia *Site Restoration*	Ex. NYS000249, D. Chanin & W. Murfin, SAND96-0957, *Site Restoration: Estimation of Attributable Costs From Plutonium-Dispersal Accidents* (May 1996)
Staff Test.	Ex. NRC000041, Pre-filed Testimony of NRC Staff Witnesses Bixler, Ghosh, Jones, and Harrison on NYS-12/16 (Mar. 30, 2012)
Tawil 1990	Exs. NYS000424A-BB, NUREG/CR-5148, *Property-Related Costs of Decontamination*, J. J. Tawil & F.C. Bold (Feb. 1990)
TIMDEC	MACCS input parameter for the time required for completion of decontamination levels
Tr.	Transcript of Evidentiary Hearing before Atomic Safety and Licensing Board, Docket Nos. 50-247-LR & 50-286-LR, ASLBP No. 07-858-03-LR-BD01

I. INTRODUCTION

Pursuant to the Commission's Memorandum and Order, CLI-15-2, issued on February 18, 2015, the State of New York provides the following response to the Commission's questions regarding the State's petition for review of the Atomic Safety and Licensing Board's Partial Initial Decision[1] as to Consolidated Contention NYS-12/12A/12B/12C ("NYS-12C").

II. RESPONSE TO QUESTIONS

1) **The Board in LBP-13-13 stated that the "genesis" of the decontamination time values used in the Indian Point SAMA analysis can be traced to a 1984 report (NUREG/CR-3673) that concluded that a 90-day decontamination time period represents "an average time to complete decontamination efforts following the most severe reactor accident."[2]**

   Address the underlying support and reasoning (if available) behind the report's conclusion that a 90-day time period is an "average" period of time for completing decontamination for "the most severe type of reactor accident."

A 1984 report "Economic Risks of Nuclear Power Reactor Accidents" NUREG/CR-3673 (May 1984) (Ex. NRC000058) is the source NRC and Entergy cite for the origin of their decontamination time (TIMDEC) values of 60 days for light decontamination and 120 days for heavy decontamination. As the Commission's first question acknowledges, the Board's decision to uphold these values as reasonable rests on this 1984 report prepared by Sandia in the wake of the Three Mile Island accident—a "no containment failure" accident which is the least severe type of reactor accident modeled in the severe accident mitigation alternatives (SAMA)

[1] *Entergy Nuclear Operations, Inc.* (Indian Point Nuclear Generating, Units 2 and 3), Partial Initial Decision (Ruling on Track 1 Contentions), LBP-13-13, 78 N.R.C. 246 (Nov. 27, 2013) (ML13331B465) ("LBP-13-13").

[2] LBP-13-13, 78 N.R.C. at 469 (referencing Ex. NRC000058, "Economic Risks of Nuclear Power Reactor Accidents," NUREG/CR-3673 (May 1984)).

analysis.[3] As the State explained, first in its pre-filed testimony and throughout this proceeding, the 1984 report does not provide support and/or reasoning for NRC's conclusion that a 90-day time period is an "average" period of time for completing decontamination for "the most severe type of reactor accident."[4] In fact, the 1984 document does not identify any basis for a 90 day decontamination period.[5]

Instead of providing support and reasoning for Staff and Entergy's decontamination time values, the 1984 report (NUREG/CR-3673) postulates a cleanup scenario in the form of a figure depicting a 120-day timeline where decontamination begins 30 days after the release and ends 120 days after the release.[6] The document merely states that "[b]ased on a mean time to completion of 90 days for the decontamination efforts, this [decontamination] program would require a workforce of ~46,000 men."[7] This single sentence—without any support or reasoning—is what Staff relies on in the 1984 document.[8]

Staff and Entergy cite nothing in the 1984 document (NUREG/CR-3673) that provides support and reasoning for using the 90-day time period for "the most severe type of reactor

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[3] *See* Tr. 1904:9-15 (Teagarden) (the "SAMA analysis actually covers a spectrum of accidents all the way from a core degradation event without containment failure which would be akin to the Three Mile Island accident to a severe accident with a large radiological release that could impact a large area outside the plant.").

[4] *See, e.g.*, Ex. NYS000420, Pre-filed Rebuttal Testimony of NYS Expert François Lemay on Contention NYS-12C (Jun. 29, 2012) at 21-23 ("Lemay Rebuttal Test.").

[5] *Id.*

[6] Ex. NRC000058, NUREG/CR-3673 at 4-5. The first 30 days after the accident sequence are used for the "collection of dose-rate information for decision making." *Id.*

[7] *Id.* at 6-25.

[8] Tr. 2249:13-15 (Harrison) (the NUREG/CR-3673 authors "just have a sentence that says the mean time to decontamination is 90 days."); *see also* Ex. NRC000041, Pre-filed Testimony of NRC Staff Witnesses Bixler, Ghosh, Jones, and Harrison on NYS-12/16 (Mar. 30, 2012) at A.81 ("Staff Test.").

accident" because the document is utterly lacking in support. For example, nowhere does the 1984 report engage in a mathematical process to calculate a "mean" or an "average" value based on identifiable data. Additionally, the 1984 document predates real-world severe accidents including Chernobyl (April 1986) and Fukushima (March 2011). The 1984 document noted the lack of available, relevant data at the time of its publication: "Little data exist which are directly applicable to the small particle sizes (~0.1-10 μm) and soluble materials which are anticipated in releases from most severe [light water reactor] accidents."[9] Due to "large uncertainties," the 1984 report recommended that the "results of future experimentation with decontamination techniques should be used to update models for decontamination."[10] These disclaimers and warnings in the 1984 document demonstrate that its authors did not expect that the reported 90 days would be used decades later without any updating.

After noting its limitations, the 1984 report (NUREG/CR-3673) states that "~11,000 man-years of effort" would be needed to complete decontamination, which the report translates to approximately 46,000 workers in 90 days.[11] The report then cautions that "manpower limitations may force an extended period for completion of the offsite decontamination program after large releases of radioactive material."[12] The State submitted an attachment to its pre-filed testimony to walk the Board through the worker calculation based on the 1984 document.[13] Using the same methodology used in the 1984 document, the State's experts determined that

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[9] Ex. NRC000058, NUREG/CR-3673 at 4-15.

[10] *Id.*

[11] *Id.* at 6-25.

[12] *Id.*

[13] Ex. NYS000431, ISR Exhibit to Rebuttal Testimony of Dr. François J. Lemay, Cost of decontamination at Surry based on assumptions contained in NUREG/CR-3673 (June 29, 2012).

decontamination at Indian Point would require deployment of 1.5 million workers for 90 days.[14] This number of workers is entirely unrealistic and unreasonable.[15] Thus, the assumption underlying the 1984 document's 90-day decontamination time is unrealistic and unreasonable for the most severe type of reactor accident, 30 years later in this proceeding involving the 50-mile area surrounding the Indian Point facilities.

Lastly, even though Staff cites the 1984 document (NUREG/CR-3673) as the ultimate source of its decontamination time (TIMDEC) values, the 1984 document reports a 90-day decontamination period while Staff used two values, 60 days for light decontamination and 120 days for heavy decontamination. Other than the conclusory statement that 90 days is the average of 60 days and 120 days, nowhere does Staff or Entergy explain how the 60 and 120 day values were derived from 90 days. There are inconsistencies in the timeline of the 1984 document (NUREG/CR-3673) and another source document, NUREG-1150, which does report 60 days and 120 days without further explanation. In the 1984 document's timeline, decontamination begins 30 days after the accident while in NUREG-1150, decontamination starts only seven days

[14] *Id.; see also* Ex. NYS000420, Lemay Rebuttal Test. at 22.

[15] Ex. NYS000420, Lemay Rebuttal Test. at 23; Tr. 2114:1-9 (Lemay) ("If you get the value of 1.5 million, clearly you've compressed the time scale so much that you need an incredible number of people that are clearly not available. If you allow the time to spread over several years, then it becomes you get a reasonable number of people. And I would argue that in the case of the massive decontamination effort anything over 100,000 to 150,000 people is not reasonable."). The 1984 report (NUREG/CR-3673) anticipates that military and disaster relief personnel would perform the decontamination work. Ex. NRC000058 at 4-20. For comparison purposes, according to the Department of Defense's Manpower Data Center, the nation's armed forces include approximately 1.3 million military personnel. *See* DMDC, *Total Military Personnel and Dependent End Strength By Service, Regional Area, and Country as of March 31, 2014*, *available at* https://www.dmdc.osd.mil/appj/dwp/rest/download?fileName=ms0_1501.pdf &groupName=milTop (last visited Mar. 24, 2014) (previously cited in State of New York Reply in Support of Petition for Review of Atomic Safety and Licensing Board's November 27, 2013 Partial Initial Decision Concerning Consolidated Contention NYS-12C at 6, n.1 (May 22, 2014) (ML14142A472)).

after the accident.[16] Although Entergy recognized these inconsistencies, it failed to explain them:[17]

> When you go back to the Burke document [*i.e.*, the 1984 report (NUREG/CR-3673)], there's just a discussion of the model development, where they explore how the model is developed. They use a basis of 90 days. But then when it's carried forward in the NUREG-1150, that's modified to reflect the 60 days and the 120 days.

These inconsistencies further underscore the lack of support and reasoning for the 90 day, 60 day, or 120 day decontamination time values.

2) Identify from the record any peer review or similar vetting of the NUREG-1150 values for the decontamination cost inputs for nonfarm land and property (CDNFRM) and the decontamination time inputs (TIMDEC) used in the MACCS2 computer code.

<u>NUREG-1150 and Associated Documents</u>

In the Partial Initial Decision, the Board upheld the decontamination cost (CDNFRM) and decontamination time (TIMDEC) values NRC Staff and Entergy used from Sample Problem A. The FSEIS explains that the Sample Problem A values "were primarily developed for the Surry plant analysis in NUREG-1150 and represent best estimate information for that site and time."[18] However, there is no evidence that the CDNFRM or TIMDEC values were reviewed as

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[16] *See* Ex. NYS000420, Lemay Rebuttal Test. at 21-23.

[17] Tr. 2242:14-20 (Teagarden). This testimony reflects a correction to the transcript adopted by the Board. *See Entergy Nuclear Operations, Inc.* (Indian Point, Units 2 and 3), Order (Adopting Proposed Transcript Corrections with Minor Edits) at 25 (Dec. 27, 2012) (unpublished) ("Dec. 27, 2012 Board Order") (ML12362A278).

[18] The Final Supplemental Environmental Impact Statement ("FSEIS") for Indian Point explains that Entergy and Staff relied upon example inputs from Sample Problem A found in the MACCS2 User Guide. Ex. NYS00133I, NUREG-1437, *Supplement 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) at G-23. Sample Problem A is one of fourteen sample problems containing example sets of test inputs included in the MACCS2 code package to ensure the code is operating properly on the host computer. Ex. NYS000243, MACCS2 User Guide at 4-3. The sole adjustment Entergy made to the Sample Problem A

part of NUREG-1150's peer review process. Although NUREG-1150 did undergo a peer review, that peer review was focused on accident probability and sequence progression issues and did not include a critical evaluation of CDNFRM or TIMDEC. None of the expert panels reviewing NUREG-1150 were tasked with reviewing the consequence assessment in any depth.[19] As the State's expert explained at the hearing,[20]

> what NUREG-1150 doesn't do is validate the input parameters that were used in the Indian Point SAMA analysis. And you can search all the volumes of NUREG-1150. I certainly did. The only references to decontamination costs are the two references I found [NUREG/CR-4551 and Os84]. So it leads me to believe that [] a very specific part of the economic cost assessment was not peer reviewed, at least in the sense that U.S. NRC staff defines it.

NUREG-1150 does not even contain a description of how the CDNFRM or TIMDEC values were derived.[21]

NUREG-1150's companion, Ex. NRC000057, NUREG/CR- 4551, *Evaluation of Severe Accident Risks: Quantification of Major Input Parameters* (Dec. 1990), also does not contain a review of the Sample Problem A values. The Board's assertion that NUREG/CR-4551 "reviewed the MACCS2 input parameters used in NUREG-1150, including TIMDEC"[22] has no basis in the record. Even the Board's selected quote from NUREG/CR-4551 is clear that not

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inputs was to update them from their 1986-based dollars to the 2005-based dollars of Entergy's SAMA analysis, using the Consumer Price Index. Ex. NYS00133I, FSEIS at G-23.

[19] *See* Ex. NYS00252A, NUREG-1150, Volume 1 at xviii- xix; Ex. NYS00252B, NUREG-1150, Volume 2, Appendix A at A-43 – A-45.

[20] Tr. 2175:17-25 (Lemay).

[21] Tr. 2004:17-2005:24 (J. Wardwell/Lemay) (explaining that NUREG-1150 does not describe how CDNFRM values are derived).

[22] LBP-13-13, 78 N.R.C. at 470.

every input parameter was reviewed.[23] Although NUREG/CR-4551 does explain certain other input values, it fails to explain decontamination costs or time and does not provide or reference a peer review of those values. NUREG/CR-4551 does cite a 1984 report (NUREG/CR-3673 (Ex. NRC00058)), but that 1984 report does not contain a description or a peer review of the CDNFRM or TIMDEC values. For TIMDEC, the 1984 report (NUREG/CR-3673) assumes an average of 90 days without support or reasoning.[24] For CDNFRM, it simply states:[25]

> 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) [Os84].

All parties agree that Os84 missing and wholly unavailable. The State requested a copy of Os84, but NRC Staff stated that "the Staff's experts from Sandia and the Staff searched for but were not able to locate the requested article."[26] Thus, Os84 does not exist and is not in the record in this proceeding. The Board, however, relied on the 1984 report's (NUREG/CR-3673) citation to the missing Os84 reference in concluding that CDNFRM was subject to "secondary peer review," finding that a "'detailed review' apparently was documented in the unpublished report by Robert Ostmeyer and Gene Runkle (*i.e.*, Os84 or the Ostmeyer report)."[27] This conclusion

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[23] *Id.* at 472 (quoting NUREG/CR-4551 at iii/iv) (emphasis added) (stating only that "*most* MACCS input parameters were reviewed.").

[24] Ex. NRC000058, NUREG/CR-3673 at 4-5.

[25] *Id.* at 4-15

[26] Ex. NYS000421, Email from Brian Harris, Esq. to Kathryn Liberatore, Esq. (April 25, 2012); Tr. 2009:21-25 (McDade, J./Jones).

[27] LBP-13-13, 78 N.R.C. at 472 (footnotes omitted). The Board's ruling assumed that Os84 was a "report," but with no competent evidence in the record as to Os84, no basis exists for the Board's assumption. Moreover, Staff and Entergy did not present evidence to the Board as to the substantive contents of Os84; thus, the record contains no evidence as to which radiological dispersion events or what decontamination methods efforts may—or may not—have been referenced in the unpublished Os84. Likewise, there is no evidence as to the geographic location of any such events or the size of the area affected such dispersion events.

was reached based on nothing more than the 1984 report's (NUREG/CR-3673) reference to the missing Os84 document as "a detailed review of decontamination effectiveness and costs performed at Sandia National Laboratories." The 1984 report (NUREG/CR-3673) does not purport to review those values—it merely states they were "taken from" Os84. In fact, the 1984 report (NUREG/CR-3673) cautions that due to "large uncertainties . . . [the] results of future experimentation with decontamination techniques should be used to update models for decontamination."[28] Thus, the 1984 report (NUREG/CR-3673) is in no way sufficient to show that the CDNFRM or TIMDEC values were peer reviewed.

Use of "Sample Problem A" Values Since the Publication of NUREG-1150

In upholding Staff and Entergy's CDNFRM and TIMDEC values, the Board found that "all prior NRC license renewal applicants have used these same values (as appropriately escalated) in their SAMA analyses."[29] Although the Board found "Entergy and the NRC Staff were justified in relying on the secondary peer reviews of the economic cost variables,"[30] it is not clear what the term "secondary peer review" means. If the Board's use of the term "secondary peer review" refers to the use of the NUREG-1150/Sample Problem A values in other SAMA analyses, such repetition does not mean the values were scrutinized or critically reviewed as appropriate for this specific proceeding. While there is plenty of evidence that the CDNFRM and TIMDEC values were repeated no matter the specific location or attributes of the

[28] Ex. NRC000058, NUREG/CR-3673 at 4-15.

[29] LBP-13-13, 78 N.R.C. 471-72.

[30] *Id.*

facility, there is no evidence that they were ever once meaningfully reviewed.[31] Most recently, NRC Staff—with the involvement of some of NRC's witnesses from Sandia who testified in this proceeding—changed course from TIMDEC values of 60 and 120 days and used a TIMDEC input value of 365 days in a MACCS2 analysis of a severe accident at a spent fuel pool.[32] This recent analysis was reviewed by Staff and the Commission. Thus, the argument that the Sample Problem A values have always been used has been proven false.

Hence, the Board's conclusion that the NUREG-1150/Sample Problem A values were subject to some sort of "secondary peer review" is based on NRC Staff and Entergy's unsupported assumptions and speculation. NRC Staff's and Entergy's testimony amounts to nothing more than a series of "educated guesses" that lack a foundation in fact and are unsupported by analysis or any other documentation.[33] Unsupported assumptions and unfounded conclusions cannot refute the State's criticism of the cost estimates in used in the SAMA

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[31] *See* Ex. NYS000242, ISR Report at 30-31, Table 12; Tr. 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.").

[32] Consequence Study of a Beyond Design Basis Earthquake Affecting the Spent Fuel Pool for a U.S. Mark 1 Boil Water Reactor, ML13256A342 (final) October 2013, and ML13133A132 (draft) June 2013 (Attachment 7 to State's Motion to Reopen the Record and for Reconsideration of NYS-12C).

[33] *See Duke Cogema Stone & Webster*, LBP-05-04, 61 N.R.C. 71, 88-89 (2005) (where an expert "concedes that [she] was making an 'educated guess[,]' . . . the Board must focus on whether the experts' opinions are sufficiently grounded upon facts."). *See Phila. Elec. Co.* (Limerick Generating Station, Units 1 and 2), ALAB-819, 22 N.R.C. 681, 735 (1985) ("where an asserted expert witness can supply no scientific basis for his statements (other than his 'belief') and disparages his own testimony, a board would be remiss in giving such testimony any weight whatsoever.").

analysis.[34] It was error for the Board to afford weight to this testimony without any documentary evidence of peer review.[35]

3) Providing references to the record, discuss the underlying reasons behind the Staff and Entergy experts' opinion that the NUREG-1150 CDNFRM and TIMDEC values continue to reflect reasonable estimates for severe accident decontamination times and costs today, including for the heavier (DF of 15) decontamination effort.

Neither Entergy nor NRC Staff have provided evidence showing that the NUREG-1150 CDNFRM and TIMDEC values continue to reflect reasonable estimates for severe accident decontamination times and costs today, including for the heavier (DF of 15) decontamination effort. The State's detailed evidence shows that the CDNFRM and TIMDEC values are wholly unreasonable for use in the Indian Point SAMA analysis.

There was no attempt on the part of NRC Staff or Entergy to verify the reasonableness or benchmark these values with current data on decontamination techniques, methods, and times. Entergy and Staff failed to explain why they did not perform a benchmarking for CDNFRM and TIMDEC, *i.e.*, Level 3 probabilistic risk assessment ("PRA") (the final level of the SAMA analysis where the MACCS2 code is used to calculate the costs associated with a severe accident). By contrast, Entergy performed extensive peer reviews and benchmarking to verify the reasonableness and robustness of earlier levels of the SAMA analysis, *i.e.*, Level 1 PRA (analysis of core damage frequency) and Level 2 PRA (analysis of release frequencies). Additionally, neither Entergy nor Staff has addressed how difficult and costly it would be to achieve the heavier decontamination effort resulting in a dose reduction factor of 15.

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[34] *See Monroe Co. Conservation Council v. Volpe*, 472 F.2d 693, 697 (2d Cir. 1972); *Natural Res. Def. Council v. Callaway*, 524 F.2d 79, 93 (2d Cir. 1975).

[35] *See Entergy Nuclear Generation Co.* (Pilgrim Nuclear Power Station), CLI-10-11, 71 N.R.C. 287, 315 (Mar. 26, 2010) ("unsupported reasoning and computations, are insufficient" and should be afforded little or no weight); 10 C.F.R. § 2.337(a) ("Only relevant, material, and reliable evidence which is not unduly repetitious will be admitted.").

<u>Sample Problem A/NUREG-1150 CDNFRM and TIMDEC Values Do Not Reflect Reasonable Site-Specific Estimates for Indian Point Today</u>

The State retained experts Dr. Francois Lemay and International Safety Research, Inc. ("ISR") to determine whether the MACCS2 input values related to economic costs, including CDNFRM and TIMEC, were reasonable for the Indian Point SAMA analysis.[36] Because the data source for the decontamination cost (CDNFRM) input values is not available or explained in any reference, ISR benchmarked Entergy and Staff's values against values ISR developed with several different sources of relevant, available data.[37] Each available data source resulted in CDNFRM values higher than Entergy's values showing that these values are not only unsourced, but also unrealistic for Indian Point.[38] The Board failed to even mention this evidence.

For TIMDEC, the State's experts examined real world decontamination efforts including Fukushima and Chernobyl.[39] The State submitted evidence—uncontroverted by Entergy or NRC Staff—that Fukushima is well within the range of severe accidents that Entergy chose to model for the SAMA analysis.[40] The Board failed to discuss decontamination times at Fukushima and afforded no weight to information from Chernobyl.

The only support Entergy and Staff supplied for the use of NUREG-1150/Sample Problem A values for CDNFRM and TIMDEC is their continued use and "pedigree." Yet, NRC

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[36] *See* Ex. NYS000420, Lemay Rebuttal Test. at 5-8.

[37] *See* Ex. NYS000242, ISR Report; Ex. NYS000430 (updating certain tables from ISR Report); Ex. NYS000420, Lemay Rebuttal Test. at 5.

[38] *See* Ex. NYS000430 at 5, Table 11.

[39] *See* Ex. NYS000420, Lemay Rebuttal Test. at 48-53; Ex. NYS000241, Pre-filed Testimony of NYS Expert François Lemay on Contention NYS-12C at 51-55 (Dec. 21, 2011) ("Lemay Initial Test"); *see also* Exs. NYS000264, NYS000265, NYS000266, NYS000267, NYS000268, NYS000269, NYS000428, NYS000263.

[40] Ex. NYS000420, Lemay Rebuttal Test. at 12-15; Tr. 2183:18-20 (Lemay).

was clear in responding to comments that called into question the failure to benchmark NUREG-1150 values: NRC stated that the NUREG-1150 values were "limited" and that it expected that site-specific estimates of decontamination costs would be developed in the future because they "are more properly considered in the context of specific regulatory actions."[41] Additionally, the final version of NUREG-1150 does not include a calculation of economic costs.[42] This further supports the conclusion that NRC determined that economic costs should be calculated on a site-specific basis for each specific regulatory action.

In addition to NUREG-1150 itself, internal NRC documents question the "pedigree" of the Sample Problem A values. Remarkably, the Board's Decision does not even mention an internal NRC email chain and what appeared to be an attachment to that email chain that expresses views contrary to the positions taken by NRC Staff and Entergy that the NUREG-1150 values are reasonable due to their pedigree.[43] This document, entitled FY13 Long-Term Research Plan, is "a staff proposal for long-term research."[44] After explaining that "applicants often begin with input values that are found in 'Sample Problem A' . . . taken from a calculation for Surry done for NUREG-1150, which was published in 1990," the document reveals that

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[41] Ex. NYS00252D, NUREG-1150, *Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants* (Dec. 1990) at D-31 - D-32 (emphasis added). *See also* Tr. 2023:15-2024:13, 2025:3-19 (Lemay) (noting the importance of discussing NUREG-1150 reviewer comments, as well as NRC's response, and quoting these comments/responses).

[42] Tr. 2035:15-22 (O'Kula) ("Now it's important to note that in the second draft, and subsequently the final draft of NUREG-1150, economic costs were not calculated, because [the] NRC report indicated that at least the discussion, as we understand it goes, that cost-benefit analyses are more properly considered in the context of specific regulatory activities."). This testimony reflects a correction adopted by the Board. Dec. 27, 2012 Board Order at 20.

[43] *See* Ex. NYS000441, Jan. 10, 2011 e-mail string, Subject: FW: Action YT-2011-0003: Request Parallel Concurrence on Document: Agency Long-Term Research Activities for Fiscal Year 2013) ("FY13 Long-Term Research Plan").

[44] Tr. 2287:3-4 (Ghosh).

"[*t*]*he pedigree of some of those input values is not known.*"[45] The text, in context, is reproduced below.

> **New Improved MELCOR Accident Consequence Code System (MACCS)**
>
> There is a need to review, and update or upgrade as necessary, certain input values often used in the MACCS2 for off-site radiological and economic consequences of severe accidents, such as reported in Severe Accident Management Alternative (SAMA) or Severe Accident Management Design Alternative (SAMDA) analyses submitted as part of combined operating license applications and standard reactor design certification applications. For instance, applicants often begin with input values that are found in "Sample Problem A" that is distributed with the MACCS2 code (NUREG/CR-6613). The values in Sample Problem A were taken from a calculation for Surry done for NUREG-1150, which was published in 1990. The pedigree of some of those input values is not known.

Because this document was plainly applicable to, directly contradicted, and undermined the arguments NRC Staff and Entergy raised in defense of Sample Problem A, the Board's failure to acknowledge and discuss the document constitutes a procedural, factual, and legal error. The document calls into question the pedigree of the Sample Problem A values taken from NUREG-1150, further supporting the conclusion that they do not reflect reasonable, site-specific values for Indian Point.

<u>Sample Problem A/NUREG-1150 CDNFRM and TIMDEC Values Do Not Reflect Reasonable Site-Specific Estimates for the Heavier (DF of 15) Decontamination Effort at Indian Point</u>

Entergy and Staff's CDNFRM and TIMDEC values fail to address the effort required to achieve a dose reduction factor of 15—the dose reduction factor they selected for heavy decontamination. The MACCS2 code allows a user to define up to three decontamination levels, but applicants typically choose to define two levels as Entergy has here: a factor of 3 for light

[45] Ex. NYS000441 at 5 (emphasis added).

decontamination and a factor of 15 for heavy decontamination.[46] Other than citing to the Sample Problem A values, which were sourced from NUREG-1150, neither Entergy nor Staff explained why they selected dose reduction factors of 3 for light decontamination and 15 for heavy decontamination. The dose reduction factor is the ratio of the radiological dose before decontamination to the dose after decontamination.[47] Thus, a dose reduction factor of 15 means the dose is 1/15 of what it would have been without decontamination, *i.e.*, a 93% decrease. Decontamination cost parameters, including nonfarm decontamination cost and decontamination time, are associated with the dose reduction factor selected.[48] This means that the nonfarm decontamination cost and decontamination time must correspond to the costs and time it takes to carry out light and heavy decontamination following a severe accident.[49] The Indian Point SAMA inputs fail to account for site-specific factors at Indian Point.

It is difficult, expensive, and time-consuming to achieve high dose reduction factors when cesium is present.[50] Simply put, it is easier to decontaminate than it is to reduce the radiological dose. Although Entergy and NRC Staff cited decontamination techniques designed to achieve high levels of decontamination, these are inconclusive at best.[51] For example, burying contaminants in place (Entergy Test. at A91) "could work well in farmland where deep-plowing can bury the contamination, but it is less applicable to the urban areas of NYC where concrete

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[46] Ex. NYS000243 MACCS2 User Guide at p. 7-9; Ex. ENT000450 Entergy Test. at 54, Table 4.
[47] Ex. NYS000243, MACCS2 User Guide at p. 7-11.
[48] Ex. NYS000242, ISR Report at 12-13; Ex. NYS000241, Lemay Initial Test. at 29-30.
[49] *Id.*
[50] Ex. NYS000420, Lemay Rebuttal Test. at 52-53.
[51] *Id.*

and paved surfaces are predominant."[52] The State's expert explained, "no matter what the decontamination technique, it is difficult to achieve a high dose reduction factor (DRF=15) where cesium is present, even if some surfaces can be decontaminated perfectly (DF [decontamination factor] >100)." *Id.* Dr. Lemay provided the following example:[53]

> [I]t may be easy to decontaminate the glass surfaces with a DF [decontamination factor]>100. However it may not be possible to decontaminate the brick to a DF [decontamination factor] >5. The actual DRF achieved near the building will be much less than DF>100 and closer to the DF[decontamination factor]=5. The lowest DF [decontamination factor] determines the achievable DRF [dose reduction factor], so even though the glass is thoroughly decontaminated, the dose reduction factor will not be as high due to the remaining cesium contamination in the brick.

In short, the Sample Problem A/NUREG-1150 decontamination cost and time values do not take the level of effort required to achieve heavier dose reduction factors such as 15.

4) Discuss the appropriateness of performing sensitivity analyses to account for uncertainties in the estimated decontamination times and non-farm decontamination costs, including what might be reasonable CDNFRM and TIMDEC inputs to use in sensitivity analyses for the Indian Point SAMA analysis.

<u>Appropriateness of Performing Sensitivity Analyses</u>

Neither Entergy nor NRC Staff performed any sensitivity analyses to account for uncertainties in the estimated decontamination times and non-farm decontamination costs.[54] Such a sensitivity analysis would have been an appropriate way for Entergy and Staff to determine the effects that ranges of reasonable, site-specific input values would have on the SAMA analysis. As discussed in more detail in response to Question 7 below, the State's expert explained that Entergy performed sensitivity analysis and benchmarking for other aspects of the

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[52] *Id.* at 52.

[53] *Id.* at 52-53. Dose reduction factor is similar to, but not the same as the decontamination factor. *See* Ex. NYS000242, ISR Report at viii, 11-12; Ex. NYS000241, Lemay Initial Test. at 17; Tr. 2301:23-25 (J. McDade/Teagarden).

SAMA analysis, but not the Sample Problem A values.[55] It is unreasonable for Entergy and NRC Staff to "expend[] considerable effort to verify the source term and core damage frequency used in accident assessment—Level 1 and Level 2," only to rely upon generic Sample Problem A values without any verification in the Level 3 PRA analysis.[56]

Entergy did, however, embrace the appropriateness of a sensitivity analysis in another contention—NYS-16B, which challenged the SAMA population estimates. In the context of NYS-16B, Entergy performed a sensitivity analysis that purported to analyze the effect that population flaws would have on the SAMA analysis.[57] Examining Entergy's NYS-16B sensitivity analysis could inform a methodology for a NYS-12C sensitivity analysis. The NYS-16B analysis focused on IP2 SAMA 025, a SAMA candidate that Entergy determined was not cost-beneficial.[58] According to Entergy, "[c]ompared to the other SAMA candidates that are not cost-effective, at 11%, IP2 SAMA 025 has the smallest margin between the current benefit and the increased benefit to become cost effective."[59] During the hearing on NYS-12C, the Board sustained Entergy's objection when the State attempted to question Entergy's witnesses regarding how the conclusions in their purported sensitivity analysis for NYS-16B would apply to NYS-12C.[60] Thus, the State was unable to develop this testimony and there is evidence

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[54] Tr. 2226:22-2227:8 (J. Wardwell/Teagarden).

[55] Ex. NYS000420, Lemay Rebuttal Test. at 9.

[56] *Id.*

[57] *See* ENT000006 (G. Teagarden, MACCS2 IP2 Population Sensitivity Case, Jan. 2012); ENT000589 (MACCS2 Sensitivity Analysis for NYS-16 Using Dr. Sheppard's Proposed Data, Oct. 9, 2012).

[58] ENT000003, Entergy NYS-16B Test. at 49-50 (A89) (O'Kula, Teagarden, Potts).

[59] *Id.* at 49-50 (A89) (O'Kula, Teagarden, Potts).

[60] Tr. 2335:20-2339:2 (J. McDade/Sutton/Bessette/Liberatore).

explaining why Entergy performed a sensitivity analysis for NYS-16B and not NYS-12C. The State was allowed by the Board to inquire whether increasing the OECR by a factor of seven would render IP SAMA 025 cost-beneficial, given that Entergy maintained that only an 11% increase in OCER was required to render that candidate cost-beneficial.[61] In response, Entergy's witnesses stated that they would need to conduct additional analysis including MACCS2 runs to answer the question.[62] Thus, although the NYS-16B analysis shows that Entergy endorsed the appropriateness of performing a sensitivity analysis for SAMA inputs, Entergy and NRC Staff decided not to analyze the effect that site-specific inputs for decontamination cost and time would have on the SAMA cost-benefit analysis.

Reasonable Ranges of Values for Sensitivity Analyses

There are several options to develop reasonable CDNFRM and TIMDEC inputs to use in sensitivity analyses for the Indian Point SAMA analysis. Entergy and Staff could use a range of inputs developed using various more recent data sources, based on data from the experience at Fukushima, and/or taking into account the limitations on the number of workers that would be available to decontaminate following a severe accident.

The State's experts, ISR, demonstrated how various sources of more recent data including the Fukushima experience could be used to calculate a range of appropriate CDNFRM and TIMDEC inputs. Before evaluating Entergy and Staff's MACCS2 inputs and developing ranges of appropriate site-specific inputs for Indian Point, ISR performed a sensitivity analysis to determine which MACCS2 input parameters have the greatest effect on economic costs, *i.e.*,

[61] *See* Tr. 2525:20-2527:21 (J. McDade/Potts/Teagarden/Liberatore).
[62] *Id.*

OECR.[63] ISR then focused its efforts on evaluating each of these parameters to determine whether Entergy's input value was reasonable for the site-specific conditions at Indian Point.[64] ISR's evaluation focused on the buildings, land uses, and population surrounding Indian Point as well as the properties of the types of particles released during a severe nuclear reactor accident. These calculations are detailed in an expert report, pre-filed testimony, and hearing testimony. The data sources include:

- Experience at Chernobyl (Exs. NYS000249, NYS000250, NYS000251, NYS000263)
- Experience at Fukushima (Exs. NYS000264, NYS000265, NYS000266, NYS000267, NYS000268, NYS000269)
- Data from *CONDO: Software for Estimating the Consequences of Decontamination Options, Report for CONDO Version 2.1*, T. Charnock et al., NRPB-W43 (May 2003) (Ex. NYS000250)
- Data from J. Roed, K.G. Anderson & H. Prip, *Practical Means for Decontamination 9 Years after a Nuclear Accident*. RISO National Laboratory, Roskilde, Denmark, RISO-R-828(EN) (Dec. 1995) (Exs. NYS000251, NYS000253)
- Data from R. Luna, H. Yoshimura & M. Soo Hoo, *Survey of Costs Arising from Potential Radionuclide Scattering Events*, WM2008 Conference, Phoenix, AZ (Feb. 24-28, 2008) (Ex. NYS000255)
- Data from D. Chanin & W. Murfin, SAND96-0957, *Site Restoration: Estimation of Attributable Costs From Plutonium-Dispersal Accidents* (May 1996) (Ex. NYS000249)
- Data from B. Reichmuth, S. Short, & T. Wood, *Economic Consequences of a Rad/Nuc Attack: Cleanup Standards Significantly Affect Risk*, Pacific Northwest Laboratory, Working Together Conference, Boston, MA (Apr. 28, 2005) (Ex. NYS000256)

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[63] Ex. NYS000242, ISR Report at 9-10; Ex. NYS000241, Lemay Initial Test. at 23-27; Tr. 2018:7-18 (Lemay) (explaining the importance of performing a sensitivity analysis); Tr. 2073:14-2074:7 (Lemay) (describing the sensitivity analysis ISR performed).

[64] Ex. NYS000242, ISR Report at 11; Ex. NYS000241, Lemay Initial Test. at 27; Tr. 2075:1-23 (Lemay).

The reasonable range of values for CDNFRM, TIMDEC, and other important parameters and their individual and cumulative effect on SAMA economic costs (OECR) is summarized in the table below.[65]

Table 13: Summary of ISR proposed inputs and calculated OECRs (costs in 2005 USD)

Parameter	Description	Entergy's value	ISR's proposed input value		ISR's calculated OECR ($/yr) and ratio[a]	
			Minimum	Maximum	Minimum	Maximum
CDNFRM (DF=3)	Per capita cost of nonfarm light decontamination	$5,184	$15,000	$184,000	3.68E+05	1.18E+06
CDNFRM (DF=15)	Per capita cost of nonfarm heavy decontamination	$13,824	$71,000	$418,000	(1.74)	(5.57)
TIMDEC (DF=3)	Time required for light decontamination	60 d	1 y	15 y	4.43E+05	1.20E+06
TIMDEC (DF=15)	Time required for heavy decontamination	120 d	2 y	30 y	(2.09)	(5.66)
VALWNF	Per capita value of nonfarm wealth (2004 USD)	$208,838	$284,189		2.51E+05 (1.18)	
DPRATE	Depreciation rate	20%	20%		2.12E+05 (1)	
DSRATE	Societal discount rate for property	12%	5%	7%	1.87E+05 (0.88)	1.95E+05 (0.92)
POPCST	Per capita cost of long-term relocation	$8,640	$10,640	$49,857	2.23E+05 (1.05)	4.41E+05 (2.08)
FRNFIM	Nonfarm wealth improvements fraction	80%	90%		2.19E+05 (1.03)	
Using all of ISR's proposed input values					**6.34E+05 (2.99)**	**1.47E+06 (6.93)**

Notes: [a] The ratio shown in brackets is the ratio of the ISR-calculated OECR to the Entergy-calculated OECR ($2.12E+05/yr).

The results of the State's analysis show that Entergy and Staff underestimated the economic costs (OECR) by a factor of two to seven. These values, or just the decontamination time and cost values, could be used in a sensitivity analysis.

Another way to develop a range of site-specific values is set out in NUREG/CR-5148 Property-Related Costs of Decontamination, Feb. 1990 ("Tawil 1990") (Exs. NYS000424A-NYS000424BB)—a report NRC commissioned that outlines methods to examine the site

[65] Ex. NYS000430 at 6, Table 13. *See* Tr. 2103:11-2104:25 (Lemay) (explaining the chart).

specific impacts of various severe accident scenarios at the Indian Point site.[66] The NRC's Indian Point-specific case study is described in Chapter 5 of Tawil 1990 (Ex. NYS000424H). Instead of improperly using the Sample Problem A values as default values supposedly applicable to every 50-mile area surrounding every reactor site, Tawil 1990 examined detailed decontamination costs for the surfaces present in individual grid elements in the area surrounding Indian Point.[67] Contrary to Entergy and Staff's contention that Tawil 1990 relied on national data, Figure 4.4 of Tawil 1990 lists numerous surface types for a single grid element in Westchester County (exterior brick walls, exterior wood walls, asphalt streets, other paved asphalt, carpeted floors, linoleum floors, wood floors, etc.), the decontamination cost for each surface type, and the portion of the grid element's area containing each surface type.[68] Entergy and Staff could use the methodology outlined in Tawil 1990 to develop ranges of values for a sensitivity analysis.

In addition to relying upon available data sources, Entergy and Staff could also have developed a range of TIMDEC and CDNFRM values that is limited by a reasonable number of

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[66] NRC failed to disclose this site-specific case study at Indian Point to the State. The State only became aware of it in researching NRC Staff's "pedigree" arguments presented in Staff's initial pre-filed testimony. *See* Ex. NYS000426 (Dr. Tawil email explaining that NRC Staff was concerned about the results of Tawil 1990); Ex. NYS000420, Lemay Rebuttal Test. at 26-27. The Board's Partial Initial Decision does not discuss or even cite to Tawil 1990.

[67] *See* Ex. NYS000420, Lemay Rebuttal Test. at 26 (explaining that the methodology behind the Tawil 1990's DECON model and database is similar to the CONDO model and database, which was one data source ISR used to calculate MACCS2 input values).

[68] *Compare* Tr. 2254:3-2255:2 (Jones) (incorrectly claiming that Tawil 1990 did not use values that were specific to the area surrounding Indian Point), *with* Ex. NYS000424H at 4.32, Figure 4.4 (detailing Tawil 1990's analysis of land use and decontamination techniques to produce site-specific decontamination costs for a single grid element in Westchester County, New York). *See also* Exs. NYS000425A-G NUREG/CR-3413, Off-Site Consequences of Radiological Accidents: Methods, Costs and Schedules for Decontamination, J.J. Tawil, et al. (Aug. 1985) (explaining the DECON code used in Tawil 1990).

workers. Using Entergy's TIMDEC values, about 1.5 million workers are required to decontaminate following an EARLY HIGH accident at Indian Point.[69] Even extending the cleanup to one year would require 363,000 workers, which is also unrealistic and unreasonable.[70] To develop a reasonable range of values for a sensitivity analysis, Entergy and Staff should develop ranges of values that consider the fact that manpower is not unlimited. Whatever approach they take to performing a sensitivity analysis, Entergy and Staff should ensure that their approach is well-documented and peer reviewed.

5) Would it be appropriate to treat decontamination times and decontamination costs (and related decontamination factors) from an uncertainty analysis standpoint, using a range of values—e.g., smaller values for smaller release accident categories and larger values for the larger release categories? Why or why not?

As is explained in more detail below, it is possible and appropriate to use smaller values for accident categories with smaller releases and larger values for accident categories with larger releases. However, because the least severe accidents have almost no impact on the frequency-weighted cost used in the SAMA analysis (OECR), the evidence shows that it is also appropriate to select the same decontamination time and cost input parameters for all release categories as long as those values align with the more severe accidents modeled in the SAMA analysis. This is true because the more severe release categories contribute to the vast majority of the economic costs used in the SAMA analysis (OECR).

Entergy selected eight different categories of severe accidents to model, called release categories, representing a range of severe accidents, from lower consequence/higher frequency

[69] Ex. NYS000420, Lemay Rebuttal Test. at 22.

[70] *Id.* at 23.

accidents to higher consequence/lower frequency accidents.[71] To perform the SAMA analysis, the applicant runs the MACCS2 code for each release category, resulting in eight separate offsite economic cost values.[72] Thus, it is possible to use different CDNFRM and TIMDEC values for each release category because the MACCS2 calculation is performed separately for each release category. After running the MACCS2 code, the applicant then weighs each release category's costs by that category's frequency and "averages" the frequency weighted costs for each of the eight release categories to determine the total costs (OECR) used in the SAMA analysis.[73]

As the State's expert explained, the MACCS2 input values should be "be best estimate[s] appropriate for the release category we're trying to simulate."[74] Staff and Entergy agreed.[75] Although a no containment failure ("NCF") accident was one of the release categories modeled by Entergy, all other categories had much larger radiation releases, with EARLY HIGH exceeding Fukushima, and EARLY MEDIUM and LATE HIGH having releases similar to Fukushima.[76]

Some of the eight modeled release categories have a relatively small economic impact, while others have a relatively large economic impact. As the following pie chart shows, based

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[71] *Id.* at 11; Tr. 1905:2-6 (Teagarden) ("We have eight bins, so to speak, release categories postulated as part of the SAMA analysis for Indian Point of different types of releases."). The frequency of a release category represents the likelihood that the release category is postulated to occur within one year. Essentially, frequency is a probability expressed on a per year basis.

[72] *See* Tr. 2191:20-22 (Teagarden) ("MACCS does not actually multipl[y] the frequency, you do that yourself at the end.").

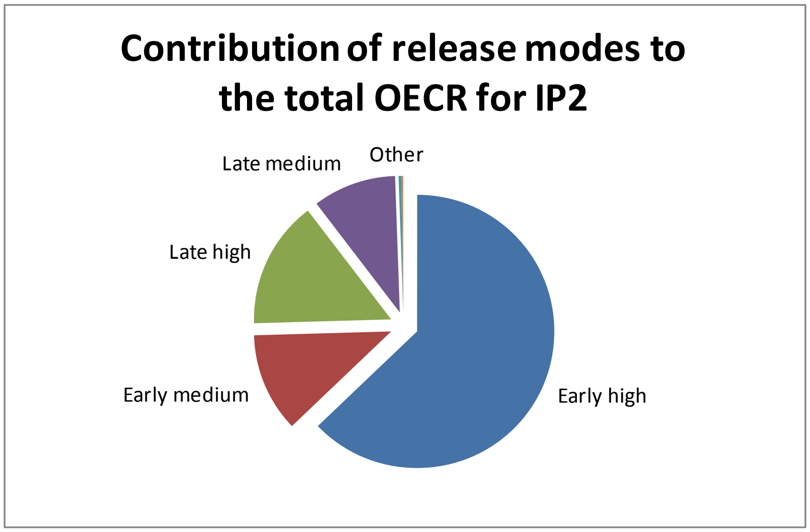
[73] *Id*.

[74] Tr. 1937:18-21 (Lemay).

[75] Tr. 1937:11-12 (Bixler) (use "the best value that you think you have for that particular parameter."); Tr. 1937:2-3 (Teagarden).

[76] Ex. NYS000420, Lemay Rebuttal Test. at 12 (using data from Entergy's MACCS2 input and output files as compared to Fukushima release data); *see also* Tr. 2184:6-2185:5 (Lemay).

upon the Indian Point SAMA analysis calculations Entergy provided, the EARLY HIGH release alone contributes over 60% to the total OECR used in the SAMA analysis. Taken together, the four most severe release categories—EARLY HIGH, EARLY MEDIUM, LATE HIGH, AND LATE MEDIUM—drive the total OECR for Indian Point, contributing over 90%.[77]



The narrow "Other" sliver combines the following four accident scenarios: NO-CONTAINMENT FAILURE (or NCF), LATE LOW, LATE LOW LOW, and EARLY LOW. These categories make an insignificant contribution to the total OECR.[78]

For the Indian Point SAMA analysis, because the more severe release categories make the largest contribution to the total OECR, the values for input parameters should more closely align with the accidents that are relatively more severe.[79] As the State's expert Dr. Lemay explained, in "calculat[ing] the OECR, . . . most of the cost comes from the worst accidents and that's quite logical. So we need to calculate those correctly. If I make a mistake on the [inputs

[77] Ex. NYS000420, Lemay Rebuttal Test. at 14-15 (using data from Ex. ENT000464, Entergy, IP-CALC-09-00265, *Re-analysis of MACCS2 Models for IPEC* (Dec. 2009) at 16, Table 5.

[78] *Id.*

[79] Ex. NYS000420, Lemay Rebuttal Test. at 15-16; Tr. 2178:17-2179:14, 2196:14-2197:3 (Lemay).

relative to the] benign accidents, it has no impact on the cost. If I make a mistake on the worst accident, it completely changes the answer."[80] In short, an error in inputs for any of the less severe accidents represented as "Other" on the chart above will have a negligible effect on the total OECR.

To further illustrate this point, the State's experts created a chart showing the effect of using the one year TIMDEC for only the most severe accidents, *i.e.*, the four most "challenging accident scenarios" that Entergy chose to model for Indian Point: EARLY HIGH, EARLY MEDIUM, LATE HIGH, and LATE MEDIUM.[81] The results of the analysis show that, altering TIMDEC to one year for the four most severe accidents listed above and using Entergy's values for all other parameters (including TIMDEC for the less severe accidents), the OECR almost doubles.[82] In fact, doubling of OECR occurs both (1) when using one year inputs for all the release categories and (2) when using one year inputs for release categories with the highest contribution to total OECR (EARLY HIGH, EARLY MEDIUM, LATE HIGH, LATE MEDIUM) and continuing to use 60 and 120 days for the others (NCF, EARLY LOW, LATE LOW, LATE LOW LOW).[83]

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[80] Tr. 2179:21-2180:2 (Lemay). This testimony reflects a correction adopted by the Board. *See* Dec. 27, 2012 Order at 24.

[81] Declaration of François Lemay in Support of the State's Motion to Reopen the Record and for Reconsideration of NYS-12C ("Lemay Decl.") ¶ 12 (Jan. 22, 2014) (ML14022A273).

[82] *Id.*

[83] *Id.*

Release Category	OECR ($/yr) with TIMDEC = 60 d (DF=3)/120 d (DF=15)*	OECR ($/yr) with TIMDEC = 365 d (DF=3)/365 d (DF=15)*	OECR ($/yr) with specific TIMDEC for each release category
NCF	1.19E+00	3.07E+00	1.19E+00
EARLY HIGH	1.33E+05	2.18E+05	2.18E+05
EARLY MEDIUM	2.48E+04	5.50E+04	5.50E+04
EARLY LOW	7.09E+02	1.62E+03	7.09E+02
LATE HIGH	3.19E+04	7.29E+04	7.29E+04
LATE MEDIUM	2.08E+04	4.63E+04	4.63E+04
LATE LOW	4.24E+02	8.94E+02	4.24E+02
LATE LOWLOW	3.27E+01	6.98E+01	3.27E+01
TOTAL	**2.12E+05**	**3.95E+05**	**3.93E+05**

*DF represents decontamination factor. Values shaded in gray are the values used in the last column. All OECR values are for Indian Point Unit 2 and are in 2005 USD/yr.

In sum, while it is possible and appropriate to use smaller TIMDEC values for less severe release categories and larger TIMDEC values for more severe release categories, it is also appropriate to use the same TIMDEC values for all release categories as long as the TIMDEC inputs align with the more severe release categories.

6) Discuss whether, and, if so, how, the SAMA analysis should account for the possibility of potential decontamination times longer than one year.

Comparing Entergy's inputs to two actual severe accidents—Fukushima and Chernobyl—it is clear that TIMDEC inputs of 60 and 120 days are unreasonable, and decontamination times would likely exceed one year.[84]

For Chernobyl, large-scale decontamination of the area affected by the accident terminated four years after the accident.[85] However, "[t]he accident at Fukushima gives us the most recent information available on the timeline and the magnitude of decontamination efforts

[84] *See* Ex. NYS000420, Lemay Rebuttal Test. at 3; Ex. NYS000241, Lemay Initial Test. at 52. *See also* Exs. NYS000264, NYS000265, NYS000266, NYS000267, NYS000268, NYS000269, NYS000428, NYS000263.

[85] Ex. NYS000242, ISR Report at 24; Ex. NYS000241, Lemay Initial Test. at 54.

following a severe accident."[86] Some estimates suggest that the decontamination could last for decades.[87] According to reports, full-scale decontamination for the outer edges of the plume deposition began one year after the accident.[88] Since this effort is on the outer edges of the plume deposition, it is representative of light decontamination.[89]

Amongst other things, the duration of the Fukushima cleanup has been partially attributable to the time needed to develop a decontamination plan, which is dependent on detailed radiation surveys and procurement of suitable and efficient decontamination equipment and materials, and by the time it has taken to gain approval of the supplementary budget by the Japanese federal government.[90] In addition, authorities needed to secure approval from the local communities for storage sites for decontamination waste.[91] In fact, it took one year to finalize plans and budgets for remediation efforts in the Fukushima Prefecture.[92] A comprehensive preparation period would also be expected following a severe radiological accident at Indian Point.[93]

The TIMDEC parameter represents the average time it takes a population in a given grid element[94] to return to their original home after evacuation.[95] "[I]t doesn't matter if the people

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[86] Ex. NYS000420, Lemay Rebuttal Test. at 13; *see also* Tr. 2182:3-16 (Lemay).

[87] Ex. NYS000241, Lemay Initial Test. at 53.

[88] Ex. NYS000420, Lemay Rebuttal Test. at 49.

[89] *Id.*

[90] *Id.*

[91] *Id.*; Ex. NYS000265.

[92] Ex. NYS000420, Lemay Rebuttal Test. at 41.

[93] Ex. NYS000420, Lemay Rebuttal Test. at 49; Tr. 2205:3-14 (J. McDade/Lemay).

[94] The MACCS2 code utilizes a polar-coordinate spatial grid for all of its calculations. Ex. NYS000243, MACCS2 User Guide at 2-3 – 2-4. Indian Point Units 2 and 3 are at the center of the grid and the surrounding 50 mile radius is divided into divided into sections, often referred to

are away because they were temporarily relocated, because decontamination took time, or because there was interdiction following the decontamination. Whatever the cause of the delay for people returning to their house, that's what drives the cost associated with TIMDEC."[96] It is possible that within a particular grid element, some people will return to their property more quickly than TIMDEC, and that decontamination efforts may continue long after TIMDEC.[97]

The State's expert explained that it is difficult to develop a precise estimate of the time it would take to decontaminate a large urban area after a severe nuclear accident, in light of the estimates that the Fukushima cleanup could last several decades and the Chernobyl cleanup, which continued for four years before it was stopped.[98] Given the uncertainty in determining this time, and in order to assess the impact of longer decontamination times more generally, the State's experts initially proposed decontamination times ranging from 2 to 15 years for light decontamination and 4 to 30 years for heavy decontamination.[99] After reviewing Fukushima data that was released after the State's initial filings, the State's experts adjusted the proposed ranges to 1 to 15 years for light decontamination and 2 to 30 years for heavy decontamination.[100]

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as grid elements. Ex. ENT000450 Entergy Test. at 31-32 (A46) (O'Kula, Teagarden, Potts); Tr. 1929:10-24 (Teagarden).

[95] Ex. NYS000420, Lemay Rebuttal Test. at 50.

[96] Tr. 2208:4-10 (Lemay); *see also* Tr. 2240:10-15 (Teagarden).

[97] Ex. NYS000420, Lemay Rebuttal Test. at 50; Tr. 2181:5-16 (Lemay). This testimony reflects a correction to the transcript adopted by the Board. *See* Dec. 27, 2012 Board Order at 24.

[98] Ex. NYS000241, Lemay Initial Test. at 54-55.

[99] Ex. NYS000242, ISR Report at 24-25; Ex. NYS000241, Lemay Initial Test. at 54-55.

[100] Ex. NYS000420, Lemay Rebuttal Test. at 48-49; Ex. NYS000430 at 6, Table 13; Tr. 2205:20-2206:5 (Lemay).

The MACCS2 code limits decontamination times to a maximum of one year.[101] Thus, the State's experts had to modify the MACCS2 source code to allow for the likelihood that decontamination would take longer than the 60 and 120 day values from Sample Problem A and longer than one year.[102] This modest modification did not alter the algorithms used by the MACCS2 code.[103] It was necessary to evaluate the effect decontamination time inputs appropriate for severe accidents at Indian Point would have on the economic costs used in the SAMA analysis and, thus, was reasonable.

Although NRC Staff witness Dr. Bixler could not cite any documentation to explain why the MACCS2 code limits TIMDEC inputs to one year by default, he took issue with modifying the MACCS2 code to accommodate TIMDEC inputs greater than one year.[104] Both NRC Staff and Entergy argue that TIMDEC inputs greater than one year are inconsistent with the intention of the MACCS2 decontamination model.[105] The State's expert, however, explains why it is reasonable to look at a range of values for decontamination time based on real-world experience with actual severe accidents such as Fukushima and Chernobyl.[106] What is not reasonable is for Entergy and NRC Staff to ignore real-world experience in favor of the unverified Sample Problem A values of 60 days for light and 120 days for heavy decontamination following a severe accident. The Sample Problem A values in NUREG-1150 create an unrealistic

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[101] Ex. NYS000242, ISR Report at 24; Ex. NYS000241, Lemay Initial Test. at 54.

[102] *Id.;* Tr. 2268:17-2269:2 (Lemay).

[103] Decl. of Dr. François J. Lemay at ¶ 15 (Feb. 17, 2012) (ML12048B413) (submitted in opposition to NRC Staff's and Entergy's Motions in Limine).

[104] Tr. 2272:24-2273:3 (J. Wardwell/Bixler).

[105] Ex. NRC000039 NRC Staff's Initial Statement of Position on Consolidated Contention NYS-12C at 13; Ex. ENT000449 Entergy's Statement of Position Regarding Consolidated Contention NYS-12C (Severe Accident Mitigation Alternatives Analysis) at 31-33.

[106] Ex. NYS000420, Lemay Rebuttal Test. at 50.

decontamination scenario and there is no justification for Entergy and Staff's use of those values at Indian Point.

Putting aside for the moment that timeframes greater than one year would be appropriate, even a TIMDEC value of one year would significantly affect the economic cost calculations. All parties, including NRC witness Dr. Bixler, agree that the MACCS2 code can accept TIMDEC inputs up to one year.[107] NRC recently used TIMDEC values of one year for light and one year for heavy decontamination in a MACCS2 analysis of a severe accident at a spent fuel pool.[108] The impact of changing TIMDEC, and TIMDEC alone, to one year for light decontamination and one year for heavy decontamination—while using Entergy's values for all other inputs—more than doubles the economic costs used in the SAMA analysis (OECR).[109] As TIMDEC increases, OECR also increases. The magnitude of the impact, however, does decrease over longer timeframes. As the State's expert report shows, the effect of TIMDEC on OECR lessens as time extends out beyond 10 or 20 years.[110] Figure 6 from the State's expert report, reproduced below, is a graphical depiction of the effect of decontamination time on cost in MACCS2.[111] Figure 6 shows that OECR increases as TIMDEC increases.[112] Economic costs increase over time because relocation costs increase as decontamination time increases.[113] As

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[107] Tr. 2202:2-5 (J. Kennedy/Bixler).

[108] Consequence Study, *supra*, n.32 (Attachment 7 to State's Motion to Reopen the Record and for Reconsideration of NYS-12C).

[109] Ex. NYS000430 at 6, Table 13; Tr. 2181:23-25 (Lemay) (using one year for light decontamination and two years for heavy decontamination).

[110] Ex. NYS000242, ISR Report at 25; Ex. NYS000241, Lemay Initial Test. at 53.

[111] Ex. NYS000242, ISR Report at 25, Fig. 6.

[112] *Id.*

[113] Ex. NYS000241, Lemay Initial Test. at 53.

OECR increases due to increased decontamination time, it eventually becomes more cost-effective for the MACCS2 model to condemn infrastructure and buildings instead of decontaminating.[114] At that point, the OECR plateaus.

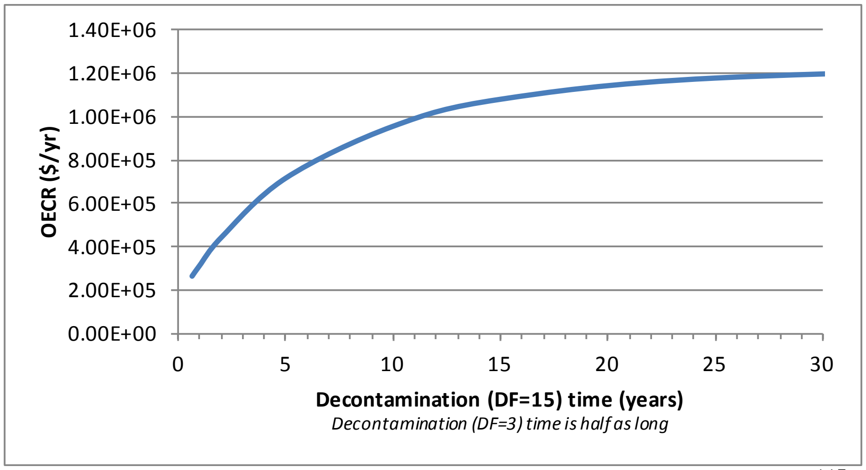

Figure 6: OECR (2005 USD) for decontamination times up to 30 years[115]

In sum, the SAMA analysis should at a minimum account for the possibility of potential decontamination times of one year because all parties agree that the MACCS2 code accepts one year TIMDEC values and NRC itself used one year TIMDEC values in a recent MACCS2 code analysis of a severe accident at a spent fuel pool. It is also important for the SAMA analysis to examine real-world data from actual severe accidents at Fukushima and Chernobyl where decontamination has lasted well past the one year mark. This real-world data necessitates examination of decontamination times longer than one year.

7) Discuss whether the Indian Point analysis contains conservatisms that bound or otherwise compensate for the uncertainty in the decontamination times and non-farm decontamination costs inputs used in the analysis.

The record contains unsupported conclusory statements that some "existing margin in the SAMA analysis [] account[s] for uncertainties."[116] As an initial matter, this statement and others

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[114] *Id.*

[115] Ex. NYS000242, ISR Report at 25, Fig. 6.

like it consist of allegations that were not supported by any calculations, spreadsheets, expert reports, or any other analysis.[117] Additionally, NRC Staff did not rely on uncertainty factors as a justification for the use of the Sample Problem A values in the FSEIS. Vague statements by NRC Staff witnesses do not show that the uncertainty factors account for incorrect TIMDEC and CDNFRM input values, or explain how they could account for such wholly unreasonable values. As such, this testimony lacks a foundation and should be afforded no weight.[118]

Furthermore, any suggestion that the uncertainty factor used in other parts of the PRA somehow accounts for issues with Entergy's MACCS2 inputs is untenable. The applicant completes a 3-level PRA as part of the SAMA analysis:[119]

- <u>PRA Level 1:</u> The evaluation of the combinations of plant failures, like equipment failures and human failures that can lead to core damage.

- <u>PRA Level 2:</u> For each core-damage sequence identified in Level 1, the evaluation of core damage progression and possible containment failure resulting in a radiological release. These are called release categories, which are discussed in more detail in response to Question 5, above.

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[116] Ex. NRC000041 Staff Test. at 14 (A6b) (Gosh).

[117] *Id.*; Tr. 2230:19-2233:3 (Ghosh) (conjecturing that there's "some degree of cushion" due to an "uncertainty multiplier" and stating "I think we feel that to some extent the existing conservatisms and uncertainty accounting in the analysis may provide the boon to consider the possibility of this type of sensitivity," but ultimately noting "[t]his is all hypothetical"); Tr. 2235:6-10 (Ghosh) ("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.").

[118] *See South Carolina Elec. & Gas Co.* (Virgil C. Summer Nuclear Station, Unit 1), ALAB-663, 14 N.R.C. 1140, 1163 (1981) ("in all circumstances the Board has the right, indeed the duty, to satisfy itself that the conclusions expressed by expert witnesses on significant safety or environmental questions have a solid foundation"); *Cf. Amorgianos v. Amtrak*, 303 F.3d 256, 266 (2d Cir. 2002) ("Thus, when an expert opinion is based on data, a methodology, or studies that are simply inadequate to support the conclusions reached, . . . [the testimony is] unreliable opinion testimony.").

[119] *See* NYS000420, Lemay Rebuttal Test. at 8-9; Tr. 1901:12-1902:19, 1907:19-25, 1908:8-21 (J. Wardwell/Teagarden).

- PRA Level 3: The evaluation of the consequences that would result from the set of radiological releases identified in Level 2, which include offsite population dose, offsite economic cost, onsite population dose, and onsite cost.

The MACCS2 code is used in the Level 3 PRA to calculate the costs associated with a severe accident, which is the focus of NYS-12C.[120] SAMA uncertainty factors of 2.1 for Indian Point Unit 2 and 1.4 for Unit 3 were calculated to account for uncertainties in predicting the frequency of internal events that lead to severe accidents causing reactor core damage in the Level 1 and Level 2 PRA.[121] They do not account for uncertainty in the Level 3 PRA (where the MACCS2 code and MACCS2 inputs such as CDNFRM and TIMDEC are used).[122]

Should Entergy and Staff cite to the external event multipliers (3.8 for Indian Point Unit 2 and 5.5 for Unit 3), it is important to note that these are not uncertainty factors and cannot account for compensate for the uncertainty in the decontamination times and non-farm decontamination costs inputs. These multipliers were calculated to take into account external events such as seismic events that lead to core damage, not uncertainty.[123] Entergy used a multiplier of 8 to represents a combination of the uncertainty factors for the Level 1 and 2 PRA and the external events multipliers. It does not account for uncertainties in the Level 3 PRA.[124] Staff may claim, as it did in its Proposed Findings of Fact and Conclusions of Law—but not in any exhibits or testimony—that this multiplier was "rounded up to 8 for some additional

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[120] Ex. NYS000420 Lemay Rebuttal Test. at 8-9; Tr. 1913:15-21 (J. Wardwell/Teagarden); Tr. 1919:16-21 (J. Wardwell/Lemay).

[121] *See* Ex. ENT000459 at 9-10.

[122] Tr. 2324:10-20 (Lemay).

[123] *See* Ex. NYS00133I, FSEIS at G-44 - G-45.

[124] Tr. 2324:10-20 (Lemay).

conservatism."[125] However as Staff stated in the FSEIS, this is a "small" amount of conservatism (0.02 for Indian Point Unit 2 and 0.27 for Unit 3).[126] There is no evidence in the record that factors of 0.02 for Indian Point Unit 2 and 0.27 for Unit 3 could account for the errors in TIMDEC and CDNFRM that result in SAMA costs estimates that are off by a factor of up to seven.[127]

Indeed, nothing in the record suggests that Entergy or Staff even considered uncertainty in the Level 3 PRA.[128] NUREG/BR-0184 (ENT00010A-D), "Regulatory Analysis Technical Evaluation Handbook," was cited by Entergy and NRC Staff as providing guidance on how to perform SAMA analyses.[129] That guidance addresses uncertainty, explaining that "NRC's Final Policy Statement on the use of probabilistic risk assessment (PRA) in nuclear regulatory activities (NRC 1995b) states that sensitivity studies, uncertainty analysis, and importance measures should be used in regulatory matters, where practical within the bounds of the state-of-the-art."[130] NUREG/BR-0184 describes seven categories of uncertainties in PRAs including data, analyst assumptions, modeling, scenario completeness, accident frequencies, accident consequences, and interpretation.[131] Despite Entergy's and Staff's failure to do so, it is possible

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[125] NRC Staff Proposed Findings of Fact and Conclusions of Law at 25, n.36 (March 22, 2013) (ML13081A698).

[126] Ex. NYS00133I, FSEIS at G-45.

[127] *See* Ex. NYS000430 at 6, Table 13.

[128] *See* ENT000459 at 9-10; Tr. 2324:10-20 (Lemay).

[129] *See* Tr. 2198:11-16 (O'Kula); Tr. 2285:9-22 (Ghosh).

[130] Ex. ENT000010A at 5.3.

[131] Ex. ENT00010A at 5.3 to 5.4.

to account for some of the uncertainty in the Level 3 PRA by following the method used to quantify uncertainty in the Level 1 and 2 PRA and using the exhibits submitted by Entergy.[132]

Consequently, there is no support for the notion that these uncertainty factors account for any and all potential uncertainty in the SAMA analysis—including errors in estimating the CDNFRM and/or TIMDEC.

8) The Indian Point SAMA analysis states that the methodology for cleaning up a nuclear weapons accident that was described in a 1996 Sandia National Laboratory study is "not relevant to clean-up following" a nuclear reactor accident.[133] Nonetheless, the SAMA analysis goes on to describe a comparison of decontamination cost values derived from the study with the decontamination cost values used in the Indian Point analysis. Address to what extent (if any) the comparison to the weapons accident study explains or otherwise substantiates the decontamination cost parameters used in the Indian Point analysis.

In determining whether the Sample Problem A TIMDEC values were reasonable for the Indian Point SAMA analysis, the State's experts reviewed several data sources including a 1996 Sandia National Laboratory study, Ex. NYS000249, D. Chanin & W. Murfin, SAND96-0957, *Site Restoration: Estimation of Attributable Costs From Plutonium-Dispersal Accidents* (May 1996). *Site Restoration* is a robust, important study that drew on experience involving radiation dispersion events from various sources including lessons learned from decontamination efforts following the Chernobyl reactor accident. As the Commission's question notes, *Site Restoration* derived the costs of a cleanup following plutonium dispersal as the result of a nuclear weapons accident, not a reactor accident. For this reason, the State's experts adjusted the *Site Restoration* values to account for the fact that cesium, and not plutonium, would be the radionuclide of

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[132] *See e.g.* Ex. ENT000464, Entergy Calculation No. IP-CALC-09-00265, Rev. 0, Re-analysis of MACCS2 Models for IPEC, Dec. 2, 2009

[133] *See* Ex. NYS00133I, FSEIS at G-23 (referencing Ex. NYS000249, "Site Restoration: Estimation of Attributable Costs from Plutonium-Dispersal Accidents," SAND96-0957 (May 1996)).

primary concern in a severe nuclear accident at Indian Point.[134] In addition, the State's experts provided a detailed response to Staff's criticisms of *Site Restoration* that appear in FSEIS, Appendix G. This response is provided in Annex A of the ISR Report, titled "Response to US NRC Staff Evaluation (Appendix G)."[135]

In the FSEIS (at Appendix G-23 – G-24), NRC Staff discusses *Site Restoration* and the difference between plutonium and cesium. Staff notes that plutonium is an alpha emitter that is more difficult and expensive to characterize and verify in the field than gamma emitters like cesium.[136] Also, the FSEIS states that plutonium is primarily an inhalation hazard with a much longer half-life than cesium. Staff recognized that cesium is primarily an external health hazard with a half-life of 30 years.[137]

The FSEIS discusses the expense associated with detecting and characterizing plutonium following a severe accident, implying that radionuclide detection and characterization is a large part of the decontamination costs.[138] The State's experts asserts that, while detection and characterization of plutonium may be more costly than for cesium, it comprises a small part of decontamination costs, less than 1% of the decontamination costs, according to *Site Restoration*.[139] The main cost of decontamination is not radionuclide detection/characterization, but decontamination, removal, transport, and storage of waste and/or building demolition.[140]

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[134] *Id.*

[135] Ex. NYS000242, ISR Report at 36-40.

[136] Ex. NYS00133I, FSEIS at G-23.

[137] *Id.* The deposition of cesium, with a 30-year half-life, in the New York metropolitan area would entail substantial economic costs.

[138] Ex. NYS000242, ISR Report at 36-37; Ex. NYS000241, Lemay Initial Test. at 65-66.

[139] *Id.*

[140] Ex. NYS000241, Lemay Initial Test. at 65-66.

Additionally, NRC Staff's discussion of the need for evacuation is irrelevant because public evacuation and the associated costs are not part of the MACCS2 code's assessment of economic costs.[141] The SAMA analysis includes the costs of longer-term dose reduction measures such as permanent relocation and decontamination.[142] It is the cost of these measures that should be assessed for plutonium and cesium.[143]

The State's experts also address NRC Staff's claim that the activities in *Site Restoration* required to support cleanup of moderate plutonium contamination align more closely with cleanup activities for heavy cesium contamination.[144] In support of this claim, NRC Staff relies heavily on work performed by Sandia concerning an example of decontaminating a road, claiming that complete removal of a road is needed for plutonium, but not for cesium decontamination.[145] After a detailed explanation, ISR concludes that any effective decontamination technique will result in some removal of cesium, plutonium, and any other radionuclides—all of which are present, including plutonium in small quantities, after a severe nuclear reactor accident.[146] ISR explains that, using the example of road decontamination, if complete removal of the road is justified on the basis of the presence of plutonium, it will also result in the full decontamination of cesium.[147]

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[141] *Id.*

[142] *Id.*

[143] *Id.*

[144] Ex. NYS000242, ISR Report at 37-39; Ex. NYS000241, Lemay Initial Test. at 66-68.

[145] Ex. NYS000218, Sandia, Technical Assistance in Support of the Indian Point Units 2 and 3 License Renewal Initial Assessment - Technical Review at 6 (Jan. 8, 2010).

[146] *Id.*

[147] *Id.*

To properly rely on *Site Restoration*, the State's experts modified the cost of decontamination values using information from Luna's *Survey of Costs* and U.S. Census data to calculate CDNFRM.[148] *Survey of Costs* used the Sandia *Site Restoration* data and analysis for Albuquerque, New Mexico, as a basis for calculating the cost of cleanup of the hyper-dense population area of New York City.[149] The State's experts modified the analysis in *Survey of Costs* and *Site Restoration* using U.S. Census data to better account for the actual building density.[150] Consequently, in NRC Staff's analysis of *Site Restoration* in the FSEIS ignores the fact that New York City has a much higher building density than Albuquerque.[151] As explained in the ISR Report and Dr. Lemay's testimony, decontamination following any radioactive release will vary considerably in cost and time depending on level of decontamination (light or heavy) and the radionuclide involved.[152] *Site Restoration* used historical data from various actual releases of plutonium and other radionuclides to derive the costs of a cleanup following plutonium dispersal in Albuquerque, New Mexico, but cesium is the radionuclide of primary concern in the event of a severe nuclear reactor accident.[153] Unlike the larger-sized plutonium particles, the small-sized cesium particles are soluble and have the ability to ion exchange with sodium and potassium present in materials such as concrete.[154] Thus, cesium will migrate

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[148] Ex. NYS000242, ISR Report at 16; Ex. NYS000241, Lemay Initial Test. at 34.

[149] Ex. NYS000241, Lemay Initial Test. at 34.

[150] *Id.*

[151] Ex. NYS000242, ISR Report at 40; Ex. NYS000241, Lemay Initial Test. at 69.

[152] Ex. NYS000242, ISR Report at 16-18; Ex. NYS000241, Lemay Initial Test. at 34-40.

[153] *Id.*

[154] *Id.*

rapidly in porous materials such as concrete.[155] This migration increases with time and, therefore, decontamination of cesium is more difficult as more time passes after the release.[156]

Although *Site Restoration* examines a methodology for cleaning up a nuclear weapons accident, it drew on real-world experience cleaning up both nuclear weapons accidents and tests, manufacturing operations, as well the nuclear reactor accident at Chernobyl.[157] Additionally, *Site Restoration* itself recognized the higher costs associated with a severe accident at a nuclear reactor.[158] Lastly, any criticism of *Site Restoration* is contradicted by the evidence showing that Os84—and thus the NUREG-1150 CDNFRM values—were likely based upon nuclear weapons releases and plutonium. NRC Staff and Entergy themselves provided conflicting, speculative testimony, ultimately conceding that the source of the NUREG-1150 values was likely not reactor accidents and cesium decontamination.[159]

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[155] *Id.*

[156] *Id.*

[157] Ex. NYS000249, Sandia, *Site Restoration* at Appendix A (examining cleanup criteria, methods, and costs in Palomares, Spain; Thule, Greenland; Enewetak Atoll; Johnston Island; BOMARC Missile Site, McGuire Air Force Base; Montclair-East Orange, New Jersey Radium Soil Site; and Fernald Plant), E-11 (taking into account that "[a]fter the Chernobyl accident, it became widely recognized that the decontamination of urban areas could be exceedingly difficult.").

[158] *Id.* at 2-3 – 2-4 ("In comparing the numbers of cancer health effects that could result from a plutonium-dispersal accident to those that could result from a severe accident at a commercial nuclear power plant, it is readily apparent that the health consequences and costs of a severe reactor accident could greatly exceed the consequences of even a "worst-case" plutonium-dispersal accident because the quantities of radioactive material in nuclear weapons are a small fraction of the quantities present in an operating nuclear power plant.").

[159] *See, e.g.*, Tr. 2025:20-2026:14 (J. McDade/Jones); Tr. 2037:1-2038:1 (O'Kula/Harrison); Tr. 2100:16-18 (Jones).

III. CONCLUSION

For the foregoing reasons, and the reasons set forth in the State's petitions for review and replies in support of the petitions for review, the Commission should resolve NYS-12C in favor of the State and hold that the Director of Nuclear Reactor Regulation is not authorized to issue, and may not issue, renewed operating licenses for the Indian Point nuclear power plants Units 2 and 3 unless and until NRC Staff cures the deficiencies in the FSEIS in a supplement that is circulated for public comment.

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