

1 UNITED STATES

2 NUCLEAR REGULATORY COMMISSION

3 BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

4 -----X

5 In re: Docket Nos. 50-247-LR; 50-286-LR
6 License Renewal Application Submitted by ASLBP No. 07-858-03-LR-BD01
7 Entergy Nuclear Indian Point 2, LLC, DPR-26, DPR-64
8 Entergy Nuclear Indian Point 3, LLC, and
9 Entergy Nuclear Operations, Inc. June 29, 2012

10 -----X

11 REBUTTAL TESTIMONY OF

12 DR. STEPHEN C. SHEPPARD, PH.D.

13 REGARDING CONTENTION NYS-16/16A/16B ("NYS-16B")

14 On behalf of the State of New York ("NYS" or "the State"),
15 the Office of the Attorney General hereby submits the following
16 testimony by Dr. Stephen C. Sheppard, Ph.D. regarding Contention
17 NYS-16/16A/16B ("NYS-16B").

18 Q. Please state your full name.

19 A. Dr. Stephen Charles Sheppard, Ph.D.

20 Q. Dr. Sheppard, could you briefly summarize the
21 testimony you provided on December 16, 2011?

22 A. I was retained by the State of New York in connection
23 with the State's Contention 16B, which asserts that Entergy and

*Rebuttal Testimony of
Dr. Stephen Sheppard, Ph.D.
Contention NYS-16B*

1 NRC Staff have underestimated the 2035 population within 50
2 miles of Indian Point likely to be exposed to radiation during a
3 severe accident. In my testimony and expert report I described
4 two key deficiencies in Entergy's and NRC Staff's population
5 estimate. The first is the failure to account for census
6 undercount and the second is the failure to account for the
7 commuter population.

8 Q. What is the purpose of this reply testimony you are
9 now providing?

10 A. The State of New York has asked me to respond to
11 Entergy's March 28, 2012 and NRC Staff's March 30, 2012
12 testimony on Contention 16B.

13 Q. What is the scope of your analysis in connection with
14 Contention 16B?

15 A. I was asked to review Entergy's and NRC Staff's
16 population estimates. These estimates, while ultimately used in
17 the Severe Accident Mitigation Alternatives ("SAMA") analysis,
18 are based on Census Bureau and other demographic data. As an
19 economist, I have expertise in estimating populations and have
20 worked frequently with census and other demographic data. While
21 it is true that I do not have experience in the nuclear field,
22 using the MACCS or MACCS2 computer codes, or performing SAMA
23 analyses, this does not affect my ability to examine and

*Rebuttal Testimony of
Dr. Stephen Sheppard, Ph.D.
Contention NYS-16B*

1 critique the population numbers relied upon by Entergy in its
2 SAMA analysis.

3 Q. Generally, what kind of training is required to be
4 able to analyze demographic data to accurately estimate future
5 populations?

6 A. To be able to analyze demographic data, one needs
7 training in the economic and social forces that determine rates
8 of migration, where populations live, and decisions about family
9 size. Training in fields such as labor or urban economics,
10 urban sociology, and human geography provides an understanding
11 of how to analyze demographic data to accurately estimate future
12 populations. Training in how to operate a computerized mapping
13 system does not provide an understanding of demography or the
14 economic and social forces that determine population levels.

15 Q. Have you reviewed any additional documents since your
16 December 16, 2011 testimony in preparation for this rebuttal
17 testimony?

18 A. Yes. I have reviewed the following documents filed by
19 Entergy on March 28, 2012: Entergy's Statement of Position
20 Regarding Consolidated Contention NYS-16B (Severe Accident
21 Mitigation Alternatives Analysis) (ENT000002)("Entergy SOP");
22 Testimony of Entergy Witnesses Lori Potts, Kevin O'Kula, Grant
23 Teagarden, and Jerry Riggs on Consolidated Contention NYS-16B

*Rebuttal Testimony of
Dr. Stephen Sheppard, Ph.D.
Contention NYS-16B*

1 (Severe Accident Mitigation Alternatives Analysis)
2 (ENT000003)("Entergy Test."); and the supporting exhibits,
3 including the Rebuttal Commuter Analysis (ENT000027). I have
4 also reviewed the supporting files for the rebuttal commuter
5 analysis (April 6, 2012 Entergy Mandatory Disclosure Log Entry
6 #9317), which include workplace county flow files and a
7 spreadsheet with calculations, provided by Entergy via email on
8 April 3, 2012.

9 Additionally, I have reviewed the following documents filed
10 by NRC Staff on March 30, 2012: NRC Staff's Initial Statement of
11 Position on Consolidated Contention NYS-16B (NRC000040) ("Staff
12 SOP"); NRC Staff Testimony of Nathan E. Bixler, S. Tina Ghosh,
13 Joseph A. Jones, and Donald G. Harrison Concerning NYS's
14 Contentions NYS 12/16 (NRC000041) ("Staff Test."); and the
15 supporting exhibits. I have also reviewed the two Excel
16 spreadsheets, titled "county to counter 2KWRKCO_NY.xlsx" and
17 "2010 census v. entergy estimate.xlsx," provided by NRC Staff
18 via email on April 12, 2012.

19 **Conservative Population Estimates**

20 Q. In estimating future populations that could
21 potentially be present in an area surrounding a nuclear power
22 plant during a severe accident at a future point in time, are
23 there any guiding principles that should be taken into account?

*Rebuttal Testimony of
Dr. Stephen Sheppard, Ph.D.
Contention NYS-16B*

1 A. Yes, an accurate and appropriate future population
2 estimate should take into account the entire potential
3 population that could be exposed to nuclear radiation, not just
4 permanent residents.

5 Q. Is there any nuclear industry guidance that recommends
6 conservatism?

7 A. Yes. The nuclear industry released NEI 05-01, Rev. A
8 (NYS000287) ("NEI 05-01"), which is cited by Entergy and
9 recommends adding conservatism to the population estimate and
10 including the transient population in that estimate. I take
11 this to mean that a conservative and scientifically valid
12 estimate of future population in the area should be provided.

13 Q. Are Entergy's and NRC Staff's population estimates
14 conservative?

15 A. No. By failing to take census undercount and
16 commuters into consideration, Entergy and NRC Staff have
17 underestimated the 2035 population likely to be exposed to a
18 severe accident at Indian Point. This underestimation is not
19 conservative because it ignores commuters, who are a significant
20 part of the potentially exposed, transient population, and a
21 well-know issue with census data, census undercount.

22 Q. Even though it did not take commuters or undercount
23 into account, did Entergy otherwise employ a conservative method

*Rebuttal Testimony of
Dr. Stephen Sheppard, Ph.D.
Contention NYS-16B*

1 of estimating population growth in the counties within a 50-mile
2 radius of Indian Point?

3 A. For three counties, Entergy's approach was not
4 conservative and is therefore inconsistent with industry
5 guidance. NRC Staff's expert, Mr. Jones, notes that Entergy
6 conducted a regression analysis for three counties to determine
7 their 2035 population. Staff Test. at 95, A86. However, NEI
8 05-01 suggests that a licensee make a conservative population
9 estimate, looking to a year within the relicensing period when
10 the population is at its highest:

11 Typically, with increasing population, the predicted
12 population is estimated for a year within the second
13 half of the period of extended operation.
14 Extrapolation to a later date, and therefore a larger
15 population, adds conservatism to the analysis. Of
16 course, if a population reduction is projected
17 extrapolation to an earlier date would be more
18 reasonable.

19 NEI 05-01 at 13. The population for New York, Rockland, and
20 Westchester counties is projected to peak within the relicensing
21 period. However, instead of looking at the peak population as
22 suggested by NEI 05-01, Entergy conducted a regression analysis
23 for these three counties to determine how much the population

*Rebuttal Testimony of
Dr. Stephen Sheppard, Ph.D.
Contention NYS-16B*

1 will decline from its peak by the year 2035. A conservative
2 estimate would include the peak population during the proposed
3 relicensing period.

4 **Commuters**

5 Q. Dr. Sheppard, let's turn to commuters. Did either
6 Entergy or NRC Staff take commuters into account?

7 A. No. Entergy's population estimate purports to include
8 "transients," but Entergy's definition of transients includes
9 only tourists and business travelers. Entergy Test. at 28, A55.
10 The data Entergy used to estimate the transient population was
11 gathered from state tourism agencies, and therefore only
12 includes visitors, not commuters.

13 Q. Do either NRC Staff or Entergy deny the existence of
14 commuters who live outside the 50-mile zone of Indian Point, but
15 travel to jobs within the zone?

16 A. No, neither NRC Staff nor Entergy denies the existence
17 of close to a million commuters. In its rebuttal commuter
18 analysis, Entergy admits that there are 964,093 such commuters.
19 ENT000027 at 2. NRC Staff's expert, Mr. Jones, states, "I
20 evaluated commuters entering the SAMA area from locations
21 outside the modeled area and agree with Dr. Sheppard (NYS000207
22 at 16) that about 1,000,000 commuters enter the SAMA area for a
23 work shift and then return home." Staff Test. at 17, A7.

*Rebuttal Testimony of
Dr. Stephen Sheppard, Ph.D.
Contention NYS-16B*

1 Q. Do either NRC Staff or Entergy deny the fact that
2 these commuters weren't included in the population estimate used
3 by Entergy in its SAMA analysis?

4 A. No.

5 Q. Entergy argues that it followed industry guidance in
6 including business travelers and tourists, but not commuters, in
7 the transient population used in its SAMA analysis (Entergy
8 Test. at 19, A41 and 28-29, A56). Do you agree that it was
9 proper to exclude commuters from the transient population?

10 A. No, I do not agree that it was proper for Entergy to
11 exclude commuters from the transient population. In fact, I
12 find it troubling that NRC Staff's expert Mr. Jones continues to
13 regard the transient population as consisting only of tourists.
14 See Staff Test. at 95, A86. The transient population is the
15 population that may be present within the area, but does not
16 reside there. This includes tourists, to be sure, but it also
17 includes commuters.

18 Furthermore, I disagree that Entergy's exclusion of
19 commuters from the transient population was consistent with
20 industry guidance. As Entergy's experts note, industry guidance
21 on SAMA analyses, NEI 05-01, recommends that the transient
22 population included in the site emergency plan should be added
23 to the census data to be used in the SAMA analysis. Entergy

*Rebuttal Testimony of
Dr. Stephen Sheppard, Ph.D.
Contention NYS-16B*

1 Test. at 28, A56; NEI 05-01 at 13. Entergy's experts also note
2 (Entergy Test. at 28, A56) that Indian Point's site emergency
3 plan incorporates the definition of transients from the Indian
4 Point Energy Center Development of Evacuation Time Estimates,
5 Rev. 2 (ENT000014) ("IPEC ETE"). IPEC ETE includes three groups
6 of people in the total population: (1) permanent residents
7 (those who are year round residents); (2) transients (people who
8 reside outside of the emergency zone and enter the area for a
9 specific purpose such as shopping or recreation, and then leave
10 the area); and (3) employees (people who reside outside of the
11 emergency zone and commute to businesses within the zone on a
12 daily basis). IPEC ETE at 3-2. Although Entergy chose to label
13 them as "employees" instead of "transients," commuters are
14 included along with other types of transients in the population
15 estimate in IPEC ETE. Furthermore, the NRC guidance document
16 for conducting evacuation time estimates (State of the Art in
17 Evacuation Time Estimate Studies for Nuclear Power Plants,
18 NUREG/CR-4831, Mar. 1992, NYS000405) that is cited in IPEC ETE
19 (ENT000014 at ES-1) specifically notes that transients,
20 including commuters, should be included in the population
21 estimate. It states, "Transients are visitors, including
22 tourists and daily employees, who live outside the EPZ
23 [emergency planning zone]." NYS000405 at 3. A more recent

*Rebuttal Testimony of
Dr. Stephen Sheppard, Ph.D.
Contention NYS-16B*

1 evacuation time estimate guidance document (Development of
2 Evacuation Time Estimate Studies for Nuclear Power Plants,
3 NUREG/CR-6863, Jan. 2005, NYS000406) also includes commuters in
4 the definition of transients, stating: "The transient population
5 group includes visitors, tourists, shoppers, employees not
6 residing in the area, and other people visiting the area
7 temporarily." NYS000406 at 6. Furthermore, NRC Staff's expert
8 Mr. Jones was the lead author of a guidance document on
9 evacuation time estimates that was issued in November 2011
10 (Criteria for Development of Evacuation Time Estimate Studies,
11 NUREG/CR-7002, Nov. 2011, ML11329A053, NYS000407). Staff Test.
12 at 4, A2c. This document states: "The transient population
13 includes tourists, shoppers, employees, etc., who visit but do
14 not reside in the area." NYS000407 at 11-13.

15 Entergy is incorrect to argue that it was following NRC and
16 industry guidance in including only tourists and business
17 travelers in the transient population. NRC guidance documents
18 recommend that commuters be included in the transient population
19 and Entergy itself considered commuters as part of the total
20 population in IPEC ETE.

21 Q. NRC Staff's expert Mr. Jones argues that it was
22 reasonable for Entergy to exclude commuters stating: "Tourists
23 including business travelers who stay overnight are included in

*Rebuttal Testimony of
Dr. Stephen Sheppard, Ph.D.
Contention NYS-16B*

1 the permanent population because they are in the modeled SAMA
2 area for an extended time and could potentially accumulate dose
3 as the result of an accident at Indian Point. Commuters, on the
4 other hand, are only in the SAMA area about a third of day (8
5 hours plus commuting time)." Staff Test. at 101, A94. Do you
6 agree with his assessment?

7 A. No. Tourists and business travelers do not necessarily
8 spend more time than commuters within the 50 mile zone and,
9 therefore, should not be considered differently for purposes of
10 determining the population input to the MACCS2 code. Tourism
11 agencies, from which Entergy obtained its data, collect
12 information from popular tourist destinations, surveys, and
13 hotel registrations. These estimates include persons who enter
14 a state for shopping or recreation and may not necessarily stay
15 overnight. In fact, commuters may be more likely to be affected
16 by a severe accident than tourists. For example, a tourist is
17 unlikely to return to the 50 mile zone after a severe accident,
18 but by definition a commuter has a job within the 50 mile zone
19 to which he or she must return. Excluding commuters from the
20 population estimate, but including tourists, is inconsistent and
21 not reasonable.

22 Q. How did Entergy calculate the transient population it
23 did include?

*Rebuttal Testimony of
Dr. Stephen Sheppard, Ph.D.
Contention NYS-16B*

1 A. The Site Specific MACCS2 Input Data for Indian Point
2 Energy Center report prepared by Enercon (NYS00270A and
3 NYS00270B, also excepted in NYS000211, at 2-2 to 2-5) describes
4 how the transient population was calculated. First, Entergy
5 obtained data on the number of annual visitors from state
6 tourism agencies. Second, it determined the number of annual
7 visits on a per county basis. Third, for each county, it
8 obtained a ratio of transient to permanent residents by dividing
9 the number of county visits per day by the permanent resident
10 county population. Fourth, it multiplied the predicted 2035
11 permanent resident population by this ratio to obtain the
12 estimated 2035 transient population for each county.

13 Q. Did Entergy adjust the state tourism data to account
14 for the portion of a day tourists and business travelers spent
15 within the 50-mile zone of Indian Point?

16 A. No, Entergy did not adjust the state tourism data to
17 account for the amount of time tourists spent within the 50-mile
18 zone, nor does the industry guidance on SAMA analysis, NEI 05-
19 01, suggest that such an adjustment be made.

20 Entergy could have used state data to cull out daily
21 visitors from overnight visitors and include only a percentage
22 of daily visitors, but including all of the transient population
23 is the more appropriate and conservative approach to estimating

*Rebuttal Testimony of
Dr. Stephen Sheppard, Ph.D.
Contention NYS-16B*

1 the population that could be exposed to radiation in the event
2 of a severe accident. Just as Entergy did not reduce the number
3 of tourists and business travelers to account for the amount of
4 time they spent in the zone, it should not reduce the commuter
5 population by half.

6 Q. Are commuters who travel from residences that are more
7 than 150 miles away already included as part of the transient
8 population Entergy received from the states and added to the
9 census data (Entergy Test. at 45, A83; Staff Test. at 102, A95)?

10 A. Because neither Entergy nor NRC Staff have provided an
11 explanation of how the state tourism agencies calculated annual
12 visitors, it is difficult to tell for sure. However, scholars
13 have documented that a small portion of the population commutes
14 very long distances to jobs on a daily or weekly basis. These
15 individuals are known in the literature as "super-commuters."
16 It is estimated that 59,000 super commuters work in Manhattan
17 alone. See Moss & Qing, *The Emergence of the "Super-Commuter"*,
18 at 9 (NYS000408)(Feb. 2012). For this reason, I believe that a
19 conservative estimate of the potential population that could be
20 within 50 miles of Indian Point during a severe accident should
21 include the small number of persons who commute over these long
22 distances. Of the 999,765 commuters that work within 50 miles of
23 Indian Point, Entergy's experts estimate that only 35,672 are

*Rebuttal Testimony of
Dr. Stephen Sheppard, Ph.D.
Contention NYS-16B*

1 long distance commuters. ENT000027 at 12. Subtracting these
2 long distance commuters causes the commuter population to
3 decrease only "slightly." *Id.*

4 Q. NRC Staff's expert Mr. Jones assumes the commuter
5 values presented in your expert report are inflated by 25% for
6 individuals who have already been counted as business travelers
7 in the state data on transient populations (Staff Test. at 104,
8 A95). On what basis does Mr. Jones make this assumption and do
9 you find it reasonable?

10 A. Mr. Jones provides no support whatsoever for that
11 claim. Indeed in Mr. Jones's testimony he states, "If we assume
12 that Dr. Sheppard's values are inflated by 25%...." Staff Test.
13 at 104, A95. He simply assumes this to be correct and offers no
14 valid evidence that his assumptions are scientifically valid.
15 This alternative appears to have more to do with presenting a
16 "counter-offer" to the commuter population I proposed in my
17 expert report than with undertaking the sort of careful and
18 scientifically valid analysis that should have been done in the
19 first place.

20 Q. What support has Mr. Jones provided for the assertion
21 that "an increase of less than 1% in the permanent population
22 would account for the commuter population" (Staff Test. at 101,
23 A94)?

*Rebuttal Testimony of
Dr. Stephen Sheppard, Ph.D.
Contention NYS-16B*

1 A. This figure, mentioned by Mr. Jones, (Staff Test. at
2 101, A94) appears to be another convenient round number that is
3 more the product of his assumptions than his analysis. Mr.
4 Jones has not provided any supporting calculations or other
5 documentation to show where the 1% value came from.

6 Additionally, the 1% figure does not appear to be related
7 to the percentage of the population that represents commuters.
8 The number of persons who commute from locations outside the 50
9 mile radius of Indian Point to workplaces within that radius was
10 nearly 890,000 persons in 2000, and this number is expected to
11 grow to over 995,000 persons by 2035. The number of commuters
12 into the region is nearly 5% of the total resident population,
13 not 1%.

14 Q. Entergy's experts argue that an accurate accounting of
15 commuters would also need to consider commuters out of the 50-
16 mile region surrounding Indian Point (Entergy Test. at 45, A83).
17 What is your response?

18 A. I do not agree with Entergy's approach of calculating
19 a daytime or "work day" population by subtracting those
20 permanent residents who commute out of the 50-mile region. It
21 is important to keep in mind that the population estimate for
22 purposes of the SAMA analysis should be conservative. One must
23 distinguish between estimating the population at a specific date

*Rebuttal Testimony of
Dr. Stephen Sheppard, Ph.D.
Contention NYS-16B*

1 and time, and generating a comprehensive picture of the
2 population over the 20 year relicensing period. A comprehensive
3 view looks at the most people who could be at risk in a typical
4 24 hour cycle. For example, during a typical rush hour,
5 commuters who reside inside and outside of the 50 mile zone of
6 Indian Point may be crossing paths inside of the zone. Indeed,
7 the IPEC ETE takes all of these individuals into account. This
8 is also consistent with the NEI 05-01 guidance, which suggests
9 that the SAMA analysis consider the peak population during the
10 relicensing period.

11 Q. Have you reviewed Entergy's experts' revised commuter
12 analysis contained in Table 4 on page 47 of Entergy's Testimony?

13 A. Yes, I have.

14 Q. What is your response to this revised commuter
15 analysis?

16 A. In the revised commuter analysis, Entergy's experts
17 attempt to calculate a "work day" population in the 50 mile
18 region surrounding Indian Point by subtracting permanent
19 residents who work outside the zone from commuters coming into
20 the zone. I believe this is unacceptable for the reasons
21 mentioned above. A conservative estimate should look at the
22 maximum amount of people who are in the area on a daily basis.
23 A "work day" population estimate involves many non-conservative

*Rebuttal Testimony of
Dr. Stephen Sheppard, Ph.D.
Contention NYS-16B*

1 assumptions. For example, it assumes that an accident will only
2 occur at Indian Point between 9 a.m. and 5 p.m., Monday through
3 Friday, after the population has arrived at their places of
4 employment. It does not account for those times of day when
5 permanent residents leaving the area and commuters entering the
6 area (or vice versa) are both within the 50 mile zone.

7 **Census Undercount**

8 Q. Let's turn to discussing census undercount. Dr.
9 Sheppard, are you challenging the use of census data?

10 A. No, I am not challenging the use of census data.
11 Census data is a proper starting point in forming a population
12 estimate. As Entergy's experts point out, there are many uses
13 of census data such as Congressional redistricting, state and
14 local redistricting, funds allocation, and governmental program
15 administration. Entergy Test. at 42, A79. It is important to
16 remember that while many uses of census data have political
17 underpinnings, the use of census data to estimate the population
18 potentially exposed to a severe accident at Indian Point is not
19 a political matter. Estimating this population is a matter of
20 public health and safety. That's why Entergy's and NRC Staff's
21 population estimates must be accurate and conservative, and why
22 underestimations are significant deficiencies.

23
*Rebuttal Testimony of
Dr. Stephen Sheppard, Ph.D.
Contention NYS-16B*

1 Q. If you are not challenging the use of census data,
2 what is the issue you raise regarding census data?

3 A. In order to form an accurate population estimate
4 appropriate for its SAMA analysis, Entergy must adjust census
5 data for those individuals who have been missed by the decennial
6 census due to census undercount.

7 Q. Is adjusting for census undercount controversial?

8 A. Census undercount is a widely-recognized phenomenon
9 that has been acknowledged by both the Census Bureau and the
10 U.S. Congress. It is an accepted fact that an undercount of
11 some degree is inevitable in any attempt to count hundreds of
12 millions of individuals. However, since the rates of census
13 undercount have been well-documented, adjusting for undercount
14 can be done using demographic analysis and/or post-census
15 sampling.

16 Census data is used for a variety of diverse purposes. For
17 example, census data is used for apportioning seats in the U.S.
18 House of Representatives, drawing the boundaries of U.S.
19 electoral districts, and allocating federal funds. Adjusting
20 census data for census undercount or for any other reason can be
21 *politically* controversial because of its consequences— a state
22 may lose a congressional seat, an electoral district's
23 boundaries may change, or a municipality may lose federal

*Rebuttal Testimony of
Dr. Stephen Sheppard, Ph.D.
Contention NYS-16B*

1 funding. The controversy arises over the political implications
2 of the adjustment, rather than the adjustment itself. It is
3 uncontroversial that adjusting for undercount provides a more
4 accurate population estimate and a population estimate that is
5 more conservative, in line with NEI 05-01.

6 Q. Why does the Census Monitoring Board Report
7 (NYS000213), characterize the statistical estimation to adjust
8 the census as a controversial issue (Staff Test. at 99, A90)?

9 A. The Census Monitoring Board Report is referring to the
10 political controversy I mentioned in my last answer. Due to the
11 very high rates of undercount in the 1990 census, Congress
12 passed the Decennial Census Improvement Act in 1991, which
13 directed the Secretary of Commerce to contract with the National
14 Academy of Sciences ("NAS") to study methods for obtaining more
15 accurate population counts. Based on the recommendations of
16 NAS, the Census Bureau announced plans to use statistical
17 sampling to supplement the data collected through census forms
18 returned in the upcoming 2000 census. Fearing that such
19 statistical sampling would hurt their majority in Congress,
20 Republicans pushed through a bill prohibiting the use of
21 sampling or statistical adjustment for the purpose of
22 determining the population to be used for Congressional
23 apportionment. This bill was then vetoed by President Clinton.

*Rebuttal Testimony of
Dr. Stephen Sheppard, Ph.D.
Contention NYS-16B*

1 The issue was later litigated and the U.S. Supreme Court
2 determined that the use of statistical sampling for
3 Congressional apportionment violates the Census Act. However,
4 the Census Bureau is not prohibited from statistically adjusting
5 the population numbers used for other purposes such as
6 redistricting or federal funds allocation.

7 It should be noted that the paragraph of the Census
8 Monitoring Board Report referred to in Staff's testimony
9 concludes that statistical adjustment could have eliminated or
10 corrected undercount in the 2000 census. NYS000213 at
11 OAGI0001265_00031.

12 Q. Did Entergy or NRC Staff adjust for census undercount?

13 A. No.

14 Q. Although Entergy did not include undercount in its
15 population estimate, is it fair to say that "it did model the
16 population growth through 2035 using some conservative
17 assumptions that adequately account for any potential undercount
18 that may have been present in the 2000 Census" (Staff Test. at
19 100, A91)?

20 A. No. Neither NRC Staff nor Entergy demonstrates that
21 any of the assumptions claimed to be conservative are comparable
22 to the magnitude of the census undercount error. The way to
23 ensure sound analysis is with a table that compares the

*Rebuttal Testimony of
Dr. Stephen Sheppard, Ph.D.
Contention NYS-16B*

1 magnitude of conservatism with the magnitude of error. Mere
2 allegations of conservatism are inadequate. The estimated costs
3 of a severe accident depend on both the number and location of
4 population. NRC Staff's and Entergy's experts have put forward
5 an analysis that fails to make appropriate conservative
6 adjustments for population, and now hope to justify this failure
7 by comparing the 2010 census figures for the entire region
8 rather than conducting a detailed analysis for each sub-area.
9 Their approach is neither scientifically valid nor consistent
10 with guidelines to make use of conservative population
11 estimates.

12 Q. Is Entergy correct in arguing that Exhibit NYS000212
13 (the Robinson et al. article) is irrelevant because it pertains
14 to the 1990 census and not the 2000 census data used by Entergy
15 in its SAMA analysis (Entergy Test. at 39, A73)?

16 A. I disagree with the assertion that the Robinson
17 article is irrelevant because it describes undercount in the
18 1990 census. The article underscores the persistent problem of
19 undercounted populations. Although it had been documented prior
20 to 1990, that was first time census undercount became a
21 significant public issue that received a large amount of media
22 attention and scholarly analysis. The article also shows that
23 there are established, reliable methods for determining the rate

*Rebuttal Testimony of
Dr. Stephen Sheppard, Ph.D.
Contention NYS-16B*

1 of undercount among different groups.

2 Q. Does the A.C.E. Revision II Technical Assessment,
3 (ENT000016) ("A.C.E. Revision II"), supersede Exhibits NYS000213
4 (U.S. Census Monitoring Board Report) and NYS000214 (ESCAP II:
5 Demographic Analysis Results), as Entergy argues (Entergy Test.
6 at 40, A73)?

7 A. The A.C.E. reports are part of the Accuracy and
8 Coverage Evaluation process that is undertaken within the Census
9 Bureau to better understand and estimate the extent of census
10 undercount. This process has provided several different
11 estimates of the magnitude of the census undercount. In
12 addition, estimates made by other demographers have been
13 published in the scientific and professional literature. The
14 estimates for the 2000 census show no or minimal undercount for
15 white populations, and undercounts for minority populations that
16 range from 5.8% for black males to less than 1% for Native
17 Americans. The variation in estimates depends upon whether one
18 relies on demographic analysis (births, deaths, and migration
19 flows) or post-enumeration sampling to estimate the magnitude of
20 the undercount. The A.C.E. Revision II utilized post-
21 enumeration sampling but noted that the demographic analysis for
22 the 2000 census found a nationwide net undercount of 0.12%, not

*Rebuttal Testimony of
Dr. Stephen Sheppard, Ph.D.
Contention NYS-16B*

1 an overcount. A.C.E. Revision II at 33-35. Each method has its
2 strengths and weaknesses.

3 I have chosen a reasonable figure within this range of
4 estimates of 3% to be applied to the non-white population within
5 the 50 mile zone. The A.C.E. Revision II does not supersede or
6 supplant this range of estimates. In fact, it recognizes the
7 existence of an undercount among minority populations in the
8 2000 census and it provides a summary of internal Census Bureau
9 research that essentially validates the reasonable 3% undercount
10 figure I have assumed. See A.C.E. Revision II at 12.

11 In evaluating the reasonableness of my adjustments in
12 comparison with the Census Bureau's reported research, it should
13 be remembered that the Census Bureau is under tremendous
14 pressure because of the use of its figures for distributing
15 appropriations and redistricting. The Census Bureau was
16 operating against strict deadlines to release population
17 estimates for use in these important functions. The SAMA
18 analysis is not, and should not be, subject to this sort of
19 pressure. Following NEI 05-01's guideline to utilize a
20 conservative population estimate, I have suggested a mid-range
21 estimate of the undercount for the region surrounding Indian
22 Point.

23
*Rebuttal Testimony of
Dr. Stephen Sheppard, Ph.D.
Contention NYS-16B*

1 Q. How do documents that report an overcount in the 2000
2 census such as Exhibit NRC000055 (Staff Test. at 99, A90) affect
3 your conclusions about census undercount?

4 A. Internal research by the Census Bureau and the
5 published reports of other scholars provide no support for the
6 idea of an overcount of minority populations. The support for
7 an overcount of white populations is very modest, with estimates
8 ranging from 0.19% to 1.4%. Given that census forms are written
9 to be very clear on who should be counted, and census
10 enumerators are trained to count only verifiable population, the
11 consensus of social scientists is that the census is more prone
12 to undercount, rather than overcount, the population. The
13 question concerns the magnitude of the undercount. The middle-
14 range undercount level I have assumed is only applied to the
15 non-white population. The 50 mile area surrounding Indian Point
16 has a significantly higher percentage of minority population
17 than the nation as a whole, which makes adjustment for
18 undercount particularly important.

19 Q. Did the Census Bureau ultimately adjust the 2000
20 census for census undercount?

21 A. Ultimately the Census Bureau decided to not adjust the
22 officially reported 2000 census figures. As I mentioned earlier
23 the Census Bureau was working under strict deadlines to release

*Rebuttal Testimony of
Dr. Stephen Sheppard, Ph.D.
Contention NYS-16B*

1 final numbers. The Census Bureau has opted to make the A.C.E.
2 process public and to release updates and reports on internal
3 estimates of the census undercount, so that users of the data
4 can make adjustments in those circumstances where it is
5 warranted. Preparing population data for use in the SAMA
6 analysis is exactly such a circumstance, and that is why I have
7 proposed adjusting the population to account for the
8 acknowledged census undercount of minority populations.

9 Q. Is your assertion that Entergy's population estimates
10 should be adjusted for undercount "directly contrary to the U.S.
11 Census Bureau's own findings" (Entergy SOP at 3)?

12 A. Not at all. Indeed, the A.C.E. report and its
13 revisions, which documented an undercount of minority
14 populations, should properly be viewed as among the "findings"
15 of the Census Bureau in understanding and interpreting the 2000
16 census. I have used these findings and those of other scholars
17 to identify a reasonable mid-range estimate of the census
18 undercount. To ignore the issue, as Entergy did in its original
19 SAMA analysis, is in fact directly contrary to the Census
20 Bureau's own findings.

21 Q. In your opinion, is census undercount more likely to
22 affect the 50 mile radius surrounding Indian Point than other
23 areas of the country?

*Rebuttal Testimony of
Dr. Stephen Sheppard, Ph.D.
Contention NYS-16B*

1 A. Yes. As I mentioned earlier, analysis of census
2 undercount indicates that it disproportionately occurs amongst
3 non-white populations. 2000 census data indicates that the
4 resident population within 50 miles of Indian Point is 42.24%
5 nonwhite. In comparison, 2000 census data indicates that the
6 United States population as a whole is 18.95% nonwhite. Within
7 50 miles of Indian Point, 20.31% of the population classified
8 themselves as Black, and 21.44% classified themselves as
9 Hispanic. This compares with 12.69% Black and 12.55% Hispanic
10 nationwide. These figures suggest that census undercount can be
11 expected to be much more severe for the area within 50 miles of
12 Indian Point than for the United States as a whole.

13 The relatively large share of population that is nonwhite
14 implies that the undercount is almost certainly not equalized by
15 a hypothesized "overcount" of the white population. While some
16 studies do suggest very modest levels of overcount of whites in
17 the 2000 census, the magnitudes are generally extremely small or
18 zero, and generally much less than 1%. For a hypothetical
19 overcount of white population to make up for the undercount of
20 nonwhite population in the area within 50 miles of Indian Point,
21 the overcount of the white population would have to be
22 approximately 1.8%. There is no credible estimate suggesting a
23 white overcount of this magnitude.

*Rebuttal Testimony of
Dr. Stephen Sheppard, Ph.D.
Contention NYS-16B*

1 Furthermore, it has been documented that census undercount
2 occurs at higher rates in places with larger populations. The
3 A.C.E. Revision II found a net undercount in approximately 60%
4 of places where the population is larger than 100,000. A.C.E.
5 Revision II at 25, Table 10. As Indian Point is located 24
6 miles from one of the largest cities in the country, census
7 undercount is more likely to affect this region than other, less
8 populous regions of the country.

9 **2010 Census Data**

10 Q. Did Entergy use 2010 census data as the basis for the
11 2035 population surrounding Indian Point?

12 A. No. Entergy's SAMA analysis was conducted prior to
13 the 2010 census, so it did not rely upon or even have access to
14 2010 census data at that time. The population estimate was
15 based on data from the 2000 census.

16 Q. Could Entergy now update its population projections
17 using 2010 census data and re-run its SAMA analysis?

18 A. Yes, as long as Entergy consistently used 2010 census
19 data. If Entergy were to update its population projections, it
20 would have to base all of its numbers, including transient
21 populations and population growth rates, on 2010 census data.
22 It would also have to account for census undercount in the 2010
23 census. Some of this data may not yet be available for the 2010

*Rebuttal Testimony of
Dr. Stephen Sheppard, Ph.D.
Contention NYS-16B*

1 census.

2 Q. NRC Staff's expert Mr. Jones compared Entergy's
3 population projections for 2010 with the results of the 2010
4 census. The results are contained in "Table 4: 2010 Census
5 Comparison" (Staff Test. at 97-98). Have you reviewed this
6 table?

7 A. Yes. The table contains a comparison between
8 Entergy's projected 2010 population by county and the population
9 counts from the 2010 census.

10 Q. Mr. Jones concludes that Entergy overestimated the
11 2010 population because the reported 2010 census population is
12 326,878 people greater than Entergy's predicted 2010 population
13 (Staff Test. at 97, A89). Is this true?

14 A. It is correct that the actual counts from the 2010
15 census are about 1.9% lower than Entergy's original projections.
16 Some counties are larger than projected, some smaller. Overall,
17 the estimate is probably within a reasonable range of error for
18 simple population forecasts of this sort.

19 Q. Mr. Jones argues that since the 2010 census reports a
20 greater population than Entergy's 2010 prediction, any failure
21 to account for census undercount or commuters has been
22 compensated for by this 2010 overestimation (Staff Test. at 100-
23 101). What is your response?

*Rebuttal Testimony of
Dr. Stephen Sheppard, Ph.D.
Contention NYS-16B*

1 A. Mr. Jones's conclusion does not represent a valid
2 analysis of the accuracy of Entergy's population estimates. It
3 would be possible to redo the population estimate using the 2010
4 census numbers (assuming all of the relevant data, such as the
5 worker flow files, has been released); however, that is not what
6 Mr. Jones has done here. Instead, he has picked a particular
7 point of comparison and argued that since Entergy's numbers are
8 higher, it compensates for any deficiencies in Entergy's
9 estimate. A comprehensive analysis does not look at one number
10 in isolation because there are other variables that must be
11 studied and accounted for. For example, the 2010 census number
12 that Mr. Jones cites has not been adjusted for undercount in the
13 2010 census. Furthermore, it does not account for any changes
14 in population growth that have occurred between when Entergy
15 originally made the 2010 population estimate and when the 2010
16 census was taken. Since the population estimate for the SAMA
17 analysis must look at changes in population over a 20 year
18 period, picking one number in isolation does not provide the
19 required comprehensive view. Additionally, my population
20 estimate is approximately 1.2 million people larger than
21 Entergy's estimate, and the number cited by Mr. Jones (326,878)
22 is only 27% of this calculated adjustment.

23
*Rebuttal Testimony of
Dr. Stephen Sheppard, Ph.D.
Contention NYS-16B*

1 **SAMA Analysis**

2 Q. Dr. Sheppard, now let's turn to the SAMA analysis. Did
3 NRC Staff re-run the SAMA analysis with a population accounting
4 for commuters and census undercount?

5 A. NRC Staff did not conduct a sensitivity analysis or
6 re-run the SAMA analysis. Instead, Staff speculates that the
7 population increases described in my expert report will not have
8 a material impact on the SAMA analysis.

9 Q. What support has NRC Staff provided to show the impact
10 accounting for census undercount or commuters would have on the
11 SAMA analysis?

12 A. NRC Staff has provided expert testimony on the
13 subject, but has not provided any calculations or computer runs
14 to verify the impact of accounting for census undercount and
15 commuters. Thus, it is not possible to assess the accuracy of
16 NRC Staff's speculations. In addition, Mr. Jones's testimony
17 relies on numerous assumptions that are not supported with any
18 cited evidence. For example, Mr. Jones assumes that in the
19 event of an accident at Indian Point, commuters will either stay
20 home, easily evacuate, or be shielded from radiation by their
21 office buildings, and therefore, they will not receive large
22 radiation doses. He cites no data to support these assumptions,
23 making them impossible to verify.

*Rebuttal Testimony of
Dr. Stephen Sheppard, Ph.D.
Contention NYS-16B*

1 Q. Mr. Jones argues that most commuters would simply
2 return home and avoid exposure, and that only under a worst case
3 scenario would they remain at work (Staff Test. at 103, A95). Do
4 you agree with this assertion?

5 A. No. Mr. Jones does not cite any documents such as an
6 evacuation time estimate report to support his assertion that
7 commuters could leave the 50 mile zone before the plume of
8 radiation reached their workplaces. Even if commuters were able
9 to escape the radiation plume on the day of the accident, they
10 would need to return to their workplaces within the 50 mile zone
11 sometime after the accident, potentially exposing them to
12 radiation. See Staff Test. at 39, A34 ("[T]he returning
13 population receives a dose that contributes to the population
14 dose."). If their businesses closed due to contamination, they
15 could lose income, thus increasing the economic costs of the
16 accident. Entergy Test. at 30, A61 ("[C]ommuters could be
17 impacted by lost income, because their job sites would be
18 impacted by interdiction.").

19 Q. Did Entergy re-run the SAMA analysis with a population
20 accounting for commuters and census undercount?

21 A. Entergy purports that "Entergy's experts performed a
22 MACCS2 sensitivity analysis in which they increased Entergy's
23 2035 population estimate for census undercount and commuters as

*Rebuttal Testimony of
Dr. Stephen Sheppard, Ph.D.
Contention NYS-16B*

1 suggested by Dr. Sheppard" (Entergy SOP at 5), but instead of
2 using the entire population increase described in my expert
3 report, Entergy took only half of the commuters into account.

4 Q. Are there any issues with halving the commuter
5 population to account for the amount of time commuters are
6 likely to spend within the 50-mile zone?

7 A. Halving the commuter population is problematic because
8 it does not reflect the costs of an accident that occurs when
9 the entire commuter population is present within the 50 mile
10 zone. As I mentioned, commuters could be exposed to radiation
11 or lose income as a result of interdiction. Any personal
12 property commuters had in the region, such as automobiles, could
13 be exposed to radiation, requiring decontamination. One
14 important cost associated with a severe accident is the
15 decontamination of property. It follows that the higher the
16 building density, the more buildings there are to decontaminate.
17 Commuters also have an impact on building density because if
18 there are more workers in a region, more buildings will be
19 required to house those workers. These extra buildings will
20 need to be decontaminated in the event of a severe accident,
21 increasing the costs of that accident. See Staff Test. at 41,
22 A35 ("The cost of achieving the DF [decontamination factor] is
23 input in terms of dollars per person (\$/person). By using a per

*Rebuttal Testimony of
Dr. Stephen Sheppard, Ph.D.
Contention NYS-16B*

1 person basis, this approach takes into account the site-specific
2 high population density of New York City and the correspondingly
3 high density of buildings.").

4 The industry guidance on SAMA analysis, NEI 05-01, does not
5 suggest reducing the transient population for the amount of time
6 spent in the zone and Entergy did not reduce the other transient
7 populations (i.e. tourists and business travelers) for the
8 amount of time they spent within the 50 mile zone. Taking the
9 entire commuter population into account is consistent with NEI
10 05-01 and is the more conservative approach.

11 Entergy's experts' sensitivity analysis does not actually
12 test the implications of my population adjustments because it
13 reduces my analysis of commuter data by 50%. Including the full
14 commuter population could yield a different SAMA analysis
15 outcome.

16 Q. Do you see any other deficiencies in Entergy's
17 experts' sensitivity analysis?

18 A. Yes. Population is an input to the MACCS2 code, but
19 it must be entered into the MACCS2 code by grid element. When
20 Entergy's experts entered their reduced population increase of
21 729,520 persons into the MACCS2 code, they utilized a flawed
22 method of allocating the population increases to the individual
23 grid elements. They allocated the population "based on visual

*Rebuttal Testimony of
Dr. Stephen Sheppard, Ph.D.
Contention NYS-16B*

1 alignment of counties to [the] 50 mile grid." ENT000006 at 1.
2 For those counties located between 0 and 10 miles of Indian
3 Point, they also "back calculated [a] uniform % increase to
4 match the visually assigned additions." *Id.* Adding in 50% of
5 the commuters and all of the census undercount as Entergy did
6 results in a 3.79% population increase. Entergy's experts,
7 however, increased the population between 0 and 10 miles by only
8 1.118%. This means that instead of adding 14,815 persons to the
9 area between 0 and 10 miles of Indian Point (a 3.79% increase),
10 Entergy added only 4,367 persons (a 1.118% increase).

11 Entergy's methodology is technically deficient for several
12 reasons. First, Entergy's experts' method of visually
13 allocating the population is not a scientifically valid method.
14 The proper way to allocate the population increases is to
15 multiply the pre-existing population for each grid element by
16 the percentage of increase in population. This method
17 distributes the population increases proportionately by grid
18 element. Second, by increasing the population closest to the
19 plant by only 1.118% instead of 3.79%, Entergy allocated an
20 unusually small share of the adjustment to the area within 10
21 miles of Indian Point, and allocated more of the population
22 adjustment to grid elements located farther away from the plant.
23 These allocations are not in proportion to existing populations,

*Rebuttal Testimony of
Dr. Stephen Sheppard, Ph.D.
Contention NYS-16B*

1 existing minority populations, or commuter flow data. This
2 flawed allocation will impact the results of the sensitivity
3 analysis because the location of the population affects the
4 MACCS2 model's calculations. For example, the population
5 located closer to Indian Point will receive larger doses of
6 radiation than the population located farther from the plant.
7 See Staff Test. at 26, A19 (The model "calculates the location
8 of the plume and the concentration of each released isotope for
9 each spatial grid cell and further determines how much
10 contamination falls out of the plume to be finally deposited
11 into each spatial grid cell."); 71, A64 ("[C]ontamination is
12 heaviest near the plant and lightest at the outer boundary of
13 the 50-mile region"); and 102, A95 (stating that those closer to
14 the plant receive a higher dose in the MACCS2 model). Therefore,
15 Entergy's purported assessment of sensitivity cannot be regarded
16 as valid.

17 I have created an exhibit, NYS000409, that shows what a
18 proper allocation of population increases would look like, using
19 both Entergy's experts' reduced population increase and the
20 total increased population from my expert report.

21 Q. Did Entergy conclude that increasing the population
22 had an effect on the SAMA analysis?
23

*Rebuttal Testimony of
Dr. Stephen Sheppard, Ph.D.
Contention NYS-16B*

1 A. Yes, even with its flawed sensitivity analysis,
2 Entergy concluded increasing population results in an increasing
3 of what Entergy characterizes as "key metrics in a SAMA
4 analysis- the population dose risk and the offsite economic cost
5 risk." Entergy SOP at 24.

6 Q. What was the increase in key SAMA metrics Entergy
7 calculated?

8 A. By ignoring 50% of the commuters and increasing the
9 population by only 3.79%, as opposed to the 6.38% increase
10 described in my report (NYS000209), and using a flawed method of
11 allocating the population increases, Entergy calculated
12 increases of PDR and OECR of 3.1% and 3.2%, respectively.

13 Q. Did Entergy perform any analyses using the population
14 from your report?

15 A. Not to my knowledge.

16 Q. Did Entergy's SAMA analysis change any inputs to the
17 MACCS2 model other than population?

18 A. No. According to the explanation provided in the
19 testimony, Entergy increased the population input, but did not
20 change any other parameters. See Entergy Test. at 48-49.

21 Q. NYS Consolidated Contention 12C challenges other
22 MACCS2 input values. Has Entergy or NRC Staff demonstrated that
23 an increased population, combined with other site-specific

*Rebuttal Testimony of
Dr. Stephen Sheppard, Ph.D.
Contention NYS-16B*

1 values, would not have a material effect on the SAMA analysis?

2 A. No. Neither Entergy nor NRC Staff have disclosed what
3 would happen if the SAMA analysis were re-run, taking both the
4 underestimation of population and the deficiencies with other
5 parameters into account.

6 Q. Entergy's testimony suggests that any underestimation
7 in population is not material because for additional SAMAs to
8 become cost-beneficial, the benefit would have to increase by
9 11%, and that the increase due to census undercount and half of
10 the commuter population is only 3.2% (Entergy Test. at 49-50,
11 A89). What is your response?

12 A. The technical details of the use of the MACCS2 model
13 in the SAMA analysis are not within my expertise, but Entergy's
14 conclusion is not adequately supported without re-running the
15 SAMA analysis: (1) to account for all the commuters; (2) to
16 properly distribute the population increases by grid element;
17 and (3) to account for any other inputs that were
18 underestimated.

19 Entergy's experts' analysis demonstrated that increasing
20 the population results in an increase in key SAMA metrics.
21 Accounting for all of the commuters would lead to a greater
22 increase. Accounting for the deficiencies in other MACCS2
23 inputs would also lead to a greater increase. It is clear from

*Rebuttal Testimony of
Dr. Stephen Sheppard, Ph.D.
Contention NYS-16B*

1 the expert testimony of Entergy and NRC Staff that use of the
2 MACCS2 model requires correct allocation of population to the
3 appropriate grid elements around Indian Point. As I discussed
4 previously, Entergy's experts' sensitivity analysis for
5 population increases involved the strange use of what they
6 characterize as "visual allocation." Careful inspection of the
7 allocation of population changes to the grid reveals that they
8 allocated a disproportionate share of the adjustments to grid
9 elements farther than 10 miles from the plant. This renders
10 their sensitivity analysis invalid.

11 Q. Is it fair to characterize a 3.2% increase as "very
12 small" in comparison to an 11% increase (Entergy Test. at 49,
13 A88)?

14 A. Entergy's experts provide no justification for this
15 qualitative characterization. Furthermore, the increase would
16 be larger if the correct inputs and grid element allocations
17 were used.

18 Q. Does this conclude your rebuttal testimony?

19 A. Yes.

*Rebuttal Testimony of
Dr. Stephen Sheppard, Ph.D.
Contention NYS-16B*

1 UNITED STATES

2 NUCLEAR REGULATORY COMMISSION

3 BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

4 -----X

5 In re: Docket Nos. 50-247-LR; 50-286-LR
6 License Renewal Application Submitted by ASLBP No. 07-858-03-LR-BD01
7 Entergy Nuclear Indian Point 2, LLC, DPR-26, DPR-64
8 Entergy Nuclear Indian Point 3, LLC, and
9 Entergy Nuclear Operations, Inc. June 29, 2012

10 -----X

11 DECLARATION OF STEPHEN C. SHEPPARD

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

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



Dr. Stephen C. Sheppard, Ph.D.
Professor of Economics
24 Hopkins Hall Drive
Williamstown, MA 10267
(413) 597-3184

June 29, 2012

Rebuttal Testimony of
Dr. Stephen Sheppard, Ph.D.
Contention NYS-16B