

1 UNITED STATES

2 NUCLEAR REGULATORY COMMISSION

3 BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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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. December 16, 2011

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11 PRE-FILED DIRECT TESTIMONY OF  
12 STEPHEN C. SHEPPARD, Ph.D.  
13 REGARDING CONTENTION 17B

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 Stephen C. Sheppard, Ph.D. regarding Contention  
17 NYS-17B.

18 Q. Please state your full name.

19 A. My name is Stephen Charles Sheppard.

20 Q. By whom are you employed and what is your position?

21 A. I am a Professor of Economics at Williams College,  
22 Williamstown, Massachusetts.

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1 Q. Please summarize your educational and professional  
2 qualifications.

3 A. I am a qualified expert on land use economics and  
4 property valuation. I hold a Ph.D. and a Masters Degree in  
5 Economics and a Bachelor's of Science in Economics. From 2007  
6 to 2010 I was the Chair of the Economics Department at Williams  
7 College, where I am now a Professor of Economics. Before I  
8 joined the faculty at Williams, I was a Professor of Economics  
9 at Oberlin College.

10 Since 1979, I have conducted research, written, lectured  
11 and taught on economic and regulatory policies as they impact  
12 housing, land use, house prices and land valuation. I teach or  
13 have taught Advanced Microeconomic Theory; Economics of Land,  
14 Location, and the Environment; Environmental Economics; Public  
15 Economics; Urban Economics; Cities, Regions and the Economy; and  
16 Economics of the Housing Market.

17 I have also published articles on these topics, including  
18 many peer-reviewed and published papers. These include *On the*  
19 *Price of Land and the Value of Amenities*, Cheshire, P., and  
20 Sheppard, S., *Economica*, 62, 247-267 (1995); *Estimating Demand*  
21 *for Housing, Land, and Neighborhood Characteristics*, Cheshire,  
22 P., and Sheppard, S., *Oxford Bulletin of Economics and*  
23 *Statistics*, 60, August 1998, 357-382; and *The Rise, Fall and*

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1 *rise Again of Industrial Location Theory*, McCann, P., and  
2 Sheppard, S., *Regional Studies*, 37, 6-7, 649-663 (2003). In  
3 2004, a co-author and I published *Capitalising The Value Of Free*  
4 *Schools: The Impact of Supply Characteristics and Uncertainty*,  
5 which dealt with the impact of schools and other neighborhood  
6 conditions on housing values. This paper was awarded the Royal  
7 Economic Society Prize for the best paper published in 2004 in  
8 the *Economic Journal*.

9 In addition to writing on the topic, I conduct original  
10 research on land use policies and economics. I have been an  
11 academic consultant at the International Monetary Fund and an  
12 academic visitor at the London School of Economics, and I have  
13 consulted for many banks and private corporations, including the  
14 World Bank and the Inter-American Development Bank. My  
15 education and experience are described in more detail in my  
16 curriculum vita (CV), which is Exh. NYS000208. A list of my  
17 publications is also included in my CV.

18 Q. I show you what has been marked as Exhibits NYS000226  
19 to Exhibit NYS000230. Do you recognize those documents?

20 A. Yes. They are copies of the declarations and reports  
21 that I previously prepared for the State of New York in this  
22 proceeding.

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1 Q. I show you what has been marked as Exhibit NYS000231.  
2 Do you recognize that document?

3 A. Yes. It is a copy of the final report, dated December  
4 11, 2011 that I prepared for the State of New York in this  
5 proceeding. That report, like its predecessors, reflects my  
6 analysis and opinions.

7 Q. What is the purpose of your testimony?

8 A. The purpose of my testimony is to discuss my views on  
9 Consolidated NYS-17B (NYS-17B), which asserts that the "FSEIS  
10 fails to address the impact of the continued operation of IP2  
11 and IP3 for another 20 years on offsite land use, including real  
12 estate values in the surrounding area in violation of 10 C.F.R.  
13 §§ 51.71(a), 51.71(d), 51.95(c)(1), and 51.95(c)(4)." In this  
14 testimony I refer to the Final Supplemental Environmental Impact  
15 Statement, NUREG-1437, Supp. 38 (Dec. 2010), which I will cite  
16 as FSEIS at \_\_. However, my testimony is equally applicable to  
17 the license renewal application. I refer to the FSEIS because  
18 it is simpler to do so but the same failures of analysis are  
19 also present in the license renewal application.

20 Q. Have you reviewed materials in preparation for your  
21 testimony?

22 A. Yes.

23 Q. What is the source of those materials?

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1           A.    Many are documents prepared by government agencies,  
2 peer reviewed articles, or documents prepared by Entergy or the  
3 utility industry.

4           Q.    I show you Exhibits NYS000232 through NYS000238,  
5 Exhibit NYS000056, Exhibit NYS00132A-NYS00132D, and Exhibit  
6 NYS00133A-NYS00133J, and ask if you recognize them: *Measuring*  
7 *the Externalities of Nuclear Power: A Hedonic Study*, Prest, B.,  
8 unpublished thesis, Williams College (2009) ("Prest Study"); S.  
9 Folland and R. Hough, *Externalities of Nuclear Plants: Further*  
10 *Evidence*, *Journal of Regional Science*, Vol. 40, No. 4 (2000)  
11 ("Further Evidence"); *The Effects of Electric Utility Power*  
12 *Plant Location on Area Property Values*, *Land Economics*, Vol. 50,  
13 No. 1 (February 1979) ("Land Economics"); D. Clark and L.  
14 Nieves, *An Interregional Hedonic Analysis of Noxious Facility*  
15 *Impacts on Local Wages and Property Values*, *Journal of*  
16 *Environmental Economics and Management*, Vol. 27 (1994)  
17 ("Interregional Hedonic Analysis"); D. Clark, L. Michelbrink, T.  
18 Allison, and W. Metz, *Nuclear Power Plants and Residential*  
19 *Housing Prices, Growth and Change*, Vol. 28 (1997) ("Residential  
20 *Housing Prices*"); 75 Fed. Reg. 81,032 (Dec. 23, 2010) ("75 Fed.  
21 *Reg. 81,032*"); *Preliminary Decommissioning Cost Analysis for the*  
22 *Indian Point Energy Center, Unit 3*, TLG Services, Inc. (December  
23 2010) (Doc. E11-1583-006) (ML103550608) ("TLG Analysis"); *Indian*

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1 *Point Retirement Options, Replacement Generation,*  
2 *Decommissioning / Spent Fuel Issues, and Local Economic / Rate*  
3 *Impacts, prepared for the County of Westchester and the County*  
4 *of Westchester Public Utility Service Agency, June 9, 2005*  
5 *("2005 Levitan Report"); Draft Supplemental Environmental Impact*  
6 *Statement for License Renewal of Nuclear Plants Regarding Indian*  
7 *Points Units 2 and 3, NUREG-1437 Supplement 38, Vol. 1, dated*  
8 *December 2008 (ML083540594) ("DSEIS"); and Final Supplemental*  
9 *Environmental Impact Statement for Indian Point Nuclear*  
10 *Generating Units 2 and 3, NUREG-1437, Supplement 38, Vol. 1,*  
11 *dated December 3, 2010 (ML 103350455) ("FSEIS").*

12       A.    Yes.  These are true and accurate copies of the  
13 documents that I referred to, used and/or relied upon in  
14 preparing my reports, declarations, and this testimony.  In some  
15 cases, where the document was extremely long and only a small  
16 portion is relevant to my testimony, an excerpt of the document  
17 is provided.  If it is only an excerpt, that is noted on the  
18 first page of the Exhibit.

19       Q.    How do these documents relate to the work that you do  
20 as an expert in forming opinions such as those contained in this  
21 testimony?

22       A.    Some of these documents represent the type of  
23 information that persons within my field of expertise reasonably

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1 rely upon in forming opinions of the type offered in this  
2 testimony. Others represent the type of information that  
3 persons within my field should not reasonably rely upon in  
4 forming opinions relevant to this matter but which have been  
5 relied upon or referred to by NRC Staff or Entergy.

6 Q. Please summarize your testimony.

7 A. In my professional judgment, the FSEIS is inadequate.  
8 It fails to address the impact on the value of residential  
9 services and house prices for residential properties within 5  
10 kilometers of IPEC. My analysis shows that there is such an  
11 impact and that, to a reasonable degree of scientific certainty,  
12 that impact is adverse. Based on conservative assumptions, my  
13 analysis suggests that denial of the license renewal application  
14 and reclamation of the site for alternative uses would generate  
15 a recovery in property values that could add more than 27% to  
16 the value of residential property located within 5 kilometers.  
17 This increase, which would total \$1,070,074,312, would  
18 significantly increase the wealth of many individuals living in  
19 the community. The FSEIS contained no analysis of the impact of  
20 license renewal on property values, which must be an integral  
21 part of any discussion of the socioeconomics of land use.

22 Q. What do you mean when you say that residential property  
23 values are an important part of land use?

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1           A.     Economic theories of land use suggest, and hundreds of  
2 careful scientific studies done over the past 50 or 60 years  
3 verify, that the market value of land and the prices of  
4 structures built on that land is a major determinant of land use  
5 and the structure of cities and neighborhoods. Absent regulatory  
6 restrictions, land is used for those purposes that generate the  
7 greatest value for the land. Any external event or factor that  
8 diminishes the market value of structures in a particular  
9 location will diminish the value of land where those structures  
10 are built. This will alter the incentives to develop the land  
11 and build the structures. In other words, this will alter land  
12 use.

13           Q.     How does the FSEIS address the impact of license  
14 renewal, or non-renewal, on land use values in the area around  
15 IPEC?

16           A.     The FSEIS does not specifically address the impact of  
17 license renewal or non-renewal on land use values. Instead, the  
18 FSEIS analyzes only "population and tax revenue changes  
19 resulting from license renewal." See FSEIS, NUREG-1437, at 4-45  
20 (Dec. 2010). With respect to population, the FSEIS concludes  
21 that "there would be no noticeable population change to drive  
22 changes in land use conditions in the vicinity of IP2 and IP3  
23 that is attributable to the plant." *Id.* at 4-46. Accordingly,

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1 the FSEIS further concludes, "there would be no population-  
2 related land use impacts during the license renewal term beyond  
3 those already being experienced." FSEIS, NUREG-1437, at 4-46  
4 (Dec. 2010). With respect to tax revenue changes, the FSEIS  
5 observes that "since Entergy started making payments to local  
6 jurisdictions, population levels and land use conditions in the  
7 Town of Cortlandt, Village of Buchanan, and Westchester County  
8 have not changed significantly, which might indicate that these  
9 tax revenues have had little or no effect on land use activities  
10 within the county." *Id.* The FSEIS concludes that "there would  
11 be no tax-revenue-related land use impacts during the license  
12 renewal term beyond those currently being experienced." *Id.* at  
13 4-46-47; *see also id.* at 4-68 ("there would be no population and  
14 tax-revenue-related land use impacts"). My analysis shows that  
15 in fact the facility has unacknowledged impacts on land use that  
16 will continue if the facility is relicensed.

17 Q. What conclusions are drawn in the FSEIS's "Cumulative  
18 Socioeconomic Impact" section?

19 A. The FSEIS analyzes two potential impacts on off-site  
20 land use: changes in population that might occur as a result of  
21 license renewal and the impact of license renewal on tax  
22 revenues. With respect to population related impacts, the FSEIS  
23 concludes that because the applicant "has no plans to add

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1 nonoutage employees during the license renewal period, there  
2 would be no noticeable population change to drive changes in  
3 land use conditions in the vicinity of IP2 and IP3," and  
4 therefore "there would be no noticeable population change to  
5 drive changes in land use conditions in the vicinity of IPEC."  
6 FSEIS at 4-46. With respect to the impact from tax revenues,  
7 the FSEIS concludes that "there would be no increase in the  
8 assessed value of IP2 and IP3 and that the annual payment-in-  
9 lieu-of-taxes and property taxes paid to the Town of Cortlandt,  
10 the Hendrick Hudson Central School District, and the Village of  
11 Buchanan would remain relatively unchanged throughout the  
12 license renewal period," and therefore, "there would be no tax  
13 revenue-related land use impacts during the license renewal term  
14 beyond those currently being experienced." *Id.* at 4-46 - 4-47.

15 Q. What is your opinion about those conclusions?

16 A. The land use impacts analysis is incomplete. And  
17 because the land use impacts analysis is incomplete, the  
18 conclusions drawn with respect to socioeconomic issues, and land  
19 use in particular, are necessarily inaccurate. The analysis  
20 also examines the wrong counterfactual, in my opinion, which  
21 further skews the conclusion.

22 Q. Let's start with the counterfactual to which you  
23 refer. First, what is a counterfactual?

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1           A.    It means something that is not true or not currently  
2 the case.  I use it, and it is used in my field, to refer to a  
3 specific hypothetical alternative to the status quo.

4           Q.    What in your opinion is wrong with the counterfactual  
5 as discussed in the land use analysis in the FSEIS?

6           A.    The analysis in the FSEIS does not compare a scenario  
7 in which the facility is closed and decommissioned (a non-  
8 operating nuclear facility) with the status quo (an operating  
9 nuclear facility).  Instead, the analysis appears to use the  
10 status quo (an operating nuclear facility) as the counterfactual  
11 to compare with the proposed change of license renewal (an  
12 operating nuclear facility).  Not surprisingly, that analysis  
13 argues there will be almost no land use impacts.

14          Q.    Okay, now let me ask you what you think is missing  
15 from this analysis, as you testified earlier.

16          A.    Property values are an important component of any  
17 discussion about land use.  The FSEIS should have analyzed the  
18 impact of the facility on property values in the vicinity of the  
19 facility.  A thorough analysis of the impacts of license renewal  
20 must be based on a thorough understanding of the facility's  
21 current impacts.

22          Q.    How did you define the vicinity?

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1           A.    I defined vicinity as the area within five kilometers  
2 of the facility.

3           Q.    Why?

4           A.    My goal was to do a conservative analysis to avoid any  
5 risk of overestimating or exaggerating the facility's impacts on  
6 property values.  Properties within 5 kms. are well within the  
7 facility's ten-mile emergency planning zone, which includes a  
8 siren system.  Although the literature would support a greater  
9 radius, five kilometers is conservative and sufficient to  
10 provide a scientifically defensible sample.  As will be seen,  
11 the statistical relationships were clearly significant within  
12 the five kilometer radius.

13          Q.    Is it possible to measure the impact on property  
14 values of an electric generating facility?

15          A.    Yes.

16          Q.    Is there any difference, for purposes of your  
17 analysis, between a coal-fired electric generating facility and  
18 an electric generating facility that is nuclear powered?

19          A.    Not in the methodology used to measure the impact,  
20 although the actual impact itself might be very different.  It  
21 is possible to measure the impact on property values of any  
22 amenity or disamenity taking place at a fixed location.  What  
23 does matter is the object of the analysis, that is, what is

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1 being impacted. In this case, I wanted to measure the impact of  
2 the facility on residential property values because the impacts  
3 on those values would serve as an indicator of impacts on land  
4 values and hence on land use.

5 Q. First, let me ask you what a disamenity is.

6 A. A disamenity is any use of land or activity that might  
7 adversely impact its neighbors.

8 Q. What is the significance of the object of the  
9 analysis?

10 A. It is not always possible to measure the impact of a  
11 particular disamenity or amenity because the sales of some types  
12 of property take place infrequently or because the sales records  
13 are not public. So it is not the type of amenity or disamenity  
14 that matters so much as whether the sales records of the target  
15 properties are available. The data provide information about  
16 the disamenity.

17 Q. Were the records available for the property types you  
18 studied in this case?

19 Q. Yes. In most communities, residential property is the  
20 most frequently traded kind of real property. A system of real  
21 property registration records those sales, their dates, and the  
22 price. Those records are public.

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1 Q. Did you use those public records in your IPEC  
2 analysis?

3 A. I did. The method by which I obtained the necessary  
4 data is set forth in my fifth report. In sum, a researcher whom  
5 I supervised photocopied the public records maintained by the  
6 assessor's offices and the data were converted into digital  
7 form, also under my supervision. I also made the decisions  
8 regarding which data should be excluded because they were  
9 potentially unreliable. In addition I used records that I  
10 obtained from the Office of Real Property Services.

11 Q. How did you measure the facility's impact on  
12 residential real property values?

13 A. In a situation where the interest is in knowing the  
14 impact of a single significant change in the community, where  
15 the location and timing of that change are unambiguous, the  
16 analysis requires thinking of housing as an asset whose rate of  
17 return is or might be affected by the single significant change.  
18 This approach is similar to so-called "event studies" that are  
19 widely used to determine the impact of events that affect the  
20 value of stocks and other financial instruments. I used this  
21 approach to study the "event" of the construction and operation  
22 of Units 2 and 3 on nearby residential properties.

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1 Q. Please tell me how you applied this approach to the  
2 arrival of the facility.

3 A. First it is important to understand the nature of real  
4 property. Residential real property is a durable good that  
5 provides its owner with important benefits, including shelter  
6 for its occupants and their personal belongings. Those services  
7 can be consumed by the owner or by someone to whom the owner  
8 rents the property.

9 Q. Are there benefits other than shelter?

10 A. Yes. One other benefit is the asset value of the  
11 property and its potential as a place to store that value. In  
12 addition, real property is a source of capital gains. These two  
13 benefits are closely related.

14 Q. Please explain.

15 A. The value of residential property as an asset is the  
16 present value of the stream of housing services less maintenance  
17 expenses and taxes over the expected life of the property.

18 Q. How is that calculated?

19 A. Using simple (as opposed to continuous) discounting,  
20 this relationship is summarized mathematically in the following  
21 expression:  
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$$price = \sum_{t=0}^T \frac{r_t - x_t - m_t}{(1+i)^t} \tag{1}$$

Where

- price* = The market price or value of the real property
- T* = The expected maximum life of the property (could be effectively infinite)
- t* = An index for the time period (year) where a value of 0 indicates the present and higher values represent the number of years in the future
- i* = The interest rate, cost of capital, or discount factor representing the cost of delaying receipt of revenues or benefits by one year
- r<sub>t</sub>* = The value of the housing services supplied (amount for which the property could be rented) during period *t*
- x<sub>t</sub>* = The value of tax payments (including property tax payments) during period *t*
- m<sub>t</sub>* = The value of required maintenance expenditures during period *t*

Q. What does this formula tell us?

A. This formula, which I have numbered 1 in both this testimony and in my December 2011 report, shows the relationship between the price or market value of the residential property and the values of the residential services, property taxes and other relevant variables. It is well understood by economists and has been empirically tested and validated in hundreds of studies. It is widely accepted scientifically.

Q. Does the formula depend on any assumptions?

A. Yes. The formula assumes that residential property will last a very long time (which, in turn, assumes that proper maintenance will be performed). It also assumes that the value of housing services, associated property taxes and maintenance



1 expenditures grow at a constant rate. With these assumptions,  
2 the second formula simplifies first to:

3

$$price = (r - x - m) \cdot \sum_{t=0}^{\infty} \frac{(1+i-\lambda)^t}{(1+i)^t} \quad (2)$$

then, in turn, to:

$$price = (r - x - m) \cdot \frac{(1+i)}{\lambda} \quad (3)$$

4

5 Q. To what does  $r$  refer?

6 A. The annual value of housing services.

7 Q. To what does  $x$  refer?

8 A. Annual Property taxes.

9 Q. And to what does  $m$  refer?

10 A. It refers to annual maintenance costs.

11 Q. So what does  $(r-x-m)$  tell us?

12 A. It expresses the value of housing services received  
13 for one year minus the cost of property taxes and maintenance.

14 It will generally yield a positive value if the house is  
15 occupied or rented. If the term it yields is negative it means  
16 that the value of the housing services provided was not  
17 sufficient to cover taxes and maintenance.

18 Q. What would happen then?

19 A. A properly functioning market would convert the  
20 property to alternative uses or result in its abandonment.

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1 Q. How do you calculate  $r$ ?

2 A. If the property is rented,  $r$  is the market rent,  
3 usually for a one year period. If that is the case, the term in  
4 parentheses would be the landlord's net income.

5 Q. Does the formula tell us anything else?

6 A. It implies that if buyers and sellers in the  
7 marketplace become aware of a change that will reduce the value  
8 of the housing services supplied by a property during some time  
9 period (that is, a decline in  $r$ ), the current price of housing  
10 will drop. Likewise, the price of housing would rise if the  
11 market becomes aware of a change that will reduce property  
12 taxes.

13 Q. What happens if a change in the marketplace will  
14 generate both impacts?

15 A. Assuming the change does not affect maintenance,  
16 housing durability, or interest rates, the sign (positive or  
17 adverse) and magnitude of the impact depend on the value of the  
18 harm arising due to the increased localized effect or disamenity  
19 relative to the value of the reduced taxes.

20 Q. How much detail does one need about individual houses  
21 in a given area to calculate the impact of an event?

22 A. There are several ways to do this kind of calculation.  
23 The hedonic approach requires a great deal of detail on the

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1 characteristics of each property and its surrounding environs.  
2 But, as I said earlier, one can also evaluate the impact of the  
3 event on housing as an asset whose rate of return might be  
4 affected by the event.

5 Q. Is there a formula for that?

6 A. Yes. The rate of return  $\rho$  to the owner of a  
7 residential property during time period  $j$  is simply the  
8 percentage increase in the value of the property during the time  
9 period:

$$\rho = \frac{\text{price}_{j+1} - \text{price}_j}{\text{price}_j} \quad (4)$$

Assuming there is no change in the base value of housing  
services, taxes or maintenance expenditures, this simplifies to:

$$\rho = \frac{\lambda}{1+i} \quad (5)$$

10 Q. So how do you use this formula in your analysis of the  
11 neighborhood around Indian Point?

12 A. Suppose we have a community where some change occurs  
13 in time period  $j$  that might affect both the value of housing  
14 services provided by residential property and also the taxes  
15 that must be paid on those properties. We would reasonably  
16 assume that the change that takes place has no impact on the  
17 maintenance costs required, the mortgage interest or discount  
18 rate, and the rate of inflation. In the context of the model  
19 presented in equations (2) through (5) this means that the

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1 values of  $m$ ,  $i$  and  $\lambda$  remain fixed. Then at time period  $j$  the  
2 base value of housing services changes from  $r$  to  $\hat{r}$  and the base  
3 value of property tax payments changes from  $x$  to  $\hat{x}$ .

4 Q. From this can we determine the impact?

5 A. The magnitude and direction (positive or negative) of  
6 the change can only be determined by analysis of the data. But  
7 we do know that if the value of housing services is reduced, we  
8 expect that  $r > \hat{r}$ . Similarly, if the required property taxes are  
9 reduced by the change in the community then we would expect that  
10  $x > \hat{x}$ .

11 Q. Your explanation has mentioned the price of  
12 residential property and also the rate of return on residential  
13 property. Can you explain how these are related and why it is  
14 correct to analyze the rate of return to estimate the change in  
15 the market value of property?

16 A. Certainly. Suppose that we observe the sales price of  
17 each house in every year, then we would expect to observe a  
18 change in the housing price that would take place when the event  
19 occurs, during time period  $j$  when the change in the community  
20 takes place. At the beginning of this time period price would  
21 be determined according to equation (3) and by the end of the  
22 time period buyers and sellers in the community would become

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1 aware of the new values of housing services and of required  
2 property taxes, so that the price would be:

$$price_{j+1} = (\hat{r} - \hat{x} - m) \cdot \frac{(1+i)}{\lambda} \quad (6)$$

3 The rate of return  $\rho$  to the owner of this asset (residential  
4 property) held during this period would be:

$$\rho = \frac{price_{j+1} - price_j}{price_j} = \frac{(\hat{r} - \hat{x} - m) \cdot \frac{(1+i)}{\lambda} - (r - x - m) \cdot \frac{(1+i)}{\lambda}}{(r - x - m) \cdot \frac{(1+i)}{\lambda}} \quad (7)$$

5 This simplifies to:

$$\rho = \frac{(\hat{r} - \hat{x}) - (r - x)}{(r - x - m)} \quad (8)$$

6 We can rearrange this expression to give the new value of  
7 housing services as a function of the rate of return:

$$\hat{r} = \rho(r - x - m) + (r - x) + \hat{x} \quad (9)$$

8 Or the new value of housing services net of the new level of  
9 property taxes:

$$\hat{r} - \hat{x} = \rho(r - x - m) + (r - x) \quad (10)$$

10 As I noted before, the term  $(r - x - m)$  is positive. This means  
11 that equations (9) and (10) have several important implications  
12 that can be summarized as follows:

13 1. The value of housing services received after the change in  
14 the community is a positive linear function of the rate of  
15 return on residential property as an asset held during the  
16 period the change occurs.

17 2. The value of housing services net of taxes after the change  
18 in the community is a positive linear function of the rate

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1 of return on residential property as an asset held during  
2 the period the change occurs.

3 3. If the rate of return on residential property as an asset  
4 is lower during the period when the change in the community  
5 occurs than during other time periods, then the value of  
6 housing services has been reduced by the change **and** the  
7 value of housing services net of required property tax  
8 payments has also declined.

9 4. If the rate of return on residential property as an asset  
10 is lower during the period when the change in the community  
11 occurs than during other time periods, then the value  
12 (price) of residential property will have declined.

13 Q. So you are saying that there is a simple mathematical  
14 relationship between the rate of return of owning a house and  
15 the price of the house after the change in the community takes  
16 place, and that relationship is given by the equation you have  
17 numbered as (9)?

18 A. Yes. Furthermore, this fact allows me to determine if  
19 the change in the community has adversely affected property  
20 values by a simple test on how the rate of return is affected  
21 during the time period when the change takes place. If the  
22 return during this time is lower than at other times, then the

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1 change has had an adverse impact on prices that is not  
2 compensated for by any associated change in tax burdens.

3 Q. When you have estimated the impact on the rate of  
4 return to housing, will you be able to calculate the total  
5 dollar value of impacts on property values?

6 A. Yes. That will be a relatively straightforward  
7 calculation.

8 Q. Now can we figure out the impact of the arrival of  
9 Indian Point on residential property values within 5 kilometers?

10 A. Almost. I think that is all the necessary background.

11 Q. Where did you get the actual data to plug into the  
12 equations that you have explained?

13 A. I obtained data about residential properties in the  
14 general vicinity of Indian Point from the New York State Office  
15 of Real Property Services (ORPS). I also obtained data from  
16 published announcements of real estate transactions, including  
17 sale/purchase dates and prices, from properties in the  
18 municipalities of Peekskill, Cortlandt and Buchanan.

19 Q. For what time period?

20 A. A ten-year period - May 1999 to June 2009 plus a small  
21 number of other properties sold outside this time period.

22 Because the data included not only the most recent sale but also

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1 earlier sales dates and values this gave me information on  
2 property sales going back as early as 1945.

3 Q. How large was the sample?

4 A. Initially, it included about 1900 properties.

5 Q. Did you obtain all the data you needed from the ORPS  
6 records?

7 A. No. After I had the initial sample, a researcher  
8 visited the assessor's offices in the Towns of Peekskill and  
9 Cortlandt to photograph the property records on file for each of  
10 the properties in the sample.

11 Q. What happened to Buchanan?

12 A. The Village of Buchanan is located in the Town of  
13 Cortlandt; the Town of Cortlandt assessor had the Buchanan data.

14 Q. Doesn't the data exist in digital form?

15 A. No. You would think it would but it does not.

16 Q. What did you do with the photographs?

17 A. A paralegal and a secretary in the Office of the New  
18 York Attorney General entered most of the information from the  
19 property data cards into a computer.

20 Q. Why only "most"?

21 A. Not all of the information was legible.

22 Q. Who supervised their work?

23 A. I did.

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1 Q. What did that involve?

2 A. I created a database using Microsoft Access, gave them  
3 instructions and answered their questions on an as-needed basis.  
4 They then provided the data to me in digital form.

5 Q. What happened next?

6 A. I reviewed the data and made decisions about which  
7 observations should be included in the sample.

8 Q. Why?

9 A. Some of the transactions appeared not to have been  
10 made at arms' length.

11 Q. How did you identify those transactions?

12 A. I reviewed each record and eliminated any transaction  
13 that appeared to be between family members, that occurred at a  
14 symbolic or zero price, took place within 60 days of the  
15 previous transfer, or contained a notation by the assessor's  
16 office that they were not made at arms' length.

17 Q. Were there other factors that led you to exclude  
18 certain properties?

19 A. Yes. I also excluded a small number of observations  
20 because they were unusual in some other way. For instance, the  
21 sales date was miscoded, or they were commercial properties  
22 converted to residential use, or they were in some other way  
23 obviously out of the ordinary.

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1 Q. Why did you do that?

2 A. Because I wanted a sample that represented fair market  
3 values reached after unconstrained negotiations between willing  
4 buyers and willing sellers.

5 Q. What was the next step?

6 A. I geocoded the data to determine the precise latitude  
7 and longitude of each property so that I would know which  
8 properties were within 5 kilometers of the facility. My  
9 December 2011 report includes a figure that shows the boundary  
10 and the location of each property included in the sample.

11 Q. What did you do with the data once you had determined  
12 the sample?

13 A. I reorganized it to provide one observation for each  
14 repeat sale.

15 Q. What does that mean?

16 A. I created one record, if you will, of each successive  
17 pair of arms' length transactions. Each one represents the  
18 length of time that a particular owner held the property.

19 Q. What else do we know about each property?

20 A. We know its distance from the facility, the purchase  
21 and sale price, and the dates of each transaction.

22 Q. Can you summarize the data for me?

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1 A. I can show you this chart, which is included in my  
2 December 2011 report.

Variable	Observations	Mean	Std.Dev	Min	Max
Sale year	1554	1997.8	10.0	1959.2	2009.3
Prior sale year	1554	1989.6	13.3	1945.4	2008.2
Ownership period	1554	8.190	8.702	0.203	59.127
Sale price	1554	215551	163128.4	223.5	2354000
Previous price	1554	165532	431574.5	100	1.50E+07
Rho	1554	0.0920	0.1983	-0.9985	0.9847
IPEC sale indicator	1511	0.109	0.31	0	1
Distance (KM)	1554	3.50	0.89	1.22	4.99
Distance (meters)	1554	3503.50	891.10	1216.04	4994.76

3 **Table 1: Descriptive statistics for sample observations**

4 Q. Can you describe them to me in different terms?

5 A. Yes. The earliest sales occurred in mid-1945; the  
6 latest in 2009. The average ownership period is just over 8  
7 years. Some properties in the sample are as close as 1216  
8 meters from the facility; on average, houses are just over 3500  
9 meters.

10 Q. What is the average sale price?

11 A. A little over \$215,000.

12 Q. Your report refers to the average prior sales price -  
13 what is that?

14 A. For each property I required two dates and two prices.  
15 The "sales price" refers to the later of the two transactions  
16 prices, and the "prior sales price" refers to the earlier. The  
17 "ownership period" is the amount of time that elapses between

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1 two consecutive arms-length transactions. The average of the  
2 "prior sales price" in the sample is \$165,532.

3 Q. What do the data allow you to calculate?

4 A. They allow me to calculate the continuous rate of  
5 return on each homeowner's period of ownership.

6 Q. What is the formula for that calculation?

7 A.

$$\rho = \left( \frac{1}{t_1 - t_0} \right) \ln \left( \frac{P_{t_1}}{P_{t_0}} \right) \quad (11)$$

8  
9 Q. What information does each of those terms represent?

10 A.  $t_1$  and  $t_0$  represent the two sales dates (purchase and  
11 sale) while  $P_{t_1}$  and  $P_{t_0}$  represent the two prices (purchase and sale).

12 Q. Did any observations surprise you?

13 A. A few. I was suspicious of transactions that exceeded  
14 a rate of return of 100% per annum as well as those that had a  
15 rate of return of less than -100% per annum. I excluded such  
16 observations from my analysis.

17 Q. Did removing those observations change the bottom  
18 line?

19 A. Had I left the suspicious observations in the sample,  
20 it would have resulted in larger estimated property value  
21 impacts but would have changed neither the sign nor the

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1 statistical significance of the estimated relationship. In sum,  
2 "no" and to the extent it had any impact, the exclusion lessened  
3 the impact of Indian Point on property values.

4 Q. I read in your December 2011 report that you  
5 constructed an indicator variable. What is that?

6 A. It is a way of identifying the residential property  
7 asset ownership periods that would have been directly affected  
8 by the construction and operation of Units 2 and 3. The 1974  
9 construction of Unit 2 and the 1976 construction of Unit 3  
10 created a "treatment group" that allows the measurement of the  
11 change in property values as a result of the "event" that  
12 occurred from 1974 to 1976. For our purposes the "event" was  
13 the commencement of operation of the two units.

14 Q. Are there ownership periods that are of particular  
15 importance for purposes of your analysis?

16 A. Three periods of ownership matter for purposes of this  
17 analysis. For ownership periods that begin *and* end before 1974,  
18 the property would have been affected only by the presence of  
19 Unit 1, a much smaller unit that was shut down in 1974. This  
20 analysis does not take Unit 1 into account. So for our  
21 purposes, that group is part of the control group.

22 Q. What's the second group?

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1           A.     That is the group whose ownership began and ended  
2 after 1976. The existence of Indian Point would have been known  
3 to those buyers who would have factored that information into  
4 their purchase price. So Indian Point might have affected the  
5 value of the property but the purchase price would have  
6 reflected it. That group is also part of the control group.

7           Q.     What is the purpose of a control group?

8           A.     A control group is necessary for comparison purposes  
9 and is required for measuring an impact. Only by comparing the  
10 target group against a control, which has not been impacted by  
11 whatever event is being measured, can we know what the impact  
12 actually is.

13          Q.     What is the third group?

14          A.     That is the group that interests us and we call it the  
15 "treatment group." This is the group that would have been  
16 directly affected. That is, these parcels were bought before  
17 1974 and sold after 1976 and they thus received the "treatment"  
18 of Indian Point. It is Indian Point's impact on this group that  
19 matters for our purposes.

20          Q.     And what is Indian Point's impact on that group?

21          A.     First let me tell you about the entire group - the  
22 treatment group plus the control group. Then I will tell you  
23 about the treatment group.

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1 Q. What is the average nominal rate of return?

2 A. Just over 9%.

3 Q. Is that good?

4 A. Quite. It is as if a mutual fund or stock increased  
5 9% over 8 years. A typical investor would be happy with that  
6 rate of return.

7 Q. What percentage of the group received the treatment?

8 A. About 10%.

9 Q. In other words, ten percent of the observed pairs of  
10 transactions involved a purchase of a house before 1974 and  
11 subsequent sale occurring after 1976?

12 A. That's right.

13 Q. How big are the respective groups?

14 A. In total, the data included 1,511 observed repeat  
15 sales that were for properties within 5 kilometers of IPEC and  
16 were included in the sample. This includes only those  
17 observations that contained all required information and had not  
18 been excluded for some reason. The treatment group included 164  
19 sales pairs, and the control group included 1347 sales pairs.

20 Q. Your chart presented above lists, in column 2, the  
21 number of observations for each variable. Those numbers range  
22 as high as 1554. Why is this number different from the 1511 you  
23 just mentioned?

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1           A.    As I said in my previous response, the analysis was  
2 undertaken only for those observations that had all the required  
3 information.  A few observations had both prices but were  
4 missing precise information on the sales date or prior sales  
5 date, for example, and therefore could not be included in the  
6 analysis.

7           Q.    Could a particular property show up in more than one  
8 observation?

9           A.    Yes.  There were 507 discrete properties in the  
10 sample.  Over a span of 65 years many properties were sold  
11 multiple times.

12          Q.    What was the impact of Indian Point on the treatment  
13 group?

14          A.    Commencement of operations of units IP2 and IP3 at  
15 Indian Point reduced by nearly 3% the nominal rate of annual  
16 return.

17          Q.    So those homeowners had a rate of return closer to 6%  
18 rather than the sample average of 9%?

19          A.    Yes.

20          Q.    Was this diminution offset by reduced property taxes?

21          A.    No.  This estimated decline in the nominal return  
22 includes the combined effect of reduced value in use for the  
23 property and coincident changes in property tax obligations.

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1 Q. Would you characterize a nearly three percent  
2 diminution in value as either undetectable or so minor that it  
3 will neither destabilize nor noticeably alter any important  
4 attribute of land use?

5 A. No, I would not. The three percent is an annual  
6 impact on each individual homeowner. It means that each year  
7 each homeowner loses 3% of the value of its asset - in this  
8 case, the return on its investment in housing. Although it is  
9 related to the aggregate impact on the community, it is not the  
10 same.

11 Q. What is the aggregate impact on the homeowners within  
12 5 kilometers?

13 A. The total estimated loss in residential property  
14 values as of January 2011 is over \$1 billion, which is slightly  
15 more than 27% of residential property values within 5 kilometers  
16 of IPEC.

17 Q. Would you explain how you obtained that figure?

18 A. There were several steps. First, as described above, I  
19 had to estimate the change in the nominal return to owning a  
20 house for the treatment group. This is a change in the annual  
21 return estimated for members of the control group, who  
22 experienced this reduction in annual return during the time they  
23 held the property. For the sample the "holding period" or time

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1 between property sales averaged 8.19 years, so homeowners who  
2 held properties when IPEC appeared experienced the reduced  
3 return for an average of 8.19 years.

4 Q. So the reduction in total value for each home was 8.19  
5 years multiplied by a 3% loss? That sounds like about 25%.

6 A. Only approximately. The actual calculation is more  
7 complicated. The change in nominal return actually varies with  
8 location somewhat, and I take that into account. In addition,  
9 the nominal return is compounded, so it is not simply the  
10 percentage annual loss multiplied by the number of years. I use  
11 data from the 2000 census on the total value of residential  
12 property in each census block group. The actual loss was  
13 experienced in 1976, so I estimate what the value of these  
14 properties would have been under 1976 price levels and market  
15 conditions.

16 Q. How did you determine these values?

17 A. I constructed a price index for the properties within  
18 the 5 km. boundary.

19 Q. How did you do that?

20 A. I combined data from the Federal Housing Finance  
21 Administration house price index data with price data from the  
22 Bureau of Labor Statistics. This allowed me to estimate total  
23 residential property values at different times.

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1 Q. Is this a precise calculation?

2 A. No, it is an estimate based on the best possible  
3 available data. A graph in my December 2011 report shows the  
4 house price index that I created, which covers Peekskill,  
5 Buchanan and Cortlandt from 1945 to 2010.

6 Q. What did your house price index allow you to do?

7 A. I used it to translate data from the 2000 Census to  
8 estimate total rental and owner-occupied property values. I  
9 translated the 2000 values to the values that would prevail with  
10 1976 prices and market conditions. Then I calculate the change  
11 in nominal return for properties in each block group. I apply  
12 this change in annual nominal return for owning residential  
13 property to the value of residential property in the block group  
14 over a period of 8.19 years. This provides an estimated change  
15 in total value of residential properties under 1976 price levels  
16 and market conditions. Then I translated the 1976 values and  
17 associated impacts to total values and impacts as of January  
18 2011 using the price index I had constructed.

19 Q. Does your analysis show greater impacts on properties  
20 that are located closer to IPEC?

21 A. The methodology I have employed does not allow me to  
22 measure this directly because of the construction of the control  
23 and treatment groups I mentioned above. In this case the group

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1 of observations received a "treatment" - and were included in  
2 the treatment group - if they were purchased before IPEC began  
3 full scale operations and sold afterwards. In order to  
4 determine if the impact was greater for properties located  
5 closer to IPEC, I would need a much larger treatment group. Then  
6 I could examine rates of return on properties at various  
7 distances, comparing ownership periods that took place entirely  
8 before IPEC or after IPEC with those that span the opening of  
9 IPEC. The amount of data available to me was sufficient to  
10 determine, to a reasonable degree of scientific certainty, that  
11 there was an effect on the entire area within a 5 kilometer  
12 radius from IPEC. The data did not permit me to determine  
13 accurately the variation in impacts as we get closer to IPEC.

14 Q. So your analysis did not consider any impact of  
15 distance from IPEC?

16 A. My model does include a variable for distance from  
17 IPEC, but this variable measures a constant impact before,  
18 during and after IPEC opens. It is included to account for  
19 variations in the rate of return on housing that are sensitive  
20 to proximity to employment centers or other factors, but it does  
21 not capture a location-related impact of IPEC.

22 Q. To what do you refer when you say "impacts"?

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1 A. By "impacts" I mean changes in the value of properties  
2 that can be reliably attributed to the construction and  
3 operation of IPEC.

4 Q. Can you describe the formula used to measure the loss?

5 A. Yes. The measured loss as of December 1976 was  
6 estimated by the formula:

$$Loss = Price_{1976} \cdot (1 - e^{-\delta_p T}) \quad (12)$$

7 Where:

$Loss$  = Estimated loss in property value as of  
December 1976  
 $Price_{1976}$  = Total property value as of December  
1976  
 $-\delta_p$  = The reduction in the nominal rate of  
return on residential property  
 $T$  = The average amount of time residential  
property is held

8  
9 This yields a conservative estimate of the reduction in property  
10 value attributable to the facility being present in the  
11 community.

12 Q. What makes the estimate conservative?

13 A. Properties in the treatment group were actually owned  
14 for longer than the 8-year average. Using that longer ownership  
15 period would have resulted in an even larger estimate of  
16 property value impacts. In addition, I am measuring the impact  
17 based on property market response that took place between 1974  
18 and 1976 when IP2 and IP3 began operations. Because  
19 construction of the plant had been going on for some time prior

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1 to this, and the much smaller IPl had actually been in  
2 operation, there may have been some adverse property value  
3 impacts that took place prior to 1974. If so, then my analysis  
4 would underestimate the total impact on property values.

5 Q. So this formula was applied to the total value of  
6 residential property in each block group after adjusting that  
7 value to 1976 prices and market conditions?

8 A. That is correct. I then summed the estimated change  
9 in total value of property across all block groups whose center  
10 was within 5 kilometers of IPEC.

11 Q. You then translated this total loss measured in 1976  
12 prices to January 2011 using your price index?

13 A. That is correct.

14 Q. Can you now tell me the magnitude and direction of the  
15 impact of Indian Point on the sample treatment properties?

16 A. I can. The direction is negative. Indian Point  
17 adversely impacts property values.

18 Q. And the magnitude of that impact?

19 A. As of January 2011, the loss suffered by residential  
20 properties within 5 kilometers of the facility was just over  
21 27%.

22 Q. What is the dollar value of that impact?

23 A. \$1,070,074,312.

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1 Q. So is this amount the dollar value of a loss that has  
2 been experienced by current residents of the area?

3 A. Not exactly. Much of the loss was experienced by  
4 property owners who owned residential property prior to opening  
5 of IPEC and continued to own the property when IPEC commences  
6 operations. When they sold their properties after 1976, they  
7 would be selling at the reduced price. My objective in this  
8 analysis, however, has not just been to estimate the losses, if  
9 any, experienced by some past owners. Many of the homes in the  
10 area today weren't even built in 1976. Rather, my objective has  
11 been to estimate how much residential land value might increase  
12 when IPEC is decommissioned and the site is returned for use.  
13 This is my counter-factual. I have estimated this by careful  
14 analysis of what happened to property values when IPEC opened,  
15 assuming that when IPEC is gone and the site is restored these  
16 changes will be undone.

17 Q. Would you characterize a 27% loss in value as  
18 undetectable or minor?

19 A. I would not. A 27% loss in value is one that will  
20 clearly have noticeable effects on land use decision making.

21 Q. Would that impact in your opinion be sufficient to  
22 destabilize the community?

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1           A.    Quite possibly.  It is certainly sufficient to result  
2 in very significant impacts.  These include economic impacts  
3 such as the value of residential property and the associated  
4 wealth of property owners.  They also could include  
5 environmental land use impacts that will arise because the  
6 increased values of residential property will cause owners to  
7 make more careful use of land and allocate the land to different  
8 types of uses.  This is why I disagree so strongly with the  
9 assertions made in the FSEIS that land use would experience "no  
10 noticeable . . . change."

11           Q.    On what do you base your opinion?

12           A.    On recent experience that we have all shared to a  
13 greater or lesser degree.  From early 2007 through the first  
14 quarter of 2011, house prices in the United States fell by  
15 approximately 16%.  A few large markets experienced a diminution  
16 in value of more than 16% and some other markets experienced a  
17 lesser diminution.  But the average impact, 16% nationwide, has  
18 had profound impacts on land use around the country; these  
19 impacts are likely to persist for at least a decade.  This  
20 event, and related economic trends, is being called the "Great  
21 Recession."  But the impacts I have documented in the five  
22 kilometers around IPEC are even greater.  By any measure, those  
23 impacts may only be described as LARGE.

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1 Q. Does this conclude your testimony?

2 A. Yes.

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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. December 16, 2011

10 -----X

11 DECLARATION OF STEPHEN C. SHEPPARD, Ph.D.

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.

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

17 

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24 December 16, 2011

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