United States Nuclear Regulatory Commission Official Hearing Exhibit

In the Matter of: Entergy Nuclear Operations, Inc.
(Indian Point Nuclear Generating Units 2 and 3)

ASLBP #: 07-858-03-LR-BD01
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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of
ENTERGY NUCLEAR OPERATIONS, INC.
(Indian Point Nuclear Generating Units 2 and 3)

Docket Nos. 50-247-LR and 50-286-LR
ASLBP No. 07-858-03-LR-BD01

August 12, 2009

DECLARATION OF STEVEN E. DOBBS IN SUPPORT OF ENTERGY'S MOTION FOR SUMMARY DISPOSITION OF NEW YORK STATE CONTENTION 8

Steven E. Dobbs states as follows under penalties of perjury:

I. INTRODUCTION

1. I am a self-employed electrical engineering consultant. I hold a Professional Engineer (P.E.) license in the State of Arkansas.

2. My education and professional experience are summarized in the *curriculum vitae* attached to this declaration. I have over 35 years work experience, 16 years of which have been in the nuclear power industry. I hold a Bachelor of Science (B.S.) degree in Physics from Arkansas Tech University, a Master of Science (M.S.) degree in Electrophysics from George Washington University, and a Doctor of Philosophy (Ph.D.) in Electrical Engineering from the University of Arkansas.

3. I taught in the Engineering Department at Arkansas Tech University from 1977 until 1990. During that time period, I taught classes in Electrical Machinery that covered the theory and operation of transformers, motors, and generators. For a period of time, I directed the laboratory associated with that class. From 1990 to 2004, I worked as an electrical engineer,

including Senior Staff Engineer, for Entergy Operations, Inc. at Arkansas Nuclear One, providing engineering support for computer and electronic systems throughout the plant.

4. I am familiar with New York State ("NYS") Contention 8 ("NYS-8"). As admitted into the proceeding by the Atomic Safety and Licensing Board, NYS-8 alleges: "The LRA for IP2 and IP3 violates 10 C.F.R. §§ 54.21(a) and 54.29 because it fails to include an aging management plan for each electrical transformer whose proper function is important for plant safety." NYS argues that these transformers are subject to aging management review ("AMR") for license renewal because, by New York's account, transformers perform their safety function without moving parts and without a change in configuration or properties. That argument is erroneous.

5. My declaration addresses the nature and operation of transformers. I will demonstrate that transformers perform their intended function with a "change in configuration or properties" and, therefore, are properly excluded from AMR under 10 C.F.R. Part 54.

II. THEORY OF TRANSFORMER OPERATION

6. This section provides a simplified explanation of the scientific principles involved in transformer construction and operation. The overall purpose of the discussion is to demonstrate that the very essence of a transformer is the process by which it accepts voltage and current at an input and then "transforms" that voltage and current to different values at its output(s). Thus, the voltages and currents associated with a transformer, which change as the transformer performs its intended function, are tied to the transformer at such a basic level that they must be considered to be properties of the transformer. Moreover, these properties will be shown to change during transformer operation. Paragraphs 7 through 15 are a short explanation of the scientific and mathematical basis for transformer operation. The discussion beginning at

paragraph 15 demonstrates how the voltage and current properties of a transformer change during operation.

7. The transformer is based on two scientific principles. First, an electric current flowing through a wire will produce a magnetic field. Second, a changing magnetic field within a coil of wire will produce a voltage across the ends of the coil.

8. A third scientific principle that affects the design of transformers is that magnetism is more easily induced into certain types of materials. The magnetic permeability, normally designated as μ, is a measure of how easily a material is magnetized. The larger the value of μ, the easier it is to magnetize the material. Air has a very low magnetic permeability, whereas iron and steel have very high values of permeability. Thus, it requires less energy to create or maintain a magnetic field in iron or steel than in air.

9. In its simplest form, a transformer is formed by winding two coils of wire around the same iron form, called a core. An alternating current is used to excite the "primary" coil. This current creates a magnetic field around the wire. Because the wire is wrapped in a coil, the magnetism produced by each turn or wrap of wire adds to the magnetic fields from the other wraps to produce a strong magnetic field within the core (*i.e.*, the greater the number of turns around the iron core the greater the strength of the magnetic field). Because the core is iron and has a high permeability, the magnetism easily permeates the entire core. Because alternating current is used to drive the primary coil, the magnetic field produced in the core has a time-varying magnitude.

10. Farady's Law relates the voltage used to drive the current through the primary wire to the magnetic flux produced in the core by the equation:

$$V_p = N_p \, {}^{d\Phi}\!/_{dt}$$ where

V_P is the voltage applied to the primary coil,

N_P is the number of turns of wire in the primary coil, and

$d\Phi/dt$ is the time-changing magnetic field in the core produced by the current in the primary coil.

11. The time-varying magnetic flux created by the primary winding permeates the core. Because the secondary winding is wound around the same core, the changing magnetic field inside the core excites the secondary winding as well. Again, Faraday's Law expresses the relation between the changing magnetic flux in the core and the voltage produced at the winding terminals:

$$V_S = N_S \, d\Phi/dt$$ where

V_S is the voltage created at the terminals of the secondary winding,

N_s is the number of turns of wire in the secondary coil, and

$d\Phi/dt$ is the time-changing magnetic field in the core produced by the current in the primary coil.

12. Because the equations depicted in paragraphs 10 and 11 both contain the identical term $d\Phi/dt$, they can be solved for that term and then set equal to each other to produce:

$$V_S/N_S = V_P/N_P$$

13. This equation can be rearranged to provide the classic transformer equation:

$$V_S/V_P = N_S/N_P$$

14. If the secondary winding is connected to a load and current is allowed to flow into that load, then power will be transferred to that load. If the transformer is considered "lossless," then the power supplied by the primary winding will be equal to the power consumed by the load connected to the secondary. In equation form, the conservation of energy can be expressed as

$$P_{Primary} = I_P V_P = I_S V_S = P_{Secondary}$$

15. Solving the equation in 14 for the ratio of the voltages leads to the following relation:

$$V_S/V_P = N_S/N_P = I_P/I_S$$ where

V_P is the voltage applied to the primary coil,

N_P is the number of turns of wire in the primary coil,

I_P is the primary coil current,

V_S is the voltage created at the terminals of the secondary winding,

N_s is the number of turns of wire in the secondary coil, and

I_S is the current in the secondary winding.

16. The equation in paragaph 15 is the mathematical statement of transformer operation. Without voltage and current, there is no transformer operation. Therefore, voltage and current are integral properties of a transformer.

17. As shown in the derivation of this equation, the voltages, currents, and the associated magnetic field all must vary in time to achieve transformer operation. Therefore, all voltages and currents associated with a transformer are alternating current ("AC") values, which vary continuously in time.

18. The following table shows how applying the results of the equation in paragaph 15 leads to the different types of transformers in common use:

N_S/N_P(Turns Ratio)	V_S in terms of V_P	I_S in terms of I_P	Type of Transformer
10	10 V_P	0.1 I_P	Step-up
1/10	0.1 V_P	10 I_P	Step-down
1	V_p	I_P	Isolation if windings not electrically connected

Thus, as the ratio of turns increases (*i.e.*, there are relatively more secondary turns as compared to primary turns), the voltage at the terminals of the secondary winding increases. If the ratio exceeds one, voltage is stepped up at the secondary terminals. If the ratio is less than one, voltage is stepped down.

19. The following table shows an example of the AC voltages and currents in a typical step-up transformer having a turns ratio of 10 under various load conditions.

Load Condition	V_P	V_s	I_p	I_s
0	0	0	0	0
0.5	100 VAC	1000 VAC	500 AAC	50 AAC
1	100 VAC	1000 VAC	1000 AAC	100 AAC

Thus, as the load increases at the primary terminals in a step-up configuration, the current output at the secondary terminals will increase in proportion to the increased load.

20. The table above (paragaph 19) demonstrates that the voltage and current properties of a transformer change depending on the load condition of the transformer.

21. The above discussion was based on the simplest possible transformer that was assumed to be "lossless." The basic principles, however, do not change by adding complexity to the design or by considering electrical and magnetic losses. That is to say, these same principles apply equally to all transformers from the smallest electronic unit to the largest distribution transformer. Neither the way the transformer is constructed nor the way in which it is used alters the principles and conclusions set forth herein. Consideration of losses will add variables and complexities to the calculations, but it will not change the underlying principles or the basic equations.

22. In summary, a transformer accepts voltage and current at an input and changes that voltage and current to some other value at its output(s). All of the voltages and currents

must vary in time. The voltages and currents also vary whenever load conditions change. Therefore, a transformer cannot perform its intended function without changes in its voltage and current properties.

III. PROPERTIES OF A TRANSFORMER

23. A transformer basically is a series of wire windings around some type of core. The core usually is constructed of a material that has a high magnetic permeability, such as iron or steel. There can be many windings or as few as one. However, regardless of the number or arrangement of the windings, the basic transformer equation described in paragraph 15 above will be true.

24. The currents in the windings of a transformer are quantities that can be measured. When a transformer is performing its intended function, currents will be present in some or all of the windings. The currents in the transformer windings will vary depending on the load placed on the transformer.

25. Voltage, current, and the winding turns ratios are all properties of a transformer. These properties are easily monitored while the transformer is performing its intended function and provide an indication as to the operational health of the transformer.

26. All transformers have internal losses, which result in heating of the unit. A normally functioning transformer will stabilize at a temperature dependent on its environment. The temperature of a transformer or its infrared signature can be monitored as a method of verifying proper operation. The heat signature of a transformer is a property that changes with load as the transformer operates.

27. The voltages, currents, and heat signature of a transformer are all traits that are peculiar to the unit, and all of these properties change as the transformer performs its intended function.

IV. DISCUSSION OF 10 C.F.R. § 54.21(A)(1)(I)

28. Section 54.21(a)(1)(i) states, in pertinent part: "Structures and components subject to an aging management review shall encompass those structures and components—(i) that perform an intended function, as described in §54.4, without moving parts or without a change in configuration or properties."

29. Section 54.21(a)(1)(i) includes a list of structures and components that are subject to AMR, as well as a list of structures and components that may be excluded. It explicitly states that neither of these lists is all-inclusive.

30. Transformers do not appear in either list.

31. Based on the facts of Sections II and III above, voltage, current, and heat signature are all properties of a transformer. When the transformer changes from an idle state to an active state, the voltages and currents change. Also, the currents and heat signature will change with a variation of the load. Because transformers perform their intended function with a change in properties, they are excluded from an AMR according to the defining statement in § 54.21(a)(1)(i).

32. This conclusion is confirmed by comparing transformers to the examples on the included and excluded lists under § 54.21(a)(1)(i). The included list contains such items as the reactor vessel, pressure boundaries, piping, component supports, penetrations, electrical cables, and electrical cabinets. The common characteristic of all of these items is that each one's ability to perform its intended function cannot be directly verified by monitoring a measurable property. Instead, indirect measurements, tests, and observations are used to predict the serviceability of the item based on an analysis of this secondary information. For example, the ability of a pipe to perform its intended function (*e.g.*, transporting water) is monitored *indirectly* by, for example, periodically measuring the thickness of the pipe's wall and observing it for signs of corrosion.

33. By contrast, it is possible to *directly* measure performance of the intended function of all the items on the excluded list. The excluded list contains such items as motors, diesel generators, pressure transmitters, pressure indicators, transistors, batteries, breakers, relays, switches, power inverters, battery chargers, and power supplies. The serviceability of these items is determined by making direct measurements of the intended function of the items. For example, the intended function of a power supply is to provide a specified current at a specified voltage. The ability of a power supply to perform its intended function can be verified by loading it to the desired current and then measuring the output voltage.

34. In studying these two lists, the closest match to a transformer is a transistor, which is found on the excluded list. A transistor has no moving parts. Its intended function is to receive voltage and current at an input and provide a different voltage and current at an output. The properties of a transistor that change while it is performing its intended function are its input and output voltages and currents. The ability of a transistor to perform its intended function is directly indicated by monitoring these voltages and currents.

35. Like a transistor, a transformer has no moving parts. A transformer's intended function is to receive voltage and current at an input and provide a different voltage and current at one or more outputs. The properties of a transformer that change while it is performing its intended function are its input and output voltages and currents. The ability of a transformer to perform its intended function is directly indicated by monitoring these voltages and currents. Because the transistor and transformer share these characteristics, a transformer also belongs on the excluded list.

V. THE 1995 STATEMENT OF CONSIDERATION FOR THE 1995 LICENSE RENEWAL RULE

36. The NRC publishes Statements of Consideration ("SOC") with rule changes. The SOC provides historical context and supplementary information that can be used to help interpret the intent of the License Renewal Rule. The SOC for the NRC's 1995 revisions to 10 C.F.R. Part 54 is available at 60 Fed. Reg. 22,461 (May 8, 1995). *See* Exhibit 1.

37. SOC Section II(4) states: "In § 54.21(a), the IPA [integrated plant assessment] process has been simplified. . . . A simplified methodology for determining whether a structure or component requires an aging management review for license renewal has been delineated. Only passive, long-lived structures and components are subject to an aging management review for license renewal." Exh. 1, 60 Fed. Reg. at 22,463.

38. SOC Section III.a.(i) states: "The Commission still believes that mitigation of the detrimental effects of aging resulting from operation beyond the initial license term should be the focus for license renewal." Exh. 1, 60 Fed. Reg. at 22,464.

39. SOC Section III.a.(i) later states: "The Commission has determined that it can generically exclude from the IPA aging management review for license renewal (1) those structures and components that perform *active* functions . . . ." Exh. 1, 60 Fed. Reg. at 22,464 (emphasis added).

40. SOC Section III.d.(v) ("Excluding Structures and Components With Active Functions") states: "Direct verification is practical for active functions such as pump flow, valve stroke time, or relay actuation where the parameter of concern (required function), including any design margins, can be directly measured or observed. For passive functions, the relationship between the measurable parameters and the required function is less directly verified. Passive functions, such as pressure boundary and structural integrity are generally verified indirectly, by

confirmation of physical dimensions or component physical condition . . . ." Exh. 1, 60 Fed. Reg. at 22,471.

41. SOC Section III.f.(i) states: "The Commission has determined that passive structures and components for which aging degradation is not readily monitored are those that perform an intended function without moving parts or without a change in configuration or properties." Exh. 1, 60 Fed. Reg. at 22,477.

42. Section III.f.(i) then states: "Further, the Commission has concluded that 'a change in configuration or properties' should be interpreted to include 'a change in state,' which is a term sometimes found in the literature relating to 'passive.' For example, a transistor can 'change its state' and therefore would not be screened in [as a passive component] under this description." Exh. 1, 60 Fed. Reg. at 22,477.

VI. APPLICATION OF 1995 SOC PRINCIPLES TO TRANSFORMERS

43. The SOC makes clear that the purpose of license renewal is to identify those structures and components that might experience the detrimental effects of aging resulting from operation beyond the initial license term and that may not be adequately monitored by current programs and activities. Items to be included in a licensee's IPA are classified as "passive."

44. The SOC states that structures and components that perform "active" functions can be generically excluded from the IPA and, thus, from AMR.

45. The SOC defines "active functions" as those where the required function can be "directly measured or observed" and "passive functions" as those where the required function must be verified indirectly. The SOC makes clear that passive structures components do not include those which perform an intended function with a change in configuration or properties, which includes a "change in state."

46. The intended function of a transformer is to accept an input voltage and current, to transform it in some way, and then supply an output voltage and current to one or more loads. All of the parameters of interest can be directly measured. The voltages and currents change as the transformer performs its intended function. Therefore, a transformer performs an active function and should be generically excluded from the IPA.

47. The fact that any transformer, regardless of size or application, is an active component means that all transformers equally should be excluded from the IPA.

VI. CONCLUSIONS

48. It is not possible to describe transformer operation without referring to the input and output voltages and currents. Therefore, these voltages and currents must be considered to be properties of a transformer.

49. The voltages and currents of a transformer change as the transformer performs its intended function. Therefore, transformers are excluded from the requirement of an AMR by the definition stated in § 54.21(a)(1)(i).

50. Of all of the items listed in § 54.21(a)(1)(i), transformers are most similar to transistors. Transistors are in the excluded list. Transformers likewise should be excluded from an AMR.

51. The SOC for § 54.21(a)(1)(i) provides additional background as to what should be included and excluded in an AMR. Items that are included are classified as "passive." Items that are excluded are classified as "active." Transformers should be classified as active because their required function (transforming voltages and currents) can be directly measured.

52. Because all transformers perform their intended function through a change in state (*i.e.,* changes in voltage and current properties), all transformers are properly excluded from AMR under § 54.21(a)(1)(i).

In accordance with 28 U.S.C. § 1746, I declare under penalty of perjury that the foregoing is true and correct.

Executed on August 12, 2009.

Steven E. Dobbs

Dr. Steven E. Dobbs, P.E.

Name: **Steven E. Dobbs**

Current Position: **Engineering Consultant, Dobbs & Associates Engr., Inc.**

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Education:

B.S. Physics, Arkansas Tech University 1971
M. S. Electrophysics, George Washington University 1975
Ph.D. Electrical Engineering, University of Arkansas 1983

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Professional Certificates/Associations:

Arkansas Professional Engineer, Certificate Number 4931
General Class Radiotelephone Certificate
Arkansas Academy of Electrical Engineering

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Employment History:

1979 to Present – Dobbs & Associates Engineering, Inc. Engineering consulting in electronics and computer applications. Primarily consulting with nuclear power plants since January 2007.

October 2006 to December 2006 – Research Associate at McMurdo Station, Antarctica. Operated, maintained, and repaired multiple long-term computer-based geophysical experiments. Responded to PI requests as required.

October 2005 to May 2006 – Research Associate at Palmer Station, Antarctica. Operated, maintained, and repaired multiple long-term computer-based geophysical experiments. Moved experiments from their old facilities to the new IMS (Terra Lab) building. Responded to PI requests as required.

1990 to 2004 – Entergy Operations, Inc., Arkansas Nuclear One. Worked in Computer Support Group, Systems Engineering, and Design Engineering providing engineering support for computer and electronic systems throughout the plant. Progressed from Senior Engineer to Senior Lead Engineer to Senior Staff Engineer (highest engineering grade). Formed the Electronics Resource Group in 1999. This group deals with electronics issues at multiple Entergy nuclear plants.

1977 to 1992 – Arkansas Tech University, Engineering Department. Taught classes in Engineering, Computer Science, and Management Science. Developed curriculum in Digital Electronic Systems. Helped department gain accreditation by ABET.

Progressed from Instructor to Assistant Professor to Associate Professor to Professor of Engineering (highest academic grade).

1974 to 1977 – Central Intelligence Agency, Office of ELINT. Worked in the area of Electronic Intelligence collection. Spent 1976-1977 at a remote collection site in Iran providing engineering support for high tech electronic signal intercept equipment.

1971 to 1973 – Central Intelligence Agency, Office of Scientific Intelligence. Prepared estimates of the nuclear capabilities of the communist block countries. Invented a statistically based computer program for estimating fissile material production at gaseous diffusion plants. Held both Top Secret and Q clearances.

Specific Areas of Experience:

Programming Experience:

- FORTRAN, PLM, COBOL, RPG, BASIC, Paradox (PAL), LabVIEW, C on industrial class single board computers, RSLogix 5000 ladder logic (Allen Bradley Control Logix)
- ASSEMBLER
- Motorola 6800, Zilog Z-80, Intel 8085, Motorola 68000, HP 21MX, 68HC11

Operating Systems Experience:

- CPM, DOS, Windows, Isis II, HP 21MX, Linux

Applications Experience:

- Word, Excel, Access, Powerpoint, Outlook, Paradox, ORCAD, TurboCAD, Visio, AutoCAD, and others too numerous to mention

Hardware Experience:

- Maintained and repaired wide-band tape recorders, antenna systems, and radio receivers.
- Designed, equipped, and set-up college level electronics laboratories. Wrote experiments and ran laboratory sessions. Repaired equipment when necessary. Ensured that these laboratories met ABET accreditation standards. Laboratories included all of the following: Circuits I, Circuits II, Electronics, Digital Systems Design, Motors and Generators, Auto-CAD, Senior Design Project.
- Configured and repaired S-100/CPM computers.
- Repaired printers

- Configured and built computer systems from S-100 through Pentium.
- Interfaced serial and parallel computer equipment.
- Designed, built, and programmed a single board computer with monitor type operating system.
- Designed, built, and programmed a real-time EKG heart arrhythmia detector.
- Designed, built, and programmed a security transaction unit including a Weigand wire badge scanner and keypad. All units networked to central security system.
- Helped in design of spent fuel crane control system. Wrote the entire controlling program in ladder logic.
- Designed and built several electronic assembly replacements for obsolete nuclear plant equipment including relay modules, power supplies, 7-segment displays, computer I/O interfaces, etc.