UNITED STATES

NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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In re:	Docket Nos. 50-247-LR; 50-286-LR
License Renewal Application Submitted by	ASLBP No. 07-858-03-LR-BD01
Entergy Nuclear Indian Point 2, LLC,	DPR-26, DPR-64
Entergy Nuclear Indian Point 3, LLC, and	
Entergy Nuclear Operations, Inc.	December 14, 2011

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PREFILED WRITTEN TESTIMONY OF
Earle C. Bascom III
REGARDING CONTENTIONS NYS-6 and 7

On behalf of the State of New York (“NYS” or “the State”), the Office of the New York State Attorney General hereby submits the following testimony by Earle Bascom regarding Contentions NYS-6 and 7.

Q. Please state your full name.

A. Earle Clarke Bascom,III

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

A. I am employed by Electrical Consulting Engineers, P.C. ("ECE"), a company I founded in 2010. I am the president and a principal engineer.

Q. What kind of consulting does ECE do?

A. Electrical Consulting Engineers, P.C. (ECE) provides engineering consulting services to the electric power industry and focuses on underground transmission and distribution cable systems. Our work includes engineering design and analysis for new cable circuits, rating capacity studies, and cable system assessments on existing cable systems. Most of our work is performed for utilities, though occasionally we work as subcontractors for architect-engineering firms that lack expertise in underground cables.

Q. Please summarize your educational and professional qualifications.

A. I hold an Associate's of Science degree in Engineering Science from Hudson Valley Community College, a Bachelor's of Science and Master's of Engineering degrees in Electric Power Engineering from Rensselaer Polytechnic Institute, and an MBA degree from the State University of New York at Albany.

Q. Please summarize your employment before you founded ECE in 2010.

A. Prior to founding ECE, I worked for nine years with Power Technologies, Inc (PTI, now part of Siemens) focusing on underground cable systems within the Transmission & Distribution Department. At the time I was employed there, PTI provided transmission and distribution engineering consulting services for overhead, underground, substation and generation equipment as well as being a supplier of power system analysis (load flow, etc.) software. In 1999, I left PTI and joined Power Delivery Consultants, Inc. (PDC); PDC was focused on providing engineering consulting services for underground transmission and distribution systems, but also offered limited services for overhead line and power transformer ratings. I was with PDC for eleven years.

Q. What is the purpose of your testimony?

A. I was retained by New York State to review Entergy's discussion in its License Renewal Application of the aging management of non-environmentally qualified inaccessible low and medium voltage power cables at Entergy's Indian Point nuclear generating units 2 and 3 that are exposed to adverse localized environments, and to assess whether Entergy has demonstrated that it will adequately manage the effects of aging on those cables so that the cables will perform their intended function during the license renewal period.

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

A. Yes.

Q. What is the source of those materials?

A. Many are documents prepared by government agencies, or documents prepared by Entergy or by the Electric Power Research Institute ("EPRI"), the research arm of the utility industry.

Q. I show you NYS Exhibits 000139 through 000145. Do you recognize these documents?

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

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

A. These documents represent the type of information that persons within my field of expertise reasonably rely upon in forming opinions of the type offered in this testimony.

Q. I show you what has been marked as Exhibit NYS000138. Do you recognize that document?

A. Yes. It is a copy of the report that I prepared for the State of New York in this proceeding. The report reflects my analysis and opinions.

Q. Please give a brief summary of your testimony.

A. Entergy has not demonstrated that it will manage the effects of aging on non-environmentally qualified ("non-EQ") inaccessible low and medium voltage cables exposed to significant moisture because its License Renewal Application lacks any substantive detail. Entergy does not specify the location or number of the relevant cables, does not identify their function or the criticality of the systems they serve, does not describe their physical characteristics, does not explain what corrective actions it will take if manhole inspections reveal periodic water accumulation, does not explain what cable condition monitoring tests it will use, does not explain the criteria for determining whether a cable passes or fails a condition monitoring test, and does not identify what corrective actions, if any, Entergy will take if a defective cable is found. Without this essential detail, Entergy has not demonstrated that its Aging Management Plan will insure the continued integrity and function of the non-EQ inaccessible cables that are exposed to significant moisture during the period of extended operation.

In addition, Entergy has not provided any plan to manage the effects of aging on non-EQ inaccessible low and medium voltage power cables that are exposed to other localized adverse environmental conditions, such as excessive heat. Also, Entergy has not demonstrated that such a plan is unnecessary because there are no non-EQ inaccessible power cables exposed to excessive heat. Cable insulation exposed to excessive heat may degrade faster than cable insulation exposed to significant moisture.

Q. What does the term non-environmentally qualified mean in the context of these cables?

A. A cable is non-environmentally qualified if it is not designed to withstand the adverse effects of the environment in which it is located.

Q. In the context of IP2 and IP3, in what way are the non-EQ low and medium voltage cables inaccessible?

A. In this context, inaccessible cables are either directly buried underground or pulled through a buried conduit.

Q. I would like to ask you some very basic questions about electric circuits. First, what is an electric current?

A. An electric current is a flow of electrons through a conductor. A conductor is generally a wire made of copper or aluminum -- materials that offer low resistance to the electron flow. In order for an electric current to perform work, the conductor must be part of a circuit through which the current continuously flows.

Q. What causes electrons to flow through a conductor?

A. In alternative current systems, voltage produced by an electric generator produces the force (electro-motive force) to move the electrons through the conductor and around an electric circuit. That force is measured in volts and is described as voltage. Electric current is measured in amperes. Electric power, or the work electricity can do, is the product of amperes and voltage and is expressed as watts.

Q. What are the basic components of an underground electric cable?

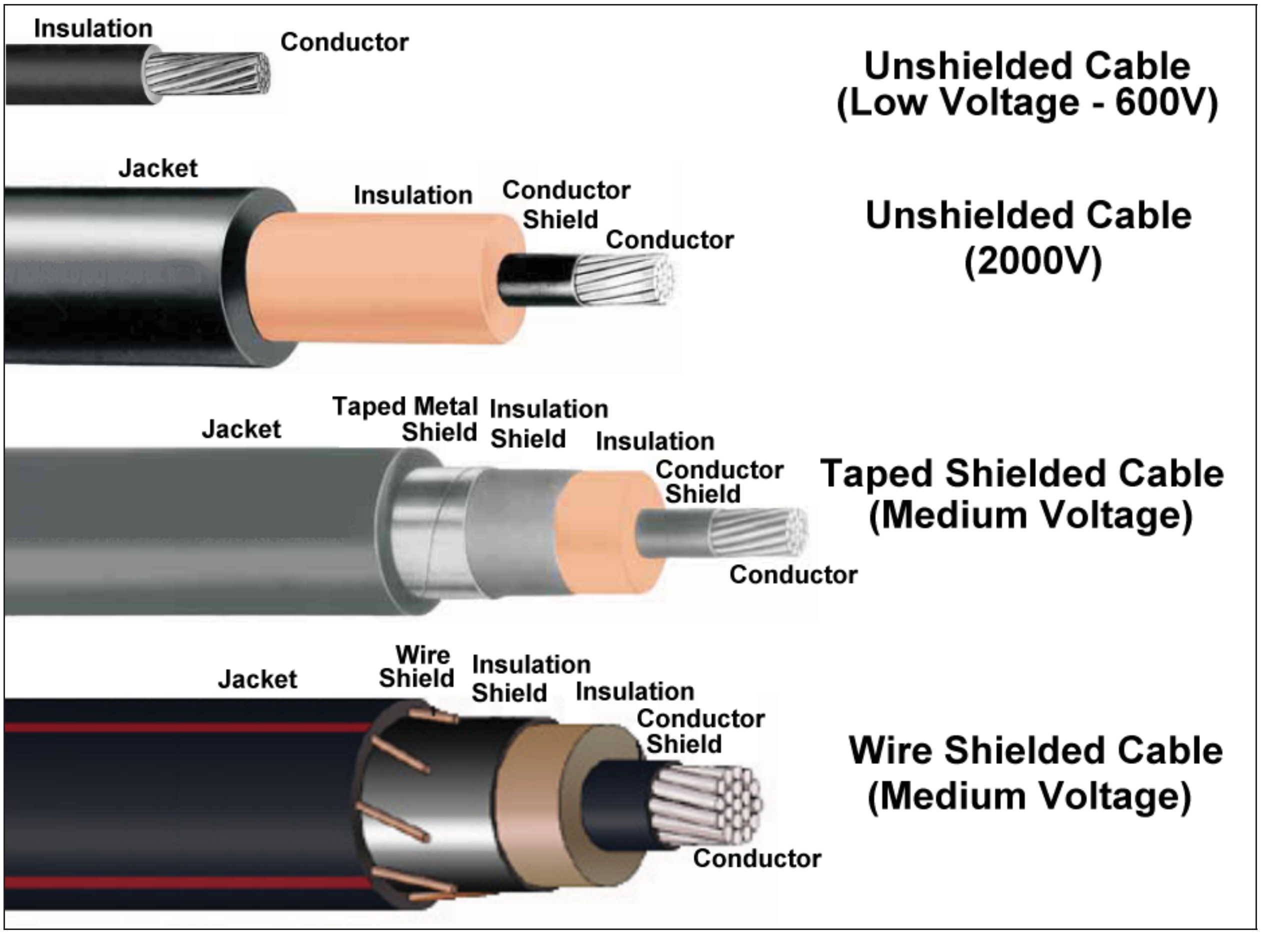
A. There are two basic components - the conductor that carries the current and the cable insulation that prevents the electricity in the conductor from discharging into the surroundings. Other components of the cable help assure that these two basic functions are maintained. If insulation is no longer capable of preventing the electricity from discharging into the surroundings, the voltage of the electricity drops, the electricity faults to ground, the cable circuit fails and the circuit is then unable to perform its task. In an electric cable, the voltage between the conductor and the outer cable layers is called "line to ground voltage." It represents the electrical potential on the conductor to drive the movement of the electrons

Q. Please define the terms "low voltage cable" and "medium voltage cable."

A. Low voltage cable generally refers to cables that are classified for operation at 2,400 volts or less and typically do not contain a metallic shield. In general, medium voltage cable refers to cables that are classified for operation from above 2,400 volts up to 69,000 volts and typically include a metallic shield. Power equipment is often designated by voltage “class” which is based on the magnitude of the voltage with which the equipment operates. “Transmission” class equipment generally operates at or above 69,000 volts. “Distribution” class equipment generally operates below 69,000 volts. In a utility setting, “medium” voltage equipment is a subset of distribution class and usually refers to equipment that operates above 2,400 volts to 69,000 volts. “Low” voltage equipment refers to equipment that operates at 2,400 volts or less. All underground distribution cables are low or medium voltage.

Q. Please describe the construction of a low or medium voltage cable.

A. To help make my testimony on this subject easier to follow, I have created Figure 2 below, which is a composite of pictures showing various cable types, to illustrate the parts of an insulated power cable. Detailed descriptions of the various components are provided below the figure.



Low and Medium Voltage Underground Cable Components

A. A cable contains a conductor that carries the electrical current. The conductor is made of either copper or aluminum and is usually manufactured using stranded wires that improve its flexibility. Because the conductor has imperfections and non-uniformity that can cause electrical stress in the overlying insulation layer, a thin semi-conducting layer of material, known as the conductor shield, is applied over the conductor to provide a smooth interface between the conductor and the surrounding insulation.

The insulation layer on a cable supports the rated line-to-ground voltage between the conductor and outer cable layers -- that is, it prevents the electricity from leaving the cable circuit, flowing into the environment and causing a voltage drop in the cable that breaks the circuit.

The insulation on cables constructed in the 1960s and 1970s was generally made of cross-linked polyethylene ("XLPE"), or ethylene-propylene-rubber ("EPR"), which is also known as high molecular weight polyethylene (“HMWPE”). The chemical components of these materials are combined using reagents, heat and pressure and then pumped, or extruded through a die, at high temperature over the conductor and conductor shield.
An insulation shield, similar to the conductor shield, is then applied to the insulation to provide a smooth interface between the insulation and the outer cable layers.

Some medium voltage cables -that is, above 2.4 kV, also include a metallic shield over the insulation shield. The metallic shield can consist of helical copper or aluminum wire strands, helical copper or aluminum tapes or longitudinal copper or aluminum foil wrap. Some cables have a foil laminate and wires. The longitudinal foil and, to a lesser degree, the helical tapes provide a degree of moisture barrier (i.e., a "sheath") to the cable insulation but generally do not form a hermetic seal.

An insulating jacket made of polyvinyl chloride or polyethylene is then placed over the insulation, insulation shield, and metallic shield, if there is one. The jacket provides mechanical protection to the shield and insulation, prevents corrosion of the metallic shield, and electrically insulates the metallic shield from the surrounding environment. The jacket is not a hermetic barrier and does not alone prevent moisture intrusion into the insulation.

Q. Are underground cables directly buried in the ground?

A. They can either be directly buried in the ground or pulled through buried conduits. Often more than one low or medium voltage cable will be installed in a single conduit.

Q. Please explain what a power cable failure is.

A. A power cable failure prevents the cable from carrying power to the intended location or equipment. This occurs when the cable stops carrying current because of a failure or interruption of the conductor, or when the cable insulation stops supporting line to ground voltage because of a failure of the insulation allowing some of the current to reach ground.

Q. Please explain the term "line to ground" voltage?

A. Power equipment is generally specified based upon system voltage, or the voltage at which a particular system will operate. System voltage or rated voltage is sometimes referred to as the systems' “class” or by electrical engineers as the “line-to-line” voltage or the difference in voltage between two phase (e.g., “line”) conductors. Since the outside of the cable is in contact with the ground or contains a metallic shield that is grounded at one location, the voltage appearing between the conductor and the metallic shield or the outside of the cable is the “line to ground voltage”. The magnitude of the line to ground voltage is equal to the system voltage divided by the square root of three.

Q. What is a cable failure?

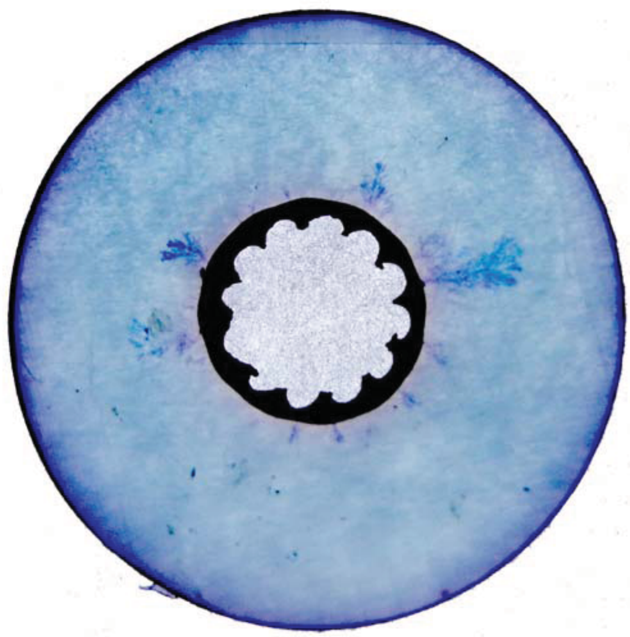
A. In the simplest terms, a “failure” occurs when a component or apparatus no longer performs its intended function. In this regard, a “power cable failure” prevents the circuit from carrying power to the intended location or equipment. Fundamentally, this means that the cable circuit stops carrying current due to a failure or interruption of the conductor or if the insulation stops supporting line-to-ground voltage due to a breakdown of the insulation, or both.

Q. What are the major causes of cable failures?

A. Many cable failures occur from mechanical damage during dig-ins, or as a result of workmanship errors in the field during the installation of cables to accessories, such as joints or terminations, or from the slow degradation of the cable insulation due to moisture intrusion or exposure to excessive heat. If the insulation is degraded, the cable may no longer be able to support the line-to-ground voltage, resulting in a breakdown or failure between the cable and ground or shield. Electricity from the conductor will then discharge into the surrounding environment, thus causing a drop in voltage and the inability of the current to complete the circuit.

Q. What is the major cause of insulation degradation in non-EQ cables constructed in the 1960s and 1970s with XLPE or EPR insulation that are exposed to significant moisture?

A. A type of electrochemical degradation, known as "water treeing" is the primary cause of the premature degradation of the insulation leading to development of electrical trees. Water treeing occurs in energized cables that are not constructed to resist water intrusion but are nevertheless wetted or submerged in water for periods of time. Water permeates the cable insulation over time and forms channels that resemble trees. Water trees are shown below in a photograph I took of a cross-section of cable insulation in which the conductor has been removed. The insulation has been dyed so that the channels of the water trees are revealed.



Example of water trees in cable insulation

Cables with extruded XLPE insulation manufactured in the 1960s and 1970s have experienced high failure rates when subjected to conditions that form water trees leading to electrical trees.

Q. In your testimony, when you refer to cable insulation, will you be referring to extruded XLPE and EPR insulation manufactured in the 1960s and 1970s?

A. Yes

Q. Do water trees themselves necessarily cause the failure of the insulation to support line to ground voltage?

A. No. A water tree does not significantly break down the dielectric (electrical) strength of the insulation and will continue to support rated voltage, although a degree of partial discharge of the electricity may occur at the locations within the water trees that have carbonized. Over time, the partial discharges (or electrical breakdown) will carbonize further, or burn, the water tree channels to form electrical trees. When sufficient electrical trees have formed through the insulation, the insulation will break down, the cable will not be able to support voltage and will therefore not be able to carry current. Water trees usually form in areas of high electrical stress within the insulation. For this reason, they usually form in the insulation nearest the cable conductor.

Q. Does XLPE and EPR cable manufactured today have the same propensity to water treeing in wet environments.

A. Generally, no. There have been technical developments in the manufacture of XLPE and EPR cables, such as dry curing of the cable, applying semi-conductive shields with substantially reduced ionic content, and incorporating tree retardant compounds in cross-linked polyethylene insulation which reduce the propensity toward water treeing.

Q. Can electrical trees form in the absence of water trees?

A. Yes. Occasionally, an electrical tree can form after prolonged operation of a cable with something protruding into the cable insulation, such as a portion of the conductor or the insulation shield, but electrical trees formed by this mechanism are manufacturing defects.

Q. Are there tests that can assess the condition of cable insulation on inaccessible cables?

A. Yes there are. The staff of the Nuclear Regulatory Commission in its guidance "Generic Aging Lessons Learned Report ("GALL") issued in December 2010 lists six maintenance or diagnostic tests that the NRC determined are proven tests for detecting deterioration of the insulation system in inaccessible power cables due to wetting or submergence. NUREG-1801, Rev. 2, *Generic Aging Lessons Learned, Final Report* (December 2010) at XI E3-2 ("New GALL"), Exh. NYS00147D. The list in the New GALL is not exclusive, and I will describe several tests that are not explicitly listed in the New GALL but are relevant to the issues in this proceeding. Maintenance and diagnostic tests are used to assess the condition of inaccessible cables. All of these tests require taking the cable out of service to fit test equipment or sensors and each has advantages and disadvantages. Some of the tests are destructive -- that is, the cable that is tested will need to be replaced if it fails the test. Moreover, the insulation on some cables may be weakened by destructive tests even though they pass the test. Other tests are non-destructive -- that is, they assess the condition of the cable insulation without necessarily harming or weakening it.

Q. Please describe the destructive tests.

A. Destructive tests can be considered "pass/fail" tests. They can all be performed on both shielded and unshielded cables. For example, the AC Voltage Withstand test subjects a cable to a voltage at or above the voltage that the cable was designed to withstand. Either the cable will withstand the increased voltage or it will fail due to a defect in the insulation, joint or termination. If there is a failure, it will occur during controlled conditions rather than failing when the cable is in service and expected to perform. If the cable fails, then it must be replaced.

The step voltage test is a variation of the AC Voltage Withstand test. DC instead of AC current is used, the voltage is raised in stages, and the leakage current is monitored during the test to determine if there are problems.

A voltage withstand test not listed in the New GALL is Very Low Frequency ("VLF") testing. If a cable contains water trees, VLF testing is more likely to convert them to electrical trees during the test than the AC Voltage Withstand test. This is a benefit of VLF testing because water trees will not necessarily cause a breakdown in the dielectric strength of the cable insulation but electrical trees will. Thus, a cable with water trees may pass the AC Voltage Withstand test even though it contains water trees that may eventually convert to electrical trees and cause a cable failure in the future. Because VLF testing converts existing water trees into electrical trees more effectively than a simple AC voltage withstand test, it will better force weakened insulation to fail during the testing outage when the cable is not expected to perform and when it can be repaired without disrupting operations or compromising safety features. If a cable fails the VLF test, as with any withstand test, it must be replaced.

Q.   Please describe the non-destructive tests listed in the New GALL.

A.   The Insulation (dielectric) dissipation factor compares the characteristics of the cable insulation (dielectric) material to that of a near-perfect dielectric using a standard capacitor and a capacitive bridge. The capacitive bridge is used to determine the dissipation factor through the known capacitance of a standard capacitor with that of the unknown capacitance of the cable. It is generally non-destructive. This test only detects "gross" effects of the cable -- that is, characteristics that affect the bulk of the cable insulation, but does not detect localized problems. It is best used on paper insulated cables that have appreciable dielectric loss.

Partial Discharge Detection detects the minute electrical “noise” (partial discharge or "PD") that is generated where localized breakdowns are occurring in electrical equipment, including in the insulation of cables and accessories, when voltage is applied. As the voltage is raised, localized breakdowns in the insulation – called “partial discharge” – generate a signal that can be detected from the end of the cable. The test takes advantage of the propagation velocity of the signal through the cable to determine the location within a cable that the PD is occurring- i.e., in a specific location within the cable, or in a joint or termination. The magnitude of the signal detected reflects the extent of the partial discharge.

In Time Domain Reflectometry, sometimes called “cable RADAR”, a signal is sent through the cable from one accessible cable end; the magnitude and timing of reflections returned to the test equipment gives a measure of the insulation impedance characteristics; the cable propagation velocity is used by the test equipment to determine the location of the impedance.

Q. In the New GALL, the AMP for inaccessible non-EQ low and medium voltage cables states that "trending actions are included as part of this AMP." Please explain what "trending actions" are.

A. The results of cable condition monitoring tests are "trendable" if the performance of the cable on a later test can be compared with the performance of the same cable on an earlier test so that its relative performance over time can be assessed. Trendable results are important because they provide information about the rate of cable insulation degradation.

Q. Are the results of the tests you have described all trendable?

A. No. The results of the destructive or pass/fail tests, such as AC Voltage Withstand, Step Voltage and VLF, are not trendable because they only tell you whether the cable withstood the voltage on a particular occasion but do not reveal anything specific about the relative condition of the cable insulation on that occasion. Therefore, the results of two tests at different times cannot be compared other than whether the cable passed the second test.

The results of non-destructive tests such as Insulation Dissipation Factor, PD and TDR can be trended. For example, a comparison of PD test results might show partial discharge occurring in a section of the cable that previously had shown no discharge which could indicate increased cable insulation degradation. Similarly, comparing test results of the Insulation Dissipation factor test might reveal an increase in the dissipation factor as the insulation ages. A comparison of TDR tests may show variations in cable impedance along a tested cable section from earlier tests, perhaps indicating a localized change in the cable condition or environment.

Q. Are all the tests listed in the New GALL equally effective on different types of cable?

A. No. The condition of cables without an intact metallic shield around the insulation cannot be effectively tested with PD or TDR. The signals evidencing the partial discharges in the PD test or TDR test are minute and are much more likely to be lost – a process called attenuation – in unshielded than shielded cables, or even in taped shields that have experienced some degree of corrosion, particularly in longer cable circuits. PD and TDR are therefore much less effective in low-voltage cables, most of which are unshielded. Also, the test equipment is sensitive to electrical interference in the vicinity. In addition, PD and TDR tests may be ineffective in cables with helical tape shields that have experienced some degree of corrosion, particularly in longer cable circuits.

The pass/fail tests such as AC Voltage Withstand, Step Voltage and VLF are effective on both shielded and unshielded cables. However, their results cannot be trended so they give almost no information about the actual condition of the cable insulation short of breakdown. In sum, there is no one ideal test to monitor the condition of a cable's insulation.

Q. Please summarize Entergy's Aging Management Plan ("AMP") for non-EQ inaccessible low and medium voltage cables exposed to significant moisture which was revised in response to Staff's Request for Additional Information and follow-up questions.

A. Entergy revised its initial AMP for non-EQ low and medium voltage power cables after the New GALL was issued. Entergy's revised AMP was expanded to apply to low voltage power cables from 400V to 2 kV as well as medium voltage power cables from 2kV to 35kV which are exposed to significant moisture.

Entergy Response (NL-11-032) to Request for Additional Information, Aging Management Programs, Indian Point Nuclear Generating Unit Nos. 2 &3 (Mar.28, 2011)("Entergy March 28 Response")Attachment 1 at 12-13, Exh. NYS000151. Significant moisture is defined in the New GALL as periodic exposures to moisture that last more than a few days- for example, cable wetting or submergence in water. New GALL at XI E3-1, Exh. NYS00147D. Entergy has indicated it will inspect for water accumulation in manholes at least once every year. In addition to the annual manhole inspections, Entergy will inspect manholes after events such as heavy rain or flooding. The manhole inspection frequency will be increased as necessary based on evaluation of inspection results. Entergy March 28 Response, Attachment 1 at 12-13, Exh. NYS000151.

Entergy has indicated that cables that are exposed to significant moisture will be tested at least once every six years to provide an indication of the condition of the conductor insulation. Test frequencies will be adjusted based on test results and operating experience. Entergy also states that its AMP will be implemented consistent with the corresponding program described in the New GALL and that it will be implemented prior to the period of extended operation. Entergy March 28 Response, Attachment 1 at 12, Exh. NYS000151.

Q. Does Entergy's revised AMP contain any more detail?

A. No.

Q. In your opinion, does Entergy's revised AMP demonstrate that the effects of aging on the intended function(s) of non-environmentally qualified inaccessible low and medium voltage cables that are exposed to adverse localized environments will be adequately managed during the period of extended operation?

A. No it does not.

Q. Please explain your conclusion that the AMP is insufficient as it relates to the manhole inspection program.

Q. Preventing cable insulation degradation in the first instance is a more effective aging management program than testing the condition of cables to determine whether its insulation has already degraded. Because water trees cannot form in a cable in the absence of water, and almost all electrical trees result from water trees, a robust program for preventing water accumulation in manholes and conduits is essential. Entergy's AMP does not describe the specifics of such a program. Entergy simply provides a schedule of manhole inspections but does not mention or commit to any of the corrective measures listed in the New GALL if water is found, such as the installation of permanent drainage systems, or sump pumps and alarms. Entergy does not identify actions it will take in the event water intrusion is a chronic problem not sufficiently managed by the proposed schedule of maintenance listed in the GALL.

Q. In your opinion, is the AMP sufficient as it relates to cable condition monitoring and testing.?

A. No it is not. Entergy has provided so little specific information, that it cannot demonstrate that its cable condition monitoring program will reasonably assure the cables' continued operation during the license renewal period.

Q. What information is missing?

A. As an example, Entergy has not given any information about the number of non-EQ inaccessible power cables exposed to adverse localized environments.

Q, Why is the number of cables important?

A. In its License Renewal Application, Entergy has committed to implement its AMP for non-EQ inaccessible power cables prior to the period of extended operation at IP 2 and IP3. The license for IP 2 expires in September 28, 2013, and its period of extended operation begins after that date. To fulfill its commitment, Entergy will have to test all the relevant cables at IP 2 within the next 20 months and will have to be able to schedule enough planned outage time to accomplish all the testing.

Q. Can you estimate the number of cables that can be tested in a normal work shift.

A. It depends on the type of test, the testing equipment, time required to obtain switching outages, and the technicians performing the test. Partial discharge testing can be performed at a rate of 3-5 cables per normal work shift of 10-12 hours; a voltage withstand test can be performed at a rate of 6-12 cables per normal work shift.

Q. Can you assess whether Entergy will be able to test all the relevant cables at IP2 before the period of extended operation.

A. I cannot because Entergy has provided no information about the number of relevant cables at either IP 2 or IP3.

Q. What other information is missing from Entergy's revised AMP?

A. The revised AMP does not identify anything about the characteristics of the non-EQ inaccessible cables that are exposed to significant moisture or identify testing methods that are appropriate for the types of cable the AMP will manage. It does not identify their location, their number, their function, or their physical characteristics. However, as the Brookhaven National Laboratory in a report prepared for the NRC in 2010 explained, the selection of an appropriate testing technique depends on cable characteristics such as voltage rating, cable insulation or jacket material, cable shielding and cable location. NUREG/CR-7000, BNL-NUREG-90318-2009, *Essential Elements of an Electric Cable Condition Monitoring Program*, Office of Nuclear Regulatory Research (January 2010) ("NUREG/CR-7000") at 3-20, Exh. NYS000148.

For example, I have assumed that the relevant cables are extruded construction for which certain tests would generally be inappropriate, such as DC Step Voltage or Insulation Dissipation Factor. Those same tests, however, would be effective for paper-lead cables, another cable type that utilities frequently used in the 1960s and 1970s.

Similarly, whether or not a cable has a metallic shield over the insulation will determine whether certain test methods such as PD or TDR will be effective. If an unshielded cable more than a few hundred feet long is tested with the PD method, then the test results may show that partial discharge is not occurring when it is - i.e. a false negative. That is because the signal that establishes whether or not partial discharges are occurring due to insulation degradation becomes attenuated in an unshielded cable or is disrupted by neighboring electrical equipment.

Because Entergy has failed to provide any information about the characteristics of the relevant cables or selected test methods appropriate for those characteristics, it has not explained what the acceptance criteria are for the tests it will conduct. For example, a voltage withstand test must apply voltage to the cable that is at or above the cable's rating to see if the cable can withstand the stress of normal operation. If a lower voltage is applied, the cable may "pass" the test when it would have failed a test with higher voltage. Similarly, in the Partial Discharge Test, the partial discharges that occur at the location of degraded insulation are measured in picocoulombs. If Entergy applies the PD test to certain cables, it must describe the level of picocoulomb discharge that is acceptable and the level that is not. Moreover, its acceptance criteria must be consistent with industry practice. The industry acceptance criterion for PD testing is no more than 5pC discharge. Otherwise, the Board cannot know whether degraded cables that should be repaired or replaced are allowed to remain in place because the test was insufficiently rigorous.

Q. Does the revised AMP include trending actions?

A. No. The revised AMP does not mention trending and because it does not select any particular tests, it is not possible to know whether test results will be trendable or if

Entergy intends to use trending in its AMP. The ability to trend test results is extremely significant because it provides information about the rate of cable insulation degradation and that information can be used preventively to repair or replace cables before they fail. Thus, if Entergy chooses a non-trendable voltage withstand test on shielded medium voltage cable over trendable tests such as PD or TDR, it will not obtain information that could be used proactively to repair or replace cables before they are on the verge of failure.

Q. Are there adverse environmental conditions, other than moisture intrusion, that can cause the degradation of power cable insulation?

A. Yes. For example, thermally induced cable degradation occurs when a power cable is operated above its rated temperature, and the insulation melts or burns causing the insulation's dielectric strength, that is, its voltage insulating properties, to degrade to the point of an electrical breakdown.

Q. Is thermal degradation a problem that must be considered in the aging management of inaccessible low and medium voltage power cables?

A. Yes. As I discuss below, there may be uncertainty about the installation environment of inaccessible power cables such as the thermal resistance of the soil in which the cables are buried. Moreover, underground power cables may be in close proximity to each other, either directly buried underground or in cable conduits which may cause the mutual heating effect, discussed below.

Q. What causes thermal degradation of cables?

A. Thermal degradation can occur in essentially three situations. First, the thermal resistance of the environment through which an underground cable passes may be too high for the heat generated by the current to pass out of the cable and into the surrounding soil. For accessible cables in air, there may be inadequate thermal convection and radiation to dissipate the heat. Second, the ambient temperature around the cables may be greater than the cable was designed to withstand because of an external heat source, such as a steam line, hot water pipe or inadequate ventilation. External heat sources can affect cable temperatures when in parallel or crossing cable circuits or when occupying the same conduits or trench areas. And third, heat from other cables in close proximity, particularly in underground conduits, will cause the temperature to rise in the vicinity of the subject cable and cause a mutual heating effect.

Q. Has Entergy prepared an AMP for non-EQ inaccessible power cables that are exposed to adverse localized environments, such as excessive heat.

A. Entergy has not prepared such a plan. Nor has Entergy shown that no plan is necessary by demonstrating that none of its inaccessible cables are ever operated above their rated temperatures.

Q. Does insulation degrade faster when exposed to excessive heat than excessive moisture?

A. This depends on the extent of the heating. Problems in cables caused by moisture intrusion generally develop over months or years. Low or moderate excessive heating can accelerate cable aging over months or years, while high excessive heating can seriously degrade a cable's condition quickly, within weeks to months. In extreme cases, serious degradation can occur even more quickly.

Q. Have any studies been done on the effect of excessive heat on low-voltage cables.

A. Yes. The Sandia National Laboratory commissioned a study entitled Aging Management Guideline for Commercial Nuclear Power Plants - Electrical Cable and Terminations, SAND96-0344. The study report was issued in 1996 and concluded that "thermal embrittlement of insulation is one of the most significant aging mechanisms for low-voltage cable." SAND96-0344, *Aging Management Guideline for Commercial Nuclear Power Plants - Electrical Cable* *and Terminations* (September 1996) at 1-3. Exh. NYS00156A.

Because all the safety-related power cables at IP 2 and 3 are low-voltage, Entergy's failure to explain how it will manage the effects of excessive heat on the insulation of non-EQ inaccessible low-voltage cables is a critical omission from its License Renewal Application. Without such a plan, Entergy has failed to demonstrate that its safety-related low-voltage power cables will continue to perform their critical function during the period of extended license operations.

Q. Are there tests that can determine whether inaccessible cables are operating in excessively hot environments?

A. Yes. The inaccessible cables could be retrofitted with a fiber optic sensor that provides temperature readings along the length of the cable every meter (3.3 feet). The results of this test method, known as Distributed Temperature Sensing (DTS), can be compared over time and can reveal whether a hot spot in a cable is getting worse.

Alternatively, discrete thermocouple temperature monitoring at known hot spots at inaccessible locations, perhaps by inserting a thermocouple up to a few hundred feet into a conduit occupied by low or medium voltage cable, can be used as an alternative to DTS or (on accessible cables) thermographic testing on accessible cables. Entergy can identify the critical locations to be monitored through the use of an integrated approach that may include (a) the review of Environmental Qualification (EQ) zone maps that show radiation levels and temperatures for various plant areas, (b) consultations with plant staff that are cognizant of plant conditions, (c) performing soil thermal resistivity tests for buried cables, and (d) the review of relevant plant-specific and industry operating experience. The results of the temperature monitoring can be trended, and continuous monitoring may be possible. Fire protection systems in some buildings utilize DTS-based systems to check the temperature of zones within a building.

Q. Under what circumstances are corrective actions required for cable overheating?

A. Power cables have “emergency” operating temperature limits intended to address short incursions above rated temperature and load. If DTS or discrete temperature tests indicate that cables are consistently operating at temperatures above their “normal” operating limits for longer than permissible emergency durations, or more frequently than periodic emergencies are allowed, or above “emergency” operating limits at any time, then corrective actions must be taken. Those actions include, but are not limited to, removing additional thermal insulation that may be placed around the cables, reducing the number of cables installed in close proximity (to mitigate mutual heating), replacing existing cables with larger conductor cables to decrease heat losses, lowering the ambient temperature in which the cables are installed, and replacing high thermal resistivity soils around the cable conduits or direct buried cables with a lower thermal resistivity thermal backfill.

Q. Please summarize your conclusions about whether Entergy has demonstrated that it will manage the aging affects of non-environmentally qualified inaccessible power cables exposed to adverse localized conditions.

A. Entergy’s AMP is lacking in substantive detail, and thus Entergy has failed to demonstrate that it will manage the effects of aging of non-EQ inaccessible cables exposed to significant moisture or excessive heat so that they will be able to perform their intended function for another 20 years during the extended licensing period of operation.

The following specific critical details about the non-EQ inaccessible power cables are missing from Entergy's LRA

- Age of the cable circuits
- The number of cable circuits

- The lengths of cable circuits
- The voltage class of the cables
- The types of cables, including insulation type
- The types of testing that will be performed
- The acceptance criteria for each of the tests
- The corrective actions
- The management of the effects of aging due to thermal stress
- Justification for failing to consider aging due to thermal stress

Because of this absence of substantive detail, the licensing board cannot adequately assess if Entergy's LRA should be approved for the continued operation of IP2 and IP3.

Q. Does this conclude your testimony?

A. Yes.

I have reviewed all the exhibits referenced herein. True and accurate copies are attached.

UNITED STATES

NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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In re: Docket Nos. 50-247-LR; 50-286-LR

License Renewal Application Submitted by ASLBP No. 07-858-03-LR-BD01

Entergy Nuclear Indian Point 2, LLC, DPR-26, DPR-64

Entergy Nuclear Indian Point 3, LLC, and

Entergy Nuclear Operations, Inc. December 14, 2011

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DECLARATION OF EARLE C. BASCOM, III

I, Earle C. Bascom, III do hereby declare under penalty of perjury that my statements in the foregoing testimony and my statement of professional qualifications are true and correct to the best of my knowledge and belief.

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

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