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OFFICE OF SECRETARY
RULEMAKINGS AND
ADJUDICATIONS STAFF

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THE EARTH'S BEST DEFENSE

Via Electronic Mail

June 18, 2012

Annette L. Vietti-Cook, Secretary
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001
Attention: Rulemakings and Adjudications Staff

Subject: NRDC's Petition for Rulemaking to Revise 10 C.F.R. § 50.49

Dear Madam Secretary:

Pursuant to 10 C.F.R. § 2.802, the Natural Resources Defense Council, Inc. ("NRDC") and Mr. Paul Blanch hereby petition the U.S. Nuclear Regulatory Commission ("NRC") to institute a rulemaking to amend the regulations applicable to nuclear facilities licensed under 10 C.F.R. § 50, § 52, § 100 and other applicable regulations.

The rationale and the bases for this petition can be found in the enclosed materials, which cite numerous reports and studies that illustrate the need for strengthening the regulations pertaining to the environmental qualification of electrical equipment applicable to existing and new reactors. Specifically, the regulatory requirements contained in 10 C.F.R. § 50.49, Criteria 2 and 4 in Appendix A to 10 C.F.R. 50, and 10 C.F.R. 54 need to be clarified and supplemented with regard to the environmental qualification of electrical equipment exposed to conditions not intended, such as water submergence, condensation, etc. The primary author of the petition is Mr. Paul Branch.

Please do not hesitate to contact us at (202) 289-6868 if you have any questions. NRDC appreciates your prompt consideration of this matter.

Sincerely,

C. Jordan Weaver, Ph.D.
Project Scientist

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June 18, 2012

Annette L. Vietti-Cook, Secretary
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001
Attention: Rulemakings and Adjudications Staff

PETITION FOR RULEMAKING

Pursuant to 10 C.F.R. § 2.802, Natural Resources Defense Council (NRDC) and Paul M. Blanch hereby petition the U.S. Nuclear Regulatory Commission (NRC) to institute a rulemaking to revise the regulatory requirements for the environmental qualification of electrical equipment important to the safe operation of existing and new reactors. Specifically, the regulatory requirements contained in 10 C.F.R. § 50.49, Criteria 2 and 4 in Appendix A to 10 C.F.R. 50, and 10 C.F.R. 54 need to be clarified and supplemented with regard to the environmental qualification of electrical equipment exposed to "submergence in water, condensation, wetting, and other environmental stresses" during routine operation and infrequent events (e.g., flooding).[1]

The petitioners request that the NRC, following notice and opportunity for comment, amend 10 C.F.R. § 50.49 "Environmental qualification of electric equipment important to safety for nuclear power plants" and clarify by rulemaking, the applicability of 10 C.F.R. 50, Appendix A, Criterion 2 and 4 to all nuclear power plants.

STATEMENT OF PETITIONER'S INTEREST

NRDC is a national non-profit membership environmental organization with offices in New York City, Washington, D.C., San Francisco, Chicago, Los Angeles, and Beijing. Petitioner has a nationwide membership of over one million combined members and activists. Petitioner's activities include maintaining and enhancing environmental quality and monitoring federal agency actions to ensure that federal statutes enacted to protect human health and the environment are fully and properly implemented. Since its inception in 1970, Petitioner has sought to improve the environmental, health, and safety conditions at the nuclear facilities licensed by NRC and its predecessor agency.

Paul Blanch is a nuclear consultant and expert witness with more than 45 years nuclear and electrical engineering experience. Mr. Blanch has been an expert witness for the State of New York opposing the relicensing of Indian Point Units 2 and 3 with contentions related to the qualification of safety related cables. He also has actively participated in the relicensing of the Vermont Yankee, Seabrook and Pilgrim nuclear power plants. Mr. Blanch is the primary author of this petition.

[1] NRC Information Notice 2010-26, Submerged Electrical Cables, Dated December 2, 2010

BACKGROUND

Most nuclear power plants currently operating in the U.S. were initially designed and licensed during the late 1960's and early 1970's. The designs for these plants feature electrical cables and wires between power sources (e.g., transformers, batteries and emergency power supplies) and safety equipment throughout the facility. The electric cables supply power to, provide control over, and enable monitoring of vital equipment.

This vital equipment includes emergency core cooling system motors and pumps as well as associated controls and instrumentation. The voltage of these cables ranges from 35,000 volts to less than 20 volts and includes both alternating current (AC) and direct current (DC) cabling. It is estimated that each nuclear plant contains many miles of cables including much that is routed underground or otherwise not readily accessible. The majority of the cables operate at less than 400 volts with many power cables operating from 480 volts to 6,900 volts AC. Safety-relevant DC cables typically are designed to operate from 100 to 250 volts and supply emergency power to valves and control systems.

Petitioner Blanch personally experienced the installation of these cables and wires at the Millstone Power Station in Connecticut and also on U.S. Navy submarines. During the design and procurement stage, it was anticipated that these cables would be contained within conduit and therefore were not specified or designed to withstand moisture or submergence.[2] During installation, these cables and wires frequently experienced various damages by pulling the cables over long distances and through sharp radius bends. These cables and wires are frequently contained within buried pipes, conduits, manholes and trenches. Conduits range in size from a few inches in diameter to over 12 inches. Some cables and wires may be buried in direct contact with the soil.

With few exceptions, these cables and wires are only designed for dry, low humidity environments and, therefore, not qualified for moist or wet environments. Cables and wires with insulation surface defects caused during or exacerbated by installation are more prone to failure when submerged in water or subjected to moisture intrusion. It was generally assumed (petitioner Blanch included) that these containers would remain dry. By existing NRC regulation, it was unnecessary to specify that these cables and wire remain functional under submerged conditions.[3]

The Atomic Energy Commission (AEC, NRC's predecessor) added Appendix A, General Design Criteria for Nuclear Power Plants, to 10 C.F.R. 50 in 1971. General Design Criterion (GDC) 2, Design Bases for Protection Against Natural Phenomena, and GDC 4, Environmental and Dynamic Effects Design Bases, established regulatory requirements for the design of nuclear power plants. GDC 2 states:

> Structures, systems, and components important to safety shall be designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches without loss of capability to perform their safety functions. The design bases for these structures, systems, and components shall reflect: (1) Appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical

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[2] This also includes all connections and splices that may be subjected to similar conditions.
[3] Petitioner Blanch was directly involved in the electrical design, construction, and operation of Millstone Units 2 and 3 from 1972 through 1993.

data have been accumulated, (2) appropriate combinations of the effects of normal and accident conditions with the effects of the natural phenomena and (3) the importance of the safety functions to be performed.

GDC 4 states:

> Structures, systems, and components important to safety shall be designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including loss-of-coolant accidents. These structures, systems, and components shall be appropriately protected against dynamic effects, including the effects of missiles, pipe whipping, and discharging fluids, that may result from equipment failures and from events and conditions outside the nuclear power unit. However, dynamic effects associated with postulated pipe ruptures in nuclear power units may be excluded from the design basis when analyses reviewed and approved by the Commission demonstrate that the probability of fluid system piping rupture is extremely low under conditions consistent with the design basis for the piping.

The large number of electrical failures that were experienced during the Three Mile Island (TMI) accident in March 1979 demonstrated that these regulatory requirements, or their enforcement, were inadequate to ensure that electrical equipment would remain functional. For example, page 5-60 of NUREG/CR-6384 Vol. 1 (April 1996, available in NRC's ADAMS Accession No. ML031480454) describes the following TMI failures[4]:

> R607 is a 137-channel instrumentation and control penetration. Of those available channels, 49 were initially chosen for testing. Most screening tests indicated there were several broken wires and corroded contacts. Measurements of insulation resistance between wires of different cables yielded evidence of "cross talk," an interference between wires in the penetration. The penetration was at the 292-ft elevation that was submerged until the water level in the reactor building's basement was lowered, and water remaining in the penetration may be the cause of the cross talk. The predominant anomaly encountered was a shift in the cable's characteristic impedance, which also could be caused by the ingress of moisture through the insulation. Subsequently, three additional channels were tested. ***Of the 52 channels, 47 exhibited anomalous behavior, and 33 of these were inoperable*** [emphasis added].
>
> ***Five cables were tested in penetration R405 and all exhibited anomalous behavior; four were judged inoperable. Also, fourteen instrumentation cables were tested in penetration R534; anomalies were observed in seven, of which five were judged inoperable*** [emphasis added]. Cross-talk voltages were observed, which suggested possible corrosion or water contamination. However, the environmentally sealed splices survived well.
>
> Penetration R506 contains reactor control circuits, including current transformers, level (pressure) transmitters, and temperature, pressure, and limit switches. ***Nineteen cables were tested; 16 exhibited anomalous behavior, of which six were judged inoperable. Additionally, of 39 pressurizer heater cables, anomalous behavior was observed in 12. Five were inoperable***

[4] As a result of the TMI accident these particular cables and penetrations are now required to comply with 10 CFR 50.49

[emphasis added]; one with an open circuit, one with a short circuit, and three with low insulation resistance.

Since the penetrations evaluated were selected because of their high probability of impairment, the data are not statistically representative of the 1800 circuits in the reactor building, but serve to indicate the circuit damage to be expected from this type of accident.

The aforementioned "high probability of impairment" that helped focus the selection of cable penetrations during TMI inspections already indicates that moisture and submersion causes cable damage and demonstrates NRC's acknowledgment of the matter thus corroborating the necessity of this rulemaking. If these conditions cause a high probability of impairment following an accident, it is logical to assume that these conditions produce a similar outcome in the absence of or prior to an accident as well.

The empirical data from TMI is supported by subsequent cable aging testing. A report from September 1996 issued by the U.S. Department of Energy (DOE) reported on the lifetime-shortening effect that submergence in water has on the polyimide cable insulation material:

Note that the thermal lifetime of polyimide (Kapton4) is estimated to be nearly 10^4 years at 90°C and 0% relative humidity; however, its estimated lifetime at 100% relative humidity (or submerged) is only in the hundreds of hours.[5]

Cable insulation with a lifetime of nearly 10,000 years in a dry environment has its lifetime shortened to only hundreds of hours when submerged in water or exposed to high humidity conditions. Table 4-3 from this DOE report showed that the degradation accelerating effect from submergence is not confined to only cables having polyimide insulation.

Table 4-3 shows the results of ICEA EM-60 water resistance testing of various cable and termination materials as specified in applicable ICEA cable standards such as ICEA S-66-524 [4.39]. This test involves the submergence of an insulated conductor in high temperature (75°C or 90°C) water for several days while the capacitance and power factor of the insulation are measured. Although these results may not be useful in directly predicting the longevity of a given insulation material in wet environments, they do provide some indication of relative performance. Data for other materials (such as CSPE, PVC, and Neoprene®) are contained in EPRI TR-103834-P1-2 [4.38].

Table 4-3 Insulation Life at 90°C During ICEA EM-60 Testing [4.38]

Material	Time to Failure
Natural Rubber	<24 hours
Silicone Rubber	3-4 months
Butyl Rubber	9 months
EPR	47 months
XLPE	35 months
ETFE (Tefzel®)	>24 months

SAND96-0344, Table 4-3

[5] SAND96-0344, "Aging Management Guideline for Commercial Nuclear Power Plant – Electrical Cable and Terminations," available in NRC's ADAMS Accession No. ML031140264

The NRC recognized from the TMI accident the need to strengthen the regulatory requirements for electrical equipment. The NRC revised its regulations to include specific requirements in 10 C.F.R. §50.49, wherein § (e)(6) explicitly addressed the submergence factor:

> (e) The electric equipment qualification program must include and be based on the following: …
> (6) Submergence (if subject to being submerged).

The regulation did not further limit this requirement to where the cables and wires were located. But the NRC staff introduced such a limitation through the following question and answer set in its Generic Letter 82-09, "Environmental Qualification of Safety-Related Electrical Equipment," dated April 20, 1982:

> Q. For equipment qualification purposes, what are the staff requirements concerning submergence of equipment outside containment?
>
> A. The Staff requires that the licensee submit documentation on the qualification of safety-related equipment that could be submerged due to a high energy line break outside containment.

The problem is that safety-related cables and wires outside containment are routinely submerged in water during normal operation. The picture shows underground electrical cables within an access man-hole.[6]

Rain water and ground water routinely submerge underground cables and wires. The safety implications from the failure of a safety-related cable inside containment submerged by an accident, outside containment submerged by a high energy line break, or outside containment submerged by nature are identical—that safety function is lost. It matters little if the portion of a safety-related cable inside containment and the portion of that same cable outside containment in a high energy line break area survive if another portion of that same cable routed underground fails due to submergence. Cable integrity is on a pass/fail basis rather than an 80 percent or even 90 percent passing grade.

[6] Presented by the NRC at the Regulatory Information conference, March 2011

The TMI accident and laboratory testing have shown that moisture/submergence of electrical cables and wires significantly increase the probability of failure. Failure of the cables and wires also causes failure of connected components (emergency core cooling system motors and pumps, valves, controls, instrumentation such as radiation monitors, and other vital parameters).

Electric Power Research Institute (EPRI) released a report in 2006[7] and two more in 2010[8] that discussed these potential failures. They noted that the majority of cables were manufactured prior to 1980 and that the techniques used during this period were less sensitive to controlling the intrusion of contaminants in the shielding material. This contamination factor in conjunction with the frequent submergence has led to a series of failures and problematic cases, as EPRI states:

> Regulatory and management concern regarding the reliability of low-voltage power cable systems at nuclear plants has been increasing for the past 5–10 years. The staff of the United States Nuclear Regulatory Commission are concerned that wetted (up to and including submergence) low-voltage power cable circuits may be degrading to the point at which multiple cable circuits may fail when called on to perform functions affecting safety. Utility managers are concerned that cables may fail, causing adverse safety consequences and/or plant shutdowns.

The current state of diagnostic testing mostly provides bulk property assessments and average values of cable condition but some testing methods can be used to determine some localized effects. However, state-of-the-art testing methods for localized defects are still being developed and they have not reached a level that can predict cable failure or help focus replacement efforts.

The reports mention that is preferable to conduct tests every 2 to 5 years to obtain trending data on cable conditions but it is likely still the case that a number of plants are performing one-time tests. NRC requirements only state that safety systems should remain functional and do not provide conditions or acceptance criteria for degraded cables. Additionally, cable degradation as an ongoing process is not a reported issue unless it leads to the failure of a cable system or it is discovered that the cables are operating in conditions for which they were not intended.

The NRC distributed Information Notice 2002-12, "Submerged Safety-Related Electrical Cables," to plant owners on March 21, 2002.[9] The NRC informed owners about recent cable and wire failures at the Oyster Creek (NJ), Pilgrim (MA), Brunswick (NC), and Davis-Besse (OH) nuclear plants caused by submergence and moisture intrusion. Remarkably, the NRC stated in its advisory that "no specific action or written response is required" by plant owners regarding these problems.

The NRC also released Information Notice 2010-26, "Submerged Electrical Cables," to plant owners on December 2, 2010. The notice listed 11 units that experienced cable failures and exhibited inspection violations due to unqualified cables being subjected to submerged environments. The observations in 2010-26 range from licensee failures to establish preventative maintenance and test programs or their failure to verify and maintain suitable environments for series of electrical cable systems. In certain cases,

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[7] *Plant Support Engineering: Life Cycle Management Planning Sourcebooks: Medium-Voltage (MV) Cables and Accessories (Terminations and Splices).* EPRI, Palo Alto, CA: 2006. 1013187.

[8] *Plant Support Engineering: Aging Management Program Development Guidance for AC and DC Low-Voltage Power Cable Systems for Nuclear Power Plants* and *Plant Support Engineering: Aging Management Program Guidance for Medium-Voltage Cable Systems for Nuclear Power Plants.* EPRI, Palo Alto, CA: 2010. 1020804 & 1020805

[9] Available online at: http://www.nrc.gov/reading-rm/doc-collections/gen-comm/info-notices/2002/in02012.html

the inspections discovered that a number of cable systems were being subjected to conditions for which they were not designed for, such as "continuous underwater environments," which led to concerning levels of insulation degradation and cable failure.

These affected cable systems included safety-related power cables, ***where the inspectors noted that failures in these systems could disable important accident mitigation systems***. In the case of the Peach Bottom Atomic Power Station (PBAPS), Units 2 and 3, the inspectors observed a safety-related motor control center that had been in a submerged environment since at least 2002, i.e. over 8 years, but personnel failed to take action to evaluate and mitigate the effects of protracted submergence in these safety-related electrical power cables. However, the NRC again explicitly stated "the suggestions that appear in this [information notice] are not NRC requirements; therefore, no specific action or written response is required."

RATIONALE FOR THE RULEMAKING PETITION

In the summer of 2009, the NRC issued this statement regarding the cables and wires submergence issue:

> NRC regulations require that cables be able to perform their design function when subjected to anticipated environmental conditions, such as moisture, flooding, heat, and radiation. Further, the design should minimize the probability of power interruption when transferring power between sources. The cable failures that could disable safety-related or risk-significant equipment are expected to have monitoring programs to demonstrate that the cables can perform their design function when called upon.[10]

This NRC statement defined the governing regulations as explicitly including GDC 2 and GDC 4 in Appendix A to 10 C.F.R. 50 and 10 C.F.R. §50.49. The problem is that past NRC decisions have constrained or eliminated the applicability of these regulatory requirements.

In its Staff Requirements Memorandum dated September 18, 1992, for SECY-92-223, "Resolution of Deviations Identified During the Systematic Evaluation Program," the NRC Commission provided the following direction to its staff regarding the applicability of the GDC:

> The Commission (with all Commissioners agreeing) has approved the staff proposal in Option 1 of this paper in which the staff will not apply the General Design Criteria (GDC) to plants with construction permits issued prior to May 21, 1971. At the time of promulgation of Appendix A to 10 CFR Part 50, the Commission stressed that the GDC were not new requirements and were promulgated to more clearly articulate the licensing requirements and practice in effect at that time. While compliance with the intent of the GDC is important, each plant licensed before the GDC were formally adopted was evaluated on a plant specific basis, determined to be safe, and licensed by the Commission. Furthermore, current regulatory processes are sufficient to ensure that plants continue to be safe and comply with the intent of the GDC. Backfitting the GDC would provide little or no safety benefit while requiring an extensive commitment of resources.

[10] NRC Cable Performance Protocols, August 25, 2009. Available in NRC's ADAMS under ML092220419.

Plants with construction permits issued prior to May 21, 1971 do not need exemptions from the GDC.[11]

As listed in Attachment 1, at least 57 of the nation's 104 operating reactors were issued construction permits prior to May 21, 1971. Hence, while GDC 2 and 4 may very well contain appropriate regulatory requirements for the qualification of electrical cables and wires, the Commission has determined that these requirements are NOT to be applied to the majority of reactors.

The NRC has also constricted the applicability of the regulatory requirements in 10 C.F.R. §50.49. The wording in 10 C.F.R. §50.49 requires applicable electrical cables and wires to be qualified for submergence if they are subject to being submerged. The regulation did not further limit this requirement to where the cables and wires were located. But the NRC staff introduced such a limitation through the following question and answer set in its Generic Letter 82-09, "Environmental Qualification of Safety-Related Electrical Equipment," dated April 20, 1982:

> Q. For equipment qualification purposes, what are the staff requirements concerning submergence of equipment outside containment?
>
> A. The Staff requires that the licensee submit documentation on the qualification of safety-related equipment that could be submerged due to a high energy line break outside containment.

The following is an excerpt by Judge Ann Marshall Young, (Chair of the Pilgrim LRA ASLB) Memorandum and Order dated August 11, 2011 responding to a contention related to the submerged/buried cables:

> "Section 50.49 also states, at subsection (c), the following:
>
> Requirements for (1) dynamic and seismic qualification of electric equipment important to safety, (2) protection of electric equipment important to safety against other natural phenomena and external events, and (3) environmental qualification of electric equipment important to safety located in a mild environment are not included within the scope of this section. ***A mild environment is an environment that would at no time be significantly more severe than the environment that would occur during normal plant operation, including anticipated operation occurrences.*** (Emphasis added).
>
> "As indicated above, Entergy maintains that "Pilgrim's inaccessible cables are located in a 'mild environment'" and therefore § 50.49 does not apply to them. Pilgrim Watch disputes this, through Mr. Blanch's Affidavit.
>
> "I note at this point that, while the question of the rule's definition of a "mild environment" is not as precise as it might be, it seems, according to its plain language, to be tied to whether the environment in question could *ever for any reason* be subject to variation (apart from "anticipated operational occurrences") that could include significantly more severe conditions than those existing during "normal plant operation." Entergy in effect claims that there are no inaccessible cables of the sort described in its amended cables AMP in any location that could ever be subject

[11] Available online at: http://adamswebsearch2.nrc.gov/webSearch2/main.jsp?AccessionNumber='ML003763736

to a salt water environment with "high corrosive salt concentrations" because the elevation of the plant is so high above sea level, and because the cables are above the groundwater level. Pilgrim Watch submits that being next to Cape Cod Bay implicitly means that the cables will be subject to a salt water environment that will "accelerate the degradation of cables in contrast to those nuclear plants located away from coastal areas." There would seem to be an issue both of *how high* salt concentrations might reach in the environment of the cables, and of whether these could ever *at any time* rise significantly above normal levels.

"This is a close case in several respects. However, while there are obviously differing opinions between Mr. Blanch, on the one hand, and Entergy and Staff and their experts, on the other, it is not appropriate to weigh the evidence presented in competing expert affidavits in a summary disposition context. Intervenor must in such a context demonstrate a genuine dispute on a material issue of fact, and I would find that Pilgrim Watch has done this, and therefore shown that it could defeat a motion for summary disposition, if not with respect to every individual issue addressed by the parties' experts, at least with respect to those issues I describe above."

This statement by Judge Young further expounds on the need for rulemaking and clarification of 10 C.F.R § 50.49 to address cables that may be exposed to harsh environments during normal, abnormal, and accident conditions.

Electrical cables and wires are prone to accelerated failure rates when submerged in water or exposed to high humidity unless designed and qualified for these environmental conditions. The NRC's regulatory requirements address environmental qualification of safety-related systems, structures, and components, including electric cables and wires. However, GDC 2 and 4 in Appendix A to 10 C.F.R. 50 are not applicable to the majority of the operating reactors and 10 C.F.R. § 50.49 has been restricted by the NRC staff to only apply to safety-related cables and wires outside containment subject to being submerged by a high energy line break.

This rulemaking will supplement and clarify NRC's regulatory requirements to ensure that safety-related electrical cables and wires will be properly qualified for all the environmental conditions they may experience during routine operation and following accidents regardless of when a reactor received its construction permit or where the safety-related cable is located.

REQUESTED CHANGES TO 10 C.F.R. 50

The petitioners request that the NRC initiate rulemaking to revise its regulations to clearly and unequivocally require the environmental qualification of all safety-related cables, wires, splices, connections and other ancillary electrical equipment that may be subjected to submergence and/or moisture intrusion during normal operating conditions, severe weather, seasonal flooding, and seismic events, and post-accident conditions, both inside and outside of containment.

Respectfully submitted,

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Dated: June 18, 2012

ATTACHMENTS:

1. The 104 operating reactors in the U.S. sorted by construction permit issuance date

ATTACHMENT 1.

	Plant Name, Unit Number	CP Issued
1.	Oyster Creek Nuclear Generating Station	12/15/1964
2.	Nine Mile Point Nuclear Station, Unit 1	04/12/1965
3.	R.E. Ginna Nuclear Power Plant	04/25/1966
4.	Dresden Nuclear Power Station, Unit 2	01/10/1966
5.	Dresden Nuclear Power Station, Unit 3	10/14/1966
6.	Indian Point Nuclear Generating, Unit 2	10/14/1966
7.	Quad Cities Nuclear Power Station, Unit 1	02/15/1967
8.	Quad Cities Nuclear Power Station, Unit 2	02/15/1967
9.	Palisades Nuclear Plant	03/14/1967
10.	H.B. Robinson Steam Electric Plant, Unit 2	04/13/1967
11.	Turkey Point Nuclear Generating, Unit 3	04/27/1967
12.	Turkey Point Nuclear Generating, Unit 4	04/27/1967
13.	Oconee Nuclear Station, Unit 1	11/06/1967
14.	Oconee Nuclear Station, Unit 2	11/06/1967
15.	Oconee Nuclear Station, Unit 3	11/06/1967
16.	Monticello Nuclear Generating Plant, Unit 1	06/19/1967
17.	Point Beach Nuclear Plant, Unit 1	07/19/1967
18.	Browns Ferry Nuclear Plant, Unit 1	05/10/1967
19.	Browns Ferry Nuclear Plant, Unit 2	05/10/1967
20.	Vermont Yankee Nuclear Power Station	12/11/1967
21.	Peach Bottom Atomic Power Station, Unit 2	01/31/1968
22.	Peach Bottom Atomic Power Station, Unit 3	01/31/1968
23.	Cooper Nuclear Station	06/04/1968
24.	Diablo Canyon Nuclear Power Plant, Unit 1	4/23/1968
25.	Three Mile Island Nuclear Station, Unit 1	05/18/1968
26.	Kewaunee Power Station	08/06/1968
27.	Arkansas Nuclear One, Unit 1	12/06/1968
28.	Prairie Island Nuclear Generating Plant, Unit 1	06/25/1968
29.	Prairie Island Nuclear Generating Plant, Unit 2	06/25/1968
30.	Surry Power Station, Unit 1	06/25/1968

31.	Surry Power Station, Unit 2	06/25/1968
32.	Fort Calhoun Station, Unit 1	06/07/1968
33.	Point Beach Nuclear Plant, Unit 2	07/25/1968
34.	Browns Ferry Nuclear Plant, Unit 3	07/31/1968
35.	Pilgrim Nuclear Power Station	08/26/1968
36.	Crystal River Nuclear Generating Plant, Unit 3	09/25/1968
37.	Salem Nuclear Generating Station, Unit 1	09/25/1968
38.	Salem Nuclear Generating Station, Unit 2	09/25/1968
39.	Donald C. Cook Nuclear Plant, Unit 1	03/25/1969
40.	Donald C. Cook Nuclear Plant, Unit 2	03/25/1969
41.	Calvert Cliffs Nuclear Power Plant, Unit 1	07/07/1969
42.	Calvert Cliffs Nuclear Power Plant, Unit 2	07/07/1969
43.	Indian Point Nuclear Generating, Unit 3	08/13/1969
44.	Edwin I. Hatch Nuclear Plant, Unit 1	09/30/1969
45.	St. Lucie Plant, Unit 1	07/01/1970
46.	James A. FitzPatrick Nuclear Power Plant	05/20/1970
47.	Sequoyah Nuclear Plant, Unit 1	05/27/1970
48.	Sequoyah Nuclear Plant, Unit 2	05/27/1970
49.	Duane Arnold Energy Center	06/22/1970
50.	Beaver Valley Power Station, Unit 1	06/26/1970
51.	Brunswick Steam Electric Plant, Unit 1	02/07/1970
52.	Brunswick Steam Electric Plant, Unit 2	02/07/1970
53.	Diablo Canyon Nuclear Power Plant, Unit 2	12/09/1970
54.	Millstone Power Station, Unit 2	12/11/1970
55.	North Anna Power Station, Unit 1	02/19/1971
56.	North Anna Power Station, Unit 2	02/19/1971
57.	Davis-Besse Nuclear Power Station, Unit 1	03/24/1971
58.	Arkansas Nuclear One, Unit 2	12/06/1972
59.	Joseph M. Farley Nuclear Plant, Unit 1	08/16/1972
60.	Joseph M. Farley Nuclear Plant, Unit 2	08/16/1972
61.	Fermi, Unit 2	09/26/1972
62.	Edwin I. Hatch Nuclear Plant, Unit 2	12/27/1972

63.	Watts Bar Nuclear Plant, Unit 1	01/23/1973
64.	McGuire Nuclear Station, Unit 1	02/23/1973
65.	McGuire Nuclear Station, Unit 2	02/23/1973
66.	Susquehanna Steam Electric Station, Unit 1	11/03/1973
67.	Susquehanna Steam Electric Station, Unit 2	11/03/1973
68.	Columbia Generating Station	03/19/1973
69.	Virgil C. Summer Nuclear Station, Unit 1	03/21/1973
70.	LaSalle County Station, Unit 1	09/10/1973
71.	LaSalle County Station, Unit 2	09/10/1973
72.	San Onofre Nuclear Generating Station, Unit 2	10/18/1973
73.	San Onofre Nuclear Generating Station, Unit 3	10/18/1973
74.	Beaver Valley Power Station, Unit 2	05/03/1974
75.	Grand Gulf Nuclear Station, Unit 1	09/04/1974
76.	Hope Creek Generating Station, Unit 1	11/04/1974
77.	Limerick Generating Station, Unit 1	06/19/1974
78.	Limerick Generating Station, Unit 2	06/19/1974
79.	Nine Mile Point Nuclear Station, Unit 2	06/24/1974
80.	Vogtle Electric Generating Plant, Unit 1	06/28/1974
81.	Vogtle Electric Generating Plant, Unit 2	06/28/1974
82.	Millstone Power Station, Unit 3	08/09/1974
83.	Waterford Steam Electric Station, Unit 3	11/14/1974
84.	Comanche Peak Nuclear Power Plant, Unit 1	12/19/1974
85.	Comanche Peak Nuclear Power Plant, Unit 2	12/19/1974
86.	Catawba Nuclear Station, Unit 1	08/07/1975
87.	Catawba Nuclear Station, Unit 2	08/07/1975
88.	South Texas Project, Unit 1	12/22/1975
89.	South Texas Project, Unit 2	12/22/1975
90.	Braidwood Station, Unit 1	12/31/1975
91.	Braidwood Station, Unit 2	12/31/1975
92.	Byron Station, Unit 1	12/31/1975
93.	Byron Station, Unit 2	12/31/1975
94.	Clinton Power Station, Unit 1	02/24/1976

95.	Callaway Plant	04/16/1976
96.	Palo Verde Nuclear Generating Station, Unit 1	05/25/1976
97.	Palo Verde Nuclear Generating Station, Unit 2	05/25/1976
98.	Palo Verde Nuclear Generating Station, Unit 3	05/25/1976
99.	Seabrook Station, Unit 1	07/07/1976
100.	St. Lucie Plant, Unit 2	05/02/1977
101.	Perry Nuclear Power Plant, Unit 1	05/03/1977
102.	River Bend Station, Unit 1	03/25/1977
103.	Wolf Creek Generating Station, Unit 1	05/31/1977
104.	Shearon Harris Nuclear Power Plant, Unit 1	01/27/1978