EDO Principal Correspondence Control

FROM: DUE: 08/29/11

EDO CONTROL: G20110563
DOC DT: 07/29/11
FINAL REPLY:

David Lochbaum
Union of Concerned Scientists

TO:

Borchardt, EDO

FOR SIGNATURE OF : ** GRN ** CRC NO:

Leeds, NRR

DESC:

2.206 - Boiling Water Reactors with Mark I and Mark II Containment Designs (EDATS: OEDO-2011-0535)

ROUTING:

Borchardt
Weber
Virgilio
Ash
Mamish
OGC/GC
Burns, OGC
Mensah, NRR
Scott, OGC
Bowman, OEDO

DATE: 07/29/11

ASSIGNED TO: NRR

CONTACT: Leeds

SPECIAL INSTRUCTIONS OR REMARKS:

Template: EDO-001

E-RIDS: EDO-01

EDATS

Electronic Document and Action Tracking System

EDATS Number: OEDO-2011-0535 Source: OEDO

General Information

Assigned To: NRR **OEDO Due Date:** 8/29/2011 11:00 PM

Other Assignees: **SECY Due Date:** NONE

Subject: 2.206 - Boiling Water Reactors with Mark I and Mark II Containment Designs

Description:

CC Routing: OGC; Tanya.Mensah@nrc.gov; Catherine.Scott@nrc.gov

ADAMS Accession Numbers - Incoming: NONE **Response/Package:** NONE

Other Information

Cross Reference Number: G20110563 **Staff Initiated:** NO

Related Task: **Recurring Item:** NO

File Routing: EDATS **Agency Lesson Learned:** NO

OEDO Monthly Report Item: NO

Process Information

Action Type: 2.206 Review **Priority:** Medium

Sensitivity: None

Signature Level: NRR **Urgency:** NO

Approval Level: No Approval Required

OEDO Concurrence: NO

OCM Concurrence: NO

OCA Concurrence: NO

Special Instructions:

Document Information

Originator Name: David Lochbaum **Date of Incoming:** 7/29/2011

Originating Organization: Union of Concerned Scientists **Document Received by OEDO Date:** 7/29/2011

Addressee: R. W. Borchardt, EDO **Date Response Requested by Originator:** NONE

Incoming Task Received: Letter

Union of Concerned Scientists
Citizens and Scientists for Environmental Solutions

July 29, 2011

R. William Borchardt, Executive Director for Operations
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: **Petition Pursuant to 10 CFR 2.206 – Demand For Information Regarding Compliance with 10 CFR 50, Appendix A, General Design Criterion 44, Cooling Water, and 10 CFR 50.49, Environmental Qualification**

Dear Mr. Borchardt:

On behalf of the Union of Concerned Scientists, I am submitting this petition pursuant to 10 CFR 2.206 requesting that the Nuclear Regulatory Commission (NRC) take enforcement action in the form of Demand For Information (DFI) issued to the licensees of the following boiling water reactors (BWRs) with Mark I and Mark II containment designs:

Browns Ferry Units 1, 2 & 3
Brunswick Units 1 & 2
Columbia Generating Station
Cooper
Dresden Units 2 & 3
Duane Arnold
Hatch Units 1 & 2
Fermi Unit 2
Hope Creek
FitzPatrick
LaSalle Units 1 & 2
Limerick Units 1 & 2
Monticello
Nine Mile Point Units 1 & 2
Oyster Creek
Peach Bottom Units 2 & 3
Pilgrim
Quad Cities Units 1 & 2
Susquehanna Units 1 & 2
Vermont Yankee

We ask that the DFI request that each licensee to describe how the facility complies with General Design Criterion 44 (GDC 44), Cooling water, within Appendix A to 10 CFR Part 50, and with 10 CFR 50.49, Environmental Qualification of Electric Equipment Important to Safety for Nuclear Power Plants, for all applicable design and licensing bases events.

www.ucsusa.org | Two Brattle Square · Cambridge, MA 02238-9105 · TEL: 617.547.5552 · FAX: 617.864.9405
1825 K Street NW · Suite 800 · Washington, DC 20006-1232 · TEL: 202.223.6133 · FAX: 202.223.6162
2397 Shattuck Avenue · Suite 203 · Berkeley, CA 94704-1567 · TEL: 510.843.1872 · FAX: 510.843.3785
One North LaSalle Street · Suite 1904 · Chicago, IL 60602-4064 · TEL: 312.578.1750 · FAX: 312.578.1751

EDO --G20110563

Compliance with these two safety standards is in question. GDC 44 requires:

> A system to transfer heat from structures, systems, and components important to safety, to an ultimate heat sink shall be provided. The system safety function shall be to transfer the combined heat load of these structures, systems, and components under normal operating and accident conditions.

The spent fuel pool in BWRs with Mark I and II containments is located within the reactor building, also called the secondary containment. The reactor building is a structure important to safety – it houses the emergency core cooling system pumps as well as the control rod drive system pumps and the reactor core isolation cooling system pump which are also capable of supplying makeup water to the reactor vessel. Following a design and licensing bases event, decay heat from irradiated fuel stored in the spent fuel pool is among the "combined heat load" within the reactor building that must be transferred to the ultimate heat sink to satisfy GDC 44. When system(s) prevent the spent fuel pool from boiling, the heat from piping losses, motor operation, etc. falls among the "combined heat loads." When system(s) cannot prevent the spent fuel pool from boiling following a design and licensing bases event, the heat emitted from the boiling pool falls among the "combined heat loads." One way or another, GDC 44 requires that the heat load from irradiated fuel stored in the spent fuel pools inside the reactor buildings at BWR Mark I and II plants be transferred to the ultimate heat sink. If GDC 44 is not satisfied, the plant's response to design and licensing bases events may be impaired or degraded. The licensees' responses to the DFI we seek would describe how they satisfy this GDC requirement, or not.

There is some uncertainty as to whether the final GDC issued by the Atomic Energy Commission in 1971 apply to older operating reactors, including the older BWRs with Mark I and II containments. Any such doubt is removed with respect to the applicability of 10 CFR 50.49 to all the reactors within the scope of this petition. Paragraph (e) to 10 CFR 50.49 requires:

> (e) The electric equipment qualification program must include and be based on the following:
>
> (1) *Temperature and pressure*. The time-dependent temperature and pressure at the location of the electric equipment important to safety must be established for the most severe design basis accident during or following which this equipment is required to remain functional.
>
> (2) *Humidity*. Humidity during design basis accidents must be considered.
>
> (3) *Chemical effects*. The composition of chemicals used must be at least as severe as that resulting from the most limiting mode of plant operation (e.g., containment spray, emergency core cooling, or recirculation from containment sump). If the composition of the chemical spray can be affected by equipment malfunctions, the most severe chemical spray environment that results from a single failure in the spray system must be assumed.
>
> (4) *Radiation*. The radiation environment must be based on the type of radiation, the total dose expected during normal operation over the installed life of the equipment, and the radiation environment associated with the most severe design basis accident during or following which the equipment is required to remain functional, including the radiation resulting from recirculating fluids for equipment located near the recirculating lines and including dose-rate effects.

(5) *Aging*. Equipment qualified by test must be preconditioned by natural or artificial (accelerated) aging to its end-of-installed life condition. Consideration must be given to all significant types of degradation which can have an effect on the functional capability of the equipment. If preconditioning to an end-of-installed life condition is not practicable, the equipment may be preconditioned to a shorter designated life. The equipment must be replaced or refurbished at the end of this designated life unless ongoing qualification demonstrates that the item has additional life.

(6) *Submergence* (if subject to being submerged).

(7) *Synergistic effects*. Synergistic effects must be considered when these effects are believed to have a significant effect on equipment performance.

(8) *Margins*. Margins must be applied to account for unquantified uncertainty, such as the effects of production variations and inaccuracies in test instruments. These margins are in addition to any conservatisms applied during the derivation of local environmental conditions of the equipment unless these conservatisms can be quantified and shown to contain appropriate margins.

Again, when a spent fuel pool is prevented from boiling following a design and licensing bases event, the heat losses from piping and equipment used to achieve that outcome must be included or accounted for within the environmental qualification (EQ) programs mandated by 10 CFR 50.49. When a spent fuel pool cannot be prevented from boiling following a design and licensing bases event, the temperature, humidity, and submergence conditions created by the boiling pool must be included or accounted for within the EQ programs. If 10 CFR 50.49 is not satisfied, the plant's response to design and licensing bases events may be impaired or degraded. The licensees' responses to the DFI we seek would describe how they satisfy this 10 CFR 50.49 requirement, or not.

Current design and licensing bases rely on safety-related equipment such as that housed within the reactor building performing safety functions for as long as 30 days following design and licensing bases events. Two recent among many examples are:

- "RLTCS [refrigerant low temperature control switch] setpoint drift problems could affect the 30 day mission time of the CSCs [control structure chillers] after a design basis accident. This finding is more than minor because it affects the equipment performance attribute of the Mitigating System cornerstone and the associated cornerstone objective of ensuring the reliability and availability of systems that respond to inhibiting events to preclude undesirable consequences." [Source: Pages 17-18 of the enclosure to NRC inspection report 05000387/2010003 and 050000388/2010003 dated August 13, 2010, for the Susquehanna nuclear plant – ADAMS ML102250028]

- "The Tennessee Valley Authority (TVA) is submitting this report in accordance with 10 CFR 50.73(a)(2)(i)(B), as any operation or condition which was prohibited by the plant's Technical Specifications. The past inoperability is based on the inability for the 1C RHR [residual heat removal] pump [located in the reactor building] to complete its 30 day mission time." [Source: Page 2 of the enclosure to TVA Licensee Event Report 50-259/2010-004, Rev. 1, dated March 31, 2011, for the Browns Ferry nuclear plant – ADAMS ML110940027]

An uncooled spent fuel pool can achieve boiling within the 30 day mission time associated with design and licensing bases events. A cooled spent fuel pool can deposit considerable amounts of heat into the reactor building during that 30 day period. GDC 44 requires that the combined heat load, including that from a cooled or boiling spent fuel pool, be transferred to the ultimate heat sink while 10 CFR 50.49 requires that electric equipment be qualified for the environments (e.g, temperature, humidity, and submergence) conditions they encounter following design and licensing bases events. UCS seeks the DFIs to ascertain how these reactors comply with the safety requirements in GDC 44 and 10 CFR 50.49 following design and licensing bases events.

UCS has repeatedly used the phrase "design and licensing bases events" for the purpose of clearly indicating that we are <u>not</u> inquiring about performance capabilities at these facilities following severe accident, beyond design bases, and/or extended design bases events.

This 2.206 petition is necessary because we have no other avenue through which to address this matter. It cannot be introduced in license renewal proceedings because that scope is essentially limited to the breadth and adequacy of aging management systems for passive systems, structures, and components. It cannot be introduced in new reactor certification proceedings because none of the proposed reactor designs features a Mark I or Mark II containment design. It cannot be introduced in the near-term task force efforts because that scope is essentially limited to beyond design bases events rather than compliance with existing design and licensing bases requirements. No other forum exists within NRC for us to formally raise and resolve this issue. The 2.206 petition process constitutes our sole option.

We have addressed all the requirements in 10 CFR 2.206 for our requested enforcement action to be handled by the NRC via its petition process, as verified by ensuring that we have satisfied all the elements stated in NRC Management Directive 8.11. We look forward to the NRC issuing the requested DFIs and to reading the licensees' responses.

Sincerely,

David A. Lochbaum

David Lochbaum
Director, Nuclear Safety Project
PO Box 15316
Chattanooga, TN 37415
(423) 468-9272, office
(423) 488-8318, cell

Enclosure: UCS fact sheet titled "Spent Fuel Pool Problems at Boiling Water Reactors with Mark I and II Containments," July 2011

Spent Fuel Pool Problems at Boiling Water Reactors

Union of Concerned Scientists

FACT SHEET

The 23 boiling water reactors (BWRs) with Mark I containments and the 8 BWRs with Mark II containments in 14 states have serious design problems that violate both the Nuclear Regulatory Commission's defense-in-depth safety philosophy and its federal safety regulations. As a result, these 31 reactors are vulnerable to accidents and the people living near them are exposed to an elevated, and undue, risk. These problems are related to the spent fuel pools for these reactors

A spent fuel pool is typically 40 to 45 feet deep with thick concrete walls and floor. Metal racks located in the bottom third of the pool store the spent fuel assemblies. To minimize the chances of draining water from the pool, there are no penetrations through the concrete below the top elevation of the storage racks. To cool the pool water, a system constantly removes water from the pool, cools it, and returns it to the pool. Water leaves the pool via holes at its surface similar to those around the upper edges of in-ground, concrete swimming pools. The water flows into a large metal pot called the skimmer surge tank. An electric pump moves water from the skimmer surge tank and routes it through metal tubes inside a heat exchanger and then through a filter/demineralizer unit before returning the cooled and treated water to the pool. At most plants, the fuel pool cooling and cleanup system performs this function.

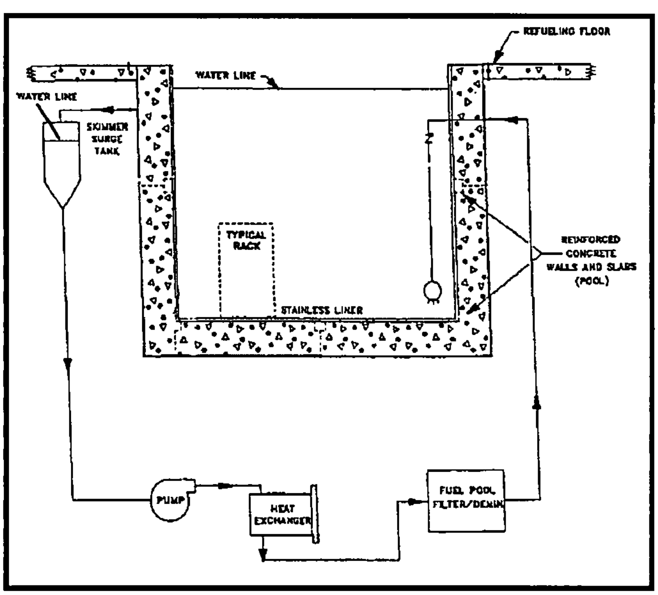
Another system sends water through the outside of the metal tubes of the fuel pool cooling system's heat exchanger. Warmth from the pool water passes through the metal walls of the tubes and is carried away by the cooling water.

BWR Mark I Containments

Browns Ferry Units 1, 2 & 3 (AL)
Brunswick Units 1 & 2 (NC)
Cooper (NE)
Dresden Units 2 & 3 (IL)
Duane Arnold (IA)
Hatch Units 1 & 2 (GA)
Fermi Unit 2 (MI)
Hope Creek (NJ)
FitzPatrick (NY)
Monticello (MN)
Nine Mile Point Unit 1 (NY)
Oyster Creek (NJ)
Peach Bottom Units 2 & 3 (PA)
Pilgrim (MA)
Quad Cities 1 & 2 (IL)
Vermont Yankee (VT)

BWR Mark II Containments

Columbia (WA)
LaSalle Units 1 & 2 (IL)
Limerick Units 1 & 2 (PA)
Nine Mile Point Unit 2 (NY)
Susquehanna Units 1 & 2 (PA)



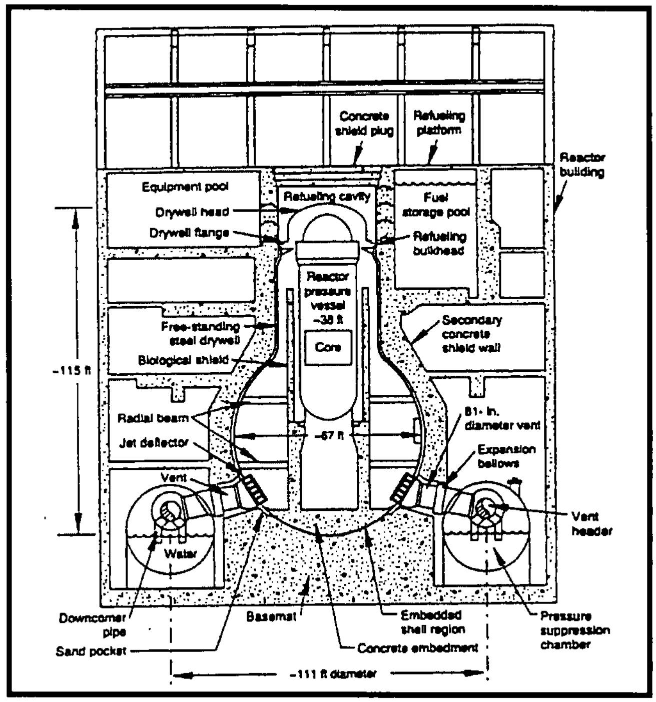
An Incomplete Solution

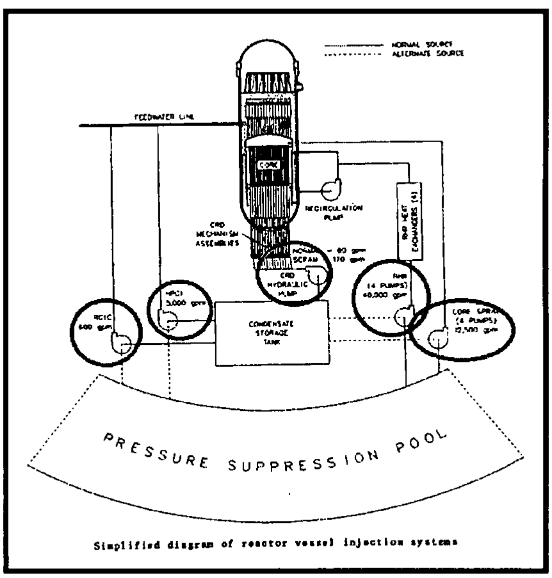
As noted on page 43 of the NRC's Near-Term Task Force report titled Recommendations for Enhancing Reactor Safety in the 21st Century (available online at http://pbadupws.nrc.gov/docs/ML1118/ML111861807.pdf), not all U.S. reactors can supply the spent fuel pool cooling system equipment and the cooling water system that interfaces with its heat exchangers with electricity should the normal power source become unavailable. Rather than require the spent fuel pools to be cooled using back-up power sources, the task force recommended that all reactors be capable of providing makeup water to their pools using pumps powered from backup sources. The makeup water compensates for the water boiling away, allowing the pool's water to continue boiling without its level dropping to uncover the spent fuel in the storage racks. Instead of assuring that a pool's water will not boil if the normal power supply is lost, the task force seeks to assure that the spent fuel in a boiling pool is protected from damage by maintaining the pool's water level above the storage racks.

For plants where the spent fuel pools are located in a building separate from the structure housing the reactor core and its emergency equipment, the task force's recommendation is adequate. The recommendation provides greater assurance that the irradiated fuel in the pools will be adequately cooled even when the pool water boils. Because the pools are in separate buildings, boiling pool water would not impair the performance of emergency systems that protect the irradiated fuel in the reactor core.

The Problem Caused by the Solution

This is not true at the BWRs with Mark I and II containments. The spent fuel pools are located within the reactor buildings at these plants. The reactor buildings also house all the pumps of the reactor's emergency core cooling systems: the high pressure coolant injection (HPCI) system pump, the core spray (CS) system pumps, and the residual heat removal (RHR) system pumps. The reactor buildings also house the reactor core isolation cooling (RCIC) system or the isolation condensers and the control rod drive (CRD) system pumps that can provide makeup water to the reactor pressure vessel. If pool water boils, it could impair or disable equipment located in the same building. The water vapor would eventually cool down and condense back into water. Much of this water would then drain down into the lower elevations of the reactor building. This is where the emergency core cooling system pumps are located. The rising water levels could submerge this emergency equipment and render it useless.





Simplified diagram of reactor vessel injection systems

Boiling pool water could also impair emergency equipment at BWR Mark I and II plants in other ways. The vapor rising from the spent fuel pool would increase the temperature and humidity of the atmosphere inside the reactor building, which could cause electrical equipment (e.g., sensors, transmitters, relays, and switches) to fail. As a result, emergency equipment not disabled by submergence could be disabled by failed control systems.

Allowing the spent fuel pool water to boil in a BWR Mark I and II plant would set the stage for a major reactor accident. Ironically, this boiling water could spell doom for the boiling water reactor. When the normal source of water (i.e., the feedwater system) to the reactor vessel is unavailable or insufficient, the RCIC, HPCI, CRD, RHR, and CS pumps are used as alternate makeup methods. But these pumps are all located inside the reactor building of a BWR Mark I and II plant, making them vulnerable to failure if its spent fuel pool water boils.

The Union of Concerned Scientists is the leading science-based nonprofit working for a healthy environment and a safer world.

Union of Concerned Scientists
Citizens and Scientists for Environmental Solutions

National Headquarters
Two Brattle Square
Cambridge, MA 02138-3780
Phone: (617) 547-5552
Fax: (617) 864-9405

Washington, DC, Office
1825 K St. NW, Ste. 800
Washington, DC 20006-1232
Phone: (202) 223-6133
Fax: (202) 223-6162

Printed on recycled paper using vegetable based inks
© UCS July 2011

The Proper Solution

Existing federal regulatory requirements would adequately protect irradiated fuel in spent fuel pools at BWR Mark I and II plants as well as protect their reactor cores from the harmful effects caused by boiling pool water. But the NRC is not enforcing them. On page 17 of its report, the NRC task force states:

> *... the current NRC regulatory approach includes (1) requirements for design-basis events with features controlled through specific regulations or the general design criteria (GDC) (10 CFR Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants") ...*

The General Design Criteria apply to design basis accidents, not just to severe accidents, beyond design basis accidents, or extended design basis conditions. General Design Criterion 44, Cooling Water, within Appendix A to 10 CFR Part 50 requires:

> *A system to transfer heat from structures, systems, and components important to safety, to an ultimate heat sink shall be provided. The system safety function shall be to transfer the combined heat load of these structures, systems, and components under normal operating and accident conditions.*

The reactor building at BWR Mark I and II plants contains systems and components important to safety. Yet, most if not all of these plants are not designed with systems that can transfer the "combined heat load" from this structure to the ultimate heat sink (i.e., the nearby lake, river, ocean, or man-made cooling pond) under accident conditions. This federal safety requirement is not being met at BWR Mark I and II plants, putting the irradiated fuel in their reactor cores and spent fuel pools at undue risk.

During normal operating conditions, the heat load from the pools at BWR Mark I and II plants is removed by the fuel pool cooling system supplied with electricity from normal power sources. But under design basis accident conditions, the normal fuel pool cooling system may not function. The heat load from the pool could not be removed by the emergency system providing reactor building cooling during a design basis accident.

The proper solution to this problem, from both a safety and legal perspective, is to enforce the existing federal requirement in General Design Criterion 44 that BWR Mark I and II plants transfer the combined heat load from the reactor building to the ultimate heat sink during normal operating and design basis accident conditions.

Some have argued that the General Design Criteria, including GDC 44, are not applicable to the older BWR Mark I and II plants for which an operating license was issued prior to the finalization of the General Design Criteria in February 1971. Even if this were true, it is undeniably true that all BWR Mark I and II plants are required to comply with the requirements in 10 CFR 50.49, Environmental Qualification of Electric Equipment Important to Safety for Nuclear Power Plants (online at http://www.nrc.gov/reading-rm/doc-collections/cfr/part050/part050-0049.html). Paragraph (e) to 10 CFR Part 50.49 requires:

> *(e) The electric equipment qualification program must include and be based on the following:*
>
> *(1)* Temperature and pressure. *The time-dependent temperature and pressure at the location of the electric equipment important to safety must be established for the most severe design basis accident during or following which this equipment is required to remain functional.*
>
> *(2)* Humidity. *Humidity during design basis accidents must be considered.*
>
> *(3)* Chemical effects. *The composition of chemicals used must be at least as severe as that resulting from the most limiting mode of plant operation (e.g., containment spray, emergency core cooling, or recirculation from containment sump). If the composition of the chemical spray can be affected by equipment malfunctions, the most severe chemical spray environment that results from a single failure in the spray system must be assumed.*

The Union of Concerned Scientists is the leading science-based nonprofit working for a healthy environment and a safer world.

Union of Concerned Scientists
Citizens and Scientists for Environmental Solutions

National Headquarters
Two Brattle Square
Cambridge, MA 02138-3780
Phone: (617) 547-5552
Fax: (617) 864-9405

Washington, DC, Office
1825 K St. NW, Ste. 800
Washington, DC 20006-1232
Phone: (202) 223-6133
Fax: (202) 223-6162

Printed on recycled paper using vegetable based inks
© UCS July 2011

(4) Radiation. *The radiation environment must be based on the type of radiation, the total dose expected during normal operation over the installed life of the equipment, and the radiation environment associated with the most severe design basis accident during or following which the equipment is required to remain functional, including the radiation resulting from recirculating fluids for equipment located near the recirculating lines and including dose-rate effects.*

(5) Aging. *Equipment qualified by test must be preconditioned by natural or artificial (accelerated) aging to its end-of-installed life condition. Consideration must be given to all significant types of degradation which can have an effect on the functional capability of the equipment. If preconditioning to an end-of-installed life condition is not practicable, the equipment may be preconditioned to a shorter designated life. The equipment must be replaced or refurbished at the end of this designated life unless ongoing qualification demonstrates that the item has additional life.*

(6) Submergence *(if subject to being submerged).*

(7) Synergistic effects. *Synergistic effects must be considered when these effects are believed to have a significant effect on equipment performance.*

(8) Margins. *Margins must be applied to account for unquantified uncertainty, such as the effects of production variations and inaccuracies in test instruments. These margins are in addition to any conservatisms applied during the derivation of local environmental conditions of the equipment unless these conservatisms can be quantified and shown to contain appropriate margins.*

If the spent fuel's decay heat is not removed by a safety-related cooling system during a design basis event (i.e., GDC 44 is not met), then a boiling spent fuel pool must be considered as a synergistic effect of the design basis event. Consequently, 10 CFR 50.49 would require that all in-scope electric equipment located within the reactor building of a BWR Mark I and II reactor be qualified for the temperature, humidity, and submergence conditions created from a boiling spent fuel pool. But this is not true at most if not all BWR Mark I and II reactors.

Union of Concerned Scientists
Citizens and Scientists for Environmental Solutions

National Headquarters
Two Brattle Square
Cambridge, MA 02138-3780
Phone: (617) 547-5552
Fax: (617) 864-9405

Washington, DC, Office
1825 K St. NW, Ste. 800
Washington, DC 20006-1232
Phone: (202) 223-6133
Fax: (202) 223-6162

Printed on recycled paper using vegetable based inks
© UCS July 2011