



**UNITED STATES
NUCLEAR REGULATORY COMMISSION**
WASHINGTON, D.C. 20555-0001

May 5, 2015

Dr. Lewis Cuthbert
President
Alliance for a Clean Environment
1189 Foxview Road
Pottstown, PA 19465

Dear Dr. Cuthbert:

On behalf of the U.S. Nuclear Regulatory Commission (NRC), I am responding to your e-mail dated March 16, 2015 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML15076A480), expressing concerns primarily about cracking, due to embrittlement, of the reactor pressure vessels at Limerick Generating Station, Units 1 and 2. I have included answers to your specific concerns in the enclosure to this letter.

Thank you for contacting the NRC with your concerns.

Sincerely,

A handwritten signature in black ink, appearing to read "R B Ennis", is positioned below the word "Sincerely,".

Richard B. Ennis, Senior Project Manager
Plant Licensing Branch I-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-352 and 50-353

Enclosure:
As stated

cc w/encl: Distribution via Listserv

NRC Response to Concerns in March 16, 2015, E-Mail

From the Alliance for a Clean Environment Regarding

Limerick Generating Station, Units 1 and 2

Background

This enclosure provides the U.S. Nuclear Regulatory Commission's (NRC's) response to concerns regarding Limerick Generating Station, Units 1 and 2 (Limerick), as discussed in the March 16, 2015, e-mail from the Alliance for a Clean Environment (ACE) (Agencywide Documents Access and Management System (ADAMS) Accession No. ML15076A480).

ACE previously raised some of the same concerns in an e-mail dated November 9, 2014 (ADAMS Accession No. ML14321A054). The NRC staff provided a response in an e-mail dated December 8, 2014 (ADAMS Accession No. ML14345A078).

Destructive Testing

ACE raised concerns regarding embrittlement of the Limerick reactors and asked if destructive testing of the reactors had been performed.

When a nuclear plant is operated, neutron radiation from the reactor core causes embrittlement of the reactor pressure vessel (RPV). Embrittlement refers to a decrease in the fracture toughness of RPV materials and affects the vessel materials in the section closest to the reactor fuel, referred to as the vessel's "beltline."

Section 50.60 of Title 10 of the *Code of Federal Regulations* (10 CFR), "Acceptance criteria for fracture prevention measures for lightwater nuclear power reactors for normal operation," requires compliance with the fracture toughness and material surveillance program requirements set forth in Appendices G and H to 10 CFR Part 50. Compliance with the requirements of this rule, and the associated appendices, provides assurance regarding the structural integrity of the reactor coolant pressure boundary (RCPB) and, specifically, the RPV.

Appendix H to 10 CFR Part 50, "Reactor Vessel Material Surveillance Program Requirements," requires nuclear power plant licensees to implement RPV surveillance programs to monitor changes in the fracture toughness properties of ferritic materials in the RPV beltline region which result from exposure of these materials to neutron irradiation. The RPV surveillance programs require destructive testing of material test specimens that are representative for the materials in the reactor. Two specific alternatives are provided for the design of a facility's RPV surveillance program to address the requirements of Appendix H to 10 CFR Part 50.

The first alternative, provided in Appendix H to 10 CFR Part 50, is the implementation of a plant-specific RPV surveillance program consistent with the requirements of American Society for Testing of Materials (ASTM) E 185, "Standard Practice for Conducting Surveillance Tests for Light-Water Cooled Nuclear Power Reactor Vessels."

The second alternative, provided in Appendix H to 10 CFR Part 50, is the implementation of an Integrated Surveillance Program (ISP). When a licensee uses an ISP, representative materials chosen for surveillance of a reactor are irradiated in one or more other reactors that have similar design and operating features.

As discussed in the NRC staff's safety evaluation for a Limerick amendment dated November 4, 2003 (ADAMS Accession No. ML032310540), Limerick, Units 1 and 2, have implemented the Boiling Water Reactor Vessel and Internals Project (BWRVIP) ISP as the basis for demonstrating compliance with the requirements of Appendix H to 10 CFR Part 50.

To comply with Appendix H to 10 CFR Part 50, the entire fleet of operating U.S. reactors, including the Limerick RPVs, contain material specimens, representative of the materials in RPV beltline region, in surveillance capsules. These surveillance capsules are removed for destructive testing of the material specimens as necessary. None of the surveillance capsules in the Limerick RPVs have been removed to date. In addition, as discussed in a Limerick license amendment dated April 8, 2011 (ADAMS Accession No. ML110691095), based on the BWRVIP ISP, Limerick is not scheduled to remove any surveillance capsules in the future. Instead, the limiting weld and plate materials for the Limerick RPVs are monitored through representative material specimens that are exposed to irradiation in other boiling water reactors, as part of the BWRVIP ISP. The BWRVIP ISP was found acceptable by the NRC staff to satisfy the requirements of Appendix H to 10 CFR Part 50, during the period of extended operation for Limerick, as discussed in the Section 3.0.3.1.11 of NUREG-2171, "Safety Evaluation Report Related to the License Renewal of Limerick Generating Station, Units 1 and 2" (ADAMS Accession No. ML14276A156).

In summary, destructive testing has not been performed on the material specimens in the Limerick RPV surveillance capsules. Destructive testing has been and will continue to be performed, for material specimens representative of the materials in the Limerick RPV, to meet the requirements in Appendix H to 10 CFR Part 50, as part of the BWRVIP ISP.

Material Fatigue Testing

ACE requested that the NRC "require independent 'material fatigue' testing of both Limerick Nuclear Plant reactors, with the results of testing immediately reported to the public."

All U.S. nuclear RPVs are designed and fabricated for operational cyclic stresses caused by all postulated loadings, including startup, shutdown, and scram events. Fatigue is explicitly evaluated as a part of the design process. Once the RPV is designed and fabricated and placed into service, licensees are required to track operational events, such as startups and shutdowns, to ensure they remain within their design bases with respect to fatigue. The NRC staff found that Limerick's fatigue program satisfied these requirements for the extended period of operation, as discussed in Section 4.3 of NUREG-2171, "Safety Evaluation Report Related to the License Renewal of Limerick Generating Station, Units 1 and 2" (ADAMS Accession No. ML14276A156). As a result of satisfying these requirements, there is no demonstrated need for material fatigue testing at Limerick.

The NRC's regulations in 10 CFR 2.206 describe the petition process, which is the primary mechanism for the public to request enforcement-related action by the NRC in a public process. This process permits anyone to petition the NRC to take enforcement-related action associated with NRC licensees or licensed activities. Depending on the results of its evaluation, NRC could

modify, suspend or revoke an NRC-issued license or take any other appropriate enforcement-related action to resolve a problem.

Although ACE's e-mail dated March 16, 2015, did not specifically cite the 10 CFR 2.206 process, it did request enforcement-related action (i.e., ACE's request to require material fatigue testing at Limerick). The NRC staff has previously offered the use of the petition process to address concerns where enforcement-related action was requested by ACE (e.g., NRC e-mail dated April 23, 2014 (ADAMS Accession No. ML14129A184)). However, ACE has previously rejected use of the NRC's petition process to address its concerns (e.g., letter dated July 25, 2014 (ADAMS Accession No. ML14216A339)). Nevertheless, the NRC staff considers the 10 CFR 2.206 petition process to be the appropriate process to address requested enforcement-related action. The NRC's petition process is available if ACE disagrees with the NRC's findings and has information the NRC did not consider in making its findings.

Borehole Testing

ACE asked whether the NRC or Exelon has done "Borehole Testing on Limerick's reactors." ACE also asked if this testing was a requirement for relicensing.

In an e-mail dated April 8, 2015, the NRC staff asked ACE for clarification on what is meant by the term "borehole testing" with respect to nuclear reactor vessels since this term is typically used in the context of a hole driven into the ground to obtain geological information. ACE provided clarification in an e-mail dated April 10, 2015 (ADAMS Accession No. ML15104A108). ACE indicated that it believed that borehole testing in the ground close to the Limerick reactors should be performed. ACE raised concerns that, if there were cracks in the reactors and cracks in the concrete surrounding the reactors, radiation could escape into the soil and contaminate the groundwater.

With respect to concerns on groundwater contamination, licensees (including Exelon at Limerick) have established and implemented programs for monitoring and analysis of onsite groundwater in response to Nuclear Energy Institute (NEI) initiative NEI-07-07, "Industry Groundwater Protection Initiative - Final Guidance Document," issued in August 2007 (ADAMS Accession No. ML072610036). That initiative provides for establishment of a comprehensive groundwater monitoring and assessment program as outlined therein. Among other aspects, the program provides objectives for: (1) evaluation of site hydrology and geology; (2) a site risk assessment of structures, systems and components (SSCs), as well as work practices for potential leakage pathway assessment; (3) guidance for remediation processes; (4) public communication and reporting; and (5) program oversight, self-assessment and re-assessment.

The groundwater monitoring program at Limerick uses a number of wells around the plant site. Consistent with the guidance in NEI-07-07, the selection of, and placement of well locations is based on a site risk assessment during which all SSCs that contain, or could contain, licensed material, and for which there is a credible mechanism for the licensed material to reach groundwater are evaluated. In addition, work practices that involve licensed material and for which there is a credible mechanism for the licensed material to reach groundwater, are also evaluated. Based on these evaluations, an on-site groundwater monitoring program is established to ensure timely detection of inadvertent radiological releases to groundwater using the hydrology and geology studies developed. As appropriate, wells are to be placed closer to SSCs that have the highest potential for inadvertent releases that could reach groundwater or SSCs where leak detection capability is limited.

To evaluate the licensee's implementation of the industry's initiative, the NRC conducted special inspections under NRC Temporary Instruction (TI) 2515/173, "Review of the Implementation of the Industry Ground Water Protection Voluntary Initiative, Revision 1," dated October 31, 2008 (ADAMS Accession No. ML082770349). That inspection was conducted at Limerick and documented during NRC Integrated Inspection 05000352/2009002 and 05000353/2009002 (ADAMS Accession No. ML091270824). The inspection concluded that an NEI-07-07 program had been established and implemented and no findings were identified. The inspector verified that the licensee had evaluated work practices that could lead to leaks and spills, and had performed an evaluation of SSCs that contain licensed radioactive material to determine potential leak or spill mechanisms. The licensee had completed a site characterization of geology and hydrology to determine the predominant groundwater gradients and potential pathways for groundwater migration from on-site locations to off-site locations. Monitoring wells had been installed at appropriate locations, to ensure timely detection of inadvertent radiological releases to groundwater, and an on-site groundwater sampling program had been implemented to monitor for potential licensed radioactive leakage into groundwater. Consistent with program guidance, the licensee reports the results of its groundwater monitoring program in its Annual Radiological Environmental Operating Reports. The NRC reviews these reports and evaluates, as part of its defined on-going inspection programs, the licensee's implementation of the program.

ACE's e-mail dated April 10, 2015, referenced Exelon's 2007 and 2009 radiological reports to the NRC for Limerick and cited concerns with radionuclides in the groundwater, sediment and broad leaf vegetation.

With respect to concerns about radionuclides in the groundwater for Limerick, with the exception of tritium (which had no offsite or onsite dose impact), no other radionuclides have been identified in onsite groundwater. Further, regarding concerns about radionuclides in the sediment and on broad leaf vegetation at Limerick, NRC senior health physics staff re-reviewed the Limerick 2007 and 2009 Annual Radiological Environmental Monitoring Reports, referenced in the ACE e-mail. Those reports did identify Cesium 137 in sediment samples associated with the liquid effluent discharge path and no Limerick-generated radionuclides were detected in broad leaf vegetation. The 2007 and 2009 reports also identified very low levels of tritium in surface water samples associated with the liquid effluent discharge path and groundwater associated with the turbine building wall leakage. The public dose projections associated with these two radionuclides were well within applicable regulatory limits. Based on our review, we did not identify any other radionuclides, attributable to plant operations, in the environment.

In summary, borehole testing is not performed at Limerick for the purposes of monitoring groundwater. Limerick uses a number of wells as part of a comprehensive groundwater monitoring program. In addition, borehole testing was not a requirement for relicensing of Limerick as testing for potential radiological releases into the groundwater does not have a nexus to aging management of plant SSCs.

Belgium Reactor Operating Experience

ACE cited issues with cracking that had been reported in two reactor vessels in Belgium.

The NRC staff is well aware of this issue. Evaluations in Belgium and the U.S. demonstrated that because these many flaws are oriented nearly parallel to the direction of stress in the reactor vessel shell, they do not pose a significant safety concern. Additionally, it should be noted that information available from Belgium suggests that the flaws occurred as part of the

initial fabrication process (i.e., flaws are not service-induced). As such, there is no indication that the flaws in the Belgium reactors are in any way related to fatigue damage.

Scrams at Limerick

ACE also raised concerns that scrams at Limerick could cause cracking due to fatigue.

As discussed above, nuclear RPVs are explicitly evaluated for fatigue during the design process, and licensees are required to track all operational events, including scrams, to ensure they remain within their design bases with respect to fatigue. The licensee's fatigue monitoring program, which captures all scrams experienced by the Limerick RPVs, was evaluated by the staff for the period of extended operation, as discussed in Section 4.3 of NUREG-2171, "Safety Evaluation Report Related to the License Renewal of Limerick Generating Station, Units 1 and 2" (ADAMS Accession No. ML14276A156).

License Renewal Commitment No. 46

ACE raised a concern about elimination of Commitment No. 46 from Limerick's re-licensing application.

Commitment No. 46 was not eliminated. This commitment is shown on page A-27 of NUREG-2171, "Safety Evaluation Report Related to the License Renewal of Limerick Generating Station, Units 1 and 2" (ADAMS Accession No. ML14276A156).

As discussed in the NRC's e-mail to ACE dated December 8, 2014 (ADAMS Accession No. ML14345A078), in Commitment No. 46, Exelon committed to enhance the Limerick operating experience program relative to aging and age related degradation. In fact, due to NRC staff review, Exelon committed to implement this commitment no later than the date that the renewed operating licenses are issued in lieu of the originally proposed implementation date of within two years following receipt of the renewed operating licenses. This is discussed on page 1-8 of NUREG-2171.

Limerick's Experiments and Permanent Plant Modifications

ACE raised concerns that its e-mail dated January 19, 2015, regarding Limerick's experiments and permanent plant modifications, had not been responded to by the NRC staff.

The NRC staff responded to the January 19, 2015, e-mail from ACE in an e-mail dated February 9, 2015 (ADAMS Accession No. ML15057A237). On March 16, 2015, the NRC staff resent the February 9, 2015, response to ACE after ACE indicated it had not received the earlier response. On March 16, 2015, ACE confirmed receipt of the response (ADAMS Accession No. ML15077A313).

Equipment Deterioration

ACE raised concerns that Limerick equipment deterioration is occurring faster than aging models have predicted. ACE questioned how the NRC verified Exelon's claims of reactor safety for Limerick re-licensing without proof that Limerick's reactors are not deteriorating faster than expected.

The safety review supporting the NRC's decision to renew the operating licenses for Limerick is detailed in NUREG-2171, "Safety Evaluation Report Related to the License Renewal of Limerick Generating Station, Units 1 and 2" (ADAMS Accession No. ML14276A156). As discussed in Section 1.2.1, "Safety Review," of NUREG-2171:

License renewal requirements for power reactors are based on two key principles:

- (1) The regulatory process is adequate to ensure that the licensing bases of all currently operating plants maintain an acceptable level of safety, with the possible exceptions of the detrimental aging effects on the functions of certain SSCs, as well as a few other safety-related issues, during the period of extended operation.
- (2) The plant-specific licensing basis must be maintained during the renewal term in the same manner and to the same extent as during the original licensing term.

In implementing these two principles, 10 CFR 54.4, "Scope," defines the scope of license renewal as including those SSCs that (1) are safety-related, (2) whose failure could affect safety-related functions, or (3) are relied on to demonstrate compliance with the NRC's regulations for fire protection, environmental qualification (EQ), pressurized thermal shock (PTS), anticipated transient without scram (ATWS), and station blackout (SBO).

Pursuant to 10 CFR 54.21(a), a license renewal applicant must review all SSCs within the scope of 10 CFR Part 54 to identify SCs [structures and components] subject to an aging management review (AMR). Those SCs subject to an AMR perform an intended function without moving parts or without change in configuration or properties and are not subject to replacement based on a qualified life or specified time period. Pursuant to 10 CFR 54.21(a), a license renewal applicant must demonstrate that the aging effects will be managed such that the intended function(s) of those SCs will be maintained consistent with the current licensing basis (CLB) for the period of extended operation. However, active equipment is considered to be adequately monitored and maintained by existing programs. In other words, detrimental aging effects that may affect active equipment can be readily identified and corrected through routine surveillance, performance monitoring, and maintenance. Surveillance and maintenance programs for active equipment, as well as other maintenance aspects of plant design and licensing basis, are required throughout the period of extended operation.

With respect to the concerns expressed by ACE, the aging management programs credited as part of the license renewal process provide reasonable assurance that the effects of aging will be adequately managed so that the intended functions will be maintained, consistent with the CLB, for the period of extended operation.

Miscellaneous Concerns

Since a number of the concerns in ACE's e-mail make assertions regarding improper conduct by the NRC staff, we have referred the ACE e-mail to the NRC's Office of the Inspector General. Further information regarding the Office of the Inspector General is available at the following link: <http://www.nrc.gov/insp-gen.html>

In addition, safety concerns associated with NRC licensed facilities can be addressed through the NRC's allegation program. Information regarding this program and how to report a safety concern is available at the following link: <http://www.nrc.gov/about-nrc/regulatory/allegations-resp.html>

May 5, 2015

Dr. Lewis Cuthbert
President
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1189 Foxview Road
Pottstown, PA 19465

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Thank you for contacting the NRC with your concerns.

Sincerely,

/RA/

Richard B. Ennis, Senior Project Manager
Plant Licensing Branch I-2
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Docket Nos. 50-352 and 50-353
Enclosure:
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