

UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
OFFICE OF NEW REACTORS
WASHINGTON, DC 20555-0001

June 29, 2011

NRC INFORMATION NOTICE 2011-13: CONTROL ROD BLADE CRACKING RESULTING
IN REDUCED DESIGN LIFETIME

ADDRESSEES

All holders of an operating license or construction permit for a nuclear power pressurized-water reactor or boiling-water reactor (BWR) issued under Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic Licensing of Production and Utilization Facilities," except those who have permanently ceased operations and have certified that fuel has been permanently removed from the reactor vessel.

All holders of and applicants for a power reactor combined license, standard design certification, standard design approval under 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants."

PURPOSE

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice (IN) to inform addressees that GE Hitachi Nuclear Energy (GEH) has discovered severe cracking in Marathon control rod blades (CRBs) near the end of their nuclear lifetime limits in an international BWR/6. As a result of investigations into the cracking, GEH has determined that the design life of certain Marathon CRBs may be less than previously stated and is revising the end-of-life depletion limits of these CRBs. The NRC expects that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. Suggestions contained in this IN are not NRC requirements; therefore, no specific action or written response is required.

DESCRIPTION OF CIRCUMSTANCES

In August 2010, GEH, as part of its surveillance program to monitor Marathon CRB performance, visually inspected four discharged CRBs at an international BWR/6 and found cracks on all four CRBs. The cracks were much more numerous and had more material distortion than those observed in previous inspections of Marathon CRBs. The cracks were also more severe in that they resulted in missing boron-carbide capsule tube fragments from two of the inspected CRBs. (A lost parts analysis determined that the missing fragments caused no negative effect on plant performance.) Additionally, these cracks occurred at locations of lower reported local boron-10 depletion than previously documented.

GEH attributed the cracking to irradiation-assisted stress-corrosion cracking that results when a material that is susceptible to irradiation is in an aggressive environment from oxidizing BWR

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water and experiences excessive stress because of boron-carbide swelling. GEH determined that a significant contributor to the extensive cracking was a rapid thermal transient that occurred when the automatic depressurization system actuated and injected cold water. GEH does not anticipate the same severe extent of Marathon CRB cracking in other plants unless a similar or more extreme thermal transient should occur. GEH further concluded that the cracking phenomenon is confined to D-lattice and S-lattice BWR plants; no inspections to date have identified cracks on C-lattice Marathon CRBs. GEH attributed this to a difference in the C-lattice design that better accommodates boron-carbide swelling.

Based on the results of the investigation, GEH determined that the lifetimes of Marathon CRBs in D-lattice and S-lattice plants may be less than previously stated. Therefore, GEH recommended a lifetime reduction. The recommended Marathon CRB lifetime reduction imposes a 60-percent local boron-10 depletion lifetime limit, or 54-percent for D-lattice $\frac{1}{4}$ segment and 55-percent for S-lattice $\frac{1}{4}$ segment lifetime limit.

GEH recommends that all plants containing D-lattice and S-lattice Marathon CRBs remove the blades from service before they exceed the revised lifetime limits. For any Marathon CRB that exceeds the revised lifetime limit while in use, GEH advises that reactor operation can continue, but the licensee should monitor reactor coolant boron and tritium concentrations in accordance with normal plant procedures. If no significant increase is observed in these concentrations, GEH recommends that reactor operation can continue until the end of the cycle before removing the CRBs from service. GEH recommends that licensees contact GEH if they detect a significant increase in boron or tritium concentration or both.

The U.S. plants that may contain D-lattice and S-lattice Marathon CRBs and that; therefore, are potentially affected are Browns Ferry-1, -2 and -3, Cooper, Clinton, Dresden-2 and -3, Duane Arnold, Grand Gulf, Fitzpatrick, Hatch-1 and -2, Monticello, Nine Mile Point-1, Oyster Creek, Peach Bottom-2 and -3, Perry, Pilgrim, River Bend, Quad Cities-1 and -2, and Vermont Yankee.

DISCUSSION

GEH's Marathon CRBs consist of a series of absorber tubes, each containing capsules filled with boron carbide (a neutron absorber), welded together to form the control rod blades. Absorber tube cracks allow water to enter both the outer absorber tube and the boron-carbide capsules, whereupon boron carbide may leach into the reactor coolant, which could result in reduced control rod worth. Licensees must maintain control rods in an operable condition as required by plant technical specifications. Technical specification requirements for reactivity anomalies give a limit for the difference between predicted versus measured core reactivity during power operation to ensure that a reactivity anomaly, such as change in control rod worth, does not result in a loss of shutdown margin or exceeding specified acceptable fuel design limits. In addition, GEH advised plant operators to continue monitoring for reactor coolant boron and tritium concentrations in accordance with normal plant procedures to detect CRB cracking and to follow the GEH Marathon CRB surveillance program, particularly for D-lattice and S-lattice plants.

CONTACT

This IN requires no specific action or written response. Please direct any questions about this matter to the technical contacts listed below or to the appropriate Office of Nuclear Reactor Regulation (NRR) project manager.

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Note: NRC generic communications may be found on the NRC public Web site, <http://www.nrc.gov>, under NRC Library.

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