UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
OFFICE OF NEW REACTORS
OFFICE OF NUCLEAR MATERIAL SAFETY AND SAFEGUARDS
OFFICE OF FEDERAL AND STATE MATERIALS
AND ENVIRONMENTAL MANAGEMENT PROGRAMS
WASHINGTON, DC 20555-0001

September 6, 2012

NRC INFORMATION NOTICE 2012-17: INAPPROPRIATE USE OF CERTIFIED MATERIAL TEST REPORT YIELD STRESS AND AGE-HARDENED CONCRETE COMPRESSIVE STRENGTH IN DESIGN CALCULATIONS

ADDRESSES

All holders of an operating license or construction permit for a nuclear power reactor issued under Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic Licensing of Production and Utilization Facilities," including those who have permanently ceased operations which have spent fuel in storage in spent fuel pools.

All holders of or applicants for combined licenses issued under 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants."

All holders of and applicants for an independent spent fuel storage installation license under 10 CFR Part 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related Greater Than Class C Waste."

PURPOSE

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice (IN) to inform addressees of issues identified during recent NRC inspections regarding the design of seismic Category I or safety-related structures. The NRC expects that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this IN are not NRC requirements; therefore, no specific action or written response is required.

DESCRIPTION OF CIRCUMSTANCES

Inappropriate Use of Certified Material Test Report (CMTR) Yield Stress

Monticello Nuclear Generating Plant

During an inspection at the Monticello Nuclear Generating Plant, NRC inspectors reviewed a calculation for a service water pipe support that the licensee used to demonstrate seismic Category I compliance. The safety-related design function of the service water pipe support structure is to hold and maintain the service water discharge line in position during a seismic Category I design-basis event to meet internal flooding license requirements. The licensee's

updated safety analysis report (USAR) requires seismic Class 1 structural steel to be analyzed in accordance with the American Institute of Steel Construction (AISC) specification. The AISC specification requires the allowable bending stress of the structural element to be based on an AISC-specified numerical value multiplied by the specified minimum yield stress. Instead, the calculation incorrectly evaluated acceptability of the baseplate component based on the material yield stress documented in a CMTR.

Additional information is available in "Monticello Nuclear Generating Plant, NRC Component Design Bases Inspection Report 05000263/2009007," dated January 6, 2010, which can be found on the NRC's public Web site using the Agencywide Documents Access and Management System (ADAMS) at Accession No. ML100060183.

Fermi Power Plant

During an inspection at the Fermi Power Plant, NRC inspectors reviewed design calculations for the reactor building steel structure. The licensee's updated final safety analysis report (UFSAR) specifies that the reactor building steel structure is to be designed to the acceptance limits specified in the AISC specification to demonstrate seismic Category I compliance. The AISC specification requires the allowable stress for axial compressive, bending, shear, and torsion to be based on the specified minimum yield stress of the structural element material. Instead, the licensee incorrectly used actual material yield stress from CMTRs for evaluating the reactor building's horizontal and vertical bracing steel members, girts, crane runway girder, building columns, and column anchor plate.

Additional information is available in "Fermi Power Plant, Unit 2 Integrated Inspection Report 05000341/2011002," dated May 2, 2011 (ADAMS Accession No. ML111220240).

Braidwood Nuclear Generating Station

During an inspection at the Braidwood Nuclear Generating Station, NRC inspectors reviewed a design calculation for a safety injection pipe support that is supported from an embedment plate inside the auxiliary building, which is a seismic Category I structure. The licensee's UFSAR specified that the auxiliary building steel structure is designed to the AISC specification. The AISC specification requires the allowable bending stress of the structural element to be based on a specified value multiplied by the material specified minimum yield stress. Instead, the licensee incorrectly used a CMTR for design-basis input to the calculation of allowable bending stress in the design-basis calculation.

Additional information is available in "Braidwood Station, Units 1 and 2, Evaluation of Changes, Tests, or Experiments and Permanent Plant Modifications Baseline Inspection Report 05000456/2011008; 05000457/2011008," dated October 28, 2011 (ADAMS Accession No. ML11301A260).

Inappropriate Use of Age-Hardened Concrete Compressive Strength

Monticello Nuclear Generating Plant

During an inspection at the Monticello Nuclear Generating Plant, NRC inspectors reviewed a pipe support calculation for the main steam piping. The safety-related design function of the pipe support is to hold a section of the main steam line in position during a seismic Category I design-basis event and maintain primary containment isolation. The licensee's USAR specified

that concrete structures are designed in accordance with the American Concrete Institute (ACI) 318 code. The design specification for anchor bolts requires the allowable load for anchor bolts to be based on a concrete compressive strength established in accordance with the ACI 318 code. Specifically, a concrete compressive strength of 3,000 pounds per square inch (psi) or 4,000 psi, depending on the plant building structure where the anchorage is located, was to be used in design calculations. Instead, the licensee used an anchor bolt with an allowed load incorrectly determined using a concrete compressive strength of 6,000 psi. This value was determined by extrapolation using the principle that concrete continues to age harden over time.

Additional information is available in "Monticello Nuclear Generating Plant, NRC Component Design Bases Inspection Report 05000263/2009007," dated January 6, 2010 (ADAMS Accession No. ML100060183).

Fermi Power Plant

During an inspection at the Fermi Power Plant, NRC inspectors reviewed a calculation for reactor building concrete structural members used to support spent fuel cask placement. The licensee's UFSAR specifies that the requirements for the reactor building concrete structural members used to support spent fuel cask placement be designed to the acceptance limits specified in ACI 318 to demonstrate seismic Category I compliance. The ACI 318 code requires the concrete compressive strength to be based on the 28-day strength or another time as indicated in design drawings or specifications. The design drawings and the UFSAR specified the compressive strength 28-day value for the reactor building as 4,000 psi. Instead, the licensee incorrectly used a concrete compressive strength of 5,900 psi for evaluation of the reactor building refuel floor slab and beams, the spent fuel pool floor slab, and the reactor building truck bay floor slab. This value was determined by extrapolation using the principle that concrete continues to age harden over time.

Additional information is available in "Fermi Power Plant, Unit 2 Integrated Inspection Report 05000341/2011003; 07200071/2010001," dated August 1, 2011 (ADAMS Accession No. ML112140118).

DISCUSSION

General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena," of Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50, states, in part, that structures, systems, and components important to safety shall be designed to withstand the effects of natural phenomena, including earthquakes. In addition, the design bases for structures, systems, and components shall reflect sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

Licensees typically use industry standards with sufficient margin to establish a seismic design basis. The AISC specifications use the specified minimum yield strength for stress evaluation of structural components. CMTRs ensure that purchased structural steel has the minimum strength specified in the design. The ACI 318 code uses a concrete compressive strength based on the 28-day strength or another time as indicated on the design drawings and specifications. Concrete cylinder tests provide assurance that the installed concrete will achieve the minimum strength specified in the design.

The AISC specification provides acceptance limits for structural steel design using the material specified minimum yield strength to determine the allowable axial, bending, shear, and torsional stresses for steel members. The NRC staff has approved the use of AISC in the design and licensing bases of nuclear power plants. The use of actual yield stress is not consistent with this specification.

The ACI 318 code provides acceptance limits for concrete design using the compressive strength of the concrete specified at the time of construction. The concrete compressive strength for installed concrete is typically 28 days or another time as indicated in design drawings or specifications. The NRC staff has approved the use of ACI 318 in the design and licensing bases of the plant. The use of concrete compressive strength based on the principle that concrete continues to age harden over time is not consistent with this code.

The use of material yield stresses and concrete compressive strengths in structural design calculations that are less conservative than specified in the plant's design and licensing basis result in inappropriate reduction in safety margins inherent in the associated specification and code requirements. The safety implication of using CMTR values is the reduction in the AISC factor of safety or safety margin. The safety implication of using age-hardened concrete compressive strength is the reduction of the ACI 318 code factor of safety or safety margins.

Licensees should verify that their calculations for structural steel and concrete use allowables that comply with the standards referenced in their licensing and design bases. Deviations from these allowables may require a license amendment prior to use. Specifically, Criterion III, "Design Control," of Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," to 10 CFR Part 50 requires, in part, that measures shall be established to include provisions to ensure that appropriate quality standards are specified and included in design documents and that deviations from such standards are controlled.

CONTACT

This IN requires no specific action or written response. Please direct any questions about this matter to the technical contacts listed below or the appropriate NRC project manager.

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Note: NRC generic communications may be found on the NRC public Web site, http://www.nrc.gov, under Electronic Reading Room/Document Collections.

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