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

January 9, 2026

NRC INFORMATION NOTICE 2026-01: DEGRADATION OF CARBON FIBER REINFORCED POLYMER COMPOSITE USED FOR PIPING REPAIR

ADDRESSEES

All holders of an operating license or construction permit for a nuclear power reactor 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, and all holders of a power reactor combined license under 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Plants."

All holders of or applicants for an early site permit, standard design certification, standard design approval, manufacturing license, or combined license 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 of the operating experience regarding the degradation of the carbon fiber reinforced polymer (CFRP) composite that was installed for piping repair. It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid impacts to the operability of structures, systems, and components important to safety. INs may not impose new requirements, and nothing in this IN should be interpreted to require specific action.

DESCRIPTION OF CIRCUMSTANCES

In October 2021, at Arkansas Nuclear One, Unit 2, degradation was found in the CFRP composite that was installed on the inner diameter of the circulating water return piping. The purpose of the CFRP repair was to mitigate corrosion in the non-safety-related piping. In the degraded condition, a portion of the CFRP composite was detached from the pipe and entangled in a downstream screen, causing back pressure to build in the pipe. Some of the material entangled in the screen was easily removed. However, one piece had to be broken before removal.

Some sections of the topcoat were also found to be missing. In addition, the licensee found that the CFRP composite was starting to delaminate at one of the terminal ends. The CFRP composite for piping repair did not include a terminal-end compression ring. In CFRP composite applications, the purpose of a terminal-end compression ring is to provide an extra layer of

ML25251A088

protection for damage to terminal ends by applying compressive forces between the composite and the substrate (i.e., the base metal of the repaired piping).

DISCUSSION

A CFRP composite is composed of reinforcing carbon fibers saturated in a polymer matrix. In piping repair using a CFRP composite to provide structural integrity or corrosion resistance, the composite material is installed on site by wet lay-up and cure-in-place processes. The quality and integrity of the CFRP repair depend on its material qualification, installation process, quality control, verification testing for the installed composite, and inspections.

The specific piping associated with the operating experience presented above is non-safety-related piping. However, when degradation of CFRP composites causes debonding or delamination in non-safety-related piping, this may create a foreign material hazard with potential impacts on the operability of safety-related systems and components that are relied upon for plant safety.

Currently, there is no NRC staff–approved generic approach for CFRP repair in the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code or code cases. The NRC staff is working with ASME and industry stakeholders to develop a generically approved approach for CFRP repair for ASME code class piping (e.g., development of a later version of ASME Code Case N-871-1, “Repair of Buried Class 2 and 3 Piping Using Carbon Fiber-Reinforced Polymer Composite, Section XI, Division 1,” to be included in Regulatory Guide 1.147, “Inservice Inspection Code Case Acceptability, ASME Section XI, Division 1”).

Within the past 10 years, the NRC staff received and approved licensees’ proposed alternatives regarding the application of CFRP composite (also called CFRP repair system) for safety-related piping. Of those approved, only one plant has installed the CFRP composite for safety-related piping, and limited operating experience has not shown such degradation as discussed above. This specific CFRP repair system (i.e., specific vendor, material, installation process, etc.) has been also used in the piping systems of nonnuclear plants and municipal water systems. In addition, this specific CFRP repair system has been used in nuclear plant non-safety-related piping systems. The licensees’ operating experience evaluation of these nonnuclear applications and nuclear plant non-safety-related applications further indicates that there was no failure due to degradation associated with this specific CFRP repair system.

However, the operating experience related to the CFRP composite degradation in the non-safety-related piping and the CFRP repair approach, which maintained the integrity of piping repair, suggests that the following approaches are important to ensure the integrity of CFRP repair systems:

- Adequate materials (e.g., carbon fiber fabric and epoxy resin) are selected based on the material qualification tests for tensile strength, tensile elastic modulus, bond strength, and glass transition temperature to ensure that the design criteria are met.

- A proper installation process is conducted with quality control using in-process inspections to ensure that qualified materials are used in the installation; the surface of the substrate (host piping) is properly prepared and clean; the substrate pipe has a proper thickness at the terminal end regions; the carbon fiber fabric is properly saturated

with the polymer resin; and the installation temperature is monitored and controlled to achieve the specified cure condition, degree of cure, and glass transition temperature.

- Verification testing is performed by using witness panels or samples, which are prepared at the installation and represent the installation process, to confirm that the properties of the installed CFRP composite (e.g., tensile strength and modulus, degree of cure and glass transition temperature) meet the design criteria.

- Preservice and in-service inspections are conducted to ensure that the installed CFRP composite does not have defects (e.g., matrix cracking, delamination, blisters, and wear) that may affect the integrity of the CFRP repair, and the CFRP composite continues to be free of degradation during the service.

- Technical personnel involved in the CFRP repair installation have sufficient training and qualification to adequately conduct the installation processes, including in-process and quality control inspections.

Although this IN does not require specific actions of licensees, the approaches discussed above can help to ensure that the CFRP repair maintains its structural integrity and performs its intended functions.

Recently, the NRC staff used the agency's probabilistic risk assessment (PRA) software and plant-specific Standardized Plant Analysis Risk models to evaluate the potential impact of CFRP failures on plant systems and components. This risk analysis was conducted for sites where the NRC staff has received and approved the proposed alternatives involving the application of CFRP composite for safety-related piping. Analysts examined plant drawings, system descriptions, and abnormal operating procedures for each plant to understand how specific plant design specifications could mitigate potential failures.

The following insights were identified based on the NRC's review of the issue:

- Verification testing, using witness panels to confirm that the margin between the cure temperature and the glass transition temperature is sufficient, would reduce uncertainty in the risk analysis.

- Licensees that analyze the effects of potential failures of CFRP on downstream components and systems, and how operators and systems would respond to such failures, can identify vulnerabilities before installation.

CONTACTS

Please direct any questions about this matter to the technical contacts listed below.

/RA/

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