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

July 15, 2016

NRC INFORMATION NOTICE 2016-09: RECENT ISSUES IDENTIFIED WHEN USING REVERSE ENGINEERING TECHNIQUES IN THE PROCUREMENT OF SAFETY-RELATED COMPONENTS

ADDRESSEES

All holders of, and applicants for, a construction permit or an operating license for a non-power reactor (research reactor, test reactor, or critical assembly) or a medical isotope production facility under Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic Licensing of Production and Utilization Facilities," except those that have permanently ceased operations.

All holders of an operating license or construction permit for a nuclear power reactor issued under 10 CFR Part 50, except those that 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 early site permit, combined license, standard design approval, or manufacturing license under 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants." All applicants for a standard design certification, including such applicants after initial issuance of a design certification rule.

All contractors and vendors that directly or indirectly supply basic components to U.S. Nuclear Regulatory Commission (NRC) licensees under 10 CFR Part 50 or 10 CFR Part 52.

PURPOSE

The NRC is issuing this information notice (IN) to inform addressees of issues that the NRC staff has identified concerning the supply of replacement safety-related components. Specifically, this IN describes instances where reverse engineering techniques were used to manufacture replacement components, and where the components were supplied without first verifying the supplied components met all safety-related design requirements. 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, the NRC requires no specific action or written response.

DESCRIPTION OF CIRCUMSTANCES

During recent inspections, the NRC identified deficiencies in certain aspects of licensees' and vendors' quality assurance programs. These quality assurance programs are intended to ensure that safety-related components can be relied upon to function, as necessary, to meet

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their intended requirements. In some instances, reverse engineering techniques were used to manufacture and supply components without first developing a full understanding of the components' safety-related design requirements.

This IN provides examples where licensees and suppliers used reverse engineering techniques to manufacture and supply safety-related equipment, but did not implement sufficient controls to verify that equipment was suitable for its intended application. In these examples, the suppliers and/or licensees were unable to provide reasonable assurance that the supplied component would be capable of operating on demand for the required life of the component and under the full range of operating and accident conditions. This led to licensees installing components that were not suitable for its intended application or that had indeterminate suitability at the time of installation. In one example, this led to a failure of the component to operate on demand during a plant event.

The list below provides a summary of the deficiencies that NRC inspectors identified as a result of the procurement of reverse engineered components:

- not developing a full understanding of design requirements
- assuming that a reverse-engineered component is identical to the original equipment manufacturer (OEM) component, even though it was not subject to the same design and manufacturing specifications and processes as the original component
- assessing only the physical attributes of the component without properly evaluating functional design requirements
- not passing on all relevant design requirements to the supplier
- not verifying that all safety-related design requirements have been met, either by testing or analysis or a combination of the two
- not clearly establishing which organization is responsible for which portion of the reverse engineering process

During recent NRC inspections, inspectors identified the following specific examples of improper reverse engineering of safety-related components.

1. The NRC identified a non-cited violation of 10 CFR Part 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," Criterion III, "Design Control," at Callaway Plant, Unit No. 1 for failure to assure that the design of the replacement reverse-engineered Modutronics controller cards used for the auxiliary feedwater control valves were suitable for their application. Specifically, the licensee failed to establish suitable interface requirements in procurement documents to Nuclear Logistics Incorporated (the vendor). The licensee also failed to verify (or ensure their supplier had verified), by either design reviews or testing, that the supplied reverse-engineered controller cards were suitable for their application. As a result, the replacement cards were supplied with motor field current rectifier bridges that were undersized and marginal for their application. Consequently, two of the circuit cards failed in service, rendering the associated auxiliary feedwater system valves inoperable. Following performance of a root cause analysis, the licensee replaced the deficient controller cards with those of a higher current rating. [NRC Inspection Report 05000483/2015009, dated January 13, 2016 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML16013A021)]

2. The NRC identified a non-cited violation of 10 CFR Part 50, Appendix B, Criterion III, "Design Control," at River Bend Station, Unit 1 for the failure to verify the adequacy of

the design of replacement accumulators, 18 of which were installed in the control rod drive system. The accumulators were reverse engineered, purchased from a commercial supplier (Tobul Accumulator), and dedicated for use as a basic component; however, the licensee's technical justification for the acceptability of the reverse-engineered component was inadequate. The equivalency evaluation failed to verify the adequacy of safety-related design requirements related to the performance of the accumulators, such as flow rates, leakage rates, pressure ranges of operation, stroke times, temperature ranges of operation, and seismic qualification. [NRC Inspection Report 5000458/2015002, dated August 11, 2015 (ADAMS Accession No. ML15223B344)]

3. The NRC identified a nonconformance to 10 CFR Part 50, Appendix B, Criterion III, "Design Control," at NOVA Machine Products Inc. for its failure to establish adequate design control measures to verify and check the adequacy of the design of hydraulic control unit (HCU) accumulators used in the control rod drive system of boiling-water reactors. Specifically, NOVA reverse engineered and subsequently manufactured approximately 881 safety-related HCU accumulator assemblies without proper design verification in the form of a design review, use of calculational methods, or through a suitable qualification testing program. [NRC Inspection Report 99901052/2015-201, dated January 15, 2016 (ADAMS Accession No. ML16006A394)]

In response to the above identified deficiencies, licensees and vendors entered the deficiencies into their corrective action programs and took appropriate corrective measures.

BACKGROUND

The regulations in 10 CFR Part 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," Criterion III, "Design Control," require that licensees, vendors, and contractors establish measures for the selection of parts and equipment essential to the safety-related functions of structures, systems, and components. Criterion III also requires that licensees, vendors, and contractors establish measures for verifying the adequacy of the design, such as by the performance of design reviews, by the use of alternate or simplified calculation methods, or by the performance of a suitable testing program. Vendors and contractors that supply safety-related components to licensees are required to adhere to these requirements when imposed on them by NRC licensees through contractual requirements.

DISCUSSION

For various reasons, including obsolescence, cost, and extended delivery schedules, licensees and their suppliers are increasingly using reverse engineering techniques to manufacture replacement safety-related components. While there is no regulatory definition of reverse engineering, it can be considered a process (or set of processes) to help manufacture or replicate a component based upon physically examining, measuring, or testing existing items; reviewing technical data; or performing engineering analysis.[1] When all safety-related design requirements, are well understood and documented, the process is not unlike a normal safety-related procurement for an alternate component. In many cases, licensees use an equivalency evaluation process to verify the new proposed component is suitable for its application (i.e., meets all relevant safety-related requirements).

[1] Definition taken in part from EPRI TR 107372, "Guideline for Reverse Engineering at Nuclear Power Plants," July 1998.

In some instances, however, the full scope of the safety-related requirements for the component is unknown and has to be regenerated. Various engineering methods can be used to help regenerate component-specific requirements. This can be accomplished through a review of relevant system and component-level design information, including information obtained from original equipment manufacturers (OEM), through the performance of new calculations, or through testing and/or examination of the original component.

While physical examination and material analysis of an OEM component may be sufficient to define the physical characteristics necessary to create a physically equivalent component design, physical examination alone is typically not sufficient to identify all the functional requirements. Identifying all functional requirements necessitates a full understanding of the intended application of the component, interface requirements, environmental parameters, and other design considerations. Although not explicitly required, recipients are encouraged to review the information and references provided in this IN for applicability and consider actions, as appropriate, for their facilities to avoid similar problems.

CONTACT

This IN requires no specific action or written response. Please direct any questions about this matter to the technical contact listed below.

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Note: NRC generic communications may be found on the NRC's public Web site, http://www.nrc.gov, under NRC Library/Document Collections.

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