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

November 21, 2013

NRC INFORMATION NOTICE 2013-21: WELDING PROBLEMS DURING FABRICATION OF REACTOR PLANT COMPONENTS

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.

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

All contractors and vendors that supply basic components to U.S. Nuclear Regulatory Commission (NRC) licensees under 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities" or 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 examples of welding problems that occurred during the fabrication of reactor plant components. 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

Three instances are described below where welding problems which required significant repair occurred during the fabrication of large reactor plant components. Weld repairs on reactor coolant system components are generally undesirable due to the introduction of residual tensile stresses, a contributor to primary water stress corrosion cracking (PWSCC).

Weld Defects in the Flamanville 3 European Pressurized Reactor (EPR) Vessel Head (France)

In November 2010, during fabrication inspections of the new Flamanville 3 EPR reactor vessel head, AREVA detected defects in several reactor head penetration nozzle welds. In April 2011, the French Nuclear Safety Authority (ASN) issued an Information Notice outlining the location of

the defects and the proposed corrective actions. In June 2011, during repairs of the penetration nozzle weld defects, AREVA discovered that there was also insufficient buttering thickness for some of the welds due to excessive grinding during nozzle weld repairs. See ASN Information Notice 2012-13 for more details.

The design of the EPR vessel head includes over 100 penetrations. This relatively large number of penetrations restricts access to the penetration welds which makes in-process cleaning, nozzle welding, and weld repairs more difficult. Also, the welding process was changed compared to previous (non-EPR) reactor head fabrication. Changes in welding practices compared to manufacturing of previous vessel closure heads included filling the weld in sequences of three layers instead of two layers, and cleaning operations at the end of the welding sequences were performed by brushing instead of grinding. The combination of poor accessibility to weld sites, and the changes in the weld cleaning process led to several weld defects.

The removal of an excessive amount of buttering material during repair of the reactor head welding defects was, in part, due to slight deformation of the vessel head which occurred during the final heat treatment. This deformation is expected, but was not appropriately taken into account when grinding was performed during penetration nozzle weld repairs. This resulted in an excessive amount of buttering material being removed.

Lessons learned from the EPR reactor vessel head repairs have led to several improvements in AREVA welding processes. These included making specific weld procedure acceptance criteria more stringent, performing more frequent weld checks during welding operations, and increasing the use of ultrasound inspections on nozzle adapter welds.

Vogtle Electric Generating Plant (Vogtle) Unit 3 AP-1000 Reactor Vessel Nozzle Weld Issues - Doosan Heavy Industries, South Korea

After welding the Vogtle Unit 3 reactor vessel nozzles at Doosan Heavy Industries in the Republic of Korea, ultrasonic testing revealed several indications in the Alloy 52M inlet nozzle-to-safe end welds. Some indications were in excess of the allowable limits of the American Society of Mechanical Engineers Boiler & Pressure Vessel Code, Section III, and therefore were determined to be defects that required repair. The primary cause for the indications was loss of weld shielding gas during welding operations due to the ventilation configuration in the vicinity of welding. Corrective actions included revising procedures to better control ventilation configurations to ensure that the correct weld shielding gas is maintained, repairing the welds by excavating the defects from the inside diameter, and re-welding.

Additional information appears in Southern Nuclear Operating Company's public meeting notes presented to the NRC on October 4, 2012. They can be found on the NRC's public Web site in the Agencywide Documents Access and Management System (ADAMS) under Accession No. ML12277A349.

Vogtle Electric Generating Plant Unit 3 AP-1000 Containment Vessel Weld Cracking

In April 2012, licensee contractors discovered cracks in four welds in the lower ring of the Vogtle Unit 3 containment vessel. The cracks were located in the welds joining 1-7/8 inch SA-738 grade B alloy steel plates. Corrective actions included modifying the fit-up procedure to reduce fit-up stresses and modifying the post weld heat treatment procedure to distribute heat during post weld heat treatment over a larger area.

Additional information appears in Southern Nuclear Operating Company Vogtle Electric Generating Plant Units 3 and 4 - NRC Integrated Inspection Reports 05200025/2012-003, and 05200026/2012-003, dated August 2, 2012, on the NRC's public Web site in ADAMS under Accession No. ML12220A476.

BACKGROUND

Related NRC Generic Communications

NRC IN 2010-08, "Welding and Nondestructive Examination Issues," dated April 9, 2010, alerted addressees to several instances of welding and nondestructive examination human performance errors and ASME code non-compliances. (ADAMS Accession No. ML091670177)

NUREG-1425, "Welding and Nondestructive Examination Issues at Seabrook Nuclear Station: An Independent Review Team Report," dated July 28, 1990, describes lessons learned regarding licensee radiographic and welding programs. (ADAMS Accession No. ML090300351).

DISCUSSION

This IN provides examples of recent welding issues that involved inadequate procedures to control critical welding parameters, inadequate quality checks, or inadequate technical evaluation of welding conditions. In each of the examples, the affected welds were removed and completely re-welded, or the welds were repaired. However, weld repairs in contact with reactor coolant are generally not preferred due to the introduction of residual tensile stresses on the surface of the weld in contact with reactor coolant. This can potentially contribute to weld degradation mechanisms such as PWSCC. The implementation of adequate procedures, training, and quality oversight is necessary to avoid these types of welding issues. Specifically, 10 CFR Part 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants": (1) Criterion VII requires that measures be established to adequately control contractor materials and services, and (2) Criterion IX requires a licensee to establish adequate measures to ensure the control of special processes, "including welding, heat treating, and nondestructive testing," and (3) Criterion XVI requires that measures be established to "assure that conditions adverse to quality" be "promptly identified and corrected."

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 Office of New Reactors (NRO) or Office of Nuclear Reactor Regulation project manager.

/RA/

Michael C. Cheok, Acting Director
Division of Construction Inspection
and Operational Programs
Office of New Reactors

/RA Sher Bahadur Acting for/

Lawrence E. Kokajko, Director
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Technical Contacts: Robert Davis, NRO
301-415-4028
E-mail: Robert.Davis@nrc.gov

Phil O'Bryan, NRO
E-mail: Phil.OBryan@nrc.gov

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

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E-mail: Phil.OBryan@nrc.gov

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OFFICE	PM:DCIP/NRO	Tech Editor:	DE/NRO	BC:CIB/DE/NRO
NAME	PO'Bryan	CHsu	RDavis	DTerao
DATE	05/31/13 e-mail	06/14/13 e-mail	05/31/13 e-mail	9/23/13 e-mail
OFFICE	BC:IGCB/DCIP/NRO	D:DE/NRO		LA:PGCB/NRR
NAME	BAnderson	MShuaibi		CHawes CMH
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