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

May 5, 2014

NRC INFORMATION NOTICE 2014-07: DEGRADATION OF LEAK-CHASE CHANNEL SYSTEMS FOR FLOOR WELDS OF METAL CONTAINMENT SHELL AND CONCRETE CONTAINMENT METALLIC LINER

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 for 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 approval, or manufacturing license under 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Reactors." All applicants for a standard design certification, including such applicants after initial issuance of a design certification rule.

PURPOSE

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice (IN) to inform addressees of issues identified by the NRC staff concerning degradation of floor weld leak-chase channel systems of steel containment shell and concrete containment metallic liner that could affect leak-tightness and aging management of containment structures. 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

Containment Basemat Shell and Liner Leak-Chase Channel System

The containment basemat metallic shell and liner plate seam welds of pressurized water reactors are embedded in 3- to 4-feet (0.9- to 1.2-meter) thick concrete floor during construction and are typically covered by a leak-chase channel system that incorporates pressurizing test connections. This system allows for pressure testing of the seam welds for leak-tightness during construction and also in service, as required. A typical basemat shell or liner weld leak-chase channel system is conceptually illustrated in elevation view in Figure 1. It consists of steel channel sections that are fillet welded continuously over the entire bottom shell or liner seam welds and subdivided into zones, each zone with a test connection. Each test connection consists of a small carbon or stainless steel tube (less than 1-inch (2.5 centimeters) diameter) that penetrates through the back of the channel and is seal-welded to the channel steel.

The tube extends up through the concrete floor slab to a small steel access (junction) box embedded in the floor slab. The steel tube, which may be encased in a pipe, projects up through the bottom of the access box with a threaded coupling connection welded to the top of the tube, allowing for pressurization of the leak-chase channel. After the initial tests, steel threaded plugs or caps are installed in the test tap to seal the leak-chase volume. Gasketed cover plates or countersunk plugs are attached to the top of the access box flush with the containment floor. In some cases, the leak-chase channels with plugged test connections may extend vertically along the circumference of the cylindrical containment shell or liner to a certain height above the floor. The NRC staff notes that there are variations in the design and layout of the leak-chase channel systems used in different containments.

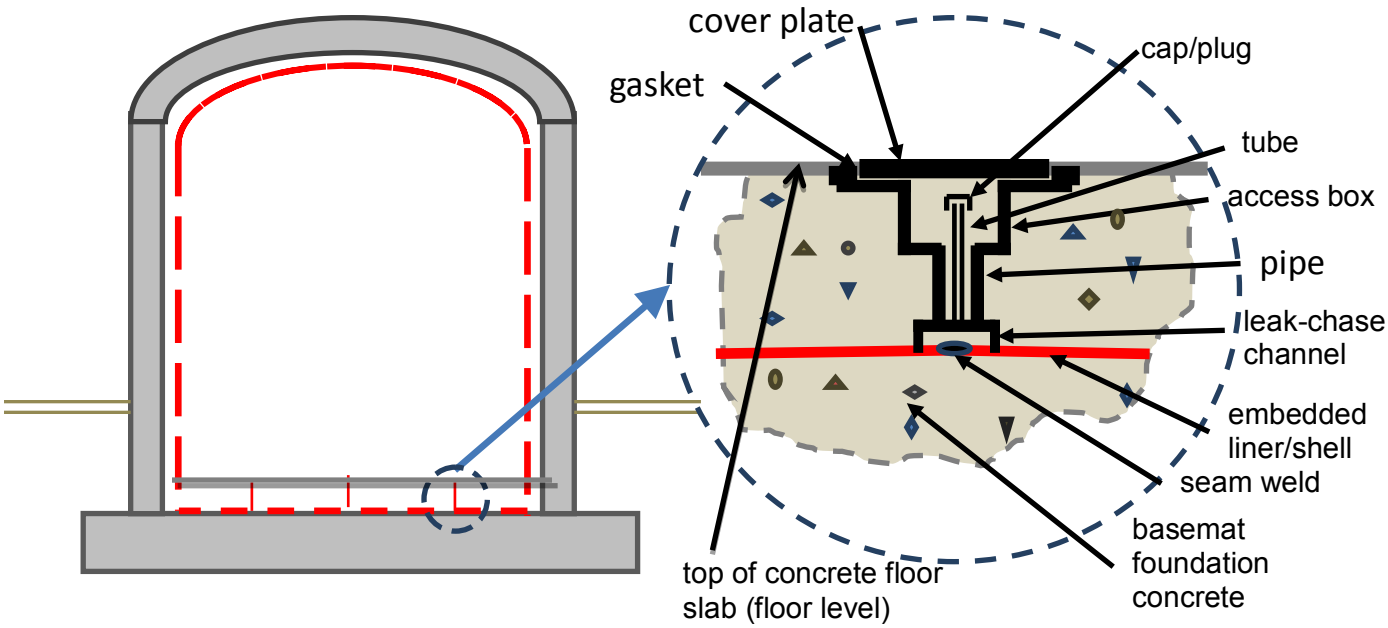

Figure 1: Conceptual illustration of typical containment basemat shell/liner leak-chase system

Leak-Chase Channel Degradation Issues Identified

NRC inspectors recently identified degradation issues related to the containment floor steel shell and liner plate leak-chase channel systems at several pressurized-water reactor (PWR) plants, examples of which are summarized below.

Virgil C. Summer Nuclear Station

During the RF-19 refueling outage (April 15–May 29, 2011), while conducting a routine containment walkdown, the NRC inspectors noticed degradation to several metal cover plates that were mounted flush with the concrete floor and had access boxes underneath. The access boxes house the test connections of the containment liner weld leak-chase channel system.

The NRC inspectors determined that the licensee had no plan in place to perform visual examinations of accessible parts of the containment liner plate leak-chase systems in accordance with American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) Section XI, Subsection IWE requirements. After the NRC inspectors raised the issue, the licensee performed visual examinations of the 51 test connection plugs; four were found with missing tube plugs, debris in the tubing, and water inside the channels. Based on the limited visual examination possible using a borescope at one location, minor indications of corrosion were evident. The licensee conducted pressure drop tests of each of these four leak-chase channel zones. The leakage measured was minor, indicating confidence in the overall leak-tightness of the liner weld areas. The licensee reassessed the conditions of these four zones during the RF-20 outage as part of a formal ASME Code Section XI, Subsection IWE augmented examination program, and took actions in its corrective action program to address the issues associated with the problem. Additional information appears in "Virgil C. Summer Nuclear Station—NRC Integrated Inspection Report 05000395/2011003," dated August 4, 2011, on the NRC's public Web site in the Agencywide Documents Access and Management System (ADAMS) under Accession No. ML112160535.

Joseph M. Farley Nuclear Plant, Unit 1

While conducting an independent walkdown of the containment during the April 1–20, 2012, refueling outage, the NRC inspectors noticed degradation and misalignment of one of 49 floor metal cover plates above access boxes that housed the test connections for the floor weld leak-chase channel system. The inspectors determined that the licensee had no program in place to inspect any portion of the leak-chase test connections for evidence of moisture intrusion that could reach the containment liner, in accordance with ASME Code Section XI, Subsection IWE requirements. The licensee subsequently conducted visual examinations of all 49 test connections and found two covers degraded and misaligned, and two covers missing with blockages in the test connection piping and significant corrosion of the access box metal plates. One test connection with blockage showed evidence of boric acid in the pipe and water in the leak-chase channel, which was subsequently removed. The licensee further evaluated these four connections to verify that containment integrity had been maintained. The licensee planned to reassess the condition of these four zones during the next refueling outage as part of a formal ASME Code Section XI, Subsection IWE augmented examination and initiated action in its corrective action program to address the issues associated with this problem. Additional information appears in "Joseph M. Farley Nuclear Plant—NRC Integrated Inspection Report 05000348/2012003; and 05000364/2012003," dated July 20, 2012, on the NRC's public Web site under ADAMS Accession No. ML12202B078.

Sequoyah Nuclear Plant, Unit 2

During an independent walkdown of containment in the fall 2012 outage, NRC inspectors observed several metal floor-covers underneath which were junction boxes that housed the test connections for the liner weld leak-chase channel system. The NRC inspectors determined that the licensee had no requirements in place, in its Subsection IWE containment inservice inspection (ISI) program, to inspect any portion of these test connections for evidence of moisture intrusion that could reach the containment liner. The licensee subsequently conducted

visual examinations on all eight of the leak-chase test connection junction boxes that revealed significant corrosion of the junction boxes, including one through-wall hole in the tubing leading down to the leak-chase channels. Upon inspection of the channels using a borescope, the licensee noted water in the channels and limited corresponding corrosion. The licensee added the junction boxes to the containment ISI plan for future inspections. The licensee entered the issue into their corrective action program to address the issues associated with this problem. Additional information appears in "Sequoyah Nuclear Plant - NRC Integrated Inspection Report 05000327/2012005, 05000328/2012005," dated February 13, 2013, on the NRC's public Web site under ADAMS Accession No. ML13050A394.

BACKGROUND

Regulations in 10 CFR 50.55a, "Codes and Standards," paragraph (g), "Inservice Inspection Requirements," requires that licensees implement the inservice inspection program for pressure retaining components and their integral attachments of metal containments and metallic liners of concrete containments in accordance with Subsection IWE of Section XI of the applicable edition and addenda of the ASME Code, incorporated by reference in paragraph (b) of the section and subject to the applicable conditions in paragraph (b)(2)(ix). The regulatory condition in 10 CFR 50.55a(b)(2)(ix)(A) or equivalent provision in Subsection IWE of the ASME Code (2006 and later editions and addenda only) requires that licensees shall evaluate the acceptability of inaccessible areas when conditions exist in accessible areas that could indicate the presence of or result in degradation to such inaccessible areas.

Paragraph (a)(1) of 10 CFR 54.29, "Standards for Issuance of a Renewed License," requires that applicants for a renewed license will manage the effects of aging, during the period of extended operation, on the functionality of structures and components that require review under 10 CFR 54.21(a)(1). NUREG-1801, "Generic Aging Lessons Learned (GALL) Report," recommends that the ASME Code, Section XI, Subsection IWE program, be used to manage aging of metal containments and metallic liners of concrete containments for license renewal.

DISCUSSION

The containment floor weld leak-chase channel system forms a metal-to-metal interface with the containment shell or liner, the test connection end of which is at the containment floor level. Therefore, the leak-chase system provides a pathway for potential intrusion of moisture that could cause corrosion degradation of inaccessible embedded areas of the pressure-retaining boundary of the basemat containment shell or liner within it. In addition to protecting the test connection, the cover plates and plugs and accessible components of the leak-chase system within the access box are also intended to prevent intrusion of moisture into the access box and into the inaccessible areas of the shell/liner within the leak-chase channels, thereby protecting the shell and liner from potential corrosion degradation that could affect leak-tightness.

The containment ISI program required by 10 CFR 50.55a to be implemented in accordance with Subsection IWE, of the ASME Code, Section XI, subject to regulatory conditions, requires special consideration of areas susceptible to accelerated corrosion degradation and aging, and barriers intended to prevent intrusion of moisture and water accumulation against inaccessible

areas of the containment pressure-retaining metallic shell or liner. The containment floor weld leak-chase channel system is one such area subject to accelerated degradation and aging if moisture intrusion and water accumulation is allowed on the embedded shell and liner within it. Therefore, the leak-chase channel system is subject to the inservice inspection requirements of 10 CFR 50.55a(g)(4) and aging management requirements of 10 CFR 54.29(a)(1).

This IN provides examples of operating experience at some plants of water accumulation and corrosion degradation in the leak-chase channel system that has the potential to affect the leak-tight integrity of the containment shell or liner plate. In each of the examples, the licensee had no provisions in its ISI plan to inspect any portion of the leak-chase channel system for evidence of moisture intrusion and degradation of the containment metallic shell or liner within it. Therefore, these cases involved the licensees' failure to perform required visual examinations of the containment shell or liner plate leak-chase systems in accordance with the ASME Code Section XI, Subsection IWE, as required by 10 CFR 50.55a(g)(4). The moisture intrusion and associated degradation found within leak-chase channels, if left uncorrected, could have resulted in more significant corrosion degradation of the containment shell or liner and associated seam welds. These examples and other similar previous industry operating experiences highlight the importance of licensees recognizing the existence of leak-chase channel systems in their containment floor. These experiences also highlight the importance of understanding the system configuration and how the leak-chase system components interact with the containment pressure-retaining metallic shell or liner plate within it to ensure that these systems are appropriately included for required examinations in the containment ISI program and the Subsection IWE aging management program.

For containments in which basemat shell/liner leak-chase channel systems exist with accessible interface at the containment floor level, licensees are required to comply with the containment ISI requirements of 10 CFR 50.55a(g)(4), in any one of the following ways:

1. *Perform general visual examination of 100 percent of accessible components of the leak-chase channel system during each inspection period in accordance with the ASME Code, Section XI, Subsection IWE, Table IWE-2500-1, Examination Category E-A, Item E1.30 "Moisture Barriers."*

   Note 3 for Item E1.30 under the "Parts Examined" column states: "Examination shall include moisture barrier materials intended to prevent intrusion of moisture against inaccessible areas of the pressure retaining metal containment shell or liner at concrete-to-metal interfaces and at metal-to-metal interfaces which are not seal-welded. Containment moisture barrier materials include caulking, flashing, and other sealants used for this application." Note 3 provides the definition of moisture barriers that are required to be examined in terms of intended function. The accessible leak-chase channel system components, which include the cover plates and countersunk plugs, and the access box and test connection components in it, prevent intrusion of moisture into the containment shell and liner plate and welds within it; and therefore, also function as moisture barriers under the Note 3 definition. Further, Table IWE-2500-1, second column "Examination Requirements/Fig. No." for Item E1.30, includes reference to Figure IWE-2500-1 "Examination Areas for Moisture Barriers." However, Figure IWE-2500-1 only provides an illustration of typical moisture barrier examination areas for concrete-to-metal interface moisture barriers. Figure IWE-2500-1 does not include illustration of metal-to-metal

interface moisture barriers, which are included as parts to be examined in the Note 3 definition of moisture barriers. Therefore, the NRC staff has determined that to meet the requirements of 10 CFR 50.55a(g)(4), the figure is not all-inclusive and does not provide a complete illustration of the parts required to be examined under the scope of Item E1.30 in accordance with Note 3. This may cause confusion to the user with regard to scope of moisture barriers to be examined under Item E1.30. Licensees have the option of including applicable accessible leak-chase channel system components as moisture barriers for general visual inspection subject to this provision. If such general visual examination detects evidence of degradation or presence of moisture or water in the accessible areas (e.g., coverplates, interior of the access box and the test connection) of the leak-chase system, further examination and evaluation of the containment shell and liner within it are required pursuant to Table IWE-2500-1, Examination Category E-C, Item E4.11, and the regulatory condition for inaccessible areas in 10 CFR 50.55a(b)(2)(ix)(A) (or equivalent code provision). In developing the general visual inspection plan, licensees are alerted to consider the fact that allowing moisture intrusion through the cover plates into the access boxes could result in degradation of the test connection tube and the cap or plug on it, even if the caps and plugs are seal welded, and allow moisture intrusion into the embedded containment shell or liner and welds.

2. *Perform augmented VT-1 visual examination of 100 percent of the accessible containment shell/liner and welds within the leak-chase channel in accordance with the ASME Code, Section XI, Subsection IWE, Subarticle IWE-1240 and Item E4.11 in Table IWE-2500-1, Examination Category E-C.*

   Subsection IWE, Subarticle IWE-1240 "Surface Areas Requiring Augmented Examination," paragraph IWE-1241 "Examination Surface Areas" states, in part, that:

   Surface areas subject to accelerated degradation and aging require the augmented examinations identified in Table IWE-2500-1, Examination Category E-C. Such areas include the following:

   (a) interior and exterior containment surface areas that are subject to accelerated corrosion with no or minimal corrosion allowance or areas where absence or repeated loss of protective coatings has resulted in substantial corrosion and pitting. Typical locations of such areas are those exposed to standing water, repeated wetting and drying, persistent leakage, and those with geometries that permit water accumulation, condensation, and microbiological attack. Such areas may include penetration sleeves, stiffeners, surfaces wetted during refueling, concrete-to-steel shell or liner interfaces, embedment zones, **leak-chase channels**, drain areas, or sump liners. "[emphasis added]"

   Paragraph IWE-1242 "Identification of Examination Surface Areas" states in part that: "Surface areas requiring augmented examination shall be determined in accordance with IWE-1241, and shall be identified in the Owner's Inspection Program."

   Since leak-chase channels have a configuration that could permit moisture intrusion and water accumulation into inaccessible containment shell and liner areas, and are explicitly mentioned in IWE-1241 as an example of an area subject to accelerated degradation and aging, the Owner has the responsibility to identify and consider including containment basemat leak-chase

channel systems in their containment ISI program as areas requiring augmented examination every inspection interval, in accordance with Table IWE-2500-1, Examination Category E-C, Item E4.11 "Visible Surfaces." This would involve VT-1 visual examination of the accessible areas of the embedded containment shell/liner and welds within the leak-chase channels. Remote visual examination techniques (e.g., borescope) allowed by IWA-2210 may have to be used to accomplish this examination. If the VT-1 examination determines that degradation and/or moisture are present, such conditions shall be corrected or evaluated in accordance with IWE-3520. Further, if it is determined that conditions exist in accessible areas of the leak-chase channel system that could indicate the presence of, or result in, degradation in inaccessible areas, the regulatory condition in 10 CFR 50.55a(b)(2)(ix)(A) (or equivalent code provision) requires that an engineering evaluation shall be performed to determine the acceptability of the inaccessible area. Such an evaluation may include performing a leak test by pressurization of the affected leak-chase zone to demonstrate leak-tight integrity of the affected area.

3. *Perform inservice inspection of leak-chase channel system using licensee-proposed alternatives to code requirements under 10 CFR 50.55a(a)(3).*

The leak-chase channel system may be examined or inspected using licensee-proposed alternatives to the ASME Code requirements in 1 and 2 above. The proposed alternatives must be submitted to and authorized before implementation by the Director, Office of Nuclear Reactor Regulation (NRR), NRC, under 10 CFR 50.55a(a)(3).

CONTACT

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

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ADAMS Accession No.: ML14070A114 *concurred via email **TAC MF3399**

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