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

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NRC INFORMATION NOTICE 2012-05: ABNORMAL RELEASES OF RADIOACTIVE MATERIAL IN LIQUIDS POTENTIALLY RESULTING IN GROUNDWATER CONTAMINATION

ADDRESSEES

All holders of an operating license or construction permit for a nuclear power reactor or a non-power (research or test) reactor 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 and have spent fuel in storage in the spent fuel pool. All Agreement State Radiation Control Program Directors and State Liaison Officers.

PURPOSE

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice (IN) to inform addressees of the sources and causes of recent abnormal, unmonitored releases of radioactive materials in liquids to the ground that could potentially migrate to groundwater. The IN summarizes some examples of recent abnormal releases, and identifies those plant systems and causes most frequently associated with these abnormal releases. Industry programs are providing more active management of situations to minimize unplanned releases. NRC staff plans to continue to assess the effectiveness of the programs through the Reactor Oversight Process. Licensees are reminded to remain vigilant and maintain their operations and designs consistent with their licensing basis to minimize unplanned releases. 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.

BACKGROUND

Nuclear power plants and non-power reactors routinely and safely discharge liquids that have dilute concentrations of radioactive materials. Licensees monitor these authorized discharges and report them to the NRC. Power reactors submit annual effluent reports that are posted on the NRC's Web site at: http://www.nrc.gov/reactors/operating/ops-experience/tritium/plant-info.html.

However, as with any industrial facility, a nuclear power plant or non-power reactor may deviate from normal operation with an abnormal release (e.g., leaks and spills) of radioactive material in liquids (e.g., tritium in water) to the on-site environment. Abnormal liquid releases onto the

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ground surface can be absorbed into the subsurface and reach the local water table, depending on the local subsurface characteristics, soil properties, and associated liquid flux of the release. The dispersion of the leaked or spilled water depends on the local subsurface geology and hydrogeologic characteristics. Contaminants such as tritium will be transported in the subsurface as a function of groundwater flow processes and conditions (e.g., hydraulic gradients, permeability, porosity, and geochemical processes) and may eventually be discharged to the unrestricted area.

Nuclear power plants use site conceptual models based on hydrogeological models and data from on-site ground water monitoring wells to predict the subsurface water flow to include the flow direction and flow rate to be used as the monitoring basis for estimating the amount of radioactive material discharged into the unrestricted area. Because of the low concentrations of radioactive material in liquids, non-power reactors generally do not have water monitoring wells or site conceptual models.

If an abnormal, unmonitored release occurs at a nuclear power plant, the NRC resident inspector and regional specialists assess the licensee's response to ensure that NRC requirements are met. Nuclear power plant licensees submit reports of abnormal, unmonitored releases in the annual radioactive effluent reports as described above. For abnormal releases, the reports provide information such as the date and duration, location, volume, estimated activity of each radionuclide, effluent monitoring results, on-site monitoring results, depth to the local water table, classification(s) of subsurface aquifer(s), size and extent of any ground water plume, expected movement/mobility of any ground water plume, land use characteristics (e.g., water used for irrigation), remedial actions considered or taken and results obtained, calculated dose to a member of the public that is attributable to the discharge, and actions taken to prevent recurrence.

For non-power reactors, NRC inspectors from the Research and Test Reactors Oversight Branch would assess the licensee's response to an abnormal unmonitored release. Non-power reactors submit information on normal releases to the environment in their annual reports to NRC. Abnormal, unmonitored releases are normally reported to the NRC as events in accordance with the facility technical specifications.

NRC Regulatory Guide 1.21, Rev. 2, "Measuring, Evaluating, and Reporting Radioactive Material in Liquid And Gaseous Effluents and Solid Waste," issued in June 2009, and NRC Regulatory Guide 4.1, Rev. 2, issued in June 2009, "Radiological Environmental Monitoring for Nuclear Power Plants," provides additional information and are available on the NRC's public Web site (Agencywide Documents Access and Management System (ADAMS) Accession Nos. ML091170109 and ML091310141, respectively).

Related NRC Requirements

NRC requirements related to radioactive liquid effluents include:

- 10 CFR 20.1301(a)(1) requires each licensee to conduct operations so that the total effective dose equivalent to individual members of the public from the licensed operation does not exceed 100 millirems (1 millisievert) in a year.

- 10 CFR 20.1302, "Compliance with Dose Limits for Individual Members of the Public," requires licensees to perform appropriate surveys in unrestricted and controlled areas to demonstrate compliance with dose limits for individual members of the public.

- 10 CFR 20.1406, "Minimization of Contamination," was amended in 2011 to add paragraph (c) [Effective date: December 17, 2012], which requires licensees, to the extent practical, to conduct operations to minimize the introduction of residual radioactivity into the site, including the subsurface.

- 10 CFR 20.1501, "General," requires licensees, in part, to conduct surveys that may be necessary to comply with 10 CFR Part 20, "Standards for Protection Against Radiation," and are reasonable under the circumstances to evaluate the magnitude and extent of radiation levels, the concentrations or quantities of radioactive material, and the potential radiological hazards.

- 10 CFR Part 50, Appendix I, "Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion 'As Low as is Reasonably Achievable' for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents," establishes design objectives for equipment installed to maintain control over radioactive liquid effluents. One design objective is that the calculated annual total quantity of all radioactive material above background discharged to unrestricted areas will not result in an estimated annual dose or dose commitment from liquid effluents in excess of 3 millirems to the total body or 10 millirems to any organ. [Appendix I to 10 CFR Part 50 is not applicable to non-power reactors.]

- Criterion 64, "Monitoring Radioactivity Releases," of Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50 requires, in part, a means for monitoring effluent discharge paths and the plant environs for radioactivity that may be released from normal operations. NRC Regulatory Issue Summary 2002-02, "Lessons Learned Related to Recently Submitted Decommissioning Plans and License Termination Plans," dated January 16, 2002, provides additional information (ADAMS Accession No. ML013510432). [Criterion 64 of Appendix A to 10 CFR Part 50 is not applicable to non-power reactors.]

- 10 CFR 50.75(g)(1) requires, in part, that each licensee keep a record of spills or other unusual occurrences involving the spread of contamination in and around the facility or site. These records must include any known information on identification of involved nuclides, quantities, forms, and concentrations. (Note: Such documentation in a decommissioning record file is important to provide a database for site characterization during decommissioning and for providing support for public and worker dose assessments. NUREG-1757, "Consolidated NMSS (Office of Nuclear Material Safety and Safeguards) Decommissioning Guidance," issued September 2003, provides guidance on decommissioning recordkeeping (ADAMS Accession No. ML032530410).

- 10 CFR 50.72, "Immediate Notification Requirements for Operating Nuclear Power Reactors," requires a 4 hour report to the NRC Operations Center when any event or situation occurs related to protection of the environment for which a news release or notification to other government agencies has been or will be made. [10 CFR 50.72 is not applicable to non-power reactors.]

Related NRC Generic Communications

- NRC IN 2006-13, "Ground-Water Contamination Due to Undetected Leakage of Radioactive Water," dated July 10, 2006 (ADAMS Accession No. ML060540038)

- NRC IN 2004-05, "Spent Fuel Pool Leakage to Onsite Ground Water," dated March 3, 2004 (ADAMS Accession No. ML040580454)

- NRC RIS 2008-03, "Return/Re-use of Previously Discharged Radioactive Effluents," dated February 13, 2008 (ADAMS Accession No. ML072120368)

DESCRIPTION OF CIRCUMSTANCES

For each of the following circumstances, the NRC reviewed the licensee's corrective actions for the abnormal releases and verified licensee analyses showing that no public dose limits or license conditions that limit radioactive material releases have been, or are expected to be, exceeded.

Oyster Creek Nuclear Generating Station

On August 25, 2009, while excavating a buried aluminum condensate transfer pipe to determine if it was leaking tritiated water into the soil, the licensee at Oyster Creek Nuclear Generating Station discovered a condensate leak of 8 gallons to 12 gallons per minute with a tritium concentration of approximately 10 million picocuries per liter. The licensee replaced the condensate transfer piping that was leaking. This event is described in Oyster Creek Generating Station—NRC Integrated Inspection Report 05000219/2009005, dated January 26, 2010 (ADAMS Accession No. ML100260020).

Dresden Nuclear Power Station

The licensee for Dresden Nuclear Power Station collected samples from June 2–6, 2009, and identified tritium concentrations of 3.2 million picocuries per liter from an onsite groundwater testing well. The licensee found that two underground condensate transfer pipes were leaking water containing tritium. The leak was stopped when the leaking pipe was isolated and drained. This event is described in Dresden Nuclear Power Station, Units 2 and 3 Integrated Inspection Report 05000237/2009-004; 05000249/2009-004, dated November 6, 2009 (ADAMS Accession No. ML093100592).

Edwin I. Hatch Nuclear Plant

On September 28, 2011, the results of the groundwater samples taken from two onsite monitoring wells indicated that there were elevated levels of tritium in the vicinity of the Unit 1 condensate storage tank. It was determined that the initial concentration of tritium was 5.34 million picocuries per liter and is confined to the condensate storage tank area. Currently, there is no evidence that the tritium has migrated outside of the area of the two sample points. The source of the tritium was identified as a condensate transfer line and use of the transfer piping was immediately terminated. No radionuclides other than tritium were detected in the groundwater samples. The affected groundwater is located in an isolated perched aquifer that is not utilized for drinking water, and does not have the potential to be used for drinking water.

Tritium concentrations have decreased since discovery as a result of eliminating the source of tritium and by extracting water from the monitoring wells.

This event is discussed in Edwin I. Hatch Nuclear Plant—NRC Integrated Inspection Report 05000321/2011004 and 05000366/2011004, dated October 28, 2011 (ADAMS Accession No. ML113010464).

LaSalle County Station

On July 1, 2010, NRC resident inspectors were informed of elevated levels of tritium around the two condensate storage tanks. Samples were taken from an onsite monitoring well adjacent to the Unit 1 tank and it was determined that the tritium concentration was 700,000 picocuries per liter. Upon inspection, the licensee identified leakage through three small holes on the bottom of the Unit 1 condensate storage tank. The leak has since been repaired. Currently, there is no evidence that the contamination has extended into the unrestricted areas.

This event is discussed in Preliminary Notification of Event or Unusual Occurrence—PNO-III-10-012A, dated July 22, 2010 (ADAMS Accession No. ML102030561).

Vermont Yankee

On January 7, 2010, the results of groundwater samples taken from an onsite groundwater monitoring well indicated tritium contamination. The licensee determined that a pair of drain pipes in the advanced off-gas pipe tunnel had corroded and were leaking nuclear plant steam, which contains tritium. In addition, the licensee found that the floor drain of the concrete tunnel was blocked with construction waste, dirt, and mud which resulted in condensate from the steam leak to collect inside the tunnel and leak out at a failed concrete joint and into the ground. The licensee terminated the leak of tritiated water from the underground pipe tunnel and cleaned the debris from the advanced off-gas pipe trench.

This event is discussed in Vermont Yankee Nuclear Power Station—Ground Water Monitoring Inspection Report 05000271/2010006, dated May 20, 2010 (ADAMS Accession No. ML101400040).

DISCUSSION

Leakage of structures, systems, and components (SSCs) that contain and transport radioactive fluids can cause groundwater contamination. The detection of groundwater contamination may be an early indicator of SSC degradation.

There are several causes for leaks and spills from various facility SSCs. The below table summarizes some sources and causes of abnormal releases.

Sources and Causes of Abnormal Releases

Sources	Causes
Spent fuel pool, reactor cavity, refueling canal	Liner leakage, no liner, clogged leak detection drainage systems, overflow, incorrect valve alignments, expansion bellows failure, seal failure, spent fuel pool cooling pump leak
Outside storage tanks (e.g., condensate storage tank, refueling water storage tank, primary water storage tank)	Aluminum pipe failures (poor coatings, improper materials selection), overflow (poor work practices or procedures), evaporation and condensation from vent lines
Circulating water conduit, liquid waste discharge line, steam generator blowdown line	Degradation, poor design, vacuum breaker valve leakage, steam generator blowdown piping failure
Pits, sumps (including turbine building sump), vaults, basins, cooling tower basins, trenches, floor drains, etc.	No liner, no leak detection system, clogged drains, no drains, poor work practices; some of these events are design discharge paths, hose breaks, inappropriate release paths, radwaste tank overfill, or cooling tower overflow that contacted contaminated equipment
Engineered ponds or ditches on site property	No liner, clay liner, liner failure, poor or inappropriate work practices, poor design, lack of strategic planning, sometimes associated with primary-to-secondary leakage
Normally clean system leakage, auxiliary boiler, demineralized water storage tank (DWST)	Contamination control practices, worker practices, maintenance evolutions, cross-contaminated DWST (work practices and procedures), pipe failure

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 Office of Nuclear Reactor Regulation (NRR) project manager.

/RA/

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

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