Release

Tritium Issues

An overview of the Tritium events that the NRC is following at several nuclear power plants.

NRR Doc,

Regulatory References

The principal regulatory basis for requiring environmental monitoring and effluent monitoring at nuclear power plants is contained in General Design Criteria 60, 61, and 64 of Appendix A of Title 10 of the Code of Federal Regulations Part 50. The criteria require that a licensee control, monitor, perform radiological evaluations of all releases, document and report all radiological effluents discharged into the environment.

We also have specific criteria that requires power reactor licensees to keep the public dose from radioactive effluents as low as it reasonably achievable (ALARA). The ALARA criteria is contained in Appendix I of 10 CFR Part 50. This criteria is very clear what the NRC expects of power reactors concerning their effluent discharges.

"The licensee shall establish an appropriate surveillance and monitoring program to:
1. Provide data on quantities of radioactive material released in liquid and gaseous effluents...;

2. Provide data on measurable levels of radiation and radioactive materials in the environment to evaluate the relationship between quantities of radioactive material released in effluents and resultant radiation doses to individuals from principal pathways of exposure; and 3. Identify changes in the use of unrestricted areas (e.g., for agricultural purposes) to permit modifications in monitoring programs for evaluating doses to individuals from principal pathways of exposure."

Specific regulations and regulatory guidance

- 10 CFR 50.34a, Design objectives for equipment to control releases of radioactive material in effluents - nuclear power reactors.
- 10 CFR 50.36a, Technical specifications on effluents from nuclear power reactors.
- 10 CFR Part 20, Standards for Protection Against Radiation.
- 10 CFR 50.72, Immediate notification requirements for operating nuclear power reactors.
- 10 CFR 50.73, Licensee event report system.
- 10 CFR 50.75(g), Reporting and recordkeeping for decommissioning planning.
- 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. (40 FR 19437 as an effective rule on May 5, 1975)
- Regulatory Guide 1.109, Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I (Rev. 1, 10/75).
- Regulatory Guide 4.1, Programs for Monitoring Radioactivity in the Environs of Nuclear Power Plants. (1/73)
- Regulatory Guide 4.2, Preparation of Environmental Reports for Nuclear Power

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Stations. (Rev. 2, 7/76)

- Regulatory Guide 4.8, Environmental Technical Specifications for Nuclear Power Plants (12/75) and Branch Technical Position (Rev. 1, 11/79; specific to environmental monitoring program).
- Regulatory Guide 4.15, Quality Assurance for Radiological Monitoring Program (Normal Operation) - Effluent Streams and the Environment.
- Regulatory Guide 1.21, Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants. (Rev. 1, 6/74)
- Regulatory Guide 1.143, Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Power Plants. (Rev. 1, 10/79)
- NUREG-0472, Radiological Effluent Technical Specifications for PWRs. (2/80)
- NUREG-0473, Radiological Effluent Technical Specifications for BWRs. (7/79)
- 10 CFR Part 50, Appendix A; Design Criteria 60, Control of Releases of Radioactive Materials to the Environment.
- 10 CFR Part 50, Appendix A; Design Criteria 61, Fuel storage and handling and radioactivity control.
- 10 CFR Part 50, Appendix A; Design Criteria 64, Monitoring Radioactivity Releases.
- 40 CFR Part 190, Environmental Radiation Protection Standards for Nuclear Power Operations. (1/77)

NRC Dose Limits from Radioactive Effluents

The requirements in 10 CFR Part 20 state that each licensee shall conduct operations so that the total effective dose equivalent to individual members of the public from the licensed operations does not exceed 0.1 rem in a year, which the licensee can demonstrate by not exceeding the concentration values specified in table 2 of Appendix B to 10 CFR Part 20 when averaged over the course of a year. For tritium, the table 2 concentration value is $1x10^{-3}$ micocuries per milliliter ($1x10^{6}$ picocuries per liter).

Furthermore, 10 CFR Part 20 requires that licensees comply with EPA's environmental radiation standards contained in 40 CFR Part 190, i.e., 25 millirems to the whole body, 75 millirems to the thyroid, and 25 millirems to any other organ of any member of the public from the uranium fuel cycle.

The NRC also has design objectives in Appendix I to 10 CFR Part 50 to meet the criterion of As-Low-As-Reasonably-Achievable (ALARA) for reactor effluents. The design objectives for liquid effluent releases is to maintain offsite annual doses below 3 millirem to the whole body and 10 millirem to any organ. If half of those radiation dose levels are exceeded in any calendar quarter, licensees are to investigate the cause(s), initiate a corrective action program, and report the actions within 30 days from the end of the quarter to the NRC.

EPA drinking water limit

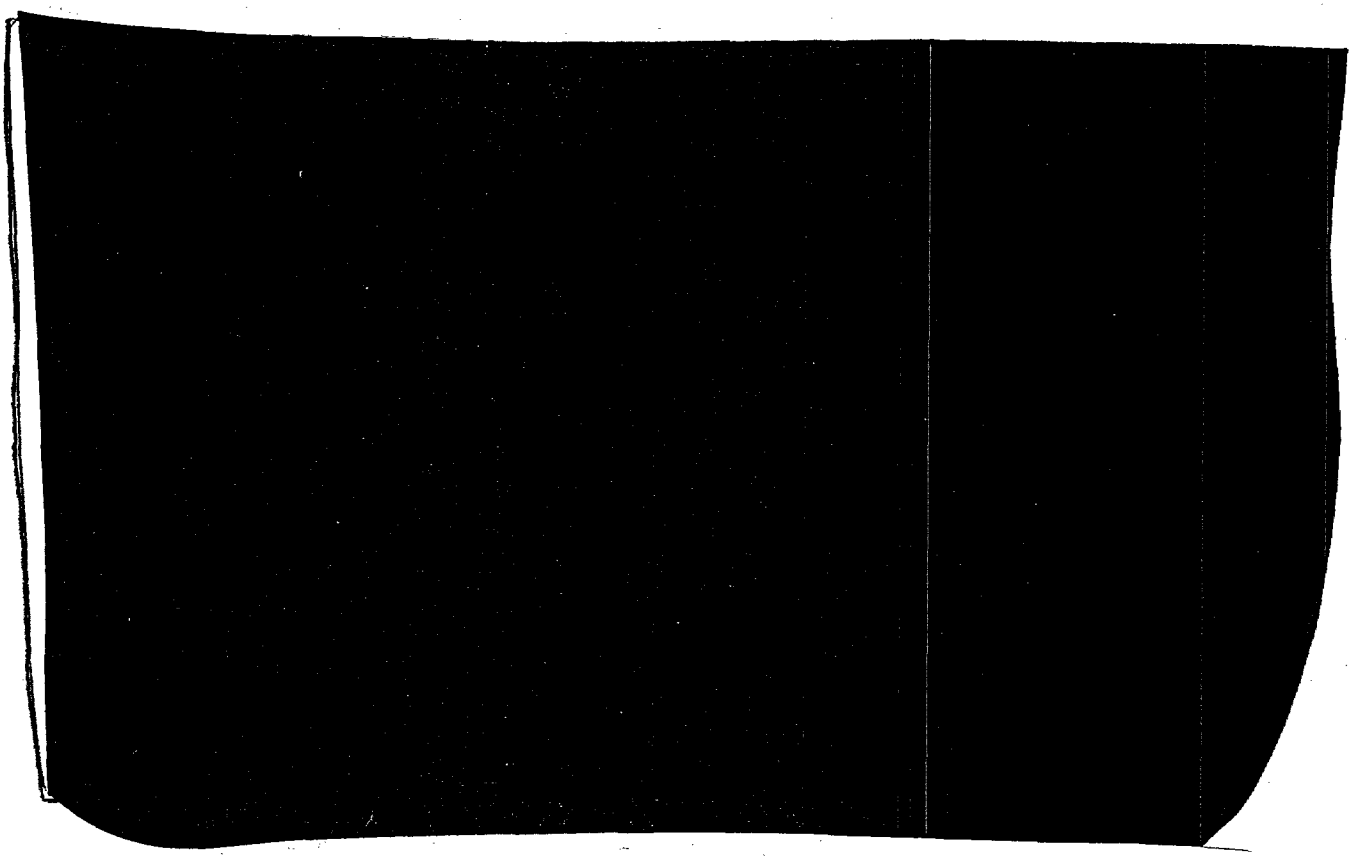
The EPA has a maximum contamination level (MCL) of 4 millirem per year for beta particle and photon radioactivity from man-made radionuclides in drinking water. If contamination is exclusively tritium, this EPA drinking water standard corresponds to a concentration of 20,000 picocuries per liter of tritium, which is based on an annual dose of 4 millirem.

Sources of Tritium at Nuclear Power Plants

Basically any system containing liquids which originated or have a connection with reactor coolant have the potential to contain tritium. Examples; spent fuel pool, liquid radwaste storage tanks, refueling water storage tanks, condensate storage tank, turbine sumps and steam generator blowdown lines.

Potential Pathways of Unexpected Leakage

Since tritium is water, it will flow in a down gradient manner into an aquifer, river, lake, or ocean.



Radioactive Waste Treatment Systems

- Tritium, because it is water is not able to easily be selectively removed from the radioactive waste stream like the other particulate radionuclides like Cesium, Cobalt, and Strontium. The particulate radionucles are removed by specialized systems which use filters, resins, or chemical ion exchange processes. The radionuclides and filter media are then solidified and sent to a licensed low level waste facility for burial. Tritium on the other hand is contained in large storage tanks and held until it is released in a controlled and monitored manner with large quantities of dilution water into the environment. Typical routine releases can be on the order of tens to hundreds of curies.

- The NRC is aware that there are specialized processes which can remove tritium from

the waste stream. However these systems are extremely complex and very expensive.

Regulatory Event Reporting Bases:

Title 10 of the Code of Federal Regulations (CFR) Part 20, "Standards for Protection Against Radiation," provide many of the reporting and notification requirements for radiological issues. These requirements are contained in Subpart M, "Reports," which provides the reports of most radiological issues that NRC licensees are required to make to the NRC. Title 10 CFR Part 50 in 50.72, "Immediate Notification Requirements for Operating Nuclear Power Plants," and 50.73, "Licensee Event Reporting System," provide emergency notification requirements and those for reporting events that relate primarily to reactor operating conditions.

While the regulations in 10 CFR Part 20 include NRC notification requirements for releases of radioactive material above prescribed limits and for radiation doses to the public in excess of specified limits, the tritium leakage that occurred at the Braidwood Station is not reportable to the NRC because none of the reporting thresholds were met. The licensee is required by their operating license to implement a program for radioactive effluent controls and for monitoring the potential impact of radioactive effluents on the environment through a radiological environmental monitoring program (REMP). The

REMP requires sampling of various environmental pathways including waterborne pathways at required intervals, which are to be analyzed for the presence of specified radiological constituents. Reporting levels for radioactivity concentrations in environmental samples are specified in the REMP and include reporting levels for tritium in water.

Should the "reporting levels" specified in the REMP be exceeded, the licensee would be required to prepare and submit a report to the NRC that identifies the problem and defines its corrective actions. The problem would also be required to be reported to the NRC in the licensee's Annual Radiological Environmental Operating Report. The reporting level for tritium required by the REMP was not exceeded for this Braidwood leak.

There are no NRC requirements for licensees to directly inform the public of leaks or to inform the public of other radiological issues that may not otherwise be reportable to the NRC under 10 CFR Part 20 or Part 50. However, should licensees make required reports to the NRC, such reports are made available to the public (absent safeguards information) on the NRC's external web site.

[redacted] Outside scope

Plant Specific Information

Braidwood

- The tritium originated from leakage from a discharge pipe which returns non-radioactive water to the Kankakee River. This pipe is also used as the routine discharge point for radiological liquid effluents. Such releases are allowed by our regulations within prescribed limits. (10E6 pCi/L per 10 CFR 50, Appendix - up to 10E7 for individual releases - annual release below a dose limit of 100 mrem to any member of the public - with design to ALARA provision of 3 mrem)
- The tritium leakage offsite appears to be related to historical leaks from valves in the discharge pipe - primarily in 1998 to 2000 time frame, although additional leaks going back to 1996 have been identified. (11 valves total - provide relief capability in the event that the flow in the pipe in disrupted)
- Although tritium has migrated offsite in areas not planned, based on current assessment results the levels do not appear to have an adverse impact on public health.
- Since identifying the migration, the licensee has taken a number of actions:
  - Suspended all radioactive liquid effluent releases as of November 23, 2005, which has been confirmed in a letter to the NRC and acknowledged with an additional commitment to inform us of any disposition of the stored water onsite.
  - Implemented efforts to characterize the full extent of the release
  - Conducted state, local and public outreach and coordination activities (conducted 3 meetings with local residents - interfaced with IEPA on enforcement and remediation actions)
- Licensee has installed more than 140 wells to characterize the release. The primary offiste impact area extends approximately 2500 feet northeast of the site boundary.
  - Three other offsite areas have been identified with tritium levels above background levels - all to the north along the discharge line.
  - One at the Braidwood Dunes forest preserve (approximately 30,000 pCi/L- Vacuum Breaker 4)
  - One at the one of the values on the discharge line about 2 miles from the river (approximately 3000 pCi/l - Vacuum Breaker 7)
  - One approximately 30 feet west Vacuum Breaker 6 (approximately 2000 pCi/l)
  - Additional well installation is planned in this area to characterize any further migration
  - Two additional small areas are being evaluated onsite - one near the first valve in the discharge line (approx. 23,000 pCi/l) and one very close in the plant on the west side of the turbine building (600 pCi/l).

- Licensee has sampled a number of residential wells in and around the affected area (47 of 49 requested) - one has been identified with tritium above background - at approximately 1/10 of the EPA drinking water standard of 20,000 pCi/l.
- Exelon is finalizing their site characterization and has completed their root cause analysis cause.
- NRC has been fully engaged in the licensee's activities since November 2005 when we became aware of the potential for offsite migration.
- Immediate response by our resident inspection staff who monitors day-to-day activities of the licensee
- Immediately dispatched a senior radiation specialist to assist the resident in his follow-up.
- Our response efforts have primarily focused on the licensee's characterization efforts and understanding corrective actions prior to any further release of liquid effluents
- We have performed independent analysis of residential wells and selected on and offsite wells. Our data has been consistent with the licensee's results.
- Ongoing onsite inspection targeted for exit on March 6, 2006. (Based on our early assessments - the material put into the pipe met regulatory requirements - however, it clearly was not released in the method planned and prior leaks were not adequately characterized.)
- NRC Region IIIalso observed the meetings between Exelon and local residents and participated in a village meeting in Godley.

[redacted]

OUTSIDE SCOPE OF REQUEST

[redacted]

- NRR is preparing a revision to the ROP Baseline Inspection Program to emphasize the agency's review of licensee identification and evaluation of spills and leaks of contaminated liquids for radiological impact to the public and environment. Expect to issue revised inspection procedure for use in April 2006.
- NRR HP staff have posted a Tritium Webpage on the NRC public website. This site will be routinely updated with new information about events the NRC is working on.
- A lessons-learned task force was formed to evaluate the tritium issues with the first meeting held on March 2, 2006. The task force is comprised of several NRR technical branches, Regions, NMSS, and RES.

TRITIUM FACTS

Where does tritium come from?

Tritium is produced naturally in the upper atmosphere when cosmic rays strike air molecules. Tritium is also produced during nuclear weapons explosions, as a byproduct in reactors producing electricity, and in special production reactors, where the isotope lithium-6 is bombarded to produce tritium.

What are the properties of tritium?

Tritium is a hydrogen atom that has 2 neutrons in the nucleus, in addition to its single proton, giving it an atomic weight near 3. Although tritium can be a gas, its most common form is in water, because, like non-radioactive hydrogen, radioactive tritium reacts with oxygen to form water. Tritium replaces one of the stable hydrogens in the water molecule, H_2O, and is called tritiated water. Like H_2O, tritiated water is colorless and odorless. Tritium has a half-life of 12.3 years and emits a very weak beta particle.

What is tritium used for?

Tritium is also produced commercially in reactors. It is used in various self-luminescent devices, such as exit signs in buildings, aircraft dials, gauges, luminous paints, and wristwatches. Tritium

is also used in life science research, and in studies investigating the safety of potential new drugs.

How does tritium get into the environment?

Tritium occurs naturally in the environment in very low concentrations. Most tritium in the environment is in the form of tritiated water, which easily disburses in the atmosphere, water bodies, soil, and rock.

In the mid-1950s and early 1960s, tritium was widely dispersed during the above-ground testing of nuclear weapons. The quantity of tritium in the atmosphere from weapons testing peaked in 1963 and has been decreasing ever since.

Today, sources of tritium include commercial nuclear reactors and research reactors, and government weapons production plants. Tritium may be released as steam from these facilities or may leak into the underlying soil and ground water. However, such releases are usually small and are required to meet federal environmental standards.

How does tritium change in the environment?

Tritium readily forms water when exposed to oxygen. As it undergoes radioactive decay, tritium emits a very weak beta particle and transforms to stable, nonradioactive helium. Tritium has a half-life of 12.3 years.

How do people come in contact with tritium?

People are exposed to small amounts of tritium every day, since it is widely dispersed in the environment and in the food chain. People who live near or work in federal weapons facilities or nuclear fuel cycle facilities may have increased exposure. People working in research laboratories may also come in contact with tritium.

How does tritium get into the body?

Tritium primarily enters the body when people swallow tritiated water. People may also inhale tritium as a gas in the air, and absorb it through their skin.

What does tritium do once it gets into the body?

Tritium is almost always found as water, or "tritiated" water. Once tritium enters the body, it disperses quickly and is uniformly distributed throughout the body. Tritium is excreted through the urine within a month or so after ingestion. Organically bound tritium (tritium that is incorporated in organic compounds) can remain in the body for a longer period.

How does tritium affect people's health?

As with all ionizing radiation, exposure to tritium increases the risk of developing cancer. However, tritium is one of the least dangerous radionuclides because it emits very weak radiation and leaves the body relatively quickly. Since tritium is almost always found as water, it goes directly into soft tissues and organs. The associated dose to these tissues are generally uniform and dependent on the tissues' water content.

Is there a medical test to determine exposure to tritium?

Urinalysis is the easiest bioassay method for determining exposure to tritium. Liquid scintillation counting is a quick and relatively inexpensive method for assessing the concentration of tritium in urine. Because tritium is found naturally in most water supplies at very low concentrations, levels in drinking water would be measured to determine whether the tritium levels exceed the levels present in the body.

OUTSIDE SCOPE OF REQUEST

Enclosure 2

What can I do to protect myself and my family from tritium?

Everyone is exposed to tiny amounts of tritium, much of it produced naturally. If you live near, or work at, a nuclear research facility, a commercial reactor, or a government weapons facility, you should be aware that your tritium exposure may be elevated. Also, be careful not to break open an exit sign, or other device that may contain tritium as an illuminating agent.

EPA Standard on tritium

EPA has established a standard of 20,000 pico Curies per liter, for the maximum amount of tritium that may be found in drinking water. In addition, before being approved for public use, sites previously contaminated with tritium must meet EPA's risk-based criteria for soil and ground water. These criteria set a person's increased risk of developing cancer from exposure to tritium at a cleaned-up site as being no more than a 1-in-10,000 to a 1-in-1,000,000 chance.

Braidwood Station, Units 1 and 2, Tritium Contamination in Groundwater
QUESTIONS AND ANSWERS

1. What is the NRC doing in response to the tritium contamination?

NRC Region III initially dispatched a Senior Radiation Specialist to the site to assist the Resident Inspectors in their review of the circumstances surrounding the elevated measurements and the licensee's plans to address the elevated tritium levels. Onsite inspection efforts are continuing relative to the licensee's current and historical actions.

In the vicinity of the onsite monitoring wells where elevated tritium levels have been measured, there are three homes and a larger parcel of vacant land with undeveloped lots. The licensee believes the movement of the groundwater is away from the homes and toward the vacant property. The licensee has contacted the homeowners and collected well water samples that were analyzed by an independent laboratory. The licensee is also drilling monitoring wells on the vacant site.

NRC Region III has contracted with its vendor to perform split sample laboratory analyses of the water samples, to independently validate the licensee contractors' laboratory sample results.

NRC Region III continues to monitor and review licensee investigation and response to the elevated tritium samples.

2. What is the health hazard to the public? Potential dose?

Initial on site shallow well samples indicate concentrations of tritium at a small fraction of the NRC limits for radioactive liquid effluent releases to the environment. Initial data provided by the licensee indicates background levels of tritium in near site residence wells, with the exception of one well. That excepted well is relatively shallow (less than 30 feet) and tritium concentrations measure approximately 1500-2000 picocuries/liter. The tritium concentration present in that shallow well is approximately 10 percent of the EPA drinking water standard of 20,000 picocuries/liter. Twelve residential wells have been tested.

The licensee is evaluating the potential dose to members of the public from the tritium in the ground water. When that evaluation is completed, the NRC will review it to determine if it is adequate. However, based on the levels of tritium detected in the groundwater to

date, it does not appear that any NRC limits will be exceeded.

3. Is the leak continuing? Is there anything that can be done to stop the contamination from moving offsite?

There is no indication of continuing leakage. Some sample data indicates off-site migration north of the licensee's restricted area (owner controlled area). The licensee's tentative plans include installing four (4) remediation wells to remove sources of contamination. The licensee has hired hydrologists and geologists to assess the situation. Additional actions are also ongoing to ensure that the source is not an active leak.

4. How did the tritium get into the groundwater?

The licensee attributes the tritium in the groundwater to past leakage from a discharge pipe which normally carries non-radioactive circulating water discharge to the Kankakee River. The discharge pipe is also used for planned liquid radioactive effluent releases with the effluent mixing with the circulating water being discharged. Braidwood, like most nuclear plants, release small concentrations of radioactive liquids under controlled and monitored conditions and within limits imposed by the NRC. Planned radioactive liquid effluent releases were made at the times when the circulating water discharge piping was subsequently found to be leaking, which accounts for the presence of tritium in the ground. As with any liquid introduced into the ground, the substance flows in a direction consistent with the hydrologic characteristics of the area and ultimately into the groundwater aquifer.

5. Is the State of Illinois involved in responding to the situation?

The licensee has notified local officials and the State of Illinois of the elevated tritium measurements. A State of Illinois inspector accompanied the dispatched NRC Region III Senior Radiation Specialist/Resident.

6. Was this reported to the NRC in 1998 and 2000? What was the NRC response? Didn't anyone realize that the water would eventually go offsite?

Resident and regional office staff were informed of the leakage and the licensee' sample analyses. That information was reviewed as part of the NRC's baseline inspection program. No formal reports were made or required to be made to the NRC

7. Is the water safe to drink?

Although one residential well has been identified with tritium above background levels, the levels are significantly lower than the EPA drinking water standard. Consequently, offsite drinking water sources are not contaminated with tritium to levels that would pose a health hazard.

8. Is the water being tested for other contaminants?

The licensee's sampling and analysis is limited to radioactive contaminants. Groundwater samples collected by the licensee and split with the NRC are being analyzed for tritium and, in some cases, gross gamma activity.

9. What's being done to keep this from happening again?

The licensee is in the process of investigating this event to determine cause. Once this investigation is complete, the licensee will develop and implement corrective actions. The NRC is in the process of reviewing and evaluating the adequacy of the licensee's investigation, and will monitor the effectiveness of the corrective actions.

10. Is there a potential for other leaks? Is the pipe being inspected (and vacuum

breakers being checked)?

The extent of condition of this event is included within the scope of the licensee's investigation. The NRC continues to review and evaluate the adequacy of the licensee's investigation.

Exemption 5

[redacted]

12. Is the tritium offsite? Bounded?

The licensee has measured tritium (about 2400 picocuries per liter) in an offsite pond on a vacant parcel of land and up to 226,000 picocuries per liter in a monitoring well between the pond and the site boundary. The licensee is currently developing an analysis to bound the offsite dose from the migration of the contamination. At the same time, the licensee is implementing plans to remediate some of the groundwater contamination.

Exemption 5

[redacted]

16. This level of tritium, if released from the site, would be a small fraction of NRC liquid release limits for radioactive effluent releases to the environment. How does the licensee know that this is the only leak?

The licensee's ground water monitoring results indicate that the leak was likely caused by the 1998 and 2000 vacuum breaker valve leakage. Those monitoring results combined with the licensee's direct inspection activities have demonstrated that the leakage has been isolated. However, the licensee continues its efforts to assure that an active leak does not exist and to assure the integrity of the blowdown line.

17. Have there been other Tritium releases from nuclear power plants into the public

domain within the last year?

We conducted a poll of the four NRC Regions and Headquarters staff and data files for any historical knowledge on abnormal tritium release and the answer is no. There have been no unplanned, unmonitored, abnormal discharges of tritium into the public domain via the groundwater pathway. Although, recent data indicates that Indian Point is discharging tritium into the Hudson river, but at levels below our detection sensitivity. However, the river is not a source of drinking water.

However, there are routine, planned, controlled, and monitored discharges of radioactive gaseous and liquid discharges, which included tritium, into the public domain from all operating nuclear plants (i.e., power and research non-power reactors). These routine discharges are in accordance with NRC regulations. The NRC routinely inspects licensees radioactive effluent release and environmental monitoring programs for compliance with regulatory requirements and safety limits. While there have been no other abnormal events in which tritium reached the public domain, there have been several events at nuclear power reactors in which there have been spills, leaks, or other unusual occurrences where tritium has been discharged onto the licensee's plant site, which did not migrate into the public domain.

18. The State of Illinois has issued a violation to Braidwood. What is the NRC's view or role associated with the state's enforcement action?

The NRC is aware that the State of Illinois issued a violation to Braidwood concerning tritium. NRC and the state have independent regulatory authorities; however, we are in communications with one another on our actions. The licensee is developing remediation plans that will be submitted to the Illinois EPA in response to the NOV. The NRC will review the remediation plans during an upcoming inspection.
Braidwood Nuclear Plant, Units 1 and 2, Tritium Contamination in Groundwater
Regulatory Basis and Requirements for Effluent Releases from Nuclear Power Plants

OUTSIDE SCOPE

[redacted]

NRR Release

Radiological Impacts of Routine Reactor Operation - Details

Radiological Gaseous and Liquid Effluents

The discharge of radioactive effluents from reactor operations can have environmental impacts--on man, animals, plants, and sea life. During the licensing of a plant, NRC issues a Final Environmental Statement which identifies these potential impacts. As part of NRC's requirements for a license, licensees must:

(1) keep releases of radioactive material to unrestricted areas during normal operation ALARA. Typically 1 mrem (0.01 mSv) per year.

(2) comply with radiation dose limits for the public in 10 CFR Part 20, Standards for Protection against Radiation [100 mrem (1.0 mSv)].

Monitoring Environmental Impacts

The NRC requires licensees to report the types and total amount of gaseous and liquid effluents released and the results of environmental monitoring around their plants to ensure that potential impacts are detected and reviewed.

The environmental reports cover sampling from TLDs (thermoluminescent dosimeters); airborne radioiodine and particulate samplers; samples of surface, groundwater, and drinking water and downstream shoreline sediment from existing or potential recreational facilities; and samples of ingestion sources such as milk, fish, invertebrates, and broad leaf vegetation.

Over the past 25 years, radioactive effluents released from nuclear power plants have decreased significantly and have leveled off at a level well below our safety limits. A significant contributor to the reduction was the addition of special systems (augmented offgas systems) to boiling water reactors, which process some of the noncondensible gases. Other contributors are improved fuel performance and improved effluent control systems.

Regulations

Current regulations to limit offsite releases and their associated radiation doses are much more restrictive than those required for nuclear power plants licensed in the 1960s. In 1975, the NRC amended its regulations (in 10 CFR Parts 50.34a and 50.36a and Appendix I to 10 CFR Part 50) to provide numerical guides for design objectives and limiting conditions for operation to meet the radiation dose criterion "as low as is reasonably achievable." Adoption of these regulations requires that plant releases be kept to doses well below the radiation exposure limits for the public in 10 CFR Part 20. (Appendix I annual dose values are: 3 mrem (0.03mSv) whole body from liquids; 5 mrem (0.05 mSv) whole body from gaseous; and 15 mrem (0.15 mSv) to any organ (thyroid) from radioiodine and particulates.

The NRC does not have dose limits for biota.

NRR Release

Inspection

The NRC conducts periodic inspections of each licensee's effluent and environmental monitoring programs once every two years, to ensure compliance with NRC requirements. The NRC documents the status of licensee programs in inspection reports that are available to the public.

Summary

Final Environmental Statements identify potential environmental impacts of radioactive materials discharged from each nuclear power plant during routine operations.

Permitted effluent releases result in very small doses to members of the public living around nuclear power plants.

Licensees report releases of radioactive liquid and airborne effluents and their associated doses in annual radioactive effluent release reports.

Licensees report radioactivity levels from the environmental sampling or air, ground, water, and ingestion pathways in annual radiological environmental operating reports. The impacts are small.

NRC regulations (10 CFR Parts 50.34a, 50.36a, and Appendix I to Part 50) require that each licensee keep releases of radioactive material to the environment ALARA, which is much less than the radiation dose limits for the public in 10 CFR Part 20.

The NRC verifies that licensees properly evaluate potential radiological impacts through NRC onsite inspections.

NRC documents licensee effluent releases and the results of their environmental monitoring and assessment effort in plant-specific inspection reports available to the public.