June 17, 2009

The Honorable Edward J. Markey
Chairman, Subcommittee on Energy
and the Environment
Committee on Energy and Commerce
United States House of Representatives
Washington, D.C. 20515

Dear Mr. Chairman:

On behalf of the U.S. Nuclear Regulatory Commission (NRC), I am responding to your letter of April 30, 2009, in which you expressed concern about a leak in buried piping at Indian Point Unit 2.

The NRC agrees that leakage in an underground pipe that has the potential to impact a plant safety system is an issue that should be addressed seriously. The NRC has reviewed the Indian Point issue noted in your letter and has closely monitored the licensee's corrective action. The NRC will continue to examine the specific details associated with the Indian Point auxiliary feed water (AFW) system leak. In addition, the staff will consider this evaluation and ongoing operating experience in reviewing the regulatory requirements and codes and standards for inspection of buried piping. In the enclosure to this letter, I have provided detailed responses to your questions.

The NRC reviews and assesses nuclear plant design, licensing requirements, and performance to ensure that reactors are operating safely and in accordance with applicable regulations. The NRC regulations require periodic testing of safety-related buried piping, and require that licensees take corrective action for degraded conditions. In the case of significant degraded conditions, NRC regulations also require that the licensee take corrective action to preclude the reoccurrence of the condition. NRC inspectors routinely inspect the licensees' programs including licensees' inservice inspection programs as part of the baseline inspections in the Reactor Oversight Process and verify that licensees have taken appropriate corrective actions. Issues identified by NRC inspectors are assessed for safety significance and documented in publicly available inspection reports. The NRC continues to closely monitor any degradation in safety-related systems at nuclear power reactors, and will take appropriate regulatory or enforcement action if conditions warrant.

The NRC continuously reviews new operating experience with buried piping for potential generic implications to the industry. Based on further or new information that becomes available through the agency's continued inspection and oversight of the issue, the NRC will consider generic aspects of the issue to determine if generic communications on the subject are warranted. The agency will also continue to review our inspection requirements and oversight processes to ensure our inspection approach appropriately considers the buried piping issues commensurate with their safety significance.

The NRC staff is available to provide a briefing for your staff if you desire. If you have additional questions on this matter, please contact me.

Sincerely,

/RA/

Gregory B. Jaczko

Enclosure: As stated

Identical Letters Sent to:

The Honorable Edward J. Markey
Chairman, Subcommittee on Energy
and the Environment
Committee on Energy and Commerce
United States House of Representatives
Washington, D.C. 20515

The Honorable John J. Hall
United States House of Representatives
Washington, D.C. 20515

NRC Response to April 30, 2009, Information Request

Question 1:

> **What is the role of auxiliary feedwater (AFW) as a safety system at Indian Point, or any other commercial pressurized water reactor? During what events is AFW intended to be relied upon? Other than AFW, what other dedicated safety-related systems exist to cool the core during an unexpected reactor shut-down?**

Answer 1:

The role of the AFW system is to supply water to the steam generators if the non-safety-related main feedwater system, which normally maintains the water level in the steam generators during power operations, were to become unavailable. The primary water supply is from the condensate storage tank (CST), which contains demineralized water. A backup water supply is available at Indian Point from the plant's city water storage tank, which is filled with municipal water, but is maintained and operated on-site completely independent of the local city water system. Generally, pressurized-water reactors rely upon the AFW system and the steam generators for core decay heat removal for all reactor shutdowns and accident conditions except for a large loss-of-coolant accident. In a large loss-of-coolant accident, the emergency core cooling system (ECCS) supplies water directly to the reactor coolant system for decay heat removal. The ECCS is also available for core decay heat removal in the unlikely event that AFW does not function during an unexpected reactor shutdown.

The February 2009 leak at Indian Point Unit 2 was on the CST return line. Although the licensee declared the CST inoperable, the supply line from the CST to the AFW system remained in service and capable of fulfilling its safety function. If a reactor shutdown had occurred during this time, the AFW system would have successfully delivered water from the CST to the steam generators.

Question 2:

> **Has the Commission performed an analysis of the consequences of a total failure of the AFW system at Indian Point, or any other commercial power reactor, that includes an analysis of what might occur if the regular feedwater supply is also interrupted by a routine power outage, terrorist attack or accident? If so, what would be the consequences of such a failure? If not, why not?**

Answer 2:

Yes, the NRC has performed such analyses as part of the design basis for the plant. If the regular (main) feedwater supply were interrupted for any reason, AFW would automatically initiate to supply water to the steam generators. In the unlikely event that all three trains of AFW failed, the operators would implement the emergency procedures and attempt to recover AFW, and use any remaining water in the condenser hotwell through the use of main feedwater and condensate pumps. If those attempts were unsuccessful or delayed, operators would initiate an emergency core cooling method using the ECCS, known as "bleed-and-feed" cooling.

“Bleed-and-feed” cooling is a viable, but less desirable method of reactor decay heat removal. The consequences are that reactor coolant system water, which contains radioactive isotopes, would be released in the containment building which would prevent releasing radioactive material to the environment but would necessitate clean-up of the containment before power operations could resume. Bleed-and-Feed had not been used at a U.S. power reactor during an event, due to the reliability of the AFW system.

Question 3:

> **Indian Point Unit 2 shut down unexpectedly on April 3, 2009. During this unplanned shutdown, apparently caused by a failed pipe in the main feedwater control system, was AFW used at any time to cool the reactor? What would have been the consequences of a concurrent failure of the AFW system at the time of the April 3, 2009, shutdown?**

Answer 3:

On April 3, 2009, Indian Point Unit 2 had an unexpected loss of a non-safety related main feedwater pump causing steam generator water levels to lower. The operators took the expected action and manually shut down the reactor in response to the decreasing steam generator water levels. The loss of the main feedwater pump was due to a low control oil pressure condition caused by a control oil tubing leak at a fitting. As designed, all three auxiliary feedwater pumps automatically started in response to decreasing water levels in the steam generators. Any one of these pumps can supply sufficient water to the steam generators for core decay heat removal.

However, if the regular feedwater supply had been interrupted and AFW would not have been available for any reason, operators would have implemented their emergency procedures as discussed in the response to question two. Operators are examined and licensed by the NRC, and are highly trained and tested on the loss of AFW as well as other decay heat removal problems. As part of the emergency procedures, the operators would attempt to recover AFW and use any remaining water in the hotwell through the use of main feedwater and condensate pumps. If those attempts were unsuccessful or delayed, operators would initiate an emergency core cooling method using the ECCS, known as "bleed-and-feed" cooling.

It is a very low probability that the safety-related, seismically qualified CST supply pipe would fail in a manner to cause a complete loss of the CST supply water to the three independent AFW pumps. Additionally, while not safety-related, it would be very unlikely that concurrent with loss of the safety-related CST, the city water storage tank supply, which is independent of the CST supply and is maintained and operated on-site completely independent of local city water, would not be available to perform a back-up function and supply the AFW pumps during an event that required decay heat removal.

If the February 2009 leak had been present during the April 3, 2009, event, the CST would still have been declared inoperable by the licensee; however, the supply line from the CST to the AFW system would have remained in service. Therefore, the AFW system would have been capable of fulfilling its safety function of removing decay heat from the reactor core for the reactor shutdown.

Question 4:

> **What was the root cause of the pipe corrosion at Indian Point? What other pipes are buried at Indian Point? Has the discovery of the 1.5 inch corrosion hole prompted the licensee to inspect other buried pipes for similar corrosion? If so, what has been found? If not, why not? Has the discovery of the 1.5 inch corrosion hole prompted the Commission to inspect other buried pipes at other reactor sites for similar corrosion? If so, what has been found? If not, why not?**

Answer 4:

Entergy's root cause evaluation included sending the failed pipe segment to a laboratory for analysis. The conclusion of the root cause evaluation was that the direct cause was a failure of the protective external pipe coating that was applied at the time of original construction, resulting in external corrosion in a localized area. Flow accelerated corrosion was not part of the failure mechanism. A potential contributing factor to the failure of the external pipe coating was the placement of the soil backfill around the pipe during original construction. The backfill contained rocks up to 8 inches in diameter, which was permitted by the backfill specification in use at the time of initial construction. An additional potential contributing factor was that this section of piping was at a low point which was close to the water table. Damp or wet conditions accelerate the general corrosion of exposed carbon steel. The external pipe coating was found to be correctly specified for the application, and, if it remains intact, is capable of protecting the pipe for the lifetime of the plant. Other safety-related buried piping at Indian Point includes service water piping; the supply and return lines to the refueling water storage tank for the emergency core cooling systems; and short runs of emergency diesel generator fuel oil piping. The licensee is developing a Buried Piping and Tank Inspection and Monitoring Program, and plans to inspect other buried piping periodically. To assess the possible extent of condition for degraded pipe, additional inspections in susceptible locations are scheduled to be completed by October 2009.

Consistent with the NRC's operating experience program, the initial information available from the Indian Point Unit 2 pipe leak has been shared with the NRC's technical review groups and regional inspectors. The NRC continuously reviews new operating experience with buried piping for potential generic communication to the industry. Based on further and/or new information that becomes available through the agency's continued inspection and oversight of the issue, the NRC will consider generic aspects of the issue to determine if further generic communications on the subject are warranted. The agency will also continue to review our inspection requirements and oversight processes to ensure our inspection approach appropriately considers the buried piping issues commensurate with their safety significance.

Question 5:

> **What are the Indian Point licensee's requirements under the current licensing basis to inspect buried pipe? What programs does the licensee have in place to assure the emergency cooling systems meet the design requirements of 10 CFR Part 50 Appendix A (GDC 44,45,46)? What programs does the licensee have in place to assure the operability of underground piping systems as required by 10**

CFR Part 50 Appendix B (Criterion X, XI and XVI), 10 CFR 50.55(a) and ASME Section XI?

Answer 5:

Licensees are required to comply with Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.55a, “Codes and Standards,” which requires that licensees implement an inservice inspection program that complies with the standards of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code). The ASME Code provides requirements for the examination and testing associated with safety-related buried piping. The ASME Code for Class 3 buried piping (e.g., CST supply/return piping) requires a pressure-drop test or flow test. Licensees, including Indian Point, implement this and all applicable ASME Code requirements through site-specific processes and procedures that comprise inservice inspection and inservice testing programs. These processes and procedures provide the necessary inspections and examinations to be conducted by licensee personnel on a periodicity to satisfy the ASME Code and NRC requirements.

The construction permits for the Indian Point reactors were issued prior to the issuance of 10 CFR Part 50 Appendix A, “General Design Criteria for Nuclear Power Plants.” The Indian Point reactors were licensed to the general design criteria stated in their Final Safety Analysis Reports (FSARs), rather than those in 10 CFR Part 50 Appendix A. In order to assure that the emergency cooling systems meet the requirements of the plant’s licensing basis, there are several testing requirements. The most important testing requirements are listed in Appendix A to the plant license, which is referred to as the plant’s Technical Specifications (TS). There are also the inspections and tests required by 10 CFR 50.55a, which reference the ASME Code requirements. The primary ASME Code programs are the inservice inspection program and the inservice test program. The NRC also conducts targeted inspections to verify conformance with the plant’s licensing basis, which includes verification that the licensee is appropriately implementing its inservice inspection and testing programs.

Entergy’s Service Water Integrity Program at Indian Point is intended to manage the maintenance of internal protective coatings and piping, as well as the prevention of excessive macro-fouling and biofouling, associated with the service water system, which contains buried piping. As recommended by NRC Generic Letter 89-13, “Service Water System Problems Affecting Safety-Related Equipment,” a condition and performance monitoring program manages the effects of material loss (corrosion) and fouling. This program includes periodic inspections and assessment of underground service water piping. Some of these inspections use video taken from inside the pipe. NRC inspectors periodically review the video, and the NRC has not identified any significant degradation of the buried service water piping at Indian Point.

The NRC, in addition to requiring conformance with 10 CFR 50.55a for buried piping, requires that licensees implement a corrective action program in accordance with NRC regulations to identify, evaluate, and correct adverse conditions commensurate with the safety significance of the condition. Entergy has entered the CST return line leak condition into its corrective action program for resolution. NRC inspectors will continue to observe, assess, and document Entergy’s performance and follow-up actions in determining the causes of the pipe corrosion and its conclusions with respect to identification of any other locations where such leakage could occur.

Question 6:

> **When was the last licensee inspection of buried pipe at Indian Point, and what were the results of the inspections? If there has not been a recent inspection, how would the licensee not be in violation of 10 CFR Part 50 Appendix B (Criterion X, XI and XVI), and 10 CFR 50.55(a)?**

Answer 6:

During October 2008, Entergy unearthed and inspected, both visually and using ultrasonic test equipment to measure the pipe wall thickness, the exterior of buried CST supply and return piping at two locations associated with different elevations (approximately a 10-foot length for each location) at Indian Point Unit 2. The sections which were inspected did not include the same section of CST supply piping which experienced the leak in February 2009. Entergy did not identify any pipe integrity issues as a result of the inspection. NRC inspectors observed the licensee's inspection and visually inspected the pipe. Entergy has also conducted flow tests or pressure drop tests of safety-related buried piping as required by the ASME Code, through the inservice inspection and inservice testing programs. NRC inspectors perform periodic reviews of these programs as part of the Reactor Oversight Process baseline inspection program, and periodically observe the tests.

Based on recent NRC inspections at Indian Point, as related to buried piping, the NRC has not identified any non-compliance with NRC regulations. The NRC's review of Entergy's performance, specific to the February 16, 2009, underground CST return pipe leak, including a review of prior opportunities for Entergy to identify the leak, is still on-going at this time.

Question 7:

> **When was the last Commission inspection of buried pipes at Indian Point, and what were the results of the inspections?**

Answer 7:

During October 2008, the NRC observed and reviewed Entergy's inspection and ultrasonic testing of buried CST supply and return piping and did not identify any non-compliance with the NRC regulations. The section of piping which Entergy inspected did not include the same section of CST piping which experienced the leak in February 2009. Additionally, the NRC's independent visual inspection of those pipes did not identify any indications of externally corroded or degraded piping.

Question 8:

> **How can the general public be assured that all buried pipes will retain structural integrity in the event of an earthquake or other external event?**

Answer 8:

Safety-related buried piping is initially designed and constructed to ensure its safety function will be met under all design-basis conditions, including earthquakes and external events. Quality assurance regulations require inspections during construction to verify proper installation. Due to its importance to safe reactor operation, NRC regulations require periodic testing of safety-related piping at all NRC-licensed nuclear power reactors. Whenever a leak in safety-related piping is identified, the licensee inspects the piping and performs an operability determination, which includes an evaluation of the structural integrity of the piping, including seismic loading. The licensee repairs the piping, determines the root cause of the problem, and then identifies what additional actions need to be taken, such as recoating or replacing sections of piping or conducting additional inspections. NRC inspectors monitor the licensee's actions. As long as structural integrity of the piping is maintained, small amounts of leakage generally do not adversely impact the ability of the system to perform its safety function. In the case of the February 2009 leak, the AFW system would have been capable of fulfilling its safety function of removing decay heat from the core for the reactor shutdown. In almost all cases throughout the country, structural integrity has been maintained, and the degradation was found to be due to a small localized defect. If the NRC identifies any degradation mechanisms that affect structural integrity, we will require licensees to take appropriate action.

Question 9:

> **Does the Commission require licensees to conduct inspections of buried pipe for cooling water generally? If so, are any licensees failing to conduct such inspections? If there have not been recent inspections, how would licensees not be in violation of 10 CFR Part 50 Appendix B (Criterion X, XI and XVI), and 10 CFR 50.55(a)?**

Answer 9:

As discussed in the answer to question 5, licensees are required to comply with 10 CFR 50.55a, which requires that licensees implement an inservice inspection program that complies with the standards of the ASME Code. The ASME Code provides requirements for the examination and testing associated with safety-related buried piping. The ASME Code for Class 2 buried piping (e.g., pump supply and return lines to the refueling water storage tank for emergency core cooling systems) and Class 3 buried piping (e.g., CST supply/return piping and service water piping) requires a pressure-drop test or flow test, but not a visual or ultrasonic inspection. All licensees conduct the required tests.

Operating experience through the mid-1980s indicated that potential problems with corrosion and failure of pipe lining materials could affect the function of the service water systems. In 1989, the NRC requested that licensees review their maintenance and inspection programs for open-cycle service water systems. With consideration of the plant design and water quality, the licensees have committed to enhanced inspection and maintenance programs. For service water piping large enough to accommodate a robotic crawler inside the pipe, the Indian Point licensee performs periodic visual inspections using a high resolution camera. The NRC inspects these programs at 3-year intervals as part of the baseline inspections in the Reactor Oversight Process.

The NRC, in addition to requiring conformance with 10 CFR 50.55a for buried piping, requires that licensees implement a corrective action program in accordance with NRC regulations to identify, evaluate, and correct adverse conditions commensurate with the safety significance of the condition. NRC licensees inspect for unusual water leakage, and have programs to take corrective action for adverse conditions, including unusual water leakage; as such, they are not in violation of 10 CFR Part 50, Appendix B. Since licensees conduct the flow tests or pressure drop tests required by 10 CFR 50.55(a), through the application of the ASME Code, they are not in violation of that regulation.

Question 10:

> **Please provide a list of licensee inspections of buried pipe in the last 10 years, and their results, including the number, size and locations of detected leaks, failures, and incidents of corrosion. Please also provide a list of Commission inspections of buried pipes in the last 10 years, and their results.**

Answer 10:

Except as documented in inspection reports or as necessary for on-going NRC inspection activities, the NRC does not typically request or maintain records to track licensee inspections in the area of buried piping. However, a document search identified the following NRC inspection records for Indian Point Units 2 and 3, which document inspections that, in part, included a review of buried piping since calendar year 1999:

- NRC Inspection Report (IR) 2001-011 (ADAMS Accession No. ML020240433, dated January 24, 2002): Documents NRC inspection review of testing related to suction piping of the auxiliary feedwater system. NRC inspectors identified a performance issue related to inadequate testing of AFW buried suction piping from the CST in accordance with ASME Code and 10 CFR 50.55a(g)(4)(ii).

- NRC IR 2001-014 (ADAMS Accession No. ML020850420, dated March 26, 2002): Documents NRC inspection of an auxiliary feedwater system pressure-drop testing that verified the integrity of underground piping in accordance with the ASME Boiler and Pressure Vessel Code, Section XI. No performance issues associated with buried piping were identified.

- NRC IR 2004-006 (ADAMS Accession No. ML041770449, dated June 24, 2004): Documents NRC inspection of underground service water piping flow tests. No performance issues associated with buried piping were identified.

- NRC IR 2007-006 (ADAMS Accession No. ML071730036, dated June 20, 2007): Documents review of station fire header flow tests which supports verification of underground fire header piping integrity. No performance issues associated with buried piping were identified.

- NRC IR 2007-004 (ADAMS Accession No. ML073170147, dated November 9, 2007): Documents NRC review of several service water buried piping videos to ascertain piping integrity. No performance issues associated with buried piping were identified.

- NRC IR 2007-004 (ADAMS Accession No. ML073170091, dated November 9, 2007): Documents NRC review of underground auxiliary steam line leaks. No performance issues associated with buried piping were identified.

- NRC IR 2007-005 (ADAMS Accession No. ML080360454, dated February 5, 2008): Documents NRC review of service water large-bore piping inspections conducted every 10 years. Additionally, the report documents the inspectors' review of a number of video-recorded internal service water piping examinations. No performance issues associated with buried piping were identified.

- NRC License Renewal IR 2008-006 (ADAMS Accession No. ML082140149, dated August 1, 2008): Documents NRC's assessment of Entergy's buried piping inspection program, service water integrity program, and a review of buried piping inspection records. The report also documents a review of the AFW system, in particular, the management program that addressed buried piping inspections, corrosion, and external surfaces. No performance issues associated with buried piping were identified.

- NRC IR 2008-005 (ADAMS Accession No. ML090340463, dated February 3, 2009): Documents NRC review of buried piping inspections of the condensate storage tank supply piping to the auxiliary feedwater system. No performance issues associated with buried piping were identified.

Additionally, NRC inspectors completed inspections of underground piping during the recent Indian Point Unit 3 spring 2009 refueling outage. The inspectors reviewed the pressure drop test on the buried AFW suction piping from the CST and reviewed the results of internal piping inspections of select service water pipes. The inspection results are preliminary and will be documented in the second quarter 2009 inspection report expected to be issued in July 2009.

Question 11:

> **Has the Commission ever considered requiring licensees to develop technologies and methods to inspect difficult-to-access buried pipes? If so, why are such requirements not in place? If not, why not?**

Answer 11:

The NRC continues to review the operating experience at nuclear power plants and has considered many different technologies and methods for inspection of components. To date, the experience with buried piping systems has indicated only minor problems that do not justify expansion of the current regulations. The NRC requires that safety-related buried piping be designed and installed so that it will perform its safety function. Buried pipes are either fabricated of corrosion-resistant materials or have coatings and linings which protect the pipe from corrosion. New corrosion resistant materials continue to be evaluated, and the NRC has recently approved the use of polyethylene pipe in certain buried systems.

Degradation that is detected in safety-related buried pipe is required to be evaluated and repaired. The NRC has a program to evaluate operating experience and disseminate the information to licensees. If an issue is significant, the agency can evaluate it under our Generic Issues program for further regulatory action. The NRC will continue to evaluate operating experience with buried pipe and will take further regulatory or enforcement actions as warranted.