POLICY ISSUE
(Information)

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FOR: The Commissioners

FROM: R. W. Borchardt
Executive Director for Operations

SUBJECT: SENIOR MANAGEMENT REVIEW OF OVERALL REGULATORY APPROACH TO GROUNDWATER PROTECTION

PURPOSE:

This paper provides the outcome of the U.S. Nuclear Regulatory Commission (NRC) senior management review of two of the four themes described in the "Groundwater Task Force Report," issued June 2010 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML101680435). Specifically, this paper describes the regulatory approach for addressing groundwater protection and addresses the themes of reassessing the regulatory framework and maintaining barriers as designed to confine licensed material. A separate memorandum to the Chairman describes the staff's initiatives to create a more reliable and consistent NRC response and to strengthen trust.

BACKGROUND:

On March 5, 2010, the Executive Director for Operations (EDO) established the Groundwater Contamination Task Force (GTF) to evaluate the completeness of NRC actions to address recent incidents of radioactive contamination of groundwater and soils at civilian nuclear power plants. As described in the charter (ADAMS Accession No. ML100640188), the purpose of the GTF was to determine whether the actions the NRC has taken, or plans to take, in response to recent incidents and to the recommendations made in the "Liquid Radioactive Release Lessons Learned Task Force (LLTF) Final Report," issued September 2006 (ADAMS Accession No. ML062650312) should be augmented.

CONTACTS: A. Louise Lund, NRR/DLR
301-415-3248

Margie A. Kotzalas, OEDO/TBPM
301-415-1727

In 2006, the LLTF reviewed the industry experience with unplanned and unmonitored releases of radioactive liquids into the environment, any associated public health impacts, NRC regulatory framework, NRC inspection and enforcement programs, industry reporting requirements, international perspectives, and communications with public stakeholders. The LLTF made 26 recommendations in a final report dated September 1, 2006, (ADAMS Accession No. ML062650312).

For several months, the GTF worked independently of Commission and NRC management direction to complete its review. On June 11, 2010, the GTF issued its final report. The report contains four major themes that provide focus for its conclusions:

Theme 1—Reassess the NRC's Regulatory Framework for Groundwater Protection
Theme 2—Maintain Barriers as Designed To Confine Licensed Material
Theme 3—More Reliable NRC Response
Theme 4—Strengthen Trust

The recommendations from the GTF report that contain potential policy issues or discuss associated activities that could impact the regulatory framework include 1) incorporating the voluntary industry initiative on groundwater protection into the regulatory framework, 2) revising the current radiological effluent performance indicator in the Reactor Oversight Process (ROP), 3) considering immediate remediation of leaks/spills at NRC-licensed facilities, and 4) participating in consensus standards development.

The EDO directed a Senior Management Review Group (SMRG) to consider the findings of the GTF and to determine how to address the conclusions and recommendations in the final report. The SMRG was chaired by the Deputy Executive Director for Reactor and Preparedness Programs, and composed of office directors from the major NRC program offices, the General Counsel, and the Regional Administrator from Region III.

DISCUSSION:

The SMRG identified: 1) near-term staff actions, and 2) potential policy issues for consideration. This paper provides the outcome of the SMRG assessment of the first two themes of the GTF report. The second two themes are addressed in a memorandum to the Chairman titled "Initiatives for Improved Communication of Groundwater Incidents," (ADAMS Accession No. ML110050252).

The SMRG held a public meeting on October 4, 2010, to seek feedback on the recommendations of the GTF report from a diverse group of external stakeholders. Perspectives from the public are discussed in Enclosure 1. The SMRG's consideration of groundwater protection within the current regulatory framework is summarized in Enclosure 2.

In its review of the first two themes, the SMRG concurred with the GTF's conclusion that the NRC is accomplishing its stated mission of protecting public health, safety, and protection of the environment through its response to groundwater leaks/spills, consistent with its regulatory framework. The NRC regulatory framework is undergirded by bedrock requirements that licensees must meet for control of effluents and release of radioactive material such as dose limits found in Title 10 of the *Code of Federal Regulations* (10 CFR) 20.1301 and design objectives found in 10 CFR 50, Appendix I, and the SMRG has concluded that, based upon staff evaluations, these requirements are being met. The SMRG also acknowledged that there are ongoing activities by the staff and industry to address groundwater protection. Significant progress has been made and many near-term activities are close to completion. This paper summarizes these efforts, and the staff's ongoing evaluation of progress on industry activities. The overall strategy is to evaluate results of the current and near-term industry activities before determining the need for the regulatory changes recommended in the GTF report.

1) Incorporating the Voluntary Industry Initiative on Groundwater Protection into the Regulatory Framework

In response to leakage and groundwater contamination incidents, the nuclear industry developed three initiatives to address stakeholder concerns. The first initiative is Nuclear Energy Institute (NEI) 07-07, "Industry Ground Water Protection Initiative (GPI)," issued August 2007 (ADAMS Accession No. ML062260198). The second industry initiative is the Buried Piping Integrity Initiative, dated November 20, 2009 (ADAMS Accession No. ML093350032). The third industry initiative is the Underground Piping and Tanks Integrity Initiative, dated September 27, 2010 (ADAMS Accession No. ML103410507). This third initiative supersedes the second initiative and broadens its applicability to all underground piping and tanks. These initiatives are discussed further in Enclosure 3.

The NRC's Buried Piping Action Plan (ADAMS Accession No. ML102590171) contains activities to evaluate the long-term effectiveness of the Underground Piping and Tanks Integrity Initiative such as 1) trending the incidence of degradation of buried piping, 2) determining how effective the program is in decreasing the occurrence of groundwater incidents, and 3) evaluating the need for changes to the ROP. Methods of evaluating the initiative include onsite inspections discussed in Enclosure 4, review of licensees' root cause analyses, tracking the frequency of leakage, and evaluating industry performance metrics related to leakage and potential groundwater contamination. The nuclear industry has developed a common database to track instances of degradation or leakage from buried and underground structures, systems, and components (SSC). This database is useful in tracking improvements in the management of buried and underground SSC leak tight integrity. In addition, the NRC staff tracks radionuclide concentrations released from the plants, and publishes them on the NRC public web page.

The GTF report recommends that the staff consider incorporating the voluntary industry initiative on groundwater protection into the regulatory framework. Many stakeholders expressed concern that the NRC is relying on an industry initiative, rather than regulatory requirements, to prevent unintended releases of radioactive material and recommended that the initiative be incorporated into the regulatory framework. The SMRG found that, based on information gained from NRC inspections, independent peer assessments, and industry assessments, licensee actions taken in response to leaks and spills have been consistent with NRC's regulatory requirements and no new regulatory requirements need to be considered with respect to groundwater protection at this time. The SMRG found that the three industry initiatives can, if properly implemented, enhance the prevention, response and remediation of potential threats to groundwater. The SMRG also found that in view of the progress being made by industry in protecting groundwater, rulemaking or some other form of regulatory requirement to codify the voluntary initiatives would not result, at this time, in a substantial increase in the overall protection of the public health and safety. Hence the SMRG did not support the GTF recommendation.

Consistent with one of the recommendations of the GTF report, the staff plans to develop a generic communication regarding leaks and spills onsite, to remind licensees to maintain their operations and designs consistent with their licenses. The intent of the generic communication will be to convey the staff's observation that the industry programs are providing more active management of situations that can lead to unplanned releases and that the staff plans to continue to assess the effectiveness of the programs through the Reactor Oversight Program.

2) Revising the Current Radiological Effluent Performance Indicator in the Reactor Oversight Program

In March 2000, the radiological effluent performance indicator was developed in accordance with NEI 99-02, Revision 0, "Regulatory Assessment Performance Indicator Guidelines," (ADAMS Accession No. ML110180011) as a leading indicator for any challenge to the public dose limit of 10 CFR Part 20. The performance indicator was set to a small fraction of the regulatory limit and licensees' performance regarding effluent releases never approached this small fraction of the regulatory limit. Based on this performance indicator, the staff has concluded that licensees' radiological effluent control programs have been satisfactory. At the same time, however, the frequency of radioactive leaks and spills (unintentional releases) was increasing. The GTF report concluded that the current radiological effluent performance indicator did not provide meaningful data on groundwater contamination and recommended that the performance indicator be revised to be more predictive of degrading performance in this area. Based on this recommendation, the staff will evaluate whether a change should be made to develop a more leading indicator of degraded performance in groundwater protection for the current Public Radiation Safety Cornerstone. This recommendation will be evaluated in the annual ROP self-assessment and will be discussed in the Commission paper associated with that review. The SMRG supports this course of action.

3) Considering Immediate Remediation of Spills at NRC-licensed Facilities

The GTF report discussed a paper that was before the Commission, SECY-09-0042, "Final Rule: Decommissioning Planning." Subsequently, the Commission approved the rule, with some changes, for publication in the *Federal Register* (ADAMS Accession No. ML103350034). Under the Decommissioning Planning Rule, licensees that identify subsurface contamination and those (except those under 10 CFR Part 40) that detect significant subsurface contamination have the option to conduct immediate remediation. The rule requires that surveys be performed if there is reason to believe that significant subsurface contamination is present. Significant contamination is that which would require remediation at the time of license termination to meet unrestricted release limits. If they do not remediate immediately, then materials licensees are required to plan for and provide funds in the form of financial assurance to conduct remediation at a later time, including at the time of decommissioning. No similar requirement is specified for power reactor licensees because the Commission's regulations already require power reactor licensees to show how they can provide reasonable assurance that funds will be available for decommissioning.

The new Decommissioning Planning Rule (SECY-09-0042) requires all licensees to ensure that records from surveys describing the location and amount of subsurface residual radioactivity identified at the site are kept with records important for decommissioning. For power reactors, the recordkeeping requirements are specified by 10 CFR 50.75(g). Per 10 CFR 50.75(f)(3), at or about 5 years prior to shutdown, power reactor licensees are required to submit a site-specific, preliminary decommissioning cost estimate, which includes an assessment of the major factors that could affect the cost of decommissioning. The assessment will include information on subsurface residual radioactivity kept in the records required by 50.75(g), and therefore, the costs of remediating subsurface contamination will be included in the site-specific cost estimate. The final rule does not mandate prompt remediation for any licensees.

Under a staff requirements memorandum dated December 10, 2007, for SECY-07-0177, "Proposed Rule: Decommissioning Planning," the Commission, among other things, directed the staff to make further improvements to the decommissioning planning process by addressing immediate remediation of residual radioactivity during the operational phase with the objective of avoiding complex decommissioning challenges that can lead to legacy sites. The staff started information gathering and analysis in support of the technical basis in fiscal year (FY) 2010. The staff is currently performing a feasibility evaluation and will formulate a recommendation in FY 2011.

4) Participating in Consensus Standards Development

Staff continues to participate in consensus standards (i.e., code) activities related to the potential for addressing nonsafety-related piping in code cases, as discussed in Enclosure 2. Many examples of degradation in buried piping have been discovered in nonsafety-related, nonclass piping, which are not subject to the jurisdiction of The American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code). The ASME Code does not currently address nonsafety-related piping nor does it address leaks that are not structurally significant. Recognizing that leaks in piping, if undetected for extended periods, could represent precursors to loss of structural integrity, the staff discussed this issue with the appropriate ASME Code committee. The staff has initiated, and plans to continue, efforts to work with consensus standards organizations to have certain provisions related to inspections of nonsafety-related piping incorporated into ASME code cases. The staff is also working with a task group within NACE International (formerly National Association of Corrosion Engineers) to evaluate the need for corrosion protection standards specific to the configuration of piping at nuclear power plants.

CONCLUSION:

As discussed above, the SMRG concluded that the staff's planned approach for addressing the issues raised in the first two themes of the GTF report are reasonable next steps. The staff plans to engage the industry to identify and to close gaps in implementation of the industry initiatives, and to evaluate the progress of these actions to reduce groundwater contamination. The staff has mechanisms in place to revisit its position based on the success of the initiatives in decreasing the trend of groundwater incidents.

COMMITMENTS:

Staff plans to evaluate the long-term effectiveness of the industry initiatives through onsite inspections, review of licensees' root cause analyses, tracking the frequency of leakage, and evaluating industry performance metrics related to leakage and potential groundwater contamination.

The staff has initiated, and plans to continue, efforts to work with consensus standards organizations to have certain provisions related to inspecting and maintaining buried piping incorporated into ASME code cases and NACE standards.

The staff will evaluate whether a change should be made to develop a more leading indicator of degraded performance in SSCs designed to prevent unplanned releases of radioactive material for the current Public Radiation Safety Cornerstone in the annual ROP self-assessment and will be discussed in the Commission paper associated with that review.

The staff is currently performing a feasibility evaluation to address remediation of residual radioactivity during the operational phase with the objective of avoiding complex decommissioning challenges that can lead to legacy sites and will formulate a recommendation in FY 2011.

RESOURCES:

The resources required to implement these activities are fully funded in the FY 2011 budget.

COORDINATION:

The Office of the General Counsel has reviewed this paper and has no legal objections. The Office of the Chief Financial Officer has reviewed this paper for resource implications and has no objections.

/RA/

R. W. Borchardt
Executive Director
for Operations

Enclosures:
1. Stakeholder Perspectives on Groundwater Releases
2. Regulatory Framework
3. Industry Initiatives
4. NRC's Inspection Program

Stakeholder Perspectives on Groundwater Releases

As the Groundwater Task Force (GTF) Report stated, detection of tritium in groundwater monitoring wells has caused licensees to take actions to address the source of the tritium and communicate the impact to their stakeholders. Implementation of the industry voluntary groundwater initiative has resulted in increased reporting by licensees of the discovery of leaks/spills that have the potential to affect groundwater, and has led to increased stakeholder interest. The report concluded that the U.S. Nuclear Regulatory Commission (NRC) response to leaks and spills has varied widely and has been case specific. Some stakeholders believe these incidents have raised questions regarding NRC actions to date, as well as licensee actions, and whether these actions should be augmented. The review by the Senior Management Revision Group (SMRG) afforded the agency an opportunity to reflect on past and current agency activities to evaluate whether additional efforts should be initiated.

After reviewing the GTF report recommendations, the SMRG held a public meeting on October 4, 2010, to seek feedback on the recommendations from a diverse group of external stakeholders. A wide range of stakeholders attended, including representatives from other Federal agencies (U.S. Environmental Protection Agency (EPA), U.S. Department of Energy (DOE), U.S. Geological Survey), the State regulatory agencies, the Canadian Nuclear Safety Commission, the Conference of Radiation Control Program Directors, the Health Physics Society, the Prairie Island Indian Community, the Nuclear Energy Institute, the National Mining Association, licensees, and public advocacy groups. The purpose of the meeting was to ensure that senior management had identified and considered the right issues on which to focus attention as it addressed the GTF report recommendations and conclusions. The meeting was transcribed, and written comments pertaining to the policy issues discussed at the meeting were accepted until November 1, 2010. The SMRG received comments from 25 different entities in total, captured in the meeting transcript or in written comments.

Reviewing this input, the SMRG realized that there are a wide range of views held by stakeholders. Some stakeholders expressed their views that no new regulations are needed, just consistent application and enforcement of current regulations. The SMRG also noted differences in perspective on NRC's role in groundwater protection and how it is viewed by some key stakeholders (States, Tribes, etc.). Some stakeholders treat groundwater and surface water as "potential" drinking water (in addition to the drinking water sources regulated by the EPA Safe Drinking Water Act) and compare testing results to the same standard as the EPA drinking water standard. State guidelines and targets may be more stringent than either the EPA or NRC regulations, and States may view that they are "filling the gap," when they perceive that NRC efforts do not go far enough. In comparison, the NRC's regulatory framework includes actions licensees must take if environmental samples exceed NRC reporting levels. The NRC design objective for light water power reactors is 3 millirems (mrem) whole body dose for liquid effluent through all pathways of exposure (Title 10 of the *Code of Federal Regulations* Part 50 Appendix I). The NRC's approach is focused on minimizing public dose within established regulatory limits and, as such, is assumed to protect the environment. The Commission has recently addressed aspects of this issue in its response to a staff paper on international standards (SECY-08-0197).

Many comments received by the SMRG focused on the importance of maintaining the integrity of buried piping in order to minimize leakage. Another stakeholder concern mentioned frequently was the location of onsite wells relative to the underground components carrying radioactive material. Stakeholders suggested that, to the extent feasible, licensees should reduce both routine and unintended radiological releases from facilities that the NRC regulates and that there should be better oversight of nonsafety-related buried piping that contains radioactive material. They were particularly concerned about the adequacy of monitoring and characterizing unintended releases on site and the condition of the piping that is either buried (in contact with soil) or underground. Stakeholders asked that the NRC recognize that this will only become more of a problem as plants age, unless piping is maintained in a manner that minimizes the possibility of leakage.

Regulatory Framework

An understanding of the routine discharge of radioactive materials, including tritium, from a nuclear power plant is necessary to gain a perspective on the unplanned releases from underground and buried components. Tritium is a naturally occurring radioactive form of hydrogen that is produced in the atmosphere when cosmic rays collide with air molecules. As a result, tritium is found in very small or trace amounts in groundwater throughout the world. It is also a byproduct of the production of electricity by nuclear power plants. A radiation dose from tritium is the same as from any other type of radiation, including natural background radiation and medical administrations. The tritium dose from nuclear power plants is much lower than the doses attributable to natural background radiation and medical administrations. Humans receive approximately 50% of their annual radiation dose from natural background radiation, 48% from medical procedures (e.g., x-rays), and 2% from consumer products. Doses from tritium and nuclear power plant effluents are a negligible contribution to the background radiation to which people are normally exposed, and they account for less than 0.1% of the total background dose (National Commission on Radiation Protection and Measurement, Report No. 160, “Ionizing Radiation Exposure of the Population of the United States: An Update,” September 2009). As an example, assume that a residential drinking water well sample contains tritium at the level of 1,600 picocuries per liter (pCi/L) (a comparable tritium level was identified in a drinking water well near the Braidwood Station nuclear facility). The radiation dose from drinking water at this level for a full year (using EPA assumptions that 20,000 pCi/L equates to 4 millirem (mrem) annually) is 0.3 mrem, which is:

- **at least three hundred times** lower than the dose from a medical procedure involving a full-body computed tomography (CT) scan (e.g., 500 to 1,500 mrem from a CT scan)
- **one thousand times lower** than the approximate 300 mrem dose from natural background radiation
- **fifty times lower** than the dose from natural radioactivity (potassium) in your body (e.g., 15 mrem from potassium)
- **twelve times lower** than the dose from a round-trip cross-country airplane flight (e.g., 4 mrem from Washington, DC to Los Angeles and back)

Virtually all commercial nuclear power plants routinely release minor amounts of radioactive materials, including tritium, to the environment in liquids and gases. These releases are planned, monitored, and documented. NRC regulations in Title 10 of the *Code of Federal Regulations* (10 CFR) Part 20, “Standards for Protection Against Radiation,” and in 10 CFR Part 50, “Domestic Licensing of Production and Utilization Facilities,” place limits and As Low As Is Reasonably Achievable (ALARA) numerical design objectives on these releases to ensure that the impact on public health is very low. On an annual basis, the NRC ALARA design objective specifies that the release of radioactive material in a liquid form from a nuclear power plant must not result in a radiation dose of greater than 3 mrem (0.03 mSv) to any individual in an unrestricted area (outside the plant perimeter). All licensees are required to report results to the NRC, and all reports have been well within this limit.

EPA's drinking water standards do not apply to private drinking water wells, such as those that may be impacted by tritium that is inadvertently released from nuclear power plants. However, many State authorities have adopted the EPA's drinking water standards as legally enforceable groundwater protection standards, and those standards are often used in assessing laboratory test results of water from private wells. In 1976, EPA established a dose-based drinking water standard of 4 mrem per year. In so doing, EPA set a maximum contaminant level of 20,000 pCi/L for tritium. This level is assumed to yield a dose of 4 mrem per year. If other similar radioactive materials are present in the drinking water, in addition to tritium, the sum of the annual dose from all radionuclides shall not exceed 4 mrem per year. Since EPA developed the 1976 drinking water standard, scientists have improved the calculation methods to equate concentrations of tritium in drinking water (pCi/L) to radiation doses in people (mrem). In 1991, EPA calculated a tritium concentration to yield a 4 mrem per year dose as 60,900 pCi/L – a threefold increase from the maximum contaminant level of 20,000 pCi/L established in 1976. However, EPA kept the 1976 value of 20,000 pCi/L for tritium in its latest regulations.

A comparison of international standards and guidelines for tritium in drinking water was recently published by the Canadian Nuclear Safety Commission in January 2008, titled "Standards and Guidelines for Tritium in Drinking Water." The guidelines for radionuclides in drinking water adopted by the majority of the international community are based on international radiation protection methodologies and recommendations of the International Commission on Radiological Protection (ICRP) and the World Health Organization. The information was provided in SI (International System) units, with the United States limit of 20,000 pCi/L converted to 740 Becquerel per Liter (Bq/L) for easy comparison. The limits ranged from 100 (most European Union countries use this as a screening value) to 76,103 Bq/L in Australia. Canada, our closest neighbor listed in the table, uses 7000 Bq/L as their limit, which is much higher than the US limit. The World Health Organization guidelines are 10,000 Bq/L, which is also much higher than the US limit.

As with any industrial facility, a nuclear power plant may deviate from normal operation with a spill or leak of liquid material. However, the plant design and the NRC's inspection program both provide reasonable assurance that safety limits will be met – even in situations where leaks occur. The NRC limits and ALARA dose controls apply to both normal effluent discharges and unplanned releases such as leaks or spills containing radioactive materials. Regardless of the source, each nuclear power plant is required to account for the radioactivity released to the environment, including planned and unplanned releases. Each licensee is responsible for accounting for the release, evaluating the release relative to NRC regulatory requirements, and reporting the quantity of radioactivity released and the highest radiation dose to any member of the public.

Licensees are required to verify that radioactive effluents, either from leak/spills or from normal operations, are within NRC regulatory limits and design objectives. The NRC limits doses received by the public from licensee operations, including releases of radioactive effluents through requirements found in 10 CFR 20.1301, "Dose Limits for Individual Members of the Public," and the design objectives are contained in 10 CFR 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." These limits and design objectives are incorporated into the licensee's technical specifications and Offsite Dose Calculation Manual (ODCM).

As part of their site programs, licensees monitor groundwater by using wells to detect whether leakage of radioactive materials is occurring. Once radionuclides are discovered in groundwater onsite, licensees are required (by their licensing basis such as Technical Specifications and ODCM) to monitor groundwater and drinking water if local supplies are likely to be affected. The intent of this routine monitoring is to assure that leaks will be detected in a timely manner, before established limits could be challenged.

The regulations identify how quickly reports on various unplanned and planned releases should be submitted to the NRC. The regulations in 10 CFR 50.72 include criteria for four-hour reports. These reports are required for any event or situation related to the health and safety of the public or onsite personnel, or protection of the environment, for which a news release is planned or notification to other government agencies has been or will be made. Such an event may include an inadvertent release of radioactively contaminated materials. The licensee's licensing basis also includes provisions for 30-day reports if any radionuclide (or combination of radionuclides) exceeds the reporting levels outlined in the licensee's ODCM. There are also reporting requirements in 10 CFR 50.73 for Licensee Event Reports tied to radioactive releases substantively above those specified in 10 CFR 20 Appendix B. The licensee's programs must be sufficiently robust to support the regulatory requirements for monitoring and reporting.

In accordance with 10 CFR 50.36a, nuclear power plant operators are required to submit an annual Radioactive Effluent Release Report to the NRC detailing the amount of radioactive material released to the environment during the past year. This report estimates the public health impact of the releases. In accordance with 10 CFR 50 Appendix I, Section IV.B, NRC regulations also require nuclear power plant operators to monitor the environment in the vicinity of the nuclear power plant to assess the cumulative impact of the radioactive material that has been released. On an annual basis, the results of the environmental monitoring program are submitted to the NRC in the Annual Radiological Environmental Operating Report. These reports are available to the public via the NRC Web site (http://www.nrc.gov/reactors/operating/ops-experience/tritium/plant-info.html).

Changing the NRC regulations to explicitly consider protection of the environment was addressed in the staff's evaluation of the 2007 recommendations of the International Commission on Radiological Protection, contained in ICRP Publication 103. The ICRP definition of environment considers a small set of reference animals and plants that are typical of the major environments. Recommendations from this publication were discussed with the Advisory Committee on Nuclear Waste and Materials (ACNW&M) during its February 12–14, 2008, meeting and summarized in an ACNW&M report, "Review of ICRP Publication 103," dated March 27, 2008 (ADAMS Accession No. ML080790301). The staff presented options to the Commission in 2008 regarding the recommendations contained in ICRP Publication 103, SECY-08-0197, "Options to Revise Radiation Protection Regulations and Guidance with Respect to the 2007 Recommendations of the International Commission on Radiological Protection," dated December 18, 2008. The associated staff requirements memorandum, dated April 2, 2009, agreed with the NRC staff that "there is no evidence that the current set of radiation protection controls is not protective of the environment, and that the NRC should not develop separate radiation protection regulations for plant and animal species." The staff's approach has followed the Commission direction. The SMRG finds that licensee actions taken in response to leaks and spills are protective of the environment and no new policy actions need to be considered with respect to protection for plant and animal species of the environment.

In 2009, in response to an increasing trend of reported occurrences of leaks in buried piping, the Chairman requested a staff evaluation of the adequacy of 1) NRC requirements for design, inspection, and maintenance of safety-related buried piping, 2) ASME Code requirements for design, inspection, and maintenance of safety-related piping, and 3) voluntary initiatives for the design, inspection, and maintenance of safety-related and nonsafety-related buried piping. The Chairman also requested a discussion of staff plans for recommending revisions to regulations, requirements, practices, or oversight related to buried piping. SECY-09-0174, "Staff Progress in Evaluation of Buried Piping at Nuclear Reactor Facilities," dated December 2, 2009, responded to the Chairman's request and discusses the NRC's current regulatory framework for maintaining the integrity of buried piping used at nuclear plants. The paper concluded that the goals of current regulations are to ensure that the piping is able to perform its intended safety function by supplying sufficient fluid flow and to maintain inadvertent releases below the licensee's technical specifications or other applicable NRC limits. The staff determined that current regulations are adequate for these purposes but are not intended to ensure pipes are leak tight.

The paper discussed the regulatory framework regarding underground systems, structures and components (SSCs) as well as groundwater protection to protect the health and safety of the public. Applicable regulations establish criteria or limits that, if met, ensure the health and safety of the public are maintained. Both buried piping (in contact with soil) and underground piping (e.g., contained in vaults) can be either safety-related or nonsafety-related piping. The criteria and limits for safety-related piping require the piping to be able to perform its safety function and require that any radioactive material that may be released not pose any credible threat of harm to public health and safety. Safety related is defined by 10 CFR 50.2 and means those items relied upon to remain functional during and following design basis events to assure: (1) the integrity of the reactor coolant pressure boundary, (2) the capability to shut down the reactor and maintain it in a safe shutdown condition; or (3) the capability to prevent or mitigate the consequences of accidents which could result in potential offsite exposures comparable to the applicable guideline exposures set forth in 10 CFR 50.34(a)(1) or 10 CFR 100.11, as applicable. Safety related piping systems generally fall into one of the ASME Code classifications (i.e., Class 1, 2 or 3). Safety-related buried piping falls under ASME Code Class 3, which means it generally contains relatively low pressure and low temperature water.

For all nuclear power plants, the regulations in 10 CFR Part 50, Appendix A, "General Design Criteria," or similar requirements imposed during plant licensing for pre-10 CFR Part 50, Appendix A facilities, provide requirements for SSCs important to safety. These regulations specify piping, including buried piping, be designed in a robust manner that ensures piping structural integrity, capability to withstand the effects of natural phenomenon such as earthquakes, configuration to permit inspection to assure integrity and capability of the system, and capability to permit appropriate periodic pressure and functional testing. The criteria presented in 10 CFR 50, Appendix A, are design and operational objectives that provide a foundation for safety at nuclear power plants.

In addition, the regulations in 10 CFR 50.55a, "Codes and Standards," require the application of various codes and standards such as the ASME Code. 10 CFR 50.55a provides requirements for examining and testing buried, safety-related piping through the endorsement of sections of the ASME Code. The ASME Code does not currently address nonsafety-related piping nor does it address all leaks that are not structurally significant. However, the integrity of underground SSCs remains important to the nuclear power plant operators, as they must monitor the releases (effluents) from their plants, regardless of whether the releases are planned or unplanned. As required by 10 CFR 50.75(g), records of spills/leaks and the locations of structures in underground locations that may be subject to contamination must be kept to facilitate safe and effective decommissioning of the facility.

NRC regulations incorporate by reference the technical requirements, safety requirements, guidelines, and recommended practices of the ASME Code for assessing structural adequacy of piping considered important to safety. The NRC staff has determined that current ASME Code requirements are adequate for ensuring that structural integrity is maintained for buried, safety-related piping such that the piping is capable of performing its safety function. The ASME Code does not currently address nonsafety-related piping nor does it address all leaks that do not challenge the structural integrity of the pipe. Historically, the focus of the NRC's regulatory requirements has been to ensure that radioactive releases—including unintended leaks and spills—stay below NRC dose limits and design objectives, within the effluent limits that are approved for the plant. Because some of the leakage that has been observed has been associated with nonsafety-related piping, and NRC regulations are not prescriptive for addressing the maintenance of nonsafety-related piping and tanks containing radioactive material, the GTF report recommended additional staff efforts in this area. The staff had earlier noted in SECY-09-0174 that discussions with ASME Code committee members resulted in the observation that changes to the ASME Code to require pipes be leak tight, or to extend Code provisions to nonsafety-related piping, would be a significant effort that would not necessarily have any beneficial effect on structural integrity, which is the current focus of the Code provisions. However, in light of NRC involvement in this issue and stakeholder attention, and recognizing the benefits to the utilities of proactive maintenance, the pertinent ASME Code committees have decided to develop a Code Case for inspection and maintenance of safety-related buried piping and are considering the development of provisions for nonsafety-related piping as well. Development of such inspection and maintenance guidance via the consensus standard process is responsive to the recommendations in the GTF report and may be included in a future update to the regulatory framework. The staff would review any additional Code provisions for endorsement through the normal 10 CFR 50.55a, "Codes and Standards," rulemaking, which incorporates Code provisions by reference into the regulations.

Over the past decade, instances of buried piping leaks have occurred in safety-related and nonsafety-related piping at nuclear power plants. Some of these leaks have caused inadvertent releases of low-level radioactive material. This has resulted in groundwater contamination at several plants. The staff evaluated these events individually and contemporaneously. The pipe degradation leading to these leaks did not affect the operability of safety systems, and the type and amount of radioactive material or chemicals released to the environment was a small fraction of the regulatory limits. Consequently, these pipe leaks have been of low significance with respect to public health and safety and the environment.

The staff evaluated whether the occurrences of release of radioactive material into the ground as a result of degradation of buried piping indicated a need to establish limits at a location other than the site boundary (within the site boundary). As part of the operational experience review associated with the development of SECY-09-0174, the staff determined that none of the events associated with degradation of buried piping resulted in releases that exceeded a small fraction of existing limits for members of the public at the site boundary. Since the staff's review of the known pipe leaks indicated the dose impact was a small fraction of existing limits at the site boundary, the staff concluded that it is not currently necessary to establish any new requirements that would be applicable inside the site boundary to address buried piping degradation.

Looking to the future, new reactors are required to meet the requirements discussed above. In addition, 10 CFR 20.1406, *Minimization of Contamination*, requires license applications submitted after August 1997 to demonstrate how the facility's design and procedures for operation will reduce contamination of both the facility and environment as well as reduce the generation of radioactive waste. Proper implementation of this regulation for new reactors should substantially reduce or eliminate the occurrence of residual contamination for the next generation of nuclear facilities, and could include adoption of predictive maintenance practices to ensure leakage and contamination is maintained as low as reasonably achievable.

Recognizing that many facilities and installations other than facilities regulated by the NRC employ buried piping, the staff has also evaluated regulations and codes and standards applicable to other industries, as discussed in SECY-09-0174. Buried piping and tanks that contain or transport potentially hazardous or environmentally sensitive material are regulated under U.S. Department of Transportation (49 CFR) and EPA (40 CFR) regulations. Generally, these regulations implement installation, corrosion protection, maintenance and condition monitoring standards developed by NACE International (formerly National Association of Corrosion Engineers). Degradation of buried piping is caused by corrosion. The implementation of these standards has been highly effective in preventing leaks in buried piping and buried tanks. These corrosion protection standards are required to be applied to many thousands of miles of buried petroleum product transportation piping and many thousands of buried tanks in the United States but are not required to be implemented at nuclear power plants. The staff reviewed these standards and concluded that implementation of these standards at nuclear power facilities could be an effective means of reducing the potential for degradation and consequential leakage from buried piping.

Current NACE standards are optimized for long straight runs of piping typical of transmission pipelines, and therefore cannot be considered optimized for use by nuclear power plant operators. In recognition of the significant interest of nuclear power plant operators in the issue of buried piping, NACE has formed a nuclear buried piping task group. The purpose of this task group is to evaluate the need for specific corrosion protection standards that could be implemented at nuclear power facilities. The staff is participating in this task group and believes that implementation of NACE standards in nuclear power plants could complement the ASME Code Section III and XI provisions and be an effective means of reducing the potential for degradation and consequential leakage from buried piping through proactive strategies such as cathodic protection. Reducing the potential for leaks by strengthening piping standards is responsive to the policy issue raised in the GTF report regarding the need to ensure that the regulatory framework is sufficient to address inadvertent leaks and spills. The nuclear power industry has developed a document through the Electric Power Research Institute, "Recommendations for an Effective Program to Control the Degradation of Buried Pipe," released publicly on October 7, 2009 (and update December 2010), for use by nuclear plants and is implemented programmatically through the industry initiatives discussed in Enclosure 3. This document contains elements of the NACE standards, which have formed the basis for the industry initiatives addressing buried piping. The Institute for Nuclear Power Operations uses the NACE guidance to evaluate plants' buried piping programs during its evaluations.

The staff has also recognized the value of these corrosion protection strategies in their license renewal guidance. In response to operating experience, the NRC staff initiated a recent update to the Buried and Underground Piping and Tanks Aging Management Program in the NRC guidance document for license renewal, NUREG-1801, Revision 2, "Generic Aging Lessons Learned (GALL) Report," issued December 2010 (ADAMS Accession No. ML103490041). The Buried and Underground Piping and Tanks Aging Management Program has been modified to inspect a wider variety of buried components subject to an aging management program and to credit the consistent use of cathodic protection for a buried component in determining the inspection frequency for the component.

The staff has also participated in developing an industry-consensus standard on evaluation of subsurface radionuclide transport at commercial nuclear power plants. This standard was completed and approved by the American Nuclear Society (ANS) and the American National Standard Institute (ANSI) as ANS/ANSI-2.17-2010 in December 2010. Its scope is to establish "the requirements for evaluating the occurrence and movement of radionuclides in the subsurface resulting from unplanned radionuclide releases at commercial nuclear power plants. This standard applies to unplanned radionuclide releases that affect groundwater, water supplies derived from groundwater, and surface waters affected by subsurface transport, including exposure pathways across the groundwater-surface water transition zone."

Other concurrent staff activities include amending environmental protection regulations, 10 CFR Part 51, for license renewal by updating the Commission's 1996 findings on the environmental impacts related to the renewal of nuclear power plant operating licenses. The most recent Commission direction on this update can be found in a 2009 Staff Requirements Memorandum, SRM-SECY-09-0034 (May 4, 2009).

The NRC proposed (74 *Federal Register* 38117; July 31, 2009), and the public has commented on, a rule that adds a new plant specific issue, "Radionuclides Released to Groundwater," to evaluate the potential impact of discharges of radionuclides, such as tritium, from plant systems into groundwater. This issue is relevant to license renewal because all commercial nuclear power plants routinely release radioactive gaseous and liquid materials into the environment, and the continuing trend of inadvertent releases from plant systems and piping being discovered at nuclear power plants. These reviews will be plant specific as no generic evaluation would apply to all plants because each site has its own unique groundwater protection program. If approved, the rule will require license renewal applicants to assess the impact of radionuclides in groundwater resources that could also have an impact on human health and the environment during the license renewal term.

Based on its review of the current regulatory framework and the industry initiatives that are intended to help industry meet the regulatory requirements in a uniform manner, the SMRG found that licensee actions taken in response to leaks and spills have been consistent with NRC's regulatory requirements and no new regulatory requirements need to be considered with respect to protection of the environment. The SMRG found that the three industry initiatives can, if properly implemented, enhance the prevention, response and remediation of potential threats to groundwater. The SMRG also found that in view of the progress being made by industry in protecting groundwater, rulemaking or some other form of regulatory requirement to codify the voluntary initiatives would not result, at this time, in a substantial increase in the overall protection of the public health and safety.

Industry Initiatives

The nuclear power industry, through the Nuclear Energy Institute (NEI), has developed industry initiatives focused on managing the various aspects of groundwater protection: Groundwater Protection Initiative, Buried Piping Integrity Initiative, and Underground Piping and Tanks Integrity Initiative. NEI 07-07, "Industry Groundwater Protection Initiative," was issued in August 2007 (ADAMS Accession No. ML072600295). The goal of the Groundwater Protection Initiative (GPI), which all plants have committed to follow, is to identify licensee actions to improve the response to inadvertent releases that may result in low but detectable levels of plant-related radioactive materials in subsurface soils and water. These actions include the development of written groundwater protection programs, improved stakeholder communications, and program oversight. One objective of the GPI is to detect leaks well before they can challenge regulatory limits for unintended release of radioactive material to the public and the environment. The GPI addresses detection and remediation of leaks but is not necessarily focused on preventing leaks, which became the intent of a later initiative regarding buried piping. The GPI elements describe conducting hydrogeologic studies, performing site risk assessments, establishing on-site groundwater monitoring, and establishing a remediation protocol. Recordkeeping, communications, self assessments, and peer assessment are also included. Based on these program elements, licensees can select locations for site monitoring wells near potential sources of contamination, in order to identify leaks early.

Industry self-assessment and peer assessment of the implementation of the GPI are key aspects of the program. For example, to ensure that the individual sites are implementing the initiative, the GPI requires licensees to do both of the following:

(1) independent peer assessments of the site's written groundwater protection program, and
(2) independent NEI assessments of the site's written groundwater protection program.

The independent industry peer assessments evaluate aspects of the site program, such as having independent hydrogeologists review the location of monitoring wells relative to SSCs that contain or could contain licensed material and for which there is a credible mechanism for the licensed material to reach groundwater. The hydrogeologist assesses whether the wells are situated in appropriate locations. For the independent NEI assessment, a team was sent to each site after 1 year, with plans to reevaluate at least once every 5 years (baseline assessments were completed by the first quarter of calendar year 2010), to ensure that the program elements are in place and that elements that are not consistent with the guidance are tracked in the licensee's corrective action program and addressed in a timely manner.

On January 14, 2011, the NRC received a summary report of the results of the NEI-sponsored peer reviews of industry implementation of the 43 acceptance criteria contained in the GPI. The report summarizes the results of the first full round of peer reviews conducted in 2009-2010 by five teams of industry subject matter experts. The report concluded that industry's implementation of the GPI has been successful in improving ground water protection. The review confirmed that each nuclear power plant site has at least one method for early detection of unintended releases to the environment and each site has improved procedures for communicating effectively to stakeholders in the event of an unintended release. The industry peer reviews were designed to be challenging evaluations that identified opportunities for improvement. The report concluded that the assessments also identified opportunities to further improve these efforts using shared operating experience and best practices. Identified gaps were most commonly due to incomplete documentation, most frequently in the following four areas:

- Documentation of evaluations of work practices to determine the potential for unintended releases;
- Improvements to the systems, structures, and components (SSC) evaluations from use of detailed information and engineering involvement, particularly on preventative maintenance programs and inspections or other means of determining the condition of some systems, structures and components);
- Establishment of a site-specific decision-making protocol for remediation efforts; and
- Evaluation of the potential contribution of monitored and controlled radioactive effluents to detectable concentrations of plant-related licensed material in ground water (as a result of planned and permitted releases).

The cover letter for the NEI report stated that upon completion of the full cycle of initial peer reviews, company chief nuclear officers followed up on the findings. They confirmed that all identified areas for improvement had been entered into the respective site corrective action programs and had either been addressed or were on an appropriate schedule for completion.

Recognizing that leaks have occurred that have affected public confidence and requiring increased monitoring, a second industry initiative was created. This initiative is the “Buried Piping Integrity Initiative”, dated November 20, 2009 (ADAMS Accession No. ML093350032). The goal of this initiative is to provide proactive assessment and management of the condition of buried piping systems, sharing of industry experience, and technology development to improve the available techniques for inspecting and analyzing buried piping.

The third initiative is the Underground Piping and Tanks Integrity Initiative, dated September 27, 2010 (ADAMS Accession No. ML103410507). Shortly after the Buried Piping Integrity Initiative was approved, Entergy identified a pipe located within an underground vault as the source of a tritium leak at Vermont Yankee. This event received much public attention in the Northeast and attracted significant stakeholder interest. This experience showed the industry that, if its Buried Piping Integrity Initiative was intended to enhance public confidence, limiting the scope of the initiative to piping that is in direct contact with the soil was not adequate when piping in vaults and other underground components could also leak into the groundwater. In response to this concern, the industry revised the Buried Piping Integrity Initiative to extend its scope to additional underground components. The added scope includes underground piping and tanks that are outside of a building and below grade (whether or not they are in direct contact with the soil) if they are safety related, or contain licensed radioactive material, or are known to be contaminated with licensed radioactive material. The revised initiative, the third consensus industry initiative, was issued with the new name, “Underground Piping and Tanks Integrity Initiative.”

The staff has initiated, and plans to continue, efforts to work with consensus standards organizations to have certain provisions related to inspection and maintenance of buried pipe incorporated into ASME Code cases and NACE standards. The industry initiative on Underground Piping and Tanks Integrity implements the philosophy of the NACE standards. Overall, these initiatives have the objective of reducing the number and severity of leaks experienced across the nuclear fleet. The GPI targets the detection of leaks when they are small, before they have a chance to grow and the Underground Piping and Tanks Integrity Initiative targets the prevention of leaks by improving maintenance and inspection (and possible replacement) of SSCs. Although the staff's review of these initiatives and interaction with the industry continues, the SMRG finds that these initiatives provide industry the programmatic infrastructure to manage groundwater protection in order to enhance their compliance with the regulatory requirements and provide the information necessary for ensuring that these initiatives achieve the expected outcome—fewer and more limited unplanned releases.

NRC's Inspection Program

The NRC has revised its inspections of nuclear power plants to evaluate licensees' programs to inspect, assess and repair equipment and structures that could potentially leak. The NRC has also placed additional emphasis on evaluating the licensees' abilities to analyze additional discharge pathways, such as groundwater, as a result of a spill or leak. The agency's resident inspectors, who work full-time at operating U.S. nuclear power plants, regularly monitor all these activities and any deficiencies discovered could trigger more intensive NRC oversight of a plant.

Prior to 2008, the NRC's baseline inspection procedures in its Reactor Oversight Program contained guidance for monitoring radioactive effluents, but the procedures lacked detailed guidance regarding inspection of licensees' groundwater monitoring programs. As a result, the NRC developed NRC Temporary Instruction TI-2515/173 in 2008.

Between August 2008 and August 2010, NRC inspectors used this Temporary Instruction to evaluate licensees' groundwater monitoring programs. As all of the nuclear plants have indicated that they are committed to following the voluntary industry initiative on groundwater protection, the Temporary Instruction has been tailored to help the NRC understand how the program as implemented on each site ensures that the regulations are met. This Temporary Instruction contained detailed guidance that NRC Inspectors used to evaluate all aspects of the licensees' groundwater monitoring programs. NRC inspectors used the Temporary Instruction at all U.S. reactor sites, and the conclusions from that effort indicated licensee's performance had improved. Minor gaps still exist for some licensees in their full implementation of the voluntary initiative on groundwater protection, and will be the subject of review for later baseline inspections.

In January 2010, the NRC baseline inspection procedures IP 071124.06 and IP 071124.07 were revised to include detailed guidance on inspecting licensees' Groundwater Monitoring Programs. These inspection procedures contain guidance that NRC inspectors use for inspecting licensees' programs for Radiological Environmental Monitoring and Radioactive Effluents, including guidance for inspecting licensees' Groundwater Monitoring Programs. The NRC will rely on these inspection procedures to ensure licensees' Groundwater Monitoring Programs contain the information necessary to comply with NRC regulations. Additionally, when gaps are identified in a licensee's groundwater monitoring program, the gaps will be entered into the licensee's corrective action program in order to track issues to resolution.

As was done for the Groundwater Protection Initiative, the NRC is developing a Temporary Instruction for inspecting licensees' programs for the Underground Piping and Tanks Integrity Initiative (formerly called the Buried Piping Integrity Initiative). This Temporary Instruction will be used to gauge the effectiveness of the licensees' Underground Piping and Tank Integrity Initiative.

The SMRG found that the NRC's Temporary Instructions and Baseline Inspection Procedures provide a sufficient framework to inspect licensees' compliance with NRC's requirements for control of effluents and release of radioactive materials, and the programs that the licensees use to enhance compliance with the regulations, and the Groundwater Protection and

Underground Piping and Tank Integrity Programs. The NRC staff will continue to use this inspection approach, along with monitoring the licensees' implementation of the NEI Initiatives, to monitor licensees' performance with respect to groundwater protection.