POLICY ISSUE
(Information)

December 2, 2009 SECY-09-0174

FOR: The Commissioners

FROM: Eric J. Leeds, Director
Office of Nuclear Reactor Regulation

SUBJECT: STAFF PROGRESS IN EVALUATION OF BURIED PIPING AT NUCLEAR REACTOR FACILITIES

PURPOSE

This paper responds to the Chairman's memorandum dated September 3, 2009, (Agencywide Documents Access and Management System (ADAMS) Accession No. ML092460648) tasking the staff to describe the activities currently underway or planned addressing the issue of leaks from buried piping. In his memorandum, Chairman Jaczko requested a staff evaluation of the adequacy of (1) Nuclear Regulatory Commission (NRC) requirements for design, inspection and maintenance of safety-related buried piping; (2) American Society of Mechanical Engineers Code (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 any revisions to regulations, requirements, practices or oversight related to buried piping.

BACKGROUND

Over the past several years, 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 and diesel fuel oil. This has resulted in groundwater contamination at several plants. The pipe degradation leading to these leaks has not affected the operability of safety systems, and the type and amount of radioactive material or chemicals released to the environment have been a small fraction of the regulatory limits. Consequently, these pipe leaks have been of low significance with respect to public health and safety.

CONTACT: Robert O. Hardies, NRR/DCI
301-415-5802

The NRC staff has evaluated these recent leakage events, root cause evaluations and licensee corrective actions. Based on application of NRC's performance-based and risk-informed Reactor Oversight Process (ROP), these recent events did not constitute performance deficiencies of greater than minor safety significance because the radiological consequences associated with the leaks were very low and because the capability of the piping to perform its safety function was not degraded. Upon application of NRC's Issue Screening and Significance Determination Processes, the staff determined the issues were of minor safety significance.[1] Accordingly, these buried pipe leakage events have not warranted enforcement actions.

In May 2006, the U.S. commercial nuclear power plants adopted the Nuclear Energy Institute (NEI) Groundwater Protection Initiative (GPI) in response to leaks containing radioactive material at several plants. The initiative is described in Attachment 1 to "NEI-07-07 Industry Ground Water Protection Initiative - Final Guidance Document," dated August 2007 (ADAMS Accession No. ML062260198). The initiative, which all plants committed to follow, identifies actions to improve licensee response to inadvertent releases that may result in low but detectible levels of plant-related radioactive materials in subsurface soils and water. The GPI provides the actions licensees are expected to take including 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. The GPI addresses detection and remediation of leaks but is not focused on preventing leaks.

NUREG/CR-6876, "Risk-Informed Assessment of Degraded Buried Piping Systems in Nuclear Power Plants," evaluated corrosion damage on buried pipe and concluded that structural integrity can be maintained even with relatively high levels of general wall thinning. Because corrosion of buried piping typically initiates at local areas of coating damage, the resulting degradation is localized. From a structural integrity perspective, localized corrosion is much less challenging than general wall thinning. Localized degradation of buried piping typically causes small leaks that do not challenge structural integrity. Reports of operating experience are consistent with this observation; there have been no challenges to functionality or structural integrity due to degradation of buried, safety-related piping at nuclear power plants.

DISCUSSION

Review of Current Regulations

The NRC staff reviewed applicable regulations governing buried, safety-related piping for operating reactors, renewal of licenses, and new reactor licenses. For all nuclear power plants, the regulations in Title 10 of the *Code of Federal Regulations* (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, and 10 CFR 50.55a, "Codes and Standards," provide design requirements for safety-related components, including some buried piping. In addition, 10 CFR 50.55a provides requirements for examining and testing buried, safety-related piping.

---

[1] Note that leakage at Braidwood Station in 2005, described in NRC Information Notice 2006-13, "Ground-water Contamination Due to Undetected Leakage of Radioactive Water" was caused by a leaking vacuum breaker and not by degradation of buried piping; therefore, it was not within the scope of this review.

Licensees are required to verify that radioactive effluents, either from pipe leakage or from normal operations, are within NRC regulatory limits and design objectives. The NRC limits for radioactive effluents are contained 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 licensee’s technical specifications and Offsite Dose Calculation Manual.

For new plants where license applications are submitted after August 20, 1997, 10 CFR 20.1406 “Minimization of Contamination” requires a description of how the facility's design and procedures for operation will minimize (to the extent practicable) contamination of the facility and environment, facilitate decommissioning, and minimize the generation of radioactive waste.

For plants applying to renew their licenses, 10 CFR Part 54, “Requirements for Renewal of Operating Licenses for Nuclear Power Plants,” establishes requirements for managing aging effects of certain systems and components, including buried piping, that are important to safety or whose failure could adversely impact the ability of systems to perform their intended safety function.

With regard to buried piping, 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 licensee’s technical specifications or other applicable limits. The staff has determined that current regulations are adequate for these purposes.

Review of the ASME Code

The staff reviewed applicable portions of the ASME Code. The ASME Code, Section III, “Rules for Construction of Nuclear Facility Components,” provides design rules for materials, design, fabrication, installation, examination, testing and overpressure protection to ensure the structural integrity of nuclear piping and components. The ASME Code, Section XI, “Rules for Inservice Inspection of Nuclear Power Plant Components,” provides requirements for the examination and testing of buried, safety-related piping. Section XI also provides acceptance criteria, rules for the evaluation of flaws, and repair/replacement rules for piping and components. The ASME Code does not currently address nonsafety-related piping nor does it address leaks that are not structurally significant.

The staff has determined that current ASME Code requirements are adequate for ensuring structural integrity is maintained for buried, safety-related piping such that the piping will be capable of performing its safety function. The staff routinely works with ASME to update the Code to address operational experience or improvements in design or inspection technology and will continue this participation.

Inspection

The staff reviewed NRC inspection guidance on licensee activities related to buried piping degradation. Under the ROP, the baseline inspection program allows inspectors to review issues associated with buried piping if they are believed to be risk significant. There is no direct guidance to select a buried piping issue as an inspection sample; however, inspectors can review flow tests, inservice inspection activities, condition monitoring, post-maintenance testing, and corrective actions using select inspection procedures. Historically, most buried pipe ROP inspection samples have been selected as a followup to an actual piping failure, known degradation, or problem identified during a review of a condition report. In addition, NRC reviews licensee implementation of the industry Groundwater Protection Initiative.

The staff has determined that the current inspection process is adequate to verify appropriate licensee implementation of current regulations and the GPI. The staff plans to evaluate and revise, as necessary, the ROP to address new industry initiatives for buried pipe.

Industry Activities

The staff has engaged industry, including at public meetings on August 20, 2009, and October 22, 2009, to gather information on the scope and status of their activities related to buried piping. Specifically, the staff met with representatives from a specific licensee with recent buried piping leakage experience, the Institute of Nuclear Power Operations (INPO), the Electric Power Research Institute (EPRI), and NEI.

INPO conducts performance-based evaluations at each plant about every two years. In 2007 INPO identified buried piping as a focus area and began to assess buried piping degradation management using predictive maintenance criteria.

In December 2008, EPRI published “Recommendations for an Effective Program to Control the Degradation of Buried Pipe,” to provide nuclear power plant licensees with guidance on implementing preventive maintenance programs to detect and mitigate degradation in piping systems before leakage occurs. The industry has recently begun to implement this guidance.

By letter dated November 20, 2009 (ADAMS Accession No. ML093350032), NEI indicated that the nuclear industry’s chief nuclear officers voted to approve a proposed “Buried Piping Integrity Initiative.” The stated goal of the initiative is to “provide reasonable assurance of structural and leakage integrity of all buried piping with special emphasis on piping that contains radioactive materials.” Objectives include proactive assessment and management of the condition of buried piping systems and technology development to improve upon available techniques for inspecting and analyzing underground piping. The staff plans to meet with the industry to further understand this initiative and assess licensee implementation.

Conclusions

Based on the staff’s review of operating experience related to buried piping degradation, current regulations and ASME Code requirements have been effective in ensuring that the structural integrity and functionality of buried, safety-related piping are maintained. Current regulations have also been effective in ensuring unintended releases of hazardous material to the environment from leaks in buried piping remain below regulatory limits. Therefore, the staff has no current plans to recommend regulatory changes to address degradation of buried piping.

The industry has recently developed the Buried Piping Integrity Initiative. The staff plans to meet with the industry to further understand this initiative and monitor industry implementation. The staff will also evaluate the need to revise NRC Inspection Procedures to assess licensee implementation of this new initiative.

The staff will continue to monitor operating experience and assess the need for any further regulatory actions or communications. The enclosure to this paper provides additional detail related to these conclusions.

COORDINATION

The Office of the General Counsel has reviewed this paper and has no legal objection.

/RA/

Eric J. Leeds, Director
Office of Nuclear Reactor Regulation

Enclosure:
Additional Information Related to
Evaluation of Buried Piping Degradation
at Nuclear Reactor Facilities

The staff will continue to monitor operating experience and assess the need for any further regulatory actions or communications. The enclosure to this paper provides additional detail related to these conclusions.

COORDINATION

The Office of the General Counsel has reviewed this paper and has no legal objection.

/RA/

Eric J. Leeds, Director
Office of Nuclear Reactor Regulation

Enclosure:
Additional Information Related to Evaluation of Buried Piping Degradation at Nuclear Reactor Facilities

WITS Item No.: 200900167/EDATS: OEDO-2009-0535
ADAMS Accession No.: ML093160004

OFICE	NRR/ADES/DCI	TECH ED*	NRR/ADES/DCI	NRR/ADES/DCI	NRR/ADRO/DIRS
NAME	RHardies	JZabel	JLubinski (MEvans for)	MEvans	FBrown
DATE	11/12/09	12/01/09	11/16/09	12/01/09	11/20/09
OFFICE	NRO/DE	RES/DE	NRR/DLR	OGC	NRR
NAME	TBergman	MCase (SRichards for)	BHolian	EWilliamson	ELeeds
DATE	11/19/09	11/20/09	11/20/09	11/23/09	12/02/09

OFFICIAL RECORD COPY

ADDITIONAL INFORMATION RELATED TO EVALUATION OF BURIED PIPING DEGRADATION AT NUCLEAR POWER PLANTS

PURPOSE

This paper provides additional detail related to the Chairman's memorandum dated September 3, 2009, (Agencywide Documents Access and Management System (ADAMS) Accession No. ML092460648) tasking the staff to describe the activities currently underway or planned addressing the issue of leaks from buried piping.

INTRODUCTION

In his memorandum, Chairman Jaczko requested a staff evaluation of the adequacy of (1) Nuclear Regulatory Commission (NRC) requirements for design, inspection and maintenance of safety-related buried piping; (2) American Society of Mechanical Engineers Boiler and Pressure Vessel Code (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 any revisions to regulations, requirements, practices or oversight related to buried piping.

The staff responded to the Chairman tasking memorandum with SECY-09-0174, Staff Progress in Evaluation of Buried Piping at Nuclear Reactor Facilities (ADAMS Accession No. ML093160004). This paper provides additional detail related to conclusions made in SECY-09-0174.

BACKGROUND

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.

In June 2005, as part of a program to assess a variety of forms of age-related degradation in passive components, the staff published NUREG/CR-6876, "Risk-Informed Assessment of Degraded Buried Piping Systems in Nuclear Power Plants." This report evaluated corrosion damage on buried pipe and concluded that structural integrity can be maintained even with relatively high levels of general wall thinning.

ENCLOSURE

In May 2006, the U.S. commercial nuclear power plants adopted the Nuclear Energy Institute (NEI) Groundwater Protection Initiative (GPI) in response to abnormal releases of radioactive material at several plants (which were not necessarily related to buried piping degradation). The initiative is described in Attachment 1 to "NEI-07-07 Industry Ground Water Protection

Initiative - Final Guidance Document," dated August 2007 (ADAMS Accession No. ML062260198). The initiative, which all plants committed to follow, identifies actions to improve licensee 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 focused on preventing leaks.

Degradation of buried piping is caused by corrosion. Structural integrity of buried piping can be readily maintained because corrosion normally occurs at localized points associated with coating damage. This corrosion has little effect on the structural integrity of the pipe because little or no corrosion occurs in areas where coating damage does not occur. Instead, localized degradation of buried piping typically causes small leaks that do not challenge structural integrity. Reports of operating experience are consistent with this observation; there have been no challenges to functionality or structural integrity due to degradation of buried, safety-related piping at nuclear power plants. Safety-related piping that has been excavated for the purposes of repairing leaks has been inspected to determine whether degradation has affected the structural integrity of the piping. In no cases has structural integrity been compromised.

EVALUATION

In preparing its response to the Chairman's tasking memorandum, the staff evaluated operational experience, regulations, codes and standards, NRC inspection activities, industry activities and international activities. The following sections discuss the staff's evaluation, conclusions and follow-up actions for each of these areas.

Operational Experience

The staff operating experience clearinghouse performed a screening of several events involving leakage from buried piping and on July 16, 2009 identified and assigned buried piping as an Issue for Resolution (IFR). As part of the IFR generic evaluation process, the staff collected and evaluated recent operational events that were reported to the NRC. The NRC staff has evaluated these recent leakage events, root cause evaluations and licensee corrective actions. Based on application of NRC's performance-based and risk-informed Reactor Oversight Process (ROP), these recent events did not constitute performance deficiencies of greater than low safety significance because the radiological consequences associated with the leaks were very minor and because the piping remained capable of performing its safety function. Upon application of NRC's Issue Screening and Significance Determination Processes, the staff determined the issues were of low safety significance.[2]

The staff performed a review of a database of operational events that is maintained by the Institute of Nuclear Power Operations (INPO) and includes descriptions of events that are not required to be reported to the NRC. The review did not reveal any additional instances (not already reported to the NRC) of degradation of safety-related buried piping or inadvertent release of radioactive material. The staff also reviewed NRC inspection findings related to buried piping. None of the findings involved events where piping functionality or structural integrity was compromised.

Conclusions

Based on a review of operational events, the staff concluded that the pipe leaks from these events have been of low significance with respect to public health and safety and the environment.

Actions

The staff is scheduled to issue the IFR report during the second quarter of FY2010 and will take any additional action, if necessary, based on the results of this generic evaluation.

The staff will continue to review operating experience of buried pipe as part of its normal operating experience review process.

Review of Current Regulations

The NRC staff reviewed applicable regulations governing buried piping. These regulations establish criteria or limits that, if met, ensure the health and safety of the public are maintained. 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. The staff evaluated whether current regulations establish appropriate criteria with respect to degradation of and release from buried piping.

The review encompassed regulations related to safety function and to release of radioactive material. Within these categories of safety function and release of radioactive materials the staff evaluated regulations related to operating plants, license renewal and new plants. Safety-related is defined by Title 10 of the *Code of Federal* Regulations (10 CFR) 50.2 and means those items relied upon to remain functional during and following design basis events to

[2] Note that leakage at Braidwood Station in 2005, described in NRC Information Notice 2006-13, "Ground-water Contamination Due to Undetected Leakage of Radioactive Water" was caused by a leaking vacuum breaker and not by degradation of buried piping; therefore, it was not within the scope of this review.

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). Piping Code classification is determined by using Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants" and 10 CFR 50.55a. 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 Title 10 of the *Code of Federal Regulations* (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 systems, structures, and components 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. The process of degradation of buried piping does not create any challenge to safety that is not already addressed by the existing GDC. Adoption of changes to the GDC to address buried piping degradation would be redundant to existing GDC. For example, a proposed enhancement to the GDC to require buried safety-related piping to be designed to be capable of withstanding natural events would be redundant to the existing requirements that all safety-related piping, including buried piping, be designed to withstand natural events. Accordingly, the staff concludes that the existing GDC are adequate, so do not need to be enhanced to address buried piping degradation.

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. Section III of the Code applies to the design of safety-related pressure-boundary components (including buried piping) in nuclear power plants. Section XI of the Code provides requirements for the examination and testing of safety-related buried piping. Among the requirements established by Section XI is a requirement to perform periodic flow tests of safety-related piping, including buried piping. The flow tests ensure piping segments are capable of performing their safety function of delivering fluid in the appropriate quantity upon demand. In practice plants test safety-related piping every ninety days. The trend from the results of this testing indicate buried safety-related piping continues to be able to perform its safety function even in instances where leaks have occurred. The safety function has not been compromised due to degradation. The staff concludes that the requirements in 10 CFR 50.55a to perform testing are adequate and that the results of the testing indicate that buried piping degradation is not currently impacting the ability of safety-related buried piping to perform its safety function.

10 CFR 50.55a requires that once leakage through the wall of Class 3 piping is discovered, it must be repaired. However, the regulation permits the licensee to postpone the repairs for up to 24 months, depending on operational circumstances. These requirements apply equally to

buried piping and to piping that may be more accessible, such as inside buildings. Licensees are required to evaluate the leakage to ensure the piping remains capable of performing its safety function until such time as repairs can be accomplished. These requirements provide flexibility to perform repairs on a schedule that permits adequate planning while still ensuring the piping always remains capable of performing its safety function.

Licensees are required to maintain radioactive effluents, either from pipe leakage or from normal operations, within NRC regulatory limits and design objectives. The NRC limits for radioactive effluents are contained 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 licensing basis for each site (e.g., licensee's technical specifications and Offsite Dose Calculation Manual (ODCM)). The effluent concentration limits of 10 CFR 20, Appendix B, Table 2 (10 CFR 20.1302(b)) would be applicable to members of the public. These regulations limit the potential dose to members of the public that could result from an inadvertent release of radioactive material.

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, 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. A tabulation that describes the radiological consequences of the leakage during the events that occurred in 2009 is provided in Table 1. As part of the industry's GPI, licensees monitor groundwater using wells, to understand whether leakage of radioactive materials is occurring. Once radionuclides are detected in groundwater onsite, licensees are required (by their licensing basis such as Technical Specifications and ODCM) to monitor ground water 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. 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.

Leakage from degraded buried piping can create contaminated soil. Worker dose accumulated during any necessary maintenance or remediation activities is controlled by site radiation protection programs and these activities have not exceeded small fractions of regulatory dose limits. Accordingly, the staff concludes that no changes to worker dose limits are warranted as a result of leakage from buried piping.

Tritium is a naturally occurring element. Its presence in public drinking water supplies is limited by Environmental Protection Agency regulations to be at concentrations no greater than 20,000 picocuries per liter (pCi/l). Most of the leaks from buried piping have been of water containing less than 20,000 pCi/l tritium, including the recent leak at Indian Point Unit 2, where the leaking water contained 2000 pCi/l, approximately one tenth the limit for drinking water. Some of the leakage events (Dresden in June, 2009, for example) involved water contaminated with tritium at concentrations that exceed EPA limits for safe drinking water. However, the water that has leaked from degraded buried piping is not intended for consumption. Additionally, water that leaks from buried piping becomes diluted as it moves away from the location of the leak. The effects of dilution are such that none of the leaks of tritiated water that have occurred have resulted in leakage offsite that exceeds a fraction of EPA limits for drinking water. This discussion is provided to illustrate the relatively low magnitude of tritium leakage from buried piping.

In addition to the above requirements which address operating power plants, 10 CFR Part 54 establishes additional requirements for power plants seeking to renew their operating licenses. These regulations require that the effects of aging be managed for structures, systems, and components which are passive and long lived and which are safety related; are not safety related, but whose failure could adversely affect safety related functions; or are relied upon to demonstrate compliance with certain regulations. License renewal regulations apply to some, but not all buried piping.

The license renewal rule requires applicants for license renewal to demonstrate that for each applicable structure, system, or component, the effects of aging will be adequately managed so that the intended functions will be maintained consistent with the current licensing basis for the period of extended operation. This is normally accomplished through the development of Aging Management Programs (AMPs). To assist in this process the staff has provided examples of AMPs in the Generic Aging Lessons Learned (GALL) report (NUREG-1801). Applicant programs which are consistent with the GALL AMPs are generally considered to be acceptable methods for managing aging. The GALL report contains several AMPs related to aging of the interior and exterior surfaces of buried piping.

Applicant’s AMPs are generally considered adequate to manage aging when they are consistent with the GALL AMPs and when the plant operating experience is no more adverse than the conditions for which the GALL AMP was designed. Several recent license renewal applications have included additional excavations and visual inspections, nondestructive examinations (various forms of ultrasonic testing), and selective replacement of some piping in response to adverse operating experience or recognized increased susceptibility of piping to aging.

The GALL report is currently undergoing a scheduled revision. During this revision all the aging management programs, including those associated with internal and external corrosion of buried piping are being examined and revised as necessary to address emerging issues. Current plans for the revision of these AMPs are to adjust or clarify inspection procedures, frequencies and locations to conform to current industry practices but to retain the goal of preventing loss of function, rather than establishing a goal of leak tightness, for these pipes. The revised GALL report, including revisions to the AMPs related to buried piping, is scheduled to be published in December 2010.

The GALL report is one acceptable way to meet the regulations. However, the staff concludes that no enhancements to regulations are required to address degradation of buried piping for plants applying for renewed licenses.

New reactors will be required to meet the requirements discussed above. In addition, they will need to comply with 10 CFR 20.1406 (Minimization of contamination), which requires license applications submitted after August 1997 to demonstrate how the facility's design and procedures for operation will reduce contamination of the facility and environment and the generation of radioactive waste. Proper implementation of this regulation for new facilities 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. It should be noted that this rule permits a licensee to address residual radioactivity by either reducing it or by provisioning additional decommissioning funding to address remediation of the residual radioactivity.

The staff has prepared a draft final rule (SECY 09-0042 - March 13, 2009) for consideration by the Commission related to minimization of contamination such as from leaks from buried piping at current operating facilities. Implementation of such a rule change would provide an incentive to operating facilities to institute predictive maintenance programs that minimize leaks from buried piping.

In practice, the combined operating license applications currently under review do not have safety-related buried piping. All of the safety related piping is proposed to be either above ground or installed in vaults or chases that provide accessibility and the ability to capture any leakage. If an applicant submitted a new design certification for consideration that featured buried safety-related piping, NRC staff reviewers would request information from the applicant describing how they intended to satisfy the requirements of 10 CFR 20.1406.

Conclusions

With regard to buried piping, 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 licensee’s technical specifications or other applicable limits which apply at the site boundary. The staff has determined that current regulations are adequate for these purposes.

Actions

The revised GALL report, including revisions to the AMPs related to buried piping, is scheduled to be published in December 2010.

Code and Standards

For all nuclear power plants 10 CFR 50.55a endorses the ASME Code. The ASME Code, Section III, “Rules for Construction of Nuclear Facility Components,” provides design rules for materials, design, margins, fabrication, installation, examination, testing and overpressure protection to ensure the structural integrity of safety-related nuclear piping and components. These rules ensure that installed piping, including buried piping, is robust and capable of performing its safety function. Degradation of buried piping is manifested primarily as localized corrosion that is caused, in part, by choice of maintenance practices that do not emphasize prevention of corrosion. Section III rules are applied to buried piping before it is placed into the ground, so do not specify or address maintenance or long term corrosion protection activities. The staff considered recent examples of buried piping degradation and determined that most of the events occurred on nonsafety-related piping, that structural integrity was not challenged in any of the events, and that the degradation generally occurred because of a choice that the licensee made regarding maintenance practices. In order to change Section III so that it addressed the situations observed in the operating events, its scope would need to be expanded to 1) piping systems that it currently does not address (nonsafety related piping is not within the scope of Section III), 2) a purpose that is not currently within its objectives (Section III requires structural integrity rather than leak tightness), and 3) address processes that it does not currently address (Section III addresses design and installation, not maintenance).

Therefore, the staff concludes that current Section III rules are adequate for their intended purpose of specifying a robust piping system and no changes are warranted.
The ASME Code, Section XI, “Rules for Inservice Inspection of Nuclear Power Plant Components,” provides requirements for the examination and testing of buried, safety-related piping. Section XI also provides acceptance criteria, rules for the evaluation of flaws, and repair/replacement rules for piping and components. Periodic flow testing required by Section XI ensures that buried piping remains capable of performing its safety function to deliver a specified quantity of liquid on demand. The staff considered whether such testing, which offers retrospective proof that safety-related buried piping is capable of performing its safety function, provide sufficient information about the future. Section XI only requires the testing be performed every approximately three years, but in practice all 104 nuclear power plants perform flow testing every ninety days. The results of quarterly tests from the start of plant operation indicate that degradation of buried piping has not compromised its ability to perform its safety function. Accordingly, the staff concludes that current ASME Code Section XI requirements are adequate for ensuring structural integrity is maintained for buried, safety-related piping such that the piping will be capable of performing its safety function.

The staff routinely works with ASME to update the Code to address operational experience or improvements in design or inspection technology and will continue this active participation. Examples of current Code activities that demonstrate evolution of the Code in response to operational experience include a committee that has been empanelled to provide a liaison function between Section XI and Section III so that experience from operating plants can be transmitted to and addressed by Section III, with the intent that new plants are able to avoid some challenges that were faced by older plants. Additionally, a Section III committee is developing updated design rules specifically for buried piping. The proposed changes involve incorporating newer soil loading calculative procedures. Once Section III publishes the newer design rules, Section XI intends to implement flaw evaluation procedures specific to buried piping. A final example of current Code activities related to buried piping involves the application of high density polyethylene (HDPE) as a material for buried piping. Buried HDPE piping has been extensively used in the water and gas industries, where its advantages of low cost, ease of fabrication and immunity to corrosion make it an attractive alternative to coated steel. The ASME is developing material property information related to long-term mechanical performance of this material in order to justify its addition as an acceptable material for application in buried, Class 3 applications. The staff is actively participating in all of these activities.

Recognizing that leaks in buried piping, if undetected for extended periods, could represent precursors to loss of structural integrity, the staff discussed the issue of buried piping degradation informally with Code members during committee meetings in November 2009. ASME Code committee members pointed out that, in general, the industry examples of degradation of buried piping had been discovered in nonsafety-related, nonclass piping, which were not subject to the jurisdiction of the ASME Code. Participants indicated that extension of ASME Code jurisdiction to nonsafety-related piping would be a large undertaking without an obvious benefit in terms of safety. With respect to the infrequent occurrences of degradation of safety-related piping, ASME Code committee personnel noted that the observed degradation did not affect structural integrity. They observed that changes to the Code to require leak tightness would be a significant effort that would not necessarily have any beneficial effect on structural integrity. They concluded that such changes to the Code were probably not warranted.

Codes and Standards in other Industries

Recognizing that many facilities and installations other than nuclear power plants employ buried piping, the staff evaluated regulations and codes and standards applicable to other industries. Buried piping and buried tanks used to contain or transport potentially hazardous or environmentally sensitive material are regulated under Department of Transportation (40 CFR) and Environmental Protection Agency (49 CFR) regulations. Generally, these regulations implement installation, corrosion protection, maintenance and condition monitoring standards developed by NACE International (formerly National Association of Corrosion Engineers). The implementation of these standards has been highly effective in preventing leaks in buried piping and buried tanks. 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. These corrosion protection standards are required to be applied to many thousands of miles of buried petroleum product transportation piping and many hundreds of thousands of buried tanks in the United States, but are not required to be implemented at nuclear power plants. Current NACE Standards have not been optimized for use by nuclear power plant operators. NACE has recognized the significant interest by nuclear power plant operators in the issue of buried piping and 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 committee, which will hold its first meeting during Spring 2010.

Conclusions

While the ASME Code Sections III and XI are adequate to ensure the capability of safety-related buried piping to perform its safety function, implementation of NACE Standards could be an effective means of reducing the potential for degradation and consequential leakage from buried piping.

Actions

The staff will continue to participate in ASME and NACE committees to develop enhancements related to advancements in technology or application of buried piping.

Inspection of Licensee Activities under the Reactor Oversight Program

The staff reviewed NRC inspection guidance on licensee activities related to buried piping degradation. Under the Reactor Oversight Program (ROP), the baseline inspection program does not require specific inspections of licensees' oversight of buried piping. The ROP allows inspectors to review issues associated with buried piping if they are believed to be risk significant. There is no direct guidance to select a buried piping issue as an inspection sample; however, inspectors can review flow tests, inservice inspection activities, condition monitoring, post-maintenance testing, and corrective actions using select inspection procedures. Historically, most buried pipe ROP inspection samples have been selected as a follow-up to an actual piping failure, known degradation, or a problem identified during a review of a condition report.

Examples of buried piping activities inspectors may review are as follows.

1. Inspectors may observe a licensee's periodic flow or pressure test of underground pipes, the video or results of a video or camera inspection of underground piping, results of a sound detection system used to detect leaks in underground piping, or the periodic maintenance conducted on a cathodic protection system (or similar system) used to protect underground piping and detect any potential leaks. These reviews can be captured under IP 71111.19, "Post Maintenance Testing" or IP 71111.22, "Surveillance Testing." Inspectors would review the licensee activities against any facility specific standards or procedures.

2. Inspectors may review a licensee's activities associated with buried piping during an inservice inspection (ISI) as one of the sample requirements in IP 71111.08, "Inservice Inspection Activities," which requires a review of two or three types of Non-Destructive Examination (NDE) activities. The licensee actions would be reviewed against the ASME Code requirements for the ISI activity. Most often for buried pipe this entails a flow test or pressure test.

3. If a buried pipe is within the licensee's maintenance rule scope, inspectors can evaluate the handling of the pipe performance or condition monitoring using IP 71111.12, "Maintenance Effectiveness."

4. If a licensee excavates underground piping for the purpose of repair and replacement, inspectors can use this opportunity for direct visual inspection of the piping. These activities can be reviewed under IP 71111.17, "Evaluations of Changes, Test, or Experiments and Permanent Plant Modifications" or IP 71111.19, "Post Maintenance Testing."

5. When a licensee implements corrective actions due to suspected underground piping leaks (as potentially identified by tritium issues, tank inventory loss, chemical loss, excessive running of pumps on fire protection piping or other “keep pressure” systems, as sink hole, etc.), an inspector can review the licensee’s actions under IP 71152, “Identification and Resolution of Problems” or IP 71111.15, “Operability Evaluations.”

An article was generated for the July edition of the quarterly Inspector Newsletter. This article provided the background associated with buried piping and detailed how these baseline NRC inspection program tools can be used to evaluate buried piping issues.

License renewal inspections are conducted to support the NRC’s review of the license renewal application and to review the licensees programs for managing aging effects on systems, structures and components (SSCs) that fall under the scope of the license renewal. IP 71002, “License Renewal Inspection” is conducted to verify that passive, long lived SSCs within the scope of license renewal are subject to an aging management review and have existing or planned aging management programs (AMPs) that conform to descriptions contained in the license renewal application. The inspection also verifies that AMPs can reasonably manage the effects of aging for these SSCs. IP 71003, “Post-Approval Site Inspection for License Renewal” verifies that a licensee has completed the necessary actions to comply with the license and has implemented the AMPs included in the staff’s license renewal safety evaluation report.

Groundwater Protection Initiative (GPI) inspections are performed using Temporary Instruction (TI) 2515/173, “Review of the Implementation of the Industry Ground Water Protection Voluntary Initiative.” The objective of this one-time inspection is to assess ground water protection programs to determine whether licensees have implemented the voluntary industry GPI.

As discussed below, the industry has recently instituted a Buried Piping Integrity Initiative. While evaluating the establishment and implementation of this initiative, the staff may perform some audits of selected licensees and may develop a TI to assess the effectiveness of this initiative.

Conclusions

Based on its evaluation of operating experience discussed above, the staff has determined that the priority placed on buried piping degradation within the current inspection process is adequate to verify appropriate licensee implementation of current regulations and the GPI.

Actions

The staff may perform audits and/or develop a TI to evaluate licensee implementation of the Buried Piping Integrity industry initiative. In addition, the staff will continue to use existing inspection tools to evaluate buried piping integrity issues on an as available basis.

Industry Activities

The staff held several public meetings with industry to gather information on the scope and status of their activities related to buried piping. For example, the staff met with INPO at a public meeting on October 22, 2009, to discuss buried piping issues. INPO conducts performance-based evaluations at each plant approximately every two years. These evaluations address the performance of passive components, such as piping and heat exchangers. In 2007, INPO identified underground piping as a focus area and began to assess buried piping degradation management using predictive maintenance criteria described in NACE standards. INPO has completed at least one evaluation of every plant and has elected to continue evaluating buried piping during the current two-year inspection cycle. During the October 22, 2009, meeting industry executives indicated that, in part due to the INPO inspection results, the industry decided to initiate some activities with the Electric Power Research Institute (EPRI) to develop specific guidance for buried piping maintenance.

In December 2008, EPRI published “Recommendations for an Effective Program to Control the Degradation of Buried Pipe’” to provide nuclear power plants with guidance on implementing preventive maintenance programs to detect and mitigate degradation in buried piping systems before leakage occurs. The staff has met with EPRI representatives and attended training on the guidance, which is modeled on the NACE standards. The industry has recently begun to implement this guidance.

In the past, the industry has reacted to operational events by establishing initiatives, such as the Groundwater Initiative (NEI 07-07) and the "Industry Initiative on Management of Materials Issues" (NEI 03-08). These initiatives established frameworks that describe the required activities, standardized approaches, action plans, and assessment criteria used to manage degradation. These initiatives include processes to ensure consistent implementation across the industry. The NRC can perform inspections of activities associated with initiatives to assess the effectiveness of plant performance with respect to the specified guidance. Where the staff has determined that the initiative guidance, scope, goals and schedule for implementation are appropriate, that the implementation of the guidance is effective and consistent, and that new regulatory requirements are not needed, additional staff regulatory actions have not been necessary.

By letter dated November 20, 2009 (ADAMS Accession No. ML093350032), NEI indicated that the nuclear industry’s chief nuclear officers voted to approve a proposed “Buried Piping Integrity Initiative.” The stated goal of the initiative is to “provide reasonable assurance of structural and leakage integrity of all buried piping with special emphasis on piping that contains radioactive materials.” Objectives include proactive assessment and management of the condition of buried piping systems and technology development to improve upon available techniques for inspecting and analyzing underground piping. The initiative implements the EPRI program that is modeled after the NACE Standards. Industry representatives have met among themselves to begin to develop implementation guidelines and other program documents. They have scheduled meetings in January and early February. They will meet with NRC staff at a public meeting in late February to provide more information related to the initiative.

Conclusions

The industry has developed a Buried Piping Integrity initiative that is intended to implement a program that is consistent with guidance provided in NACE Standards. This initiative has the potential to reduce the incidence of leakage from buried piping.

Actions

The staff will work with industry to understand the initiative, including the schedule for action. Also, as discussed previously, the staff will determine whether to perform audits and/or develop a TI to assess licensee implementation of the industry Buried Piping Integrity Initiative.

International Activities

The staff plans to assess international operating experience, standards, and maintenance practices related to buried piping. Staff has proposed to lead this activity through the Nuclear Energy Association's Committee on the Safety of Nuclear Installations (CSNI). This activity falls under a broader international effort to assess issues related to the long-term operation (i.e., more than 60 years) of nuclear plants. The proposed activity on buried piping was approved by CSNI during its semiannual meeting in December 2009. Results from this activity will also be used to assess the need for, and subsequently inform, future regulatory actions.

SUMMARY

Based on the staff's review of operating experience related to buried piping degradation, current regulations and ASME Code requirements have been effective in ensuring that the structural integrity and functionality of buried, safety-related piping are maintained. Current regulations have also been effective in ensuring unintended releases of hazardous material to the environment from leaks in both safety-related and nonsafety-related buried piping remain below regulatory limits. Therefore, the staff has no current plans to recommend regulatory changes to address degradation of buried piping.

The staff will continue to actively participate in ASME Code and NACE standards activities. The revised GALL report, including revisions to the AMPs related to buried piping, is scheduled to be published in December 2010.

The industry has recently developed the Buried Piping Integrity Initiative. The staff plans to meet with the industry to further understand this initiative and monitor industry implementation. The staff will also evaluate the need to revise NRC inspection procedures to assess licensee implementation of this new initiative.

The staff will continue to monitor operating experience and assess the need for any further regulatory actions or communications.

Table 1: Radiological Consequences of Several Recent Buried Piping Degradation Events

Date	Site	Brief Description
August 25, 2009	Oyster Creek, Unit 1	On August 25, 2009 water containing tritium leaked from an underground condensate transfer pipe at Oyster Creek, Unit 1. The aluminum pipe is 6" in diameter (with 0.288" wall thickness) and is not safety related. It had been replaced in 1994 and was examined most recently in April 2009. At the point of the leak, the tritium concentration was approximately 11E6 pCi/l, and the flow rate was approximately 5 gpm. Since the leak was on Oyster Creek property, no member of the public has received any exposure from this leak. No radioactivity from this leak has been detected in any publically accessible area. The water in the ground on-site is not publicly accessible and is not drinking water, so the Environmental Protection Agency (EPA) drinking water standards would not apply. However, EPA would classify drinking water containing 11E6 pCi/l of tritium as exceeding the safe drinking water standards for radionuclides of 20,000 picocuries per liter (pCi/L). Tritium from the leak is being diluted by the ground water and as a result, the remaining tritium concentration is constantly being reduced as it travels underground toward the site boundary. Once the tritium leaves Oyster Creek's property, the projected public doses will be below the Oyster Creek's licensing limits (described in the licensee's Technical Specification and ODCM). As a result, when the tritium leaves Oyster Creek's property, the effluents will conform to NRC's design objectives described in 10 CFR 50, Appendix I. This satisfies the NRC requirement that effluents are ALARA. The NRC is concerned because this release was an abnormal release from an unapproved release point. The licensee is required to include information about this leak in either the licensee's Annual Effluent Report or the Annual Environmental Report. This level of tritium does not exceed any NRC limit (that would be applicable on-site), and after additional dilution and decay it will not exceed any NRC limit at the site boundary or offsite. Although this leak does not exceed any NRC limit, either on-site or offsite, this level of tritium would trigger the licensee to initiate voluntary communications with local and state officials as outlined in the industry Groundwater Initiative, NEI 07-07. During an October 22, 2009, public meeting the licensee indicated future plans to reposition existing risk significant piping to above ground or more accessible locations to enable enhanced monitoring of pipe conditions.

Date	Site	Brief Description
July 9, 2009	Peach Bottom	The results of 6 tritium test wells in the vicinity of the Unit 3 turbine building show the tritium level in 3 wells were > 20,000 pCi/L. The maximum level was 122,748 pCi/L from geo-probe well #4 for a sample drawn on July 8, 2009. The licensee followed the NEI Voluntary Tritium Reporting Initiative in communicating with external stakeholders. There is no information that the tritium is migrating offsite or affecting drinking water sources for site personnel. This level of tritium does not exceed any NRC limit (that would be applicable on-site), and after additional dilution and decay it will not exceed any NRC limit offsite. Although this leak does not exceed any NRC limit, either on-site or offsite, this level of tritium would trigger the licensee to initiate voluntary communications with local and state officials as outlined in NEI 07-07.
June 5, 2009	Dresden	On June 5, 2009 water containing tritium leaked from two underground condensate transfer pipes at Dresden. At (or near) the point of the leaks, the tritium concentration was as high as approximately 3.2E6 pCi/l. Since these leaks were on Dresden property, no member of the public has received any exposure from these leaks. No radioactivity from this leak has been detected in any publically accessible area. The water in the ground on-site is not publicly accessible and is not drinking water, so the EPA drinking water standards would not apply. However, EPA would classify drinking water containing 3.2E6 pCi/l of tritium as exceeding the safe drinking water standards for radionuclides. Tritium from the leak is being diluted by the ground water and as a result, the remaining tritium concentration is constantly being reduced as it travels underground toward the site boundary. Once the tritium leaves Dresden's property, the projected public doses will be below Dresden's licensing limits (described in the licensee's Technical Specification and ODCM). As a result, when the tritium leaves Dresden's property, the effluents will conform to NRC's design objectives described in 10 CFR 50, Appendix I. This satisfies the NRC requirement that effluents are ALARA. The NRC is concerned because this release was an abnormal release from an unapproved release point. The licensee is required to include information about this leak in either the licensee's Annual Effluent Report or the Annual Environmental Report. This level of tritium does not exceed any NRC limit (that would be applicable on-site), and after additional dilution and decay it will not exceed any NRC limit offsite. Although this leak does not exceed any NRC limit, either on-site or offsite, this level of tritium would trigger the licensee to initiate voluntary communications with local and state officials as outlined in NEI 07-07. State of Illinois regulations require

Date	Site	Brief Description
		notification if off-site releases are greater than 200 pCi/l or if concentrations on-site exceed 0.002 curies. The licensee estimated the total amount of tritium on site exceeded 0.002 curies and the state of Illinois was contacted. Dresden experienced similar leaks In 2004 and 2006 and had replaced some underground pipe at that time.
April 15, 2009	Oyster Creek	On April 15, 2009, water containing tritium leaked from two underground condensate transfer pipes at Oyster Creek, Unit 1. Both pipes were carbon steel pipe; one 8" in diameter and the other 10” in diameter. Neither is safety related. Near the point of the leaks, the tritium concentration was approximately 4.5E6 pCi/l. Since the leak was on Oyster Creek property, no member of the public has received any exposure from this leak. No radioactivity from this leak has been detected in any publically accessible area. The water in the ground at the source of the leak on-site is not publicly accessible and is not drinking water, so the EPA drinking water standards would not apply on-site at that location. However, EPA would classify drinking water containing 4.5E6 pCi/l of tritium as exceeding the safe drinking water standards for radionuclides. Tritium from the leak is being diluted by the ground water and as a result, the remaining tritium concentration is constantly being reduced as it travels underground toward the site boundary. Once the tritium leaves Oyster Creek’s property, the projected public doses will be below the Oyster Creek’s licensing limits (described in the licensee’s Technical Specification and ODCM). As a result, when the tritium leaves Oyster Creek’s property, the effluents will conform to NRCs design objectives (described in 10 CFR 50, Appendix I). This satisfies the NRC requirement that effluents are ALARA. The NRC is concerned because this release was an abnormal release from an unapproved release point, and as a result, the licensee is required to include information about this leak in either the licensee’s Annual Effluent Report or the Annual Environmental Report. This level of tritium does not exceed any NRC limit (that would be applicable on-site), and after additional dilution and decay it will not exceed any NRC limit offsite. Although this leak does not exceed any NRC limit, either on-site or offsite, this level of tritium would trigger the licensee to initiate voluntary communications with local and state officials as outlined in NEI 07-07.