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A Review of Buried Piping Management in Nuclear Power Plant

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1. Introduction

Over the past several years, instances of buried piping leaks have occurred in safety-related and nonsafety-related piping at nuclear power plants. Buried piping systems are used for fire suppression, radiation waste treatment, or component cooling. This piping may be either concrete or metal. For example, nuclear power plants require an external heat sink, such as a lake or river, in order to maximize thermal cycle efficiencies and provide an ultimate safety heat sink.

Typically, the piping between these heat sinks and the plant secondary cooling loop is known as raw water piping. Degradation of raw water piping affects the plant's ability to remove excess heat in case of an accident. Access to these pipes could be extremely limited.

In this paper, various issues and activities related to buried piping are discussed.

2. Review of Code and Standards

The ASME Code, Section III, Rules for Construction of Nuclear Facility Components, provide 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 (NPP) Components, 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.

ASME Code Case N-755 was developed for High Density Poly-Ethylene (HDPE) pipe to replace the safety class buried pipes in the new NPPs. It isn't still permitted by U.S.NRC to use, but actively revised by the nuclear industry because it is assumed as a promising candidate materials for buried piping.

Based on the results of ASME Code and Code Case requirements, they are adequate for ensuring structural integiry is maintained for buried, safety-related piping.

3. Activities related to Buried Piping in NPPs

Three areas of industry improvement and potential research related to buried piping were identified these days: 1) condition assessment, 2) repair methodology, and 3) selection of replacement materials. Condition assessment addresses improved methodologies for determining the health of the existing piping and predictions of the remaining service life.

Because buried piping will slowly degrade from exterior and interior pitting, as well as biofouling of the pipe internals, it is likely that significant repairs or replacements will be necessary during extended plant operations. At present, assessment and inspections of these pipes occur using either visual exams or with a guided wave technology. Both methods have disadvantages. Physical inspections are time consuming, require a large skilled labor resource, and expose the piping to potential damage during excavation and backfilling. In order to reduce the risk of damage, use of remote inspections, like guided wave technologies, may be an alternative to physical inspections. However, inspections using these technologies, may be an alternative to physical inspections. However, inspections using these technologies are currently limited to just a short piping distance from the access point.

Research in this area could address the assessment of in-situ piping conditions, development of less labor-intensive repair methodologies, and development of new material.

Research related to condition assessment strategies could focus on both developing better degradation models for buried piping and improving inspection techniques. Development of a robust degradation may allow for better assessment planning and more accurate predictions for buried piping life-cycle management purposes. Improvements to global inspection methods and advancements in remote instrumented vehicles will provide plant operators with better assessment tools.

In addition, construction of material characterizations for alternate buried piping material characterizations may be required for extended nuclear plant operations. These characterizations may take the form of PE piping to replace existing pipes or polymer-coated metal pipes to inhibit or retard corrosion. It is also possible that smart coatings could be employed that would give a visible indication when they begin to degrade.

4. Conclusions

Based on the results of current regulations, ASME Code requirements and activities, they have been effective in ensuring that the structural integrity and functionality of buried, safety-related piping are maintained.

Considering the worldwide trends toward long-term operation of NPPs, however, both the industry and regulatory body should have to understand from degradation monitoring methodologies and mechanism to various repair techniques for buried piping.

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