UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO REQUEST FOR ALTERNATIVE TO THE ASME CODE FOR

NORTHEAST NUCLEAR ENERGY COMPANY

MILLSTONE NUCLEAR POWER STATION, UNIT NO. 3

DOCKET NO. 50-423

1.0 INTRODUCTION

Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.55a(g) requires nuclear power facility piping and components to meet the applicable requirements of Section XI of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (hereafter referred as the Code) and that are incorporated by reference in paragraph (b)[1] of this section to the extent practical within the limitations of design, geometry, and materials of construction of the components. Section XI of the Code specifies Code-acceptable repair methods for flaws that exceed Code acceptance limits in piping that is in-service. A Code repair is required to restore the structural integrity of flawed Code piping, independent of the operational mode of the plant when the flaw is detected. Those repairs not in compliance with Section XI of the Code are non-Code repairs. However, the implementation of required Code repairs to ASME Code Class 1, 2 or 3 systems is often impractical for nuclear licensees since the repairs normally require an isolation of the system requiring the repair, and often a shutdown of the nuclear power plant.

Alternatives to Code requirements may be used by nuclear licensees when authorized by the Director of the Office of Nuclear Reactor Regulation if the proposed alternatives to the requirements are such that they are shown to provide an acceptable level of quality and safety in lieu of the Code requirements [10 CFR 50.55a(a)(3)(i)], or if compliance with the Code requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety [10 CFR 50.55a(a)(3)(ii].

A licensee may also submit requests for relief from certain Code requirements when a licensee has determined that conformance with certain Code requirements is impractical for its facility [10 CFR 50.55a(g)(5)(iii)]. Pursuant to 10 CFR 50.55a(g)(6)(i), the Commission will evaluate determinations of impracticality and may grant relief and may impose alternative requirements as it determines are authorized by law and will not endanger life or property or the common defense and security and are otherwise in the public interest

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[1] 10 CFR 50.55a(b) references Section III of the ASME Code

giving due consideration to the burden upon the licensee that could result if the requirements were imposed on the facility.

2.0 BACKGROUND

In a letter to the NRC dated November 20, 1995, Northeast Nuclear Energy Company (licensee) requested approval to perform repairs on two 26-inch service water discharge pipes at Millstone Unit 3, using an alternative to Section III of the ASME Code, pursuant to 10 CFR 50.55a(a)(3)(i) and (ii).

3.0 LICENSEE'S RELIEF REQUEST

3.1 Components for Which Relief is Requested

Two 26-inch service water discharge pipes, which run from the Engineering Safety Feature building to the circulating water discharge tunnel, are copper nickel material, ASME Class 3, buried underground, and the degraded areas are embedded in an 8' x 4.5' reinforced concrete encasement. During a refueling outage in May 1995, visual inspection of the pipes revealed localized pitting at the inner surface of 90° elbow in each train at the bottom of a 16-foot vertical drop. The licensee believes that the pitting was due to impingement-induced erosion by the waterfall into the 16-foot vertical section of the pipes. The pits were varied in depth with a maximum of 0.25 inch, and the pipe wall thickness in the area is approximately 0.325 inch to 0.331 inch. Thus, the pitting is severe but not yet through-wall. In addition, subsequent visual inspection verified that the concrete encasement structure remains intact.

3.2 Section III Edition for Millstone Unit 3

1971 Edition of the ASME Code, Section III, through and including 1973 Addenda.

3.3 ASME Section III Code Requirement

Article ND-3640 in Section III of the ASME Code, requires the thickness of pipe walls to meet a minimum value, which is determined based on piping material capability to ensure the pressure retaining function of the pipe. When minimum wall thickness cannot be met, replacement or repair to restore Code requirements should be performed.

3.4 Content of the Relief Request

Relief is sought from replacing the copper nickel liner in accordance with the requirements of Article ND-3640.

3.5 Basis for Relief and Proposed Alternative

The licensee indicated that the degraded piping areas are 28 feet below ground surface and located in a place containing buried plant utilities. Access for Code repair would require extensive excavation, as well as destruction and reconstruction of the reinforced concrete encasement. The licensee believes

with reinforced concrete encasement remaining structurally sound, the pressure retaining function of the service water lines is ensured. Further, the licensee has committed to inspect the affected service water piping during each refueling outage and during any planned or unplanned outage of greater than 5 weeks duration, and monitor the inside of the discharge tunnel during every other future planned refueling outage to confirm that no service-related degradation of the concrete in the vicinity of the expansion joints is occurring. Therefore, the licensee believes that the alternatives described provide an acceptable level of quality and safety and that undue hardship and expense for performing the Code-repair can be avoided without compromising in quality and safety.

4.0 STAFF EVALUATION

In a conference call between the NRC staff and the licensee on May 29, 1996, details and root cause of service water discharge piping degradation and recent inspection results were discussed, as well as the technique and the merit of applying the epoxy coating; methods and bases to verify structural integrity of the concrete encasement; and measures to be taken by the licensee to ensure the pressure retaining function of the service water discharge pipes. The licensee documented discussion results and their commitments in a letter to the NRC on July 23, 1996. The following summarizes the staff's evaluation:

4.1 Root Cause of Piping Degradation

The licensee conducted robotics inspection of the service water piping and noted the pitting at the lower region of the elbow at the bottom of the 16-foot vertical section in both trains of the service water discharge pipes. A subsequent inspection found that the pits were varied in depth and predominantly on the intrados at the upstream weld and on the extrados at the center of the elbow. An ultrasonic measurement of pipe wall thickness confirmed that the pits were not through-wall. During normal plant operation, the discharge piping receive only minimal flow of approximately 225 gpm. These elbows are normally under water due to the tide and circulating water flow in the discharge tunnel. The licensee's evaluation concluded that the waterfall effect of the minimum flow, cascading over the 16-foot vertical drop into the elbow, had caused erosion damage to the elbow, because the soft oxide layer on the copper nickel piping can easily be stripped away when exposed to water impingement attack. A new oxide film will be formed again and be stripped away again. Thus, this erosion/corrosion process was the root cause of pitting.

Judging from configurations of service water flow path, operating conditions, and piping material properties, the staff concludes that the licensee's evaluation on degradation mechanism appears logical and justified for the pitting locations that were detected.

4.2 Repair Technique Used

For preventing further erosion/corrosion, the licensee applied epoxy-based Arcor-30 coating to the pitted elbow and adjacent areas in both trains of the service water discharge piping. Additionally, piping areas with potential for flow impingement attack were also coated. The licensee indicated that they have had successful experience over the last 5 years in using the Arcor coating throughout the service water and other piping systems in Millstone Unit 3, and recent inspections had further evidenced that the coating did perform well in places with cavitating and highly turbulent flows.
The staff evaluation has the following concerns: (1) the use of Arcor-30 coating for permanent piping repair has not been reviewed by the NRC, and the licensee has no quantified information in existence by which to gage its effectiveness and to predetermine how long the coating is going to remain effective, and (2) with severely pitted areas coated with Arcor-30, can structural capability of the service water discharge piping be maintained to ensure its design intended function, such as pressure retaining function under normal plant operation conditions and under low probability events such as earthquake, for the remaining life of Millstone Unit 3?

In order to address the first concern, a periodic inspection program more stringent than what the licensee initially proposed was requested by the staff for the service water discharge piping for monitoring its coating performance and for verifying its pressure boundary conditions. As for the second concern, the staff has reviewed the licensee's presentation regarding structural integrity and pressure retaining capability of the concrete encasement. The staff's evaluation of these two concerns are discussed in later sections of this report.

4.3 Inspection Inside the Affected Piping

In its letter to the NRC dated November 20, 1995, the licensee indicated that Arcor-30 coating was applied to affected piping areas during the refueling outage in May 1995 as a result of pitting found in the service water discharge piping. The licensee also indicated that inspection on the coating will be performed during the next refueling outage.

In response to a staff request that the licensee provide an inspection program that will enable the licensee to monitor coating effectiveness at the effected piping are[illegible]y letter dated July 23, 1996, the licensee revised its alternati[illegible] committing to perform an inspection on the inside of the service water piping during each refueling outage and during any planned or unplanned outage of greater than 6 weeks duration. The inspections will be performed using submersible robotics video cameras. The results from the previously recorded inspections, including the areas that were repaired, and the historic condition of adjacent piping will be used in evaluating the results of each inspection. The staff concludes that the licensee's commitment on inspection is adequate and acceptable.

4.4 Functional Capability of Concrete Encasement

As discussed previously, the portions of service water discharge pipes that contain pitted elbows are embedded in a 8′ x 4.5′ reinforced concrete encasement. The pipe is served as a liner and was designed to provide pressure boundary integrity, and the concrete encasement was designed to provide dead weight and seismic capability. As a result of severely pitted elbows, the pipe alone can no longer be counted for pressure boundary integrity. The concern is whether an integrated pipe and encasement assembly is capable of ensuring the pressure retaining function.

Also, in its July 23, 1996, letter, the licensee indicated that the concrete encasement has hoop reinforcing bars adjacent to the perimeter of the pipe. These bars were intended for additional assurance of pressure boundary integrity and are capable of restraining the hoop stress created by the piping at pressures well above those predicted in any system operating conditions. In addition, the pits found at the elbow areas were not through the pipe wall, thus, the concrete encasement and reinforcement should not be degraded by the pitted pipes.

The licensee had also sent divers to perform inspection of the concrete in the discharge canal and the concrete adjacent to all seven canal expansion joints downstream of the entry point of the service water piping. The inspection found that all expansion joints and the concrete canal are structurally sound. In addition, the licensee committed by letter dated July 23, 1996, to inspect the inside of the discharge tunnel during every other future planned refueling outage to confirm that no service-related degradation of the concrete in the vicinity of the expansion joints is occurring.

Due to the fact that the service water discharge piping has shown its pressure retaining capability in the current pitted condition, the staff evaluation concludes that such capability is likely to remain if there is no further degradation of the pipes and no damage to the concrete encasement and related structures. In addition, seismic capability of the concrete encasement will not be impaired as long as the encasement is structurally sound. Thus, the licensee's inspection commitments on pipes and on concrete structures will provide assurance for timely measures when needed.

5.0 CONCLUSION

The staff has determined that the licensee's proposed alternatives of (1) applying epoxy-based coating to all the eroded areas, (2) inspecting the affected service water piping during each refueling outage and during any planned or unplanned outage of greater than 6 weeks duration, and (3) monitoring the inside of the discharge tunnel during every other future planned refueling outage are acceptable. Further, the staff has determined that crediting the service water concrete encasement as a pressure retaining structure to satisfy the requirements of the ASME Code is acceptable. Portions of the affected pipes are encased in concrete and excavation and replacement of the encasement would be required to meet the Code. Because the proposed alternatives provide reasonable assurance of structural integrity, the NRC has determined that compliance with the Code would result in hardship

or unusual difficulty without a compensating increase in the level of quality and safety. Therefore, the staff concludes that the repair proposed by the licensee as an alternative is acceptable. The NRC should be informed, however, if the inspection findings, at any time, show further degradation in the piping or concrete structures.

Therefore, pursuant to 10 CFR 50.55a(a)(3)(ii), the staff concludes that the proposed alternatives provide an acceptable level of quality and safety in lieu of the Code requirements and are authorized.

Principal Contributor: S. Hou
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