10 CFR 50.55a
Generic Letter 90-05

Boston Edison
Pilgrim Nuclear Power Station
Rocky Hill Road
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BECo Ltr. 2.98.004

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Request for NRC Review of a Proposed Non-ASME Code Pipe Repair

Purpose

This letter requests NRC review of a proposed non-ASME code pipe repair to a previously repaired spool piece in the salt service water (SSW) system. Based on a verbal discussion between the NRC and Pilgrim of the following evaluation, the NRC granted approval for the repair via telephone on November 18, 1997. Shortly following the repair, the affected spool was replaced during a forced outage that commenced on November 23, 1997. Although the spool piece has subsequently been replaced, this letter provides a mechanism for formally requesting and receiving NRC approval of the second non-ASME code repair of the spool.

Background

By letter of July 7, 1997, Boston Edison Company reported degradation of a spool piece associated with Pilgrim Nuclear Power Station's (PNPS) salt service water (SSW) system. This system provides the ultimate heat sink for containment heat removal.

In addition, the July 7, 1997, letter requested NRC permission to perform a temporary repair in accordance with Generic Letter (GL) 90-05 and, in part, ASME Code Case N-562 using carbon steel plates.

Relief to perform this repair was requested from the NRC under the purview of 10CFR50.55a (g)(6)(i). Verbal permission was granted, the repair was made with carbon steel plates, and the NRC safety evaluation was received in an NRC letter dated October 1, 1997.

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The piping immediately downstream of the MO-3806 butterfly valve had through-wall leaks due to localized delamination of the rubber lining and subsequent erosion and corrosion of the carbon steel pipe prior to the repair. The leaks were adjacent to the pipe slip-on flange that mates with the valve. This location is downstream of the reactor building closed cooling water (RBCCW) heat exchanger.

After the repair, we performed inspections to monitor the condition of the repair and the erosion/corrosion rate. The pipe in the area of the repair was found to be eroding at a rate greater than that projected; therefore, we intended to perform further repairs using 300 series (316 or 304) stainless steel plates in place of the carbon steel plates used in our first repair effort.

Evaluation

Boston Edison Company (BECo) performed a structural integrity evaluation of the affected piping using ultrasonic testing (UT) data for wall thickness in the vicinity of the original leaks. The pipe evaluation is in accordance with the guidance provided in Generic Letter 90-05 for a through-wall flaw in American Society of Mechanical Engineers (ASME) Safety Class 3 piping. The method evaluates the stress intensity factor "K_I" in the pipe with the limiting circumferential length removed based on the pipe stresses from existing PNPS piping analysis of record for combined loads including seismic (SSE). The maximum allowable flaw length was calculated using the GL90-05 fracture toughness criteria of $K_{Ic} = 35\ (ksi)(in)^{0.5}$. There were three discrete through-wall flaws; all are within the stress criteria allowable flaw size.

GL90-05 requires that the flaw size be limited to the lesser of 3 inches or 15% of the length of the circumference. Based on the measured flaw sizes, including the total length that is below t_{min} adjacent to the through-wall area, the flaws are within the criteria. The GL90-05 proximity requirement that the adjacent through wall flaws be spaced at greater than twice t_{min} was also considered. Therefore, the piping was structurally sound and capable of performing its design function.

Based on the known operating history, inspection, maintenance and test requirements for the SSW system as validated through interviews with the design engineers, system engineer, and QC/ISI inspectors, the preliminary root cause of the through-wall leaks has been attributed to delamination of the aging rubber pipe lining. The erosion/corrosion rate is further exacerbated by localized high flow velocities resulting from throttling of the butterfly valve immediately upstream. Rubber-lined steel piping flaws experience accelerated erosion and corrosion where the rubber lining has delaminated. Where the lining remains intact the pipe remains at its nominal full wall thickness (t_{nom}). Hence, the wall thinning is local to the areas where lining has delaminated, while elsewhere there is no effect. Therefore, the through-wall leaks in this piping were due to a small area delamination of the lining resulting in localized erosion and corrosion.

Prior to the July 7, 1997, request, PNPS performed an analysis using a hydraulic model for the SSW system to evaluate the actual pressure at the subject location in the SSW piping. This analysis showed the pressure at this location is usually slightly negative except at the highest yearly tides (above +11 ft). At the highest tides, this location has a slight positive pressure, resulting in service water leakage. No safety-related components are within the proximity of the piping flaw location that would be directly affected by this leakage. The leakage would be accommodated by the design of the auxiliary bay.

There is usually a small vacuum in the pipe at this location related to the changing tides. Air in-leakage has a negligible effect on the flow rate through the RBCCW heat exchanger.

Conclusion of Evaluation

The above discussion and associated calculations/operability evaluation demonstrated that the pipe structural integrity was acceptable. The effect from SSW leakage into the auxiliary equipment bay and/or air in-leakage into the flow stream (i.e., when the pressure is negative at this location) were acceptable. Therefore, the system associated with the degraded spool piece was capable of performing its safety function; hence, it was operable.

The preliminary root cause determination indicated the flaws can be attributed to delamination of the aging rubber pipe lining. The erosion/corrosion rate was further exacerbated by localized high flow velocities resulting from throttling of the butterfly valve immediately upstream.

Monitoring Measures

Immediate compensatory measures were not required to assure system operability or safe operation because the piping was structurally sound and leakage did not adversely impact system operability.

Ongoing pipe monitoring using UT was being performed periodically to ensure that the pipe condition did not deteriorate beyond acceptable limits. In addition, operator tours were performed once per shift to monitor for changes to the leakage rate.

In addition, GL90-05 requires that a minimum of 5 locations be subject to augmented inspections to evaluate other system locations for similar degradation. As stated in the July 7, 1997, request, auxiliary bay SSW piping is inspected on a programmatic basis. Therefore, the only locations that required immediate inspection were similar locations downstream of the other RBCCW and TBCCW heat exchanger outlet valves.

To address this, 5 locations described in our July 7, 1997, request were inspected in accordance with GL 90-05 guidance prior to the initial repair. All augmented inspection results at these locations found values greater than the manufacturer's t_{min}.

Reason for Non-Code Temporary Repair

As provided in our July 7, 1997, request, the impact a code repair would have on plant operation was assessed. Also assessed was the impact of a number of non-code repair methods. The code repair methods require removing one loop of the SSW system from service and cross tying the RBCCW systems during power operation, placing Pilgrim in a 24 hour limiting condition for operation (LCO) under Technical Specification section 3.5.B.3. The code repair we considered viable (spool replacement) requires removing a loop from service for greater than the LCO's 24 hours, resulting in a plant shutdown. Hence, we requested relief in accordance with the guidance of GL 90-05 for a non-code repair that could be executed with the loop in-service.

Description of Proposed Temporary Repair

A revised temporary non-code repair in the area previously repaired was proposed to stop potential leakage caused by erosion/corrosion occurring at a faster rate than projected at the time of developing the original repair. This proposed stainless steel repair maintained structural integrity until the piping spool was replaced during the November 23, 1997, forced outage. The temporary repair was a stainless steel cover plate welded to the pipe at the leak location.

The repair added stainless steel cover plates to the earlier repair. One cover plate was fillet welded to the existing cover plate in the flange area near the valve (MO-3806). The second cover plate was welded to the pipe downstream of the existing cover plate. This was done because the carbon steel cover plate originally installed was locally eroding and the pipe downstream of the original cover plate was also locally eroding. The purpose of the original

(July 7, 1997) temporary modification was to stop the leak in the SSW system (Spool JF 29-8-2) and maintain structural integrity until replacement. The leak was in the service water outlet piping from RBCCW heat exchanger E-209B, downstream of valve MO-3806.

ASME Code Case N-562, although written as guidance for a weld overlay repair method, was used as a technical guide to attach the cover plate. The cover plate method was selected as the preferred temporary repair instead of the overlay method for the following reasons:

- The cover plate repair method would stop the leak with less risk of enlarging the flaws than the overlay method. All other guidance of N-562 was followed as applicable.
- The cover plate was acceptable for 100 psi, although the pressure at the leak's location ranges from a slight vacuum to a slight positive pressure. (It is dependent on tide level because the line discharges to the sea.) The line's 100 psi design specification was selected at Pilgrim's construction to make it uniform to other parts of the system that are subjected to higher pressures; therefore, 100 psi was a conservative value for the repair.
- The pipe's stress is low (4 ksi) as shown by BECo's calculation M747 (which was provided with our July 7, 1997, request). If it is intensified by a factor of 2.1, as prescribed by N-562, it would be within the allowable limit of 18 ksi.
- The cover plate method was less intrusive to the structural integrity of the pipe because it exposes the pipe to less heat from the welding process. Qualified welding procedures were used.
- The cover plate method did not affect plant operations.

The rate of material removal due to direct water impingement was not accurately predictable prior to the original repair. The carbon steel material chosen for that repair is prone to direct impingement erosion, but the estimated rate was such as to allow the selection of carbon steel. Later (post-repair) data indicated that it was preferable to use a 3/8" rolled 300 series stainless plate material for the cover plates which were welded with E308 wire.

A cover plate had been welded to the 18 inch SSW pipe and flange where flow-assisted corrosion/erosion had occurred. The cover plate was eroding and the pipe downstream of the cover plate was also eroding. Two additional cover plates were installed to address the erosion problem. One stainless steel cover plate was welded to the existing cover plate and one was welded to the pipe down stream of the existing cover plate. ASME Code Case N-562 was used as a guide for performing the temporary modification. The cover plate was treated like an overlay weld, and the same N-562 rules were applied for overlap of the thinned area and for the NDE required. N-562 allows welding to the pipe with water inside with proper procedure qualification.

The minimum width of the new cover plates beyond the required repair area is given in the Code Case as:

$S_m = 0.75 \times (R x t_{num})^{1/2}$ where R = outer radious of pipe; t_{nom} = nominal pipe wall thickness

For this case, R = 9 in, and the nominal wall thickness is 0.312 in. This results in $S_m = 1.26$ in. A distance of 2 inches was used.

Repair's Safety Impact

Pilgrim performed a safety impact evaluation of the repair that determined the following:

- The safety-related functions of the SSW system remained qualified for plant design bases loads after completion of the temporary repair.

- The temporary repair did not increase the probability of occurrence or consequences of an accident or malfunction of equipment important to safety. The possibility of creating an accident or malfunction other than those evaluated in the UFSAR was not increased because the temporary modification did not introduce any interaction with other safety-related systems.

- This temporary repair did not increase the probability of occurrence or consequences of failure of equipment important to safety because no new failure mechanisms were introduced.

Commitments

Our July 7, 1997, letter contained commitments that would have remained in force with the new repair; however, spool piece replacment made these compensatory measures unnecessary.

Should you require further information on this issue, please contact P.M.Kahler at (508) 830-7939.

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