NORTHEAST UTILITIES
THE CONNECTICUT LIGHT AND POWER COMPANY
WESTERN MASSACHUSETTS ELECTRIC COMPANY
HOLYOKE WATER POWER COMPANY
NORTHEAST UTILITIES SERVICE COMPANY
NORTHEAST NUCLEAR ENERGY COMPANY

General Offices • Selden Street, Berlin, Connecticut

P.O. BOX 270
HARTFORD, CONNECTICUT 06141-0270
(203) 665-5000

April 28, 1989

Docket No. 50-423
B13230
Re: I&E Inspection
Report 50-423/88-24

U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555

Gentlemen:

Millstone Nuclear Power Station
Unit No. 3
Service Water System Leak Repair Program

The subject inspection report(1) documents the Staff's concerns related to the service water system leaks at Millstone Unit No. 3. In a subsequent inspection, the Staff raised questions regarding present Northeast Nuclear Energy Company's (NNECO) practices to perform interim nonwelded repair of service water system leaks as they occur, with permanent (ASME Section XI) repairs to be made during the refueling outages and other outages occurring during the cycle. On April 20, 1989, a conference call was held between NNECO representatives and the NRC Staff to discuss actions taken by NNECO regarding the service water system leaks. The purpose of this letter is to document our multiphased program that has been carried out in response to degradation which occurred in both small- and large-bore piping of the service water system.

Background

The service water system at Millstone Unit No. 3 is constructed of both 90/10 copper-nickel (Cu-Ni) and copper nickel clad carbon steel (CNC-CS). The choice of material is dependent on the pipe size, with smaller piping constructed of solid Cu-Ni and the larger piping of clad carbon steel. The service water system at Millstone Unit No. 3 is Safety Class 3 and provides cooling water for heat removal from the reactor plant auxiliary systems during all modes of operation and from the turbine plant auxiliary system during power operation. The service water system working fluid is seawater. The 90/10 Cu-Ni material has been demonstrated as a reliable and cost-effective choice for seawater services.

Discussion

During the first two cycles of Millstone Unit No. 3 operation, the service water system experienced degradation in some small-bore piping and several leaks in large-bore piping which resulted in localized through-wall leaks (see

---

(1) L. H. Bettenhausen letter to E. J. Mroczka, Millstone 3 Routine Inspection 50-423/88-24, dated February 16, 1989.

8905100202 890428
PDR ADOCK 05000423
Q PDC

IE01
1/1

Attachment 1). The cause of the small-bore degradation was determined to be due to the erosion/corrosion mechanism. The large-bore piping leaks are believed to be Cu-Ni weld cladding that were ground back too far for weld inspection during original fabrication. Each of the areas identified were addressed on an individual basis to determine if system operability was challenged. The following outlines those specific actions taken for each leak and or area of pipe degradation.

1. Leak or wall loss identified.

2. Nonconformance Report initiated/NDE data gathered.

3. Preliminary technical assessment of degraded area for continued system operation. (This review would include review of stress analysis and FSAR criteria to determine if a welded repair must be made. If a weld repair is not required, then engineering provides direction regarding the type of nonwelded repair.)

   All permanent welded repairs are made in an approved ASME Section XI repair plan. However, a temporary welded path was installed on the vendor-supplied carbon steel piping (see Attachment 1). This will be repaired during the second refueling outage with proper material in accordance with ASME Section XI.

4. For all nonwelded interim repairs, a detailed engineering review is conducted considering the following parameters:

   a. Structural integrity of the piping is evaluated considering missing wall sections against the ASME Section III Code and FSAR criteria. If results are unacceptable, an ASME Section XI repair is made.

   b. Projections are made with regard to additional erosion/corrosion for the remainder of the operating cycle. These projections are then evaluated for structural adequacy in the same manner as (1) above. Determination is then made if a permanent repair might be required prior to the end of the cycle.

   c. Whether a permanent repair is needed or not, the affected area is monitored by periodic NDE inspections and routine operation surveillances.

5. Also considered in these evaluations are the potential effects on adjacent equipment if a spray down or flooding were to occur, along with the potential loss of flow to the service water system.

6. If all items above are considered acceptable, a nonwelded interim repair is allowed until the next scheduled refueling outage. In the case where there is not a through-wall leak, the piping is left as is and monitored.

In addition, a multiphased program was initiated to determine the extent of the erosion/corrosion phenomenon in the service water system, to initiate long-term corrective measures for the affected piping, and to develop methods to prevent recurrence. Attachment 2 provides details of the actions completed to date and those planned for the second refueling outage and beyond.

Summary

Interim nonwelded repairs to the service water system piping leaks at Millstone Unit No. 3 are intended to stem the uncontrolled leakage of water within the plant. Nonwelded patches are installed as a maintenance activity, and the piping system is reviewed for the added mass effects. The patching of a piping leak with bands with steel strongbacks and rubber gaskets, etc., is not being considered an ASME XI repair, and no credit is taken for the patch, bands, etc., in the structural qualification of the piping. The affected piping area is shown to maintain structural integrity in the eroded condition until such time that a Section XI welded repair or pipe replacement is performed.

The progression of erosion/corrosion in a piping system is being monitored under a periodic surveillance program to augment the initial NDE screening of a system to determine baseline conditions. In addition, typical configurations of redundant trains of a system are evaluated to ensure that common mode failures do not occur. The procedure developed by NNECO to evaluate and repair an eroded area has been reviewed by the Plant Operations Review Committee (PORC), and the approach has been reviewed by the plant American Nuclear Insurer.

Based on the above discussion, NNECO believes that the original design basis criteria and the technical specification operability requirements for the service water system have been maintained. All interim repairs are ultimately weld-repaired or replaced with permanent repairs in accordance with the requirements of ASME Section XI.

We trust the above information satisfactorily responds to your concerns. Should you have any questions concerning the above discussion, or if you would like additional information on similar repair programs utilized on Millstone Unit Nos. 1 and 2, please contact us.

Very truly yours,

NORTHEAST NUCLEAR ENERGY COMPANY

E. J. Mroczka
Senior Vice President

cc: W. T. Russell, Region I Administrator
D. H. Jaffe, Nuclear Project Manager, Millstone Unit No. 3
W. J. Raymond, Senior Resident Inspector, Millstone Unit Nos. 1, 2, and 3

Docket No. 50-423
B13230

Attachment 1

Millstone Nuclear Power Station
Unit No. 3

Service Water System Piping Leaks
and Actions Taken to Date

April 1989

Service Water System Piping Leaks and Actions Taken to Date

Clad Carbon Steel Pipe

- Elbow on Outlet Elbow From an RPCCW Heat Exchanger
  - -- Leak discovered on March 4, 1986, during start-up testing of Millstone Unit No. 3.
  - -- Determined to be due to cladding failure at fabrication weld.
  - -- Immediate weld repair performed in accordance with ASME Section XI.
- Elbow Supply to "A" RSS Heat Exchanger
  - -- Leak discovered on September 18, 1986.
  - -- Determined to be due to cladding failure at fabrication weld.
  - -- Temporary banded soft patch applied.
  - -- Weld repair performed in accordance with ASME Section XI during midcycle outage on March 27, 1987.
- Tee on Outlet of Service Water Pump Discharge Valve 3SWP*MOV102D
  - -- Leak found while replacing adjacent valve during the first refueling outage (November 19, 1987).
  - -- Determined to be due to cladding failure at fabrication weld.
  - -- Immediate weld repair performed in accordance with ASME Section XI.
- Flange Adjacent (Downstream) to 3SWP*MOV71A
  - -- Leak found during normal operation on July 25, 1988.
  - -- Initially started as a pinhole.
  - -- UT inspection of surrounding pipe, the circumference of the pipe, and the pipe downstream of 3SWF*MOV71B. No other substantial indications found.
  - -- Pipe strap lined with rubber used as temporary leak prevention measure.

- -- Weld repair in accordance with ASME XI will be performed during the second refueling outage.

- o Flange Adjacent (Downstream) to 3SWP*MOV71B

  - -- Leak found during normal operation on February 9, 1989.
  - -- Initially started as a pinhole.
  - -- UT reinspection of leak showed that cladding failure had probably started under flange neck.
  - -- Pipe strap with clamping device used to hold soft patch in place used as temporary leak-prevention measure.
  - -- Weld repair in accordance with ASME XI will be performed during the second refueling outage.

- o Flange Adjacent to 3SWP*V35 (Outlet of an RBCCW Heat Exchanger)

  - -- Leak found during normal operation on February 20, 1989.
  - -- Immediate area examined for degradation; no substantial wall loss found.
  - -- Original soft patch held in place with metal bands.
  - -- Replacement soft patch held in place with nylon strap.
  - -- Weld repair in accordance with ASME XI will be performed during the second refueling outage.

<u>Copper Nickel Piping</u>

- o Erosion/Corrosion Leaks in 1.5-, 2.0-, and 3.0-inch (Normal Pipe Size) Pipe

  Since mid-1986 there has been a history of leaks at elbows in the service water system. While initially occurring in the 1.5-inch piping, there has been a progression to 2.0- and 3.0-inch piping. In the course of performing repairs it was determined that the mechanism for the failures was erosion/corrosion. There have been approximately 25 leaks to date. At the present time there are 5 leaks which have soft patches applied to them. There are 2 on the 1.5-inch piping going to and from the "B" train high-pressure safety injection pump cooling system, 2 on the outlet piping from an engineered safety features (ESF) building HVAC unit, and one on a 3-inch pipe on return header in the ESF building. All of the leaks have been evaluated based on local stress loadings and found

acceptable for continued operation. All of these leaks will be repaired in accordance with ASME XI during the upcoming refueling outage.

o 6-Inch Spool Piece at Control Building Ventilation Unit

-- Leak found during normal operation on July 3, 1988.

-- Immediate area examined for degradation; wall loss consistent with erosion/corrosion due to throttling valve immediately upstream of spool.

-- Spool on opposite train examined; similar degradation found, but minimum wall acceptable,

-- Temporary leak prevention measure installed and parts ordered for replacement of spool.

-- Areas downstream of other butterfly valves that throttle or that had previously throttled examined; no similar wall loss found.

-- Permanent ASME XI replacement performed on October 22, 1988.

Vendor-Supplied Piping

o 8-Inch Carbon Steel Pipe Spool Between Diesel Heat Exchangers

-- Leak found during normal operation on October 25, 1988.

-- Immediate area examined for degradation; wide area affected.

-- Opposite train spool piece examined; no immediate problem.

-- Temporary welded patch installed; commitment made to repair during the second refueling outage with proper material in accordance with Section XI.

-- Program was initiated to inspect the opposite train pipe every two months until it is replaced during the second refueling outage.

Docket No. 50-423
B13230

Attachment 2

Millstone Nuclear Power Station
Unit No. 3

Service Water System
Repair/Replacement Program

April 1989

Service Water System
Repair/Replacement Program

The service water system at Mi stone Unit No. 3 utilizes either solid 90/10 Cu-Ni for small-bore pipe or carbon steel pipe clad with 90/10 Cu-Ni for large bore pipe to convey seawater for cooling. 90/10 CU-Ni is very resistant to corrosion due to seawater and has been successfully used in a large number of ocean-going ships to convey cooling water. Monel is used in very limited applications due to its mechanical properties. During the first two cycles of operation at Millstone Unit No. 3, degradation has occurred in both the small- and large-bore pipes that has resulted in small leaks. In response to these problems, a multiphased program has been carried out.

- Following the April 1987 minioutage, a destructive metallurgical examination of a degraded small-bore pipe was done. This examination showed that the root cause of the degradation in the small-bore pipe was due to erosion/corrosion caused by excessive local flow velocity at changes in flow direction; i.e., elbow and tees.

- Next a large-bore pipe with degradation was examined during the first refueling outage. This work showed that the root cause of the leak was that the cladding had been ground too thin or off in some locations during fabrication, resulting in the seawater corroding the carbon steel pipe. This large-bore pipe was repaired in accordance with ASME Section XI.

- Following the first refueling outage, all the braze joints (the location of the degradation) in small-bore pipe (3-inch and under) piping systems were given an ECT examination. For those joints that showed degradation, a UT examination was done to better quantify the wall loss. In areas with significant wall loss (.100-inch or less remaining), these UT exams were repeated in 1- to 3-month intervals.

- For the large-bore pipes, a UT examination was done of piping with a similar geometry in the redundant train to the ones that had corroded. These results have been mixed, some showing the proper wall thickness while others are not. None appear to have lost all the cladding.

- Once the small-bore examinations clearly identified a number of degraded areas, a redesign of the affected areas was begun. This redesign utilizes large (four or five times pipe diameter) radius bends instead of small radius fittings or Monel 400 pipe where constraints in piping geometry were significant. The large radius bends will reduce the local flow velocities to acceptable levels while the Monel 400 is resistant to erosion/corrosion at the flow rates that harm 90/10 Cu-Ni. The redesign for the piping that has leaked is scheduled to be implemented during the second refueling outage in May and June of 1989.

- Also, during the second refueling outage, the large-bore pipes with through-wall leaks will be repaired to bring the pipes back to the original condition. Careful measurements will verify that the proper cladding thickness is present. The large-bore pipes suspected of having wall thinning will be visually inspected to determine if a problem exists and what the cause could be.

- During Cycle 3, the redesigned areas will be monitored with UT at selected locations to verify that the erosion/corrosion has been eliminated. Adjacent areas of the piping system will also be monitored to ensure that the redesign has not caused erosion/corrosion in other areas. The large bore repaired areas will also be monitored to verify that the degradation was due to construction and not operation.

- During the first two cycles when degradation created excessive wall loss or a leak, an evaluation was done according to the guidelines described in the cover letter, and a plant procedure was developed for this situation. These guidelines were developed when it became clear that these small-bore leaks were due to operation and not problems with construction; i.e., brazing. The large bore leaks are still considered to be fabrication problems until the data shows otherwise. This evaluation considered a variety of criteria which are described in detail in the cover letter. Following this evaluation, an interim, nonwelded patch to seal the pipe was installed. The number of times that this was done and in what locations are described in Attachment 1.

- The patched areas were then repaired with the original design at the next available outage. For the small-bore pipe this has occurred in April 1987, the first refueling outage, and November 1988. With the large-bore pipe this has been done prior to start-up, the April 1987 minioutage, and at the first refueling outage. One exception to this was a 6-inch spool piece downstream of the butterfly valve that was replaced with Monel 400 during September of 1988.

- Depending upon the outcome of the monitoring done during Cycle 3, more sections of the service water system may require redesign. Further changes would be implemented during the third refueling outage.