U.S. NUCLEAR REGULATORY COMMISSION
REGION I

DOCKET/REPORT NO. 50-213/94-04

LICENSE NO. DPR-61

LICENSEE: Connecticut Yankee Atomic Power Company
P.O. Box 270
Hartford, Connecticut 06141-0270

FACILITY NAME: Haddam Neck

INSPECTION AT: Haddam, Connecticut

INSPECTION DATES: February 8 and 9, 1994

NRR REPRESENTATIVE: James A. Davis, Materials
and Chemical Engineering Branch

INSPECTORS:

Michael C. Modes, Chief
Materials Section, EB, DRS

3/2/94
Date

Michael Mayfield, Acting Deputy Director
Division of Reactor Safety

3/3/94
Date

Inspection Summary: During the period of February 8 and 9, 1994, two regional managers reviewed the microbiological influenced corrosion failures in the service water system to the emergency diesel generators. The inspection consisted of viewing a portion of the service water system in the auxiliary building and service water intake, and interviews of the system engineer and inspection personnel. The metallurgical samples taken from the earlier failure of the system were reviewed. Discussions were undertaken with the plant manager, engineering manager and other Northeast Utility personnel about the probable cause of failure, fracture analysis, operability of the system and compensatory plans.

Inspection Findings: As of the end of the inspection, the licensee had neither completed nor developed a conclusive bounding analysis, no finalized inspection plan, techniq or evaluation standards. Further, the fracture analysis of the system had not been completed for dynamic seismic loading and the metallurgical report had not been finalized. There was no remediation plan nor long term monitoring program for MIC in the service water system. The final piping design for the replacement of the diesel service water system was incomplete. The utility was not reacting in a comprehensive man to the safety implications of the degraded condition of the piping. As evidenced by the lack of analysis, the utility could not fully assess the operability of the service water piping system.

DETAILS

1.0 SCOPE

In June 1993, during refueling outage RFO17, Northeast Utilities, the licensee for Haddam Neck Power Station, replaced a leaking elbow in the service water pipe (6"-WS-121-167) supply line to the "B" emergency diesel generator (EDG). The elbow was leaking through the wall near the heat affected zone of a weld. A similar segment was replaced in the "A" EDG, during the same refueling outage. In January 1994, another elbow, taken from line 6"-WS-121-168, was removed for investigation. A metallurgical evaluation by Northeast Utilities concluded that the "appearance and morphology of the attack was characteristic of microbiological influenced corrosion (MIC) and that the weld root condition did create a crevice." It was also observed, in the report, that two of the four welds examined showed lack-of-penetration in the weld. The NRC inspection was undertaken to review the operability of the piping system, the monitoring of the corrosive progress and the remediation of this problem by Northeast Utilities.

2.0 INSPECTION

2.1 Operability

An operability determination was made by Northeast Utilities, on January 5, 1994, for the EDG service water supply lines. The operability determination considered the degree of degradation noted in the metallurgical report. It assumed, for the purposes of fracture toughness, that the MIC was uniformly distributed along the entire internal surface of the piping. Based on this assumption, Northeast Utilities determined that the piping system was operable. The NRC noted that this analysis did not account for the concentration of stress at the sharp corner of the lack-of-penetration (LOP) defect in the piping. This analysis also did not take into account the degree of MIC involvement in the LOP. The NRC, therefore, did not agree with the results of the analysis and indicated that the licensee needed to account for the stress concentration by an appropriate fracture mechanics model.

After discussions with the NRC, the licensee chose Appendix H of the 1992 edition of the American Society for Mechanical Engineers, Section XI, as the appropriate model for this analysis. As a basis for the fracture calculation, the maximum measured defect depth was used; taken from the three samples referred to above. This analysis determined that a wall thickness of 0.100" was sufficient to maintain structural integrity of the piping system. Seismic requirements constituted the largest load contributor. There was sufficient remaining wall of 0.10" to allow continued service. The NRC independently performed the same analysis, utilizing the licensee's input, and arrived at essentially the same conclusion. The NRC noted, however, that the calculations showed the remaining wall thickness was only 20 mils from being unacceptable and concluded this was a narrow margin considering some of the assumptions that were used in the computation. The licensee indicated that the calculations could be more precise if dynamic loading was used. The licensee undertook a refinement, of the calculations, during the period of this inspection.

2.2 Monitoring

The licensee was in the process of developing a long term piping condition monitoring program. This program was essential in order to determine the current condition of the piping and to assure that the minimum wall thickness was maintained during operation. Using the current refinement of the fracture calculations, the monitoring method would have to be accurate enough to trend a 20 mil deterioration of the wall thickness. The licensee was radiographing the piping in order to locate additional welds having LOP with MIC involvement. This radiography was being used to sort the population of welds in the systems with respect to the existence of significant areas of LOP. The licensee incorrectly assumed that MIC corrosion was limited to older piping and focused their evaluation on welds in older, stagnant piping.

At the time of this inspection, the utility had established a total system weld count of 140 welds in the stagnate service water lines to the EDGs. Of this total count, 85 welds were categorized, by the utility, as not vulnerable to MIC with LOP because they were new (installed since approximately 1990). The NRC did not agree with this conclusion because there was no empirical data to support the lack of vulnerability of these newer welds. Because new piping, placed into old piping systems fouled with MIC, is not fully passivated by the system flow, it can corrode at rates far greater than the rest of the piping system. In addition, no extraordinary precautions had been taken during the welding of these piping replacements (radiography, ultrasonic testing, internal visual examination, etc.) to preclude the presence of LOP. An additional 37 welds were inaccessible to volumetric examination because they were either contained within a wall or were underground. This left 18 accessible welds that could be volumetrically examined.

The radiography revealed 3 of these 18 welds with LOP and possible MIC involvement. These were welds 21 and 12, attaching service water isolation valve SW-V-156B to line 6"-WS-121-167 and weld 22, attaching one half of service water isolation valve SW-V-144A to line 6"-WS-121-168. Welds 21 and 22 are down stream of the service water isolation valves. Breaks or leaks in these welds could only be isolated by the main service water isolation valves located in the service water intake at the river. These valves are in the lower level of the intake pump house and are identified as SW-V-109B and SW-V-109A. The results of the examination, when linearly projected to the rest of the system, meant there were possibly another 27 welds with the same condition.

A final determination of the individual weld quality could not be made based on this radiographic evaluation. However, the method could be easily used to determine if the welds had LOP with MIC involvement. The licensee intended to evaluate the indications revealed by this method and to arrive at a final disposition.

Concurrent with this effort, the licensee was empirically developing an eddy current method for determining the remaining wall thickness in the pipe. The NRC noted that this examination process tends to be omnidirectional in its interrogation of the material volume and the NRC questioned its efficacy. This difficulty is exacerbated by current bridging across intermittent defects (i.e., tight cracking) and saturation of small defect signals by larger defects (i.e., worm holes originating in corroded LOP). At the time this methodology was reviewed by the NRC, final accuracy could not be conclusively determined. Further development was required to correlate the eddy current signal derived from electro-discharge machined (EDM) notches and actual LOP with MIC and to evaluate signal saturation effects caused by volumetrically large defects. The licensee committed to finalize development of the eddy current method before depending on it for long term monitoring of the piping systems.

Some exploration of ultrasonic techniques had been undertaken by the licensee with little success. The amount of beam spread, even with focused transducers, tended to obscure defect signal height, making defect sizing difficult in this thickness range of material. If consideration is given to surface condition and weld surface, the signal scatter is increased until it is too obscure to characterize. The licensee intended further exploration of this technique, even though they understood that weld surface preparation was required as part of the technique refinement process. The surface preparation contemplated was weld crown grinding. The licensee felt that the eddy current results, at this point in the development process, were reliable enough to allow for some weld surface preparation. The licensee concluded, based on eddy current, that there was at least 0.095" of wall (0.005" less than the analysis called for) remaining in all cases. The NRC was not confident in the results of the eddy current.

2.3 Remediation

The licensee planned, in the short term, to reinforce welds 12, 21 and 22, by mechanical clamps, in order to increase the structural margin of safety. In addition the licensee was already designing a replacement for the EDG service water piping. This replacement included rerouting the piping to eliminate underground and in-wall placement. It was apparent, from the amount of microbiological fouling present in the removed samples, that the current program of injection of hypochlorite was not successful. The licensee was waiting for the results of a bacteriological culture taken from the system, in order to categorize the type of fouling and, therefore, the most appropriate remediation. The licensee intended to control the overall MIC problem by the use of biocides; however, plans at this point in time were only tentative.

In addition to the above plans, the licensee had formulated a compensatory plan, in the event of service water failure to the diesel generators. Some of this plan is detailed in Connecticut Yankee correspondence, dated January 12, 1994 (DECY-94-1008), and included the placement of a fire hose that could be used to supply cooling water to the EDGs, the use of an air cooled diesel generator, and concurrent repair of the header system.

3.0 CONCLUSIONS

The NRC determined that the licensee had not completed a conclusive bounding analysis, nor had it finalized an inspection plan, technique, or evaluation standard. At the time of the inspection, the fracture analysis of the system had not been completed for dynamic seismic loading and the metallurgical report had not been finalized. There was no final remediation plan nor long term monitoring program for MIC in the service water system. The final piping design for the replacement of the diesel service water system was incomplete. The NRC concluded that the licensee's operability evaluation was weak, but no specific inadequacies other than the fracture mechanics analysis model were identified.

4.0 MEETINGS

During the course of this inspection, the NRC managers met with Haddam Neck personnel during an entrance meeting on February 8, 1994. The NRC managers shared their conclusion with licensee management at an exit meeting on February 9, 1994. The management of Haddam Neck did not offer any objections to the views expressed by the NRC during this meeting. The following personnel attended the exit meeting:

Northeast Utilities

J. LaPlatney	CY Unit Director
R. Palmieri	CY Engineering Director
M. Wilson	Manager Nuclear Licensing
G. Van Noordennen	CY Licensing Supervisor
T. Cleary	Lead Licensing Engineer
K. Sickles	CY Engineering
T. Shaffer	Component Engineering
C. Gladding (By Phone)	Engineering Supervisor
T. Galloway (By Phone)	Engineering Supervisor
R. Kasuga (By Phone)	Plant Engineer Service Water

U.S. Nuclear Regulatory Commission

M. Mayfield	Acting Deputy Director, DRS, RI
M. Modes	Chief Materials Section, DRS, RI
J. Davis	Senior Engineer, EMCB, NRR
W. Raymond	Senior Resident Inspector, Haddam Neck