CENTERIOR ENERGY

PERRY NUCLEAR POWER PLANT
10 CENTER ROAD
PERRY, OHIO 44081
(216) 259-3737

Mail Address:
P.O. BOX 97
PERRY, OHIO 44081

Michael D. Lyster
VICE PRESIDENT - NUCLEAR

April 3, 1992
PY-CEI/NRR-1467 L

U. S. Nuclear Regulatory Commission
Document Control Desk
Washington, D. C. 20555

Perry Nuclear Power Plant
Docket No. 50-440; 50-441
Suppression Pool Corrosion Monitoring

Gentlemen:

This letter provides an update to our action plan in response to the Perry Nuclear Power Plant (PNPP) suppression pool stainless steel cladding sensitization issue which was originally documented in Deviation Analysis Report (DAR) 037 dated October 6, 1980. This update is based on the results of a reassessment of our Unit 1 Suppression Pool corrosion monitoring efforts, which were described in a letter to the NRC Region III dated May 31, 1983 and implemented in May of 1985 in response to the subject cladding sensitization issue. The reassessment was undertaken following a review of the results obtained from the monitoring over the first five years of its implementation. Based on the results obtained from the monitoring, and on our reassessment, the following update of our action plan is provided:

(1) Electrochemical potential monitoring of the fissured heat affected zones of select pool welds has been completed.

(2) Examination of surveillance specimens of preconditioned stainless clad carbon steel plate has been completed.

(3) Periodic visual examinations of the suppression pool wall from the Elevation 599' platform will be continued on a refueling outage frequency and an additional examination will be performed whenever the suppression pool is drained. If corrosion effects are observed, additional visual inspections will be performed to assess the condition and, if determined necessary, appropriate corrective action will be implemented.

Background

In the latter part of 1980, liquid penetrant examinations of welds in the containment vessel and drywell vent structures in the region of the suppression pool at Perry Nuclear Power Plant Units 1 and 2 revealed a number of indications in the stainless steel cladding adjacent to the weld seams.

A Deviation Analysis Report (DAR 037) was initiated in October 1980 and an investigation was conducted to determine the extent, nature and significance of these indications.

It was generally agreed that the fissures were the result of the welding process and would not lead to fracture or failure of the structure. There was also little likelihood of stress corrosion cracking of the stainless steel because of the low temperature and benign environment. Metallographic examination disclosed that the indications were intergranular fissures in the heat affected zones of the stainless steel cladding. The cladding is AISI type 304 stainless steel with a carbon content of 0.049 to 0.076 percent. Although the stainless material was found to have a large amount of carbide precipitated at the grain boundaries as a result of heat treatment following cladding, evidence indicated that the fissuring resulted from hot cracking during welding rather than by corrosion. Analysis using the design loads indicated that the fissures would not propagate to a critical size by fatigue nor would they initiate fracture in the structures. The potential for corrosion of the sensitized stainless was found to be small because of the relatively low temperature in the suppression pool. However, crevice attack on the underlying carbon steel at unrepaired fissures was considered a possibility.

Because opinions differed about the future behavior of the existing microfissures, their potential corrosive effect on the underlying carbon steel and what mitigating action(s), if any, should be taken, a monitoring program was instituted. By letter dated May 31, 1983, the Cleveland Electric Illuminating Company (CEI) submitted a plan of action which outlined the Suppression Pool corrosion monitoring activities that would be taken, and the proposed corrective actions to be taken should crevice corrosion occur in the cladding fissures adjacent to weld seams in the PNPP suppression pool wall. The monitoring was designed to evaluate the potential for crack propagation and the possibility of detrimental effect on the pool wall. The efforts included periodic visual examination of the suppression pool wall, installation of surveillance specimens in the suppression pool for destructive examination and initiation of electrochemical potential (ECP) monitoring of fissured and nonfissured areas of the pool wall. DAR 037 was closed in July 1985, after the monitoring program was put in place.

Since its discovery, extensive research has been performed to assess the stainless steel cladding sensitization condition of the PNPP suppression pool walls. Intense effort and ingenuity was required from a wide spectrum of disciplines to develop an essentially custom-made program for the investigation, from which a significant amount of data was accumulated. Furthermore, the inplant monitoring of this problem has evolved to the point where conclusions can be drawn and steps taken to update our current action plan. A synopsis of the theory involved, the mechanics of the program implementation, the program's limitations and the results obtained is presented below.

Electrochemical Potential Monitoring Program Description

The objective of the electrochemical potential monitoring program was to detect differences in current emanating from fissured and non-fissured regions of the suppression pool wall which would indicate active penetrating cracks.

The corrosion potential monitoring system consisted of 12 reference electrodes positioned so that the liquid junctions were within 1/16th inch of the surface. Six of the electrodes were placed over fissures in the heat affected zone (HAZ) while the other six were placed over non-fissured areas for comparison.

The output from the reference electrodes was directed first to a junction box, then to a field effect transistor buffer amplifier and finally to a computer. There, the outputs were sampled by a 12 bit A/D converter and stored as binary numbers on magnetic disk or tape. The potential of each electrode and thermocouple was sampled every 30 minutes. The raw data was processed and monthly trend charts were created. A statistical function of correlation analysis was used for a direct comparison between the cracked and non-cracked regions of the pool wall, in order to account for conditions that would cause variances which otherwise would be difficult to assess.

Electrochemical Potential Monitoring Program Results

The monthly trend plots for corrosion potential versus time for fissured and non-fissured areas of the pool wall were examined. Results of the comparison showed no significant differences between fissured and non-fissured regions over time periods in which valid results were obtained. Measurable variations were observed over several isolated intervals, however such variations were attributed to damaged electrodes, faulty equipment or other identifiable and correctible causes, and the results discounted.

Routine chemical laboratory analytical data for dissolved oxygen, chloride, pH and conductivity were also examined for any discernible correlation between their fluctuations and variations in corrosion potential. Despite variations in the chemical parameters during the review period, there were no differences in response between fissured and non-fissured samples.

In summary, the nearness of corrosion potential results and the similarity of behavior in response to environmental changes for both fissured and non-fissured samples over the extended evaluation period gave no indication of active corrosion of the pool wall.

While the electrochemical potential monitoring results gave no indication of active corrosion of the fissured areas monitored, the results are not conclusive considering that the estimated capability of the electrochemical monitoring system to detect active cracks is of the order of $5x10^{-8}$ cm/s (0.25 inch/year).

Surveillance Specimen Program Description

Due to the uncertainty of the sensitivity of ECP monitoring in this novel application, a surveillance specimen program was also instituted. Pre-fissured specimens of clad steel were exposed in the pool and removed at intervals for metallographic examination. Archive specimens were also examined simultaneously for comparison. Actual specimens of the suppression pool wall were not available for the program, making it necessary to prepare them from virgin clad steel. The pool wall material was duplicated and welds similar to the ones in the pool wall were made.

Producing cracks in the cladding proved to be quite difficult but was finally achieved by using a sodium thiosulfate procedure. However, this could only be accomplished with the aid of a corrosive environment and increased stress. One sample of the finished product was destructively examined to determine the extent of the cracking that had been induced by this process. The cracks were intergranular in nature, restricted to the HAZ, ran parallel to the fusion lines and extended to the stainless steel/nickel interface.

Specimen Results

Surveillance specimens were removed from the pool twice for metallographic examinations by scanning electron microscopy. Archive specimens were also examined at the same time using identical techniques. The first specimen was removed in 1987 after more than two years of exposure in the pool and another two were removed in 1989 after four years of exposure. In both sets of samples the results for pool and archive samples were essentially the same. All had crack progressions highly branched with a number of defect indications (voids) at the nickel flash/carbon steel interface. However, there was one difference between the two sets. Cracks propagated into the carbon steel for both pool and archive specimens in the first inspection, but did not penetrate into the carbon steel in any of the second samples.

In light of the above, crack behavior at the nickel flash is worth addressing. The general belief of all investigators was that cracks would be either stopped or deflected at the flash and the carbon steel would remain unaffected. This was generally true for the actual failures of the suppression pool wall. In all of those examined, there was only one "reported" instance of a crack penetrating the nickel. This was by Newport News Industrial Corp. of Ohio (pool installer) in their first report on the fissure problem. However, the sample could not be produced upon Perry's request and no such condition was ever found in any of the examinations made by other investigators.

The results noted previously for actual samples from the pool wall were in sharp contrast to the relatively high number of nickel flash penetrations found in the prepared specimens during the first inspection. However, for the prepared ones, there were no significant differences in results between the pool and the archive specimens. In fact, the penetration rate into the carbon steel was slightly higher for the unexposed archive specimens than for those installed in the pool. The unexpected behavior of the prepared specimens is attributed to the severity of the sodium thiosulfate technique required to induce fissuring.

In summary, while the surveillance specimen examination results gave no indication of active corrosion, the results again must be considered inconclusive due to the nature of the examination involved and due to the inability to correlate processing differences between the surveillance specimens and the actual pool wall. Consequently, the value of continuing the surveillance specimen examination program has been re-examined.

Visual Examination Monitoring Results.

Visual examinations of the Unit 1 suppression pool walls at the air to water interface were performed quarterly. Observations remained consistent and acceptable over prior inspection periods.

Results indicate slight uniform discoloration of the pool wall existing at the air/water interface causing the wall to be judged to be ANSI N45.2.1 Class B below the air/water interface and Class C above. However, no areas of localized corrosion have been observed.

Suppression Pool Corrosion Monitoring Reassessment

The results obtained from the monitoring performed to date have been positive. At no time throughout the duration of the monitoring program were there any indications of active corrosion from any of the investigation methods carried out. However, the results are not conclusive. If there is active crack growth or corrosion occurring in the pool wall fissures, it is at a rate lower than can be monitored by the electrochemical potential methodology. Consequently, the electrochemical monitoring program has served its purpose. Continued monitoring would not likely produce results of greater value than have already been obtained. Furthermore, the surveillance specimens showed no difference in the amount of cracking between the archive samples and the samples suspended in the pool, and no corrosion was observed. Therefore, the results of the surveillance sampling program have also been obtained and continued examinations of the prepared specimens would not likely produce results of greater value than have already been obtained, considering the differences between the prepared specimen fissures and those in the pool wall. The electrochemical corrosion monitoring and the surveillance specimen examinations are therefore considered to be completed. However, the visual examination program will be continued on a refueling outage basis, and a closer examination will be performed whenever the suppression pool is drained.

Sincerely,

Michael D. Lyster

MDL:CJF:ss

cc: NRC Region III
NRC Project Manager
NRC Resident Office