UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION IV
611 RYAN PLAZA DRIVE, SUITE 400
ARLINGTON, TEXAS 76011-8064

AUG 21 1992

Docket No. 50-298
License No. DPR-46

Nebraska Public Power District
ATTN: Guy R. Horn, Nuclear Power
Group Manager
P.O. Box 499
Columbus, Nebraska 68602-0499

Gentlemen:

SUBJECT: NRC INSPECTION REPORT NO. 50-298/92-16

This refers to an audit of the erosion/corrosion program performed by NRC Headquarters personnel from June 15-18, 1992. The audit included a review of activities authorized for your Cooper Nuclear Station facility. At the conclusion of the audit, the findings were discussed with those members of your staff identified in the enclosed report.

The areas examined during the audit are identified in the report. Within these areas, the audit consisted of selective examination of procedures and representative records, interviews with personnel, and observations of activities in progress.

Within the scope of this audit, no violations or deviations were identified. Based on the results of the audit, it appears that the licensee's erosion/corrosion program meets the requirements specified in Generic Letter 89-08.

In accordance with 10 CFR Part 2.790 of the NRC's "Rules of Practice," a copy of this letter and its enclosures will be placed in the NRC Public Document Room.

Should you have any questions concerning this inspection, we will be pleased to discuss them with you.

Sincerely,

A. Bill Beach, Director
Division of Reactor Projects

cc: (see next page)

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bcc to DMB (IE01)

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DRSS-FIPS	RSTS Operator
Project Engineer (DRP/C)	RIV File
DRS	Chief, Technical Support Section

Senior Resident Inspector - River Bend
Senior Resident Inspector - Fort Calhoun

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bcc to DMB (IE01)

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RIV:C:DRP/C	*D:DRS	D:DRP		
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08/21/92	08/21/92	08/21/92		

*previously concurred

NRC AUDIT OF EROSION/CORROSION PROGRAM
AT COOPER NUCLEAR STATION

AUDIT DATES: June 15-18, 1992

NRC AUDIT PARTICIPANTS:
K Parczewski, NRR *#
J Medoff, NRR *#
L Gilbert, RIV *#
R Kopriva, Res. Insp. #
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* Denotes those attending the entrance meeting.
# Denotes those attending the exit meeting.

BACKGROUND

Erosion/Corrosion (E/C) of carbon steel piping systems has occurred in the turbine cycle of both fossil and nuclear plants for a number of years. The catastrophic failure of a main feedwater elbow in December 1986 at Virginia Power's Surry Power Station prompted the NRC to focus on this issue and to identify whether licensees were instituting special programs for controlling erosion/corrosion of carbon steel components in their plants. In this regard, the NRC issued the following generic communications related to erosion/corrosion.

- Information Notice 82-22
- Information Notice 86-106 and Supplements 1, 2, and 3
  Information Notice 87-13
- Information Notice 88-17
- Information Notice 91-18 and Supplement 1
- Information Notice 92-07
- Information Notice 92-35
- IE Bulletin 87-01
- Generic Letter (GL) 89-08

In 1988, ten plants were audited on their response to the IE Bulletin 87-01. As a result of these audits, NRC issued GL 89-08. In this Generic Letter, NRC specifically requested licensees to develop programs consisting of systematic measures to ensure that erosion/corrosion does not lead to degradation of single phase or two phase high-energy carbon steel systems. The NRC intends to verify how well these programs are implemented at individual plants. An inspection procedure has been developed (Inspection Procedure 49001) which provides guidance for NRC inspectors.

In 1992 the NRC developed a plan to further evaluate this area. Five plants were selected for pilot audits. The purpose of these pilot audits is twofold: (1) to provide an indication of how well E/C programs are being implemented by the industry, and (2) help refine the inspection procedure. The review at the Cooper Nuclear Station is the fourth in the series of five planned audits.

AUDIT SCOPE

A review of Nebraska Public Power District's (NPPD) erosion/corrosion (E/C) program was performed by the E/C audit team at the Cooper Nuclear Station (CNS) from June 15-18, 1992. The audit team reviewed the following areas using NRC Manual Chapter 49001 as a guide:

- Licensee's response to GL 89-08
- Licensee's organization responsible for implementing the E/C program
- Licensee's method of selecting systems for inclusion in the program
- Licensee's method of predicting/selecting components for inspection
- Licensee's method of performing inspections of components
- Qualifications of personnel performing ultrasonic testing (UT) inspections
- Licensee's E/C acceptability criteria and method of evaluating UT data
- Licensee's repair/replacement program for components which fail current E/C criteria

No walkdown of balance of plant piping was performed during this audit as the licensee was operating at power (Mode 1), making the condenser bay area a high radiation area. In addition, piping insulation made it difficult for the licensee to demonstrate UT measurements. As a result, no verification of UT measurement taking was witnessed during this audit.

LICENSEE'S E/C PROGRAM AND ORGANIZATION

The licensee's site Engineering Department is responsible for overall administration of the E/C program. This includes activities involved in inspection efforts, performing inspection data evaluations, and current efforts to implement CHEC/CHECMATE into the E/C program. The E/C Coordinator is responsible for the initial evaluations after receiving the UT data. Results of the evaluations are forwarded to the Corporate Engineering Department.

The Nuclear Engineering Department's (NED, a corporate department) System Engineer reviews the E/C evaluations and gets involved if the evaluations suggest that a component would reach minimum wall thickness prior to the next refueling outage. The System Engineer then recommends that the component be either repaired or replaced, and an Automated Work Order (AWO) is issued and sent to maintenance. The System Engineer also recommends that sample expansion be performed for components which fail to meet minimum wall requirements.

LICENSEE'S METHOD OF SELECTING SYSTEMS AND COMPONENTS FOR INSPECTION

NPPD has been performing E/C inspections at CNS since 1983, when it was discovered that some of the extraction steam (ES) lines were exhibiting E/C related wear. As a result, the licensee developed special test procedures to perform inspections of the ES piping. These inspection locations were selected by an engineering judgement basis.

After the Surry event of 1986, the licensee hired an outside contractor to design a program for predicting which piping systems were susceptible to E/C. The program is clearly described in a reviewed and approved contractor procedure, and includes a systematic method of performing UT measurements (including specification of grid sizes and locations) and of evaluating UT data. Systems are included in the program which meet the following inclusion criteria:

- system must be single phase water system at 195-500 F or two phase water/steam system (i.e., steam quality < 1)
- fluid velocity must be > 10 fps
- system must have low oxygen content
- system piping must be made of carbon steel
- system must be normally operating

These criteria result in the inclusion of the following systems in the E/C program: main steam, feedwater, condensate, condensate drains, extraction steam, residual heat removal, reactor equipment cooling (= reactor closed cooling), and turbine equipment cooling (= turbine closed cooling).

The contractor uses the M.I.T. - NUREG method to predict which system components are most susceptible to E/C. This method evaluates wear of components in single and two phase systems based on mass transfer, oxygen content, and thermodynamic parameters. The contractor corrected the results for geometry of the components by applying the Keller equation to the results, and normalized all of the results to single phase wear rates. The predicted wear rate results were used to rank the system components in order to provide a systematic means of prioritizing initial component inspections.

The licensee has inspected 117 components in the first pass according to the contractor's recommendations. Other components were added to the list based on plant/industry experience or as a result of expansions. This has yielded approximately 300-400 components for inclusion in the program. The vast majority of the components has been inspected over the last three refueling outages.

LICENSEE'S METHOD OF PERFORMING UT INSPECTIONS

The licensee's program for inspecting components is clearly described in a reviewed and approved E/C engineering procedure. The licensee's procedure is compatible with and parallel to the contractor's recommended program, but also delineates the responsibilities of the different departments involved in the program. Components are selected for inspection from the list provided by the contractor in their final report to the licensee. Selection is done on a ranking/priority basis. Additional components may be selected for inspection based on engineering judgement, operating experience, or industry experience. Inspection packets are prepared by the responsible E/C engineer. Inspection packets include isometric drawings and corresponding material data sheets.

Inspections are performed by non-destructive testing (NDT) specialists supplied by a second independent contractor. Inspections are performed in accordance with an approved NDT procedure. This procedure covers inspection orientation conventions, qualifications/certifications of NDT personnel, and calibration of NDT instruments. The auditors confirmed that previous inspections were performed by NDT personnel qualified/certified in accordance with the contractor's NDT procedure.

LICENSEE'S METHOD OF EVALUATING UT MEASUREMENT DATA

The licensee's method for evaluating UT measurement data is described in their E/C engineering procedure. The E/C Coordinator evaluates the UT data by calculating the following parameters:

- wear rate = (t-max - t-min-meas)/total generation time to outage.
- minimum projected thickness at next outage.
- actual time (t-p) remaining before reaching minimum wall thickness.
- an index to tell whether a component is in immediate need of repair or replacement.
- a safety factored time (t-r) to reinspection/replacement. This is t-p divided by a safety factor of 1.1. This time must be less than the actual time remaining before reaching minimum wall.

- an inspection index calculated by dividing t-r by t-p. This index predicts when it is time to reinspect/replace the component.

Minimum wall thicknesses are the greater values of either the minimum code required wall thicknesses or 70% of the nominal thickness. The E/C Coordinator compares the minimum measured wall thickness (t-min-meas) to the minimum allowable wall thickness. Components whose minimum measured wall thickness are less than the minimum allowable thickness require immediate repair or replacement. Components with inspection indexes < 1 are required to be replaced within t-r years of generating time. Componerts whose inspection indexes are between 1 and 2 are required to be reinspected at the next scheduled outage and re-evaluated. Components with inspection indexes > 2 are scheduled to be reinspected and re-evaluated within t-r years of generating time. These acceptability criteria give the licensee a systematic method of determining when to reinspect and/or repair/replace the components included in the program.

AUDITOR REVIEW OF INSPECTION PACKETS

The members of the audit team selected the feedwater system inside containment as the Class I system for review. It is important to include this system in the E/C program since it is part of the reactor coolant pressure boundary (safety related), and since it lies in a non-isolable portion of the plant. The most susceptible portion of this system is an area which contains an isolation valve, an 18"x12" tee, an 18"x12" reducer, and a 12" elbow all within 3 pipe diameters of each other. The auditors confirmed that these components were included in the program and were recommended for inspection by the contractor. None of the safety related feedwater components exhibited excessive wear or were below minimum wall requirements upon further review of the UT data evaluations.

Members of the audit team also reviewed packets for components in the feedwater heater drain system, and the extraction steam system. These systems are balance of plant systems, and are therefore not considered to be safety-related. The extraction lines to the "A" #4 and #5, and "B" #4 and #5 Feedwater Heaters were discovered to be below minimum wall thickness, and were replaced with a more wear resistent 5% Cr, 0.5% Mo steel. The extraction lines to the "A" and "B" #3 Feedwater Heaters are currently being re-evaluated by the licensee's corporate NED. The licensee furnished the audit team with memo CNSS927201 as proof of their request for NED evaluations of the extraction line components. Other packets of components in the extraction steam system and feedwater heater drain system were consistent with the licensee's program as set forth in their E/C procedures.

CONCLUSION

Nebraska Public Power Districts has been implementing its erosion/corrosion program since 1988. Use of an outside contractor has aided the licensee in designing a systematic program for inspecting systems and components that are most susceptible to E/C. Initial inspection locations were selected using the M.I.T. Model. Inspections are performed in accordance with approved procedures, and, as a minimum, by certified level II NDT personnel. UT data

evaluations are calculated in a manner which allows the licensee to pinpoint eroded components prior to any failures. The licensee is currently training members of the engineering staff in the use of CHECMATE. The licensee intends to use CHECMATE only as an additional aid for predicting susceptible systems and components. This E/C program meets the requirements of GL 89-08.