VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

W. R. CARTWRIGHT
VICE PRESIDENT
NUCLEAR

January 19, 1989

United States Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D. C. 20555

Serial No. 88-689C
NO/DAS:vlh
Docket Nos. 50-280
50-281
License Nos. DPR-32
DPR-37

Gentlemen:

VIRGINIA ELECTRIC AND POWER COMPANY
SURRY POWER STATION UNITS 1 AND 2
CONFIRMATION OF ACTION LETTER
SECONDARY PIPE THINNING
SUMMARY OF RECENT INSPECTIONS

Our letter (Serial No. 88-689) of October 19, 1988, in conjunction with commitments made during a meeting on October 26, 1988, identified several items which required investigation and appropriate corrective action prior to plant restart. One of those items was to complete NDE inspections of secondary piping consistent with our existing program. This letter forwards for your information a summary of those inspections.

Should you have any questions concerning this investigation summary, please do not hesitate to contact us.

Very truly yours,

JWilson
for W. R. Cartwright

Attachment
Secondary Pipe Inspection Program -
Summary of Recent Inspections

IE36
1/1

cc: U. S. Nuclear Regulatory Commission
Region II
101 Marietta Street, N. W.
Suite 2900
Atlanta, Georgia 30323

Mr. W. E. Holland
NRC Senior Resident Inspector
Surry Power Station

Mr. B. C. Buckley
NRC Surry Project Manager
Project Directorate II-2
Division of Reactor Projects - I/II

VIRGINIA ELECTRIC AND POWER COMPANY

SURRY POWER STATION

UNITS 1 AND 2

SECONDARY PIPE INSPECTION PROGRAM

SUMMARY OF RECENT INSPECTIONS

UNIT 1 1988 FORCED OUTAGE
UNIT 2 1988 REFUELING OUTAGE

JANUARY 19, 1989

h134-MWH-193-1

January 19, 1989

SECONDARY PIPE INSPECTION PROGRAM

SUMMARY OF RECENT INSPECTIONS

1.0 INTRODUCTION

The feedwater pump suction pipe rupture at the Surry Power Station, Unit 2 on December 9, 1986, was determined to have been caused by flow-assisted corrosion commonly referred to as single phase erosion/corrosion (E/C). Subsequently, we began an investigation into E/C and its effects on secondary piping systems. From this investigation, a Secondary Pipe Inspection Program has been developed that inspects piping components which are considered to be susceptible to E/C wear in both single and two phase piping systems.

The purpose of this report is to provide results of the ongoing secondary piping system inspection program conducted at the Surry Power Station during the Unit 2 1988 Refueling Outage and the Unit 1 1988 Forced Outage.

2.0 PRE-OUTAGE INSPECTION PLAN

The Unit 2 inspection plan was developed prior to the refueling outage and 156 piping components were selected to be inspected based on the following:

a. Previous outage inspections indicated that the component should be inspected

b. To obtain actual wear rates or obtain baseline information for individual components

c. The components were classified as a priority point either by previous Surry or North Anna inspections or by computer analysis using "CHEC".

3.0 IMPLEMENTATION OF INSPECTION PROGRAM

3.1 Component Evaluations

The determination of E/C pipe component degradation is made by measuring the current wall thickness using ultrasonic testing (UT) methods. Each piping component is inspected by a zone layout which is specifically designed for the component based on its size, type, orientation, and whether it is subject to single or two phase flow. Within each zone, there is a grid pattern (i.e., 1-inch x 1-inch pattern with alternating rows being offset) which locates each UT inspection point. The number of UT inspection points for each component can range from approximately 180 to over 1,000 points depending on component size and type. After a piping component has been inspected by UT methods, the data is evaluated by Engineering.

For components which have been previously inspected and baseline UT data is available which can be correlated to the current data, an estimated wear rate is calculated for the time period between inspections. If a component is being inspected for the first time or data cannot be accurately correlated, an evaluation of the current data is performed to determine an estimated wear rate. Once the component wear rate is determined, the projected component life is calculated based on allowable minimum wall thickness. The piping components are then categorized into the following four groups for further action based on remaining component life: immediate replacement, potential next outage replacement, inspect next outage, and future inspection. Refer to Tables I and II for specific criteria.

3.2 Expansion of Pre-Outage Inspection Plan

As previously noted, the Unit 2 Inspection Plan selected 156 piping components for inspection. During the inspection, the inspection scope was expanded due to the identification of unexpected high pipe wear rates and associated unexpected component replacements. The inspection scope was expanded by inspecting additional piping components upstream and downstream of the components experiencing unexpected high wear. Piping components of similar configuration on the same system were also added to this expanded scope. This information was also factored into the expanded inspection program for the other unit.

Higher than expected wear rates were encountered on components which were replaced during the 1986/1987 forced outage. This finding resulted in an expansion of the Unit 2 inspection program to include all components replaced during the 1986/1987 forced outage. Likewise in Unit 1, previously replaced components on that unit which had not been inspected during the earlier 1988 refueling outage were also added to the inspection scope. Because of the above, the inspection program was expanded from an initial 156 components to 368 components for Unit 2 and an additional 103 components for Unit 1.

4.0 PIPING COMPONENT INSPECTION AND REPLACEMENT SUMMARY

Component inspection and replacement results are tabularized below:

	Unit 2 1988 R.O.	Unit 1 1988 F.O.	Unit 1 1988 R.O.
COMPONENTS EVALUATED	368	103	285
TOTAL REPLACEMENTS	100*	42**	27

*31 Components are being replaced due to construction convenience;
81 Replaced components are located in single-phase piping systems and
19 replaced components are located in two-phase piping systems.

**12 Components are being replaced due to construction convenience;
All replaced components are located in single-phase piping systems.

5.0 OUTAGE INSPECTION OBSERVATIONS

5.1 Engineering Component Evaluations

Several observations were made by Engineering during the evaluations of the inspected pipe components. They are as follows:

a. For original piping components, the measured wear was a "local" area phenomenon.

b. For replaced piping components, the measured wear was a "general" area phenomenon due to a lack of a protective oxide layer on the interior of the component.

c. The measured wear, in some components, was as much as 2 to 3 times the projected wear which was based on previous inspection data.

5.2 Metallurgical Examination

Due to the higher than anticipated E/C wear rates, a detailed metallurgical examination (i.e., surface morphology, micro-structure, chemistry, hardness, etc.) was initiated. Preliminary results of the metallurgical examination of the pump suction elbows is as follows:

a. The elbows have been subjected to single phase E/C wear.

b. The elbows had been blast cleaned prior to installation in order to insure maximum levels of cleanliness. Materials Engineering examined the surface profile of piping which had been blast cleaned. It has been determined that the surface profile (i.e., depth and contour) is similar to the "dimpled appearance" of the carbon steel piping which has active E/C. From this examination, it has been concluded that blast cleaning removes the protective oxide layer and also creates a surface profile which can immediately enhance the piping component's sensitivity to E/C. Therefore, blast cleaning is now prohibited for cleaning the interior portions of secondary piping components. The only piping components which received a blast cleaning and were installed this outage are those components used for extraction steam piping. These components will be monitored in the future per the inspection program to determine wear rate and effective life.

c. The elbows were found to have an extremely low trace chrome content, in the range of 0.006 to 0.007 weight percent chrome. The carbon steel material specification for these elbows (i.e., A234 WPB) does not specify a weight percent chrome content.

d. The pipe flanges welded to the E/C thinned pump suction elbows showed no wear due to E/C. This has been attributed to the higher trace chrome content in the flange material (i.e., 0.14 to 0.22 weight percent chrome).

5.3 Plant Chemistry

Since the 1986/1987 forced outage, the Surry units have operated at pH levels between 8.8 and 9.1 and Oxygen levels between 1 to 4 ppb. Research has shown that E/C is significantly curtailed when the pH can be raised above 9.4 and oxygen levels maintained above 10 ppb. However, Westinghouse's Guide for Secondary Water Chemistry and EPRI's Secondary Side Water Chemistry Guidelines specifies less than or equal to 5 ppb of dissolved oxygen in order to mitigate steam generator tube denting. Likewise, at this time, the pH level is restricted to an upper limit of 9.2 because of a concern with the transport of copper corrosion products to the steam generators. There is an ongoing study which is evaluating how to raise the pH level in the secondary water chemistry.

6.0 COMPONENT REPLACEMENT

Based on the metallurgical examinations, current industry research, and the limitations associated with raising the pH levels at this time, replacement of secondary piping will be with 2¼% chromium - 1% molybdenum material (P22) wherever practical. The 1¼% chromium - ½% molybdenum material (P11) will be used when P22 is not available. Carbon steel is being utilized only for a wear test case on the feedwater pump suction side and in areas where the components had already been installed prior to the decision to use P22 material.

7.0 CONCLUSIONS

Our conclusions from the current inspection data are as follows:

(a) Unexpected high wear of previously replaced pipe components was due to:

- blast cleaning of interior pipe surfaces which removes the protective oxide layer and creates a surface profile sensitive to E/C.

- the extremely low trace chrome content of the replacement pipe material which we now believe caused the material to be more sensitive to E/C.

- uncertainty in determining when the "accelerated" E/C process actually began. Current methodology had not accounted for plant chemistry changes since the beginning of unit operation.

(b) For component replacement, 2¼% chromium - 1% molybdenum material will be used wherever practical.

TABLE I

PIPING COMPONENT CATEGORIZATION

NON-SAFETY RELATED COMPONENTS

ACCEPTANCE CATEGORY	CRITERIA	REMARKS
A. Immediate Replacement	$L < 1.65$ years	1.65 years represents the time to the next outage plus 10%
B. Potential Next Outage Replacement of Component	$1.65 \leq L < 3.3$ years	3.3 years represents two fuel cycles plus 10%. Component will be inspected at the next outage to verify the wear rate in order to confirm the need for future replacement.
C. Inspect Next Outage	$3.3 \leq L < 4.95$ years	4.95 years represents three fuel cycles plus 10%. Component will be inspected at the next outage to verify the wear rate. Future inspection will be based on this second evaluation.
D. Future Inspection	$L \geq 4.95$ years	Future inspection intervals for component will be established based on Engineering evaluation.

L = projected time until code minimum wall.

TABLE II

PIPING COMPONENT CATEGORIZATION

SAFETY-RELATED COMPONENTS

ACCEPTANCE CATEGORY	CRITERIA	REMARKS
A. Immediate Replacement	$L < 2.2$ years	2.2 years represents the time to the next outage plus 47%
B. Potential Next Outage Replacement of Component	$2.2 \leq L < 4.4$ years	4.4 years represents two fuel cycles plus 47%. Component will be inspected at the next outage to verify the wear rate in order to confirm the need for future replacement.
C. Inspect Next Outage	$4.4 \leq L < 6.6$ years	6.6 years represents three fuel cycles plus 47%. Component will be inspected at the next outage to verify the wear rate. Future inspections will be based on this second evaluation.
D. Future Inspection	$L \geq 6.6$ years	Future inspection intervals for component will be established based on Engineering evaluation.

L = projected time until code minimum wall