VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

February 24, 1997

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

Serial No. 97-079
NL&OS/ETS
Docket No. 50-338
50-339
License No. NPF-4
NPF-7

Gentlemen:

VIRGINIA ELECTRIC AND POWER COMPANY
NORTH ANNA POWER STATION UNITS 1 AND 2
RELIEF FROM ASME SECTION XI REQUIREMENTS

On October 31, 1996, a pin hole leak was identified in a four-inch line of the shared ASME Class 3 Service Water System. During further inspection and evaluation of the Service Water System in November 1996, additional pin hole leaks and other locations with possible evidence of previous leakage were identified in the Service Water System. In accordance with Generic Letter (GL) 90-05, "Guidance for Performing Temporary Non-Code Repair of ASME Code Class 1, 2, and 3 Piping," to the extent possible an evaluation of the Service Water System was performed to determine operability and continued safe operation of both units until the necessary ASME Code repairs could be completed. When meaningful radiographic examination data could be obtained, the evaluation included an assessment of the structural integrity of the flawed service water piping using a "through-wall flaw" evaluation technique. Each confirmed or suspected leaking weld was repaired per the requirements of the ASME Code by December 14, 1996. A relief request associated with these pinhole leaks was submitted to the NRC on February 3, 1997 (Serial No. 96-571). During a January 8, 1997, system walkdown three additional locations with evidence of leakage were identified. Again in accordance with GL 90-05, an evaluation of the Service Water System was performed to determine operability and continued safe operation until the necessary ASME Code repairs could be made. These three welds were repaired by January 23, 1997. A relief request is being developed for submittal to the NRC on these additional pinhole leaks.

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Based on radiographic examination and subsequent laboratory assessment of the welds exhibiting minor leakage or evidence of previous leakage, the failure mechanism was determined to be microbiological influenced corrosion (MIC). In order to avoid specific relief requests for each additional pin hole leak or location with possible evidence of previous leakage identified during routine service water piping walkdowns,

we have developed and are submitting for review and approval a MIC monitoring program. The monitoring program includes provisions for evaluating continued system operability in accordance with GL 90-05 until appropriate Code repairs can be completed. Therefore, pursuant to 10 CFR 50.55a (g) (5), relief is requested for both Units 1 and 2 from ASME Section XI, paragraph IWA-5250 to permit continued Service Water System operation for up to eighteen months from the date of discovery of each minor leak or indication of previous leakage attributed to MIC. Relief Request NDE-32 details the MIC monitoring program and is provided in the Attachment to this letter.

A routine monitoring program has been developed for the Service Water System. The monitoring program includes walkdowns of the affected welds and the accessible portions of the stainless steel Service Water System piping to identify, monitor and quantify any leakage. When a leak or evidence of previous leakage is identified, structural analysis and increased monitoring of the affected welds will be implemented as detailed in Relief Request 32.

This relief request has been reviewed and approved by the station Nuclear Safety and Operating Committees.

This letter does not establish any additional commitments. If you have any additional questions concerning this relief request, please contact us.

Very truly yours,

J. P. O'Hanlon

J. P. O'Hanlon
Senior Vice President - Nuclear

Attachment

Commitments made in this letter:

None

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

Mr. R. D. McWhorter
NRC Senior Resident Inspector
North Anna Power Station

ATTACHMENT

ASME Section XI Relief Request
NDE-32

MIC Monitoring Program

Virginia Electric and Power Company
North Anna Power Station Units 1 and 2

Virginia Electric & Power Company
North Anna Power Station Unit 1 and Unit 2
Second 10 Year Interval
Request for Relief Number NDE-32 Revision 1

I. IDENTIFICATION OF COMPONENTS

	Drawing #
Service Water System	11715-CBB-40D-2 SHTS. 1 and 2
	11715-CBM-78A-2 SHTS. 1 and 4
	11715-CBM-78B-2 SHTS. 1, 3, and 4
	11715-CBM-78C-2 SHTS. 1 and 2
	11715-CBM-78G-2 SHTS. 1 and 2
	11715-CBM-78H-2 SHT. 1

(a) The above welds are Class 3, moderate energy stainless steel piping, pipe class 153A and 163, in the Service Water (SW) system and;

(b) Provide cooling water from the service water reservoir to safety related equipment and return service water back to the return headers. Normal operating pressure is 100 psig. The design pressure is 150 psig and design temperature is 150°F.

II. IMPRACTICABLE CODE REQUIREMENTS

The Service Water System has experienced through-wall leakage caused by Microbiological Influenced Corrosion (MIC). Chemical treatment of the Service Water System has not been effective in eliminating MIC. The Service Water System is being monitored for MIC. Identification of additional through-wall leakage is anticipated. Through-wall leakage must be located and evaluated in accordance with the requirements of IWA-5250 of the 1983 Edition and Summer 1983 Addenda for Unit 1 and 1986 Edition for Unit 2. The specific Code requirement for which relief is requested is IWA-5250(a)(2).

"IWA-5250 Corrective Measures:
(a) The source of leakage detected during the conduct of a system pressure test shall be located and evaluated by the Owner for corrective measures as follows:...
(2) repairs or replacements of components shall be performed in accordance with IWA-4000 or IWA-7000, respectively."

Articles IWA-4000 and IWD-4000 of ASME Section XI Code repair requirements would require removal of the flaw and subsequent weld repair.

Code repairs for through-wall leaks require the line to be isolated and drained. Taking a train of service water out of service in some instances is a major evolution and requires entering a Tecnical Specification action statement. Welds and piping with through-wall flaws caused by MIC can be shown to have adequate structural integrity to remain in service. This type of through-wall flaw is unpredictable but normally not catastrophic. It is impractical to force a Code repair within the time required by the Technical Specification Limiting Condition for Operation every time a through-wall flaw is identified.

Generic Letter 90-05, "Guidance for Performing Temporary Non-Code Repair of ASME Code Class 1, 2, and 3 Piping", provides guidance for submitting relief requests to allow continued operation with a through-wall flaw. Submitting a relief request for each instance of through-wall leakage caused by MIC will be an administrative burden and cause additional reviews for the NRC. Implementing GL 90-05 each time a through-wall flaw is identified is impractical.

This relief request establishes a plan for continued operation with through-wall flaws in stainless steel piping in the Service Water System based upon the guidance of GL 90-05 to the extent it is believed practical. This relief request will be implemented upon receiving NRC approval. In the interim, GL 90-05 will be followed for through-wall flaws and separate relief requests will be submitted.

III. ISI BASIS FOR RELIEF REQUEST

This relief request is submitted in a format laid out in NRC GL 90-05. The following information and justification is provided in accordance with the guidelines of Part B and C of Enclosure 1 to GL 90-05.

Scope, Limitations and Specific Considerations

Scope

The scope consists of welds and stainless steel piping, pipe class 153A and 163, with evidence of possible through-wall leaks in the Service Water System at North Anna Power Station Units 1 and 2.

Limitations

Based on radiographic examinations and laboratory examinations of removed portions of piping from replacements, North Anna Power Station is experiencing MIC in its stainless steel piping. The MIC caused flaws originate on the inner diameter of the pipe. The Service

Water System is common to both Units. As long as one Unit is in Mode 1, 2, 3, or 4 both trains of service water must be operable. If both Units are in Mode 5 or 6 then one train of Service Water must be operable. The intent of this relief is to permit continued operation with the identified through-wall flaws until repairs are accomplished in a scheduled service water outage.

Specific Considerations

System interactions, i.e. consequences of flooding and spray will be evaluated. The flaws located on piping, such that potential through-wall leakage could affect plant safety related equipment will be declared inoperable and the appropriate Technical Specification action statement entered.

Butt welds and piping accessible to radiography with through-wall flaws will be evaluated for structural integrity within 14 days of identification for all design loading conditions, including dead weight, pressure, thermal expansion and seismic (DBE) loads. The methods used in the structural integrity analysis will consist of area reinforcement, fracture mechanics, and limit load analyses. These methods are detailed in Attachment 1. The welds that are found to be unacceptable will be declared inoperable and the appropriate Technical Specification action statement entered.

A 3/4" hole will be postulated for any location with a through-wall flaw that can not be characterized volumetrically by ultrasonics or radiography, socket welds and welds that are inaccessible for radiography. Laboratory examination of cut sections of MIC degraded socket weld samples indicate that flaws are enveloped within 3/4" size. A leaking socket weld location will be analyzed by treating the cross section as equivalent to the cross section of the attached pipe with a 3/4" hole. The methods used in the structural integrity analysis will consist of area reinforcement, fracture mechanics, and limit load analyses. These methods are detailed in Attachment 1. A through-wall flaw size is postulated in order to perform a structural analysis. Additional monitoring is performed for a period of two (2) months on socket welds to assure the degradation mechanism is behaving in a manner expected for a MIC flaw.

The structural integrity for all welds identified with evidence of through-wall leakage will be monitored by the following methods:

- Weekly visual monitoring of through-wall flaws from the time of identification until completion of structural integrity analysis. If the welds are determined to be structurally acceptable then the visual monitoring frequency will be decreased to once a month.

- Weekly visual monitoring of through-wall flaws in socket welds and butt welds inaccessible to radiography for a period of two (2) months. If there is no significant change in the leakage rate the monitoring frequency will be decreased to monthly until the welds are repaired.

  A significant change is defined as a 0.5 gpm increase in the leakage rate from the initial observed leakage condition for each weld. Should any location reach the threshold of a significant change the weld will be reassessed for structural integrity and flood/spraying consequences.

- A total leakage rate limit of 1.0 gpm for a single supply or return line to an individual component will be established. If this total leakage rate limit is exceeded then an evaluation will be performed to determine if design service water flow is available to affected components. Inadequate service water supply will cause the associated service water lines and equipment to be declared inoperable and appropriate action will be taken according to Technical Specifications.

The temporary non-code repair will be to leave the welds as they are found, subject to monitoring and meeting the criteria for consequences and for structural integrity as described above.

Evaluation

Flaw Detection During Plant Operation and Impracticality Determination

The Service Water System is a common system for both Units at North Anna Power Station. Both trains are required to be operational or the appropriate Technical Specification action statement be entered. The through-wall flaws on Service Water lines in service are anticipated based on the North Anna Power Station history of MIC. Virginia Electric and Power Company requests to evaluate the flaws and leave acceptable through-wall flaws in service in order to perform Code repairs in controlled conditions during scheduled service water outages.

Root Cause Determination and Flaw Characterization

The Service Water System at North Anna Power Station has previously experienced MIC. Radiograph examinations of service water welds having evidence of through-wall leakage revealed small voids surrounded by exfoliation, which is typical of MIC. No other type of inservice defects were identified by the radiographs near the areas with through-wall leaks. Additionally, a visual examination performed by a Virginia Electric and Power Company staff metallurgist of a sample of piping segments removed to repair the leaking welds confirmed the presence of MIC.

Butt welds identified with through-wall leakage and accessible for radiography will be radiographed and evaluated for structural integrity within 14 days of discovery.

Through-wall flaws that cannot be characterized by radiography, socket welds and inaccessible butt welds, will be characterized as a 3/4" hole for each area of leakage.

Flaw Evaluation

Flaw evaluation for welds with through-wall leakage will be performed as described in Attachment 1. The flaws in butt welds that can be characterized by radiography will be evaluated by three types of analyses, area reinforcement, limit load analyses, and fracture mechanics using the guidance from NRC Generic Letter 90-05. The flaws in welds that can not be characterized by radiography, i.e. socket welds and inaccessible butt welds, will be evaluated by the same analysis by assuming a 3/4" hole for each point of leakage within a weld with through-wall leakage. Socket welds will be analyzed by treating the cross section at the socket weld as equivalent pipe cross section.

IV. AUGMENTED INSPECTION

An augmented inspection program will monitor a sample of butt welds in the Service Water System using radiography. Radiography will be performed every three (3) months. The frequency of radiography will be assessed after a year and may be adjusted for each location based on the results of the radiographs.

V. ALTERNATE PROVISIONS

As an alternative to performing Code repairs in accordance with IWA-5250(a)(2) to through-wall flaws in the Service Water System the through-wall flaws will be left as is. The through-wall flaws will be monitored for leakage and must

meet the criteria for flooding and spraying consequences and for structural integrity as described to remain in service. Operation in this mode will continue until the subject welds are replaced. All welds identified with through-wall flaws will be replaced within 18 months from the time of discovery.

The structural integrity of the Service Water System will be monitored by the following methods until the repairs required by IWA 5250(a)(2) are completed.

- Weekly visual monitoring of through-wall flaws from the time of identification until completion of structural integrity analysis. If the welds are determined to be structurally acceptable then the visual monitoring frequency will be decreased to once a month.

- All welds identified as having a through-wall flaw will be assessed for structural integrity within 14 days of detection. Butt welds will be radiographed, if accessible, to characterize the flaws. Socket welds and butt welds inaccessible to radiography will be assessed for structural integrity by assuming a conservative large hole. Welds determined to be structurally adequate will be included in the above monitoring program. Identification of a structurally inadequate weld will result in the associated piping to be declared inoperable and the appropriate Technical Specification action statement to be taken.

- Weekly visual monitoring of through-wall flaws in socket welds and butt welds inaccessible to radiography for a period of two (2) months. If there is no significant change in the leakage rate the monitoring frequency will be decreased to monthly until the welds are repaired.

  A significant change is defined as a 0.5 gpm increase in the leakage rate from the initial observed leakage condition for each weld. Should any location reach the threshold of a significant change the weld will be reassessed for structural integrity and flood/spraying consequences.

- Monthly walkdown of the accessible stainless steel portions of the Service Water System will be performed. The frequency of monthly walkdowns will be assessed after a year and adjusted based on the results of monthly inspections.

- A total leakage rate limit of 1.0 gpm for a single supply or return line for an individual component will be established. If this total leakage rate limit is exceeded then an evaluation will be performed to determine if design service water flow is available to affected components. Inadequate service water supply will cause the associated service water lines and equipment to be declared inoperable and appropriate action will be taken according to Technical Specifications.

- An augmented inspection program will monitor a sample of butt welds in the Service Water System using radiography. Radiography will be performed every three (3) months. The frequency of radiography will be assessed after a year and may be adjusted for each location based on the results of the radiographs.

The proposed alternative stated above will ensure that the overall level of plant quality and safety will not be compromised.

VI IMPLEMENTATION SCHEDULE

This alternative to Code requirements will be followed upon receiving NRC approval for the remainder of the second ten-year inspection intervals. The Unit 1 second ten-year inspection interval will end on December 24, 1998 and the Unit 2 second ten-year interval will end on December 14, 2000.

Attachment:

1. Flaw Evaluation Methods and Results

References:

1. USAS B31.1 Power Piping 1967 Edition
2. EPRI Report NP-6301-D, "Ductile Fracture Handbook"
3. Nuclear Regulatory Commission Generic Letter 90-05 "Guidance for Performing Temporary Non-Code Repair of ASME Code Class 1, 2, and 3 Piping"

Attachment 1

Flaw Evaluation Methods and Results

Introduction

Butt welds identified as having possible through-wall leaks will be radiographed, if accessible. Flaws in butt welds that are inaccessible for radiography will be postulated as a 3/4" hole for each area identified with a through-wall flaw. All butt welds will be analyzed for structural integrity by three methods, area reinforcement, limit load analysis, and linear elastic fracture mechanics evaluation.

Flaw size in socket welds identified as having possible through-wall leaks cannot be characterized by nondestructive examination. A conservatively large hole, 3/4", will be postulated for each area identified with a through-wall flaw. The postulated flaw will be analyzed for structural integrity by treating the cross section as equivalent to the cross section of the attached pipe.

Area Reinforcement Analysis

The area reinforcement analysis is used to determine if adequate reinforcing exists such that ductile tearing would not occur. The guidelines of ANSI B31.1 paragraph 104.3.(d) 2 (reference 1) are used to determine the Code required reinforcing area. The actual reinforcing area is calculated and is checked against the required reinforcement area.

The Code required reinforcement area in square inches is defined as:

$$1.07(t_m)(d_1)$$

Where t_m is the code minimum wall, and d_1 is the outside diameter

The Code reinforcement area required is provided by the available material around the flaw in the reinforcing zone.

Limit Load Analysis

The structural integrity of the piping in the degraded condition will be established by calculating the minimum margin of safety based upon a Limit Load Analysis. These methods are documented in EPRI report NP-6301-D (Ductile Fracture Handbook) (reference 2).

The limit load analysis of the postulated flawed sections will be performed with a material flow stress representing the midpoint of the ultimate strength and yield point stress.

The flawed sections will be subjected to deadweight, thermal, and seismic DBE loading.

The allowable limit load is given by,

$M_a = 2 \cdot \sigma_f \cdot R_m^2 \cdot t \cdot (2\cos(\beta) - \sin(\theta))$ in-lbf

σ_f = flow stress = 0.5 (S_y + S_u) psi
S_y = yield stress psi
S_u = ultimate stress psi

R_m = mean radius of the pipe

$$\beta = \frac{\Theta}{2} + \frac{\Pi \cdot (R_i^2 \cdot P) + F}{4 \cdot \sigma_f \cdot R_m \cdot t}$$

R_i = internal radius of the pipe
P = pressure psig
F = axial load in lbs
t = pipe thickness = inches
D = Outside diameter inches
θ = half angle of the crack (radians) = $\frac{\text{crack length}}{2 \cdot R_m}$

MR = Resultant Moment
$$MR = \sqrt{MY^2 + MZ^2 + T^2}$$

MY = Bending Moment
MZ = Bending Moment
T = Torsion

The calculated factor of safety is,

$$FS = \frac{M_a}{(MR)}$$

The minimum factor of safety of 1.4 is required to be qualified for continued operation.

Fracture Mechanics Evaluation

A linear elastic fracture mechanics analysis will be performed for circumferential through-wall crack using the guidance provided in NRC Generic Letter 90-05. The structural integrity of the piping in the degraded condition was established by calculating the minimum margin of safety based upon a Fracture Mechanics evaluation. This method is documented in EPRI report NP-6301-D (Ductile Fracture Handbook) (reference 2).
A through-wall circumferential crack will be postulated for every

area containing MIC. The cracks will be subjected to a design pressure loading in addition to the deadweight, normal operating thermal and seismic DBE loadings. For the purpose of this evaluation a generic allowable stress intensity factor of K_{IC} = 135 ksi$\sqrt{in}$ will be used for the stainless steel material per NRC GL 90-05.

The applied stress intensity factor for bending, K_{IB}, is found by:

$$K_{IB} = [\sigma_b \cdot (\pi \cdot R_m \cdot \theta)^{0.5}] \cdot F_b$$

The applied stress intensity factor for internal pressure, K_{IP}, is found by:

$$K_{IP} = \sigma_m \cdot (\pi \cdot R_m \cdot \theta)^{0.5} \cdot F_m$$

The applied stress intensity factor for axial tension, K_{IT} is found by:

$$K_{IT} = \sigma_t \cdot (\pi \cdot R_m \cdot \theta)^{0.5} \cdot F_t$$

The stress intensity factor for residual stresses, K_{IR} is found by:

$$K_{IR} = S \cdot (\pi \cdot R_m \cdot \theta)^{0.5} \cdot F_t$$

Total applied stress intensity K_T includes a 1.4 safety factor and is calculated by:

$$K_T = 1.4 \cdot (K_{IB} + K_{IP} + K_{IT}) + K_{IR}$$

The allowable stress intensity factor is taken from Generic Letter 90-05.

$$K_{ALL} = 135 \text{ ksi}\sqrt{in}$$

Stress Intensity Factor Ratio is defined as:

$$SR = \frac{K_T}{K_{ALL}}$$

The stress intensity factor ratio shall be less than 1.0 for continued operation.