CP&L
A Progress Energy Company

JAN 1 8 2002

10 CFR 50.55a(g)(5)(iii)

SERIAL: BSEP 02-0008

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

BRUNSWICK STEAM ELECTRIC PLANT, UNIT NO. 2
DOCKET NO. 50-324/LICENSE NO. DPR-62
RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION - INSERVICE INSPECTION PROGRAM RELIEF REQUEST FOR SERVICE WATER SYSTEM PIPING NON-CODE REPAIR (NRC TAC NO. MB3498)

Ladies and Gentlemen:

On November 28, 2001 (Serial: BSEP 01-0135), Carolina Power & Light (CP&L) Company submitted a request for relief from the requirements of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section XI for the Brunswick Steam Electric Plant (BSEP), Unit 2. This request for relief pertains to the requirements of subparagraph IWA-4000(a) regarding the repair of a through-wall leak identified on Service Water line 2-SW-103-24-157. On January 8, 2002, the NRC provided an electronic version of a request for additional information (RAI) regarding this submittal. The response to this RAI is enclosed.

Please refer any questions regarding this submittal to Mr. Steven F. Tabor, Supervisor - Licensing/Regulatory Programs, at (910) 457-2178.

Sincerely,

Leonard R. Beller

Leonard R. Beller
Manager - Regulatory Affairs
Brunswick Steam Electric Plant

Brunswick Nuclear Plant
P.O. Box 10429
Southport, NC 28461

A047

WRM/wrm

Enclosures:
1. Response to Request for Additional Information (RAI)
2. Engineering Service Request 01-00439, "Operability Evaluation of Thru Wall Leak on 2-SW-103-24-157"

cc: U. S. Nuclear Regulatory Commission, Region II
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U. S. Nuclear Regulatory Commission
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Response to Request for Additional Information (RAI)

Background

On November 28, 2001 (Serial: BSEP 01-0135), Carolina Power & Light (CP&L) Company submitted a request for relief from the requirements of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section XI for the Brunswick Steam Electric Plant (BSEP), Unit 2. The request for relief pertains to the requirements of subparagraph IWA-4000(a) regarding the repair of a through-wall leak identified on Service Water line 2-SW-103-24-157. On January 8, 2002, the NRC provided an electronic version of a RAI regarding this request for relief.

NRC Question 1

Provide the design temperature and pressure of the subject piping.

CP&L Response

The design temperature of the subject piping is 105 degrees Fahrenheit. The design pressure for the subject piping is 150 psig. This information is documented in Section G.3 of Engineering Service Request (ESR) 01-00439, "Operability Evaluation of Thru Wall Leak on 2-SW-103-24-157," a copy of which is provided in Enclosure 2.

NRC Question 2

Provide the nominal pipe thickness, the actual hole size, and the minimal wall thickness which is used in the K calculations.

CP&L Response

The nominal pipe wall thickness for the subject piping is 0.375 inches. The minimal wall thickness used in the stress intensity factor calculations is 0.120 inches. This information is contained in Attachment E of ESR 01-00439. The actual flaw hole size is 0.2 inches (i.e., see Attachment C of ESR 01-00439).

NRC Question 3

Provide the stress used in the K calculation and its source.

CP&L Response

The stress intensity factor "K" used in the "through-wall flaw" evaluation was 30.092 ksi(in)$^{0.5}$, which is less than the applicable acceptance criterion of 35 ksi(in)$^{0.5}$. Section C.3.a of Enclosure 1 to NRC Generic Letter 90-05, "Guidance for Performing Temporary Non-Code Repair of ASME Code Class 1, 2, and 3 Piping," discusses the use of the "through-wall flaw" approach for flaw evaluation. This was the source used for the stress intensity factor "K" acceptance criterion of 35 ksi(in)$^{0.5}$.

NRC Question 4

Please confirm that the stress is a result of considering the combination of deadweight, pressure, thermal expansion, and SSE load.

CP&L Response

The combined bending stress used in evaluating the subject piping considered a combination of deadweight, pressure, thermal expansion, and Safe Shutdown Earthquake (SSE) loads (i.e., see Attachments E and F of ESR 01-00439).

NRC Question 5

Please confirm that system interactions, such as the consequences of flooding and spraying water on equipment, have been considered and a potential significance of a loss of flow of the system has been considered.

CP&L Response

The consequences of flooding and spraying water on equipment were considered as part of evaluating the Service Water System through-wall flaw. The flaw leakage from the piping is approximately 200 drops per minute. The Service Water System hydraulic analysis demonstrates that the system can fulfill its design basis function with minor leakage from the subject piping. The flaw has been covered with a "soft patch" to stop all practical leakage, thereby preventing water from dripping onto other components.

ENCLOSURE 2

BRUNSWICK STEAM ELECTRIC PLANT, UNIT NO. 2
DOCKET NO. 50-324/LICENSE NO. DPR-62
RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION - INSERVICE INSPECTION PROGRAM RELIEF REQUEST FOR SERVICE WATER SYSTEM PIPING NON-CODE REPAIR (NRC TAC NO. MB3498)

Engineering Service Request 01-00439,
"Operability Evaluation of Thru Wall Leak on 2-SW-103-24-157"

Form 1

ENGINEERING SERVICE REQUEST

ESR # 01-00439 Rev # 0	Passport WO # 191080	Other Documents (CR, OEF, etc.) CR-0051158 -WR 31993

Plant/Unit BNP 2	Primary System Number & Name 4060 SW-SERVICE WATER SYSTEM	☐ Multiple Systems Affected

Title	Originator/Phone
Operability Evaluation of Thru Wall Leak on 2-SW-103-24-157	SHERRILL, THOMAS M /850-2703

Due Date: 11-09-2001

TURNOVER REQUIRED ☐ Yes ☒ No

Reviews (Print Name, Sign, Date)

Design Verification C. Eames 11/9/01

☐ Other Reviews Required ☐ Records Attached

ENGINEERING DISCIPLINES (print name, sign, date)

Civil/Struct/Seismic A. Borodotsky 11-09-01

Syst Engr 4060 Thomas Sherrill 11/9/01

ENGINEERING PROGRAMS (print name, sign, date)

ISI/IST/App L. Wheatley 11-9-01

PLANT CUSTOMERS (print name, sign, date)

Regulatory Affairs R.A. Turkal 11-9-01

Product Type	Additional Systems	ESR Team	Quality Class
ENG EVAL		N/A	A Safety-Related

APPROVALS

☐ NAS Before Approval/Implementation
☐ PNSC Before Approval/Implementation
☐ NRC Before Implementation

Is a 10CFR50.59 Screen or Evaluation required?

☒ Yes ☒ Screen ONLY
☐ Evaluation
☐ N/A (Engineering Disposition Only)

Responsible Engineer ARON BORODOTSKY 11-09-2001

Responsible Manager (Print Name, Sign, Date) G. S. Burnes 11/9/01 FOR

Plant General Manager (Print Name, Sign, Date)

Procedure: Form EGR-NGGC-0005-1-14 DCM01a2a 03/22/2001

Form 1

ENGINEERING SERVICE REQUEST

ESR #	Rev #	Title
01-00439	0	Operability Evaluation of Thru Wall Leak on 2-SW-103-24-157

Request:

There is a through wall leak on Service Water pipe 2-SW-103-24-157 downstream of 2-SW-V104. An operability evaluation is needed.

Response:

The evaluation of this ESR concludes that a code repair of the pipe through-wall defect identified by CR 0051158 & UT NDE inspection data in the Service Water pipe segment between valves SW-V104 & SW-V105 in the suction line 2-SW-103-24-157 to the RHR Pumps 2D & 2B is not required at present time. The line will operable until the next refueling Unit 2 outage. See body of this ESR for required action items to support operability of the evaluated line.

C. List of Effective Pages

ESR Pages:

Page	Rev	Page	Rev	Page	Rev	Page	Rev	Page	Rev	Page	Rev
1	0	4	0	7	0	10	0	13	0		
2	0	5	0	8	0	11	0	14	0		
3	0	6	0	9	0	12	0				

Attachment A Comment Review Forms:

Page	Rev	Page	Rev	Page	Rev	Page	Rev	Page	Rev	Page	Rev
1	0										

Attachment B Not Used:

Page	Rev	Page	Rev	Page	Rev	Page	Rev	Page	Rev	Page	Rev

Attachment C UT NDE Inspection Report:

Page	Rev	Page	Rev	Page	Rev	Page	Rev	Page	Rev	Page	Rev
1	0	2	0	3	0	4	0	5	0		

Attachment D 10 CFR 50.59 Review:

Page	Rev	Page	Rev	Page	Rev	Page	Rev	Page	Rev	Page	Rev
1	0	2	0	3	0	4	0				

Attachment E GL 90-05 Through Wall Structural Evaluation

Page	Rev	Page	Rev	Page	Rev	Page	Rev	Page	Rev	Page	Rev
1	0										

Attachment F Structural Evaluation of UT NDE Inspected Components

Page	Rev	Page	Rev	Page	Rev	Page	Rev	Page	Rev	Page	Rev
1	0	2	0	3	0	4	0	5	0		

D. Table of Contents

A. ESR FORM 1, ELECTRONIC COVER PAGE 1

B. ESR FORM 1, REQUEST / RESPONSE 2

C. LIST OF EFFECTIVE PAGES 3

D. TABLE OF CONTENTS 4

E. PROBLEM STATEMENT 5

F. SOLUTION STATEMENT 6

G. DESIGN SPECIFICATION 7

G.1. SCOPE DESCRIPTION 7
G.2. REFERENCES 7
G.3. DESIGN INPUTS 8
G.4. ASSUMPTIONS 10
G.5. EVALUATIONS 11
G.6. PRECAUTIONS AND LIMITATIONS 12

H. TURNOVER SUMMARY 13

I. ATTACHMENTS LIST 14

E. Problem Statement

Objective:

The objective of this ESR is to document the structural evaluation of the through-wall leak identified in the Unit 2 Service Water Line SW-103-24-157.

On 11/08/2001 a through-wall leak was discovered in the Unit 2 Service Water l ine 2-SW-103-24-157. The plant is operational. The leak is in the 24" diameter pipe between valves 2-SW-V104 and line 2-SW-V105. Ultrasonic testing of the area around the leak has been completed, and final report(s) are included as Attachment C to this ESR. The structural integrity of the piping with the through-wall leak will be evaluated to determine the operability of this condition.

The leak initiates from the inside of the pipe. In subsequent discussions with the System Engineer, the leak was noted to be approximately 200 drops per minute.

The leak is located in a section of piping that is isolable, but is impractical to repair. The valve that isolates the leak from the Unit 2 Nuclear Service Water header is a 24" Fisher wafer style butterfly valve. To access the piping to repair the leak would require that the Nuclear Service Water header be drained. This would place Unit 2 in a 4 hour LCO action statement. Due to the inability to repair this leak without draining the Nuclear Service Water header it is impractical for this repair to be performed while Unit 2 is on line.

A structural evaluation is needed to show acceptance of the component for continuing operation with the subject flaw. The pipe component with the flaw present must satisfy the criteria contained in CP&L Procedure EGR-NGGC- 320 "Civil/Structural Operability Reviews" for Short Term Structural Integrity and/or CP&L Procedure EGR-NGGC-0308 "Pipe Stress Analysis" until the end of the next Unit 2 refueling to be in compliance with our UFSAR identified design criteria. The methodology outlined in the Industry standards listed in the reference G2.1.1.2 will be used for the structural evaluation.

Historical Information:

Not applicable.

Root Cause Evaluation:

Until line 2-SW-103-24-157 can be isolated and examined from the inside, the root cause of the flaw cannot be definitively confirmed. However, it is suspected that a local failure of the cement liner on the inside of the pipe allowed salt water to come in contact with the carbon steel pipe. The pipe then experienced localized corrosion at the water contact point. The flaw appears to be very localized as may be determined from the UT report included in the Attachment C and discussions with NDE technicians performing the exam.

ESR Team Members:

None

F. Solution Statement

The flaw is located in the suction supply line 2-SW-103-24-157 to the SW booster Pumps 2B & 2D. The flaw is on the segment of the pipe between valves 2-SW-V104 and 2-SW-V105.

To repair the flaw (weld repair or component replacement), the line must be removed from service. The leak is located in a section of piping that is isolable, but is impractical to repair. The valve that isolates the leak from the Unit 2 Nuclear Service Water header is a 24" Fisher wafer style butterfly valve. To access the piping to repair the leak would require that the Nuclear Service Water header be drained. This would place Unit 2 in a 4 hour LCO action statement. Due to the inability to repair this leak without draining the Nuclear Service Water header it is impractical for this repair to be performed while Unit 2 is on line. A request for relief from the requirements of subparagraphs IWA-4000 (a) of the ASME Code, Section XI for repair should be filed with the NRC.

- It is proposed to perform a structural integrity evaluation of the piping with the through-wall leak in order to determine the operability of the piping system. The pipe component with the flaw present must at least satisfy the Short Term Structural Integrity criteria contained in CP&L Procedure EGR-NGGC- 320 "Civil/Structural Operability Reviews" until the end of the next Unit 2 refueling outage to be in compliance with our UFSAR identified design criteria.

- In order to only perform a non-code repair of the through-wall flaw (pinhole leak), the flaw must be found acceptable by the "Through-Wall Flaw Approach" discussed in USNRC Generic Letter 90-05 Enclosure 1, Section C.3.A. An evaluation consistent with the guidelines contained in Reference G2.1.1.2 must be conducted confirming the appropriateness of performing a temporary non-code repair until the next Refueling Outage.

- This ESR is part of a relief request consistent with the guidance provided in Reference G2.1.1.2 to permit a temporary non-code repair of the through-wall flaw detected in line 2-SW-103-24-157 until the next Unit 2 Refueling or a scheduled outage of thirty (30) days or more.

As indicated in the last paragraph of Enclosure 1, Section B.3 of Reference G2.1.1.2, code Class 3 piping in moderate energy systems may remain in service without a code repair if an evaluation confirms it is satisfactory relative to the requirements specified in Reference G2.1.1.2.

G. Design Specification

G.1. Scope Description

- The pipe component with the flaw present must at least satisfy the Short Term Structural Integrity criteria contained in CP&L Procedure EGR-NGGC- 320 "Civil/Structural Operability Reviews" until the end of the next Unit 2 refueling outage to be in compliance with our UFSAR identified design criteria.

- In order to only perform a non-code repair of the through-wall flaw (pinhole leak), the flaw must be found acceptable by the "Through-Wall Flaw Approach" discussed in USNRC Generic Letter 90-05 Enclosure 1, Section C.3.A. An evaluation consistent with the guidelines contained in Reference G2.1.1.2 must be conducted confirming the appropriateness of performing a temporary non-code repair until the next Refueling Outage.

- This ESR is part of a relief request consistent with the guidance provided in Reference G2.1.1.2 to permit a temporary non-code repair of the through-wall flaw detected in line 2-SW-103-24-157 until the next Unit 2 Refueling or a scheduled outage of thirty (30) days or more.

- The functional requirements for this evaluation are found in the references listed below. The piping is to comply with Short Term Structural Integrity (STSI) criteria and the appropriate BNP Specifications and Procedures. In this case, this piping is required to meet STSI allowable values per Reference G2.4.4.3 as a minimum for operability. As the pipe has a detected through-wall leak, the conditions specified in the "Through-Wall Flaw Approach" identified in Enclosure 1, Section C.3.a of Reference G2.1.1.2 must also be satisfied.

G.2. References

1. Industry Standards:
   - 1.1. USAS B31.1.0 - 1967 Power Piping
   - 1.2. USNRC Generic Letter 90-05, Guidance for Performing Temporary Non-Code Repair of ASME Code Class 1, 2 and 3 Piping
   - 1.3. ASME Code, Section XI, 1989
2. Specifications:
   - 2.1. Spec 248-117 Installation Of Piping Systems
3. Drawings:
   - 3.1. P&ID's:
     - 3.1.1. D-02537, Sht 2. Service Water System, Unit 2
   - 3.2. FSP/FP Drawings
     - 3.2.1. 2-FP-60865, Service Water Reactor Bldg, Unit 2
4. BNP Procedures:
   - 4.1. EGR-NGGC-0308, Pipe Stress Analysis Procedure
   - 4.2. EGR-NGGC-0005, Engineering Service Requests
   - 4.3. EGR-NGGC-0320 Civil/Structural Operability Reviews
   - 4.4. 0PLP-18 Repair/Replacement Program
   - 4.5. 0BNP-TR-001 Inservice Inspection Technical Report
5. Calculations:
   - 5.1. SA-SW-250-255 Pipe Stress Analysis for Service Water lines
   - 5.2. Analysis ID G0050A-10
6. Others:
   - 6.1. DBD-43 Service Water System

G.3. Design Inputs

The following items are those applicable to this ESR from the list provided in Attachment 2 of Procedure EGR-NGGC-0005.

1. Basic Functions:

The basic function of the line 2-SW-103-24-157 is to proved suction to the Divisions II & I Loops A & B RHR Booster Pumps. These pumps are required to supply sufficient cooling water flow to the RHR heat exchangers and to maintain service water pressure higher than primary system pressure. The pressure of the service water should be maintained slightly higher than that of the reactor water to prevent any leakage of primary coolant into the RHR Service Water System.

Division II pumps (B & D) are normally supplied from the NSW service water header but can be supplied with service water (either from NSW or CSW header) to the reactor vessel through the "B" loop of RHR. This evolution is performed only under emergency operating conditions when no other preferred source of water is available to keep the core covered. The Division II Residual Heat Removal Service Water (RHRSW) System Pumps B and D can be used in emergency conditions to provide a last resort backup supply of water to flood the reactor vessel.

2. Performance Requirements, Capacity, Rating, Output, etc.:

This topic is not applicable

3. Codes, Standards, and Regulatory Requirements:

   3.1. USAS B31.1.0 - 1967 Power Piping

   3.2. USNRC Generic Letter 90-05, Guidance for Performing Temporary Non-Code Repair of ASME Code Class 1, 2 and 3 Piping

4. Design Conditions, Pressure, Temperature, etc.:

Per Specification 248-117 the design conditions for line class 157 are:

System Pressure:	150 (psig)
System Temperature:	105 Deg. F

5. Loads, Seismic, Wind, Thermal, Dynamic, etc.:

The pipe and piping component shall maintained structural integrity under loading conditions specified by the references in Section G2.

6. Environmental Conditions:

Not Applicable

7. Interface Requirements:

Not Applicable

8. Material Requirements:

Not Applicable

9. Mechanical Requirements:

See section 5

10. Structural Requirements:

See section 5.

11. Hydraulic Requirements:

This design input topic is not applicable to this ESR.

12. Chemistry Requirements:

This design input topic is not applicable to this ESR.

13. Electrical Requirements:

This design input topic is not applicable to this ESR.

14. Layout and Arrangement Requirements:

This design input topic is not applicable to this ESR

15. Operational Requirements:

This design input topic is not applicable to this ESR

16. Instrument and Control Requirements:

This design Input topic is not applicable to this ESR.

17. Access and Admin. Control for Security:

This design Input topic is not applicable to this ESR.

18. Redundancy, Diversity, and Separation Requirements:

This design Input topic is not applicable to this ESR.

19. Failure Effects:

This design Input topic is not applicable to this ESR.

20. Test Requirements:

This design Input topic is not applicable to this ESR.

21. Accessibility, Maintenance, Repair, and ISI Requirements:

This design input topic is not applicable to this ESR

22. Personnel Requirements and Limitations:

This design Input topic is not applicable to this ESR.

23. Transportability Requirements:

This design Input topic is not applicable to this ESR.

24. Fire Protection and Resistance Requirements:

This design Input topic is not applicable to this ESR.

25. Handling, Storage, and Shipping Requirements:

This design Input topic is not applicable to this ESR.

26. Requirements to Prevent Undue Risk to Public Health and Safety:

This design Input topic is not applicable to this ESR.

27. Materials, Processes, Parts, and Equipment Suitability for Application:

This design Input topic is not applicable to this ESR

28. Safety Requirements for Preventing Personnel Injury:

This design Input topic is not applicable to this ESR.

G.4. Assumptions

Assumptions are identified in the body of calculation.

G.5. Evaluations

The ESR is evaluated for change effects on design margins and for compliance with identified design inputs including:

Quality Class Determination

Line 2-SW-103-24-157 is ISI Class 3. The structural integrity of this line and its interfacing structures and components are Quality Class A (safety related). This ESR documenting the continued structural integrity of line 2-SW-103-24-157 is Safety Related.

Original Structural Integrity Criteria

To permit continued operation with the reduced thickness at the pipe, it is shown, as a minimum, that the Short Term Structural Integrity Criteria (STSI) contained in Reference G2.4.3 is satisfied through the time until permanent welded repairs are made. Compliance with the long-term structural criteria is demonstrated for the flawed component in this ESR's Attachment F. Long Term Structural Integrity Criteria is more stringent than the STSI, and ensures acceptability of the flawed pipe until the next scheduled outage exceeding 30 days or until the end of next Refueling Outage.

Structural Integrity Assessment

Per Enclosure 1, Section C.3 of Reference G2.1.1.2 for a through-wall flaw to remain in service with only a non-welded repair, the structural integrity of the flawed piping shall be assessed consistent with and satisfy the criteria of the "Through-Wall Flaw Approach" of Enclosure 1, Section C.3.a of Reference G2.1.1.2. The "Through-Wall Flaw Approach" structural evaluation is contained in this ESR's Attachment E. The calculated stress intensity factor "K" is less than the maximum allowed value of 35 ksi $(in)^{.5}$ and the 2a dimension is less than 3" and 15% of the pipe OD circumference. These results satisfy the required Reference G2.1.1.2 structural integrity criteria.

A piece of approved gasket material will be secured over the actual thru wall hole to stop the leakage. The gasketing material will be held in place with metal or plastic band(s). The only significant loads the patching components will experience is their initial installation (preload) forces. If the repair components can resist their installation loads, they will be able to resist any other possible design loadings. The Service Water line being patched operates at low temperature and will experience negligible thermal cycling. The weight of the patch components is small and seismic loads are well within the ultimate strength of the patch components. A possible degradation method is corrosion of the patch components that will be monitored weekly and assessed when degradation is noted.

The band will have a negligible effect on the .375" nominal thick pipe (which remains near or at its nominal thickness 1" away from the through wall hole).

Inventory & Splash Concerns

The nature of the through-wall flaw has been determined from the visual and UT measurements of and about the flaw. The UT results are recorded in Attachment C of this ESR. The actual through-wall flaw size is only big enough to permit the fluid to drip out. The flaw will be covered with a soft patch to stop all practical leakage. This will ensure the Service Water system water inventory is not reduced. It will prevent water from dripping onto other components. The corroded pipe has a significant amount of material thickness within an inch of the flaw. The soft patch will not be capable of exerting enough pressure on the outside diameter of the pipe to reduce the internal diameter of the components decreasing the service water flow.

The flaw leakage from the piping is approximately 200 dpm. It is not credible that the leakage from this flaw could increase to more than a few gpm. The hydraulic analysis of the Service Water system (Analysis ID G0050A-10) has considerable margin and demonstrates that the system can fulfill its design basis function with minor leakage from this piping.

Subsequent and Additional Inspections

Visual inspections of the non-welded repair will be made weekly, and UT shall recharacterize the defect every three months to reconfirm continued compliance with Reference G2.1.1.2 structural integrity criteria (see this ESR's required Actions Section).

The above evaluation satisfies Reference G2.1.1.2 criteria for permitting through-wall pipe flaws to remain in service with a non-welded repair until the next refueling or scheduled outage of 30 days or more.

Required Actions

- A code welded repair and/or replacement of the pipe with the through-wall flaw is to be implemented prior to startup following the next Unit 2 Refueling Outage or scheduled outage of 30 days or more.
- A soft patch is to be installed on the pipe with the through-wall flaw. The patch shall be sufficient to stop practically all leakage.
- Visual inspections of the repair are to be made weekly to the temporary repair. A qualitative assessment of leakage through the temporary non-code repair should be made if changes in leakage are detected. An engineering evaluation should be made to assess the rate and extent of the degradation to determine what remedial measures are required.
- UT inspections in the flaw area are to be made at least every three months in accordance with the guidelines of Reference G2.1.1.2.
- Augmented inspections via UT or RT to assess the overall degradation of the Service Water System are to be made within 15 days of the flaw detection in accordance with the guidelines of Reference G2.1.1.2.
- A relief request will be submitted to the Commission within the required time frame.

Conclusions

Service Water line 2-SW-103-24-157 is operable until the next scheduled outage exceeding 30 days or until the end of the next Unit 2 Refueling Outage.

G.6. Precautions and Limitations

The following precautions and limitations have been identified and should be observed with implementation of this ESR:

See Required Action Section above.

H. Turnover Summary

Evaluating requirements regarding turnover in accordance with Procedure EGR-NGGC-0005 indicated the following:

There are no changes to systems, structures, components, procedures, EDBS, drawings, training, testing, programs, and/or other documents associated with this ESR. No Procedure EGR-NGGC-005 identified "Turnover" is required for this ESR.

I. Attachments List

The following Attachments are included in this ESR.

Attachment A	Comment Review Forms
Attachment B	Not Used
Attachment C	UT Thickness NDE Report
Attachment D	10 CFR 50.59 Review
Attachment E	GL 90-05 Through Wall Structural Evaluation
Attachment F	ASME Code Case N-597, Section XI, Division 1. Structural Evaluation of UT NDE Inspected Components

ESR 01-00439, REV. 0
ATTACHMENT A

ATTACHMENT 2
Sheet 1 of 1
Record of Lead Review

Design ESR 01-00439 Revision 0

The Signature below of the Lead Reviewer records that:
- the review indicated below has been performed by the Lead Reviewer;
- appropriate reviews were performed and errors/deficiencies(for all reviews performed) have been resolved and these records are included in the design package;
- the review was performed in accordance with EGR-NGGC-0003.

☑ **Design Verification Review** ☐ **Engineering Review** ☐ **Owner Review**
- ☑ Design Review
- ☐ Alternate Calculation
- ☐ Qualification Testing

☐ Special Engineering Review

☐ YES ☑ N/A Other Records are attached.

Charles H. Eames/ Charles H. Eames Civil/Seismic 11/9/01
Lead Reviewer (print/sign) Discipline Date

Item No.	Deficiency	Resolution/Date
1	Because the Generic Letter 90-05 Through Wall Flaw Evaluation was conducted assuming the design pressure to be 150 psi. rather than a more realistic design pressure of 100 psi (which is slightly greater than the Service Water Pumps' Shut Off Head – The actual Design Pressure may be further reduced by considering elevation differences between the pumps and pipe location), the evaluation is quite conservative. The higher than necessary Design Pressure caused the minimum code wall thickness to be larger than would be identified for a smaller pressure causing the size of the flaw considered to be larger than required. The increased Design Pressure also caused the GL 90-05 Thru Wall Flaw Evaluation's calculated K is larger with the larger conservatively assumed Design Pressure.	The use of a Design Pressure greater than any possible expected line pressure in the Flaw Evaluation is conservative. No resolution is required.

FORM EGR-NGGC-0003-2-5
This form is a QA Record when completed and included with a completed design package. Owner's Reviews may be processed as stand alone QA records when Owner's Review is completed.

ESR 01-00439, REV. C

FOR INFORMATION ONLY

ATTACHMENT C

QA UT-8 Rev 3

CP&L

DIGITAL ULTRASONIC THICKNESS NDE REPORT

PLANT: Bnp UNIT 1☐ 2☒ 3☐ 4☐ JOB NO. 191080-02

Component/Item Tested 2-SW-103-24-157 AT 2-SW-V104	NDE Procedure No. NDEP 427 Rev. 4 IC Ø
Component Material ☒ C/S A106 (Type) ☐ S/S N/A (Type) ☐ Other (Specify) N/A	Expected Nominal T Range .1 - .5"
Thickness Gauge Mfg. Panametrics Model DL 26+ S/N 96366811 (UTG-2) Software Rev. No. 1.6.03FD	Couplant ultragel II BATCH 99-125
Calibration/Reference Std. ☐ Test Item-Mic./Caliper No. N/A ☒ Step Block S/N CPL-545m (SW-545) ☒ C/S ☐ S/S ☐ Other (Describe Below)	Primary Cal. Thickness .1 - .5" Cal. Check Thickness .1 - .5"

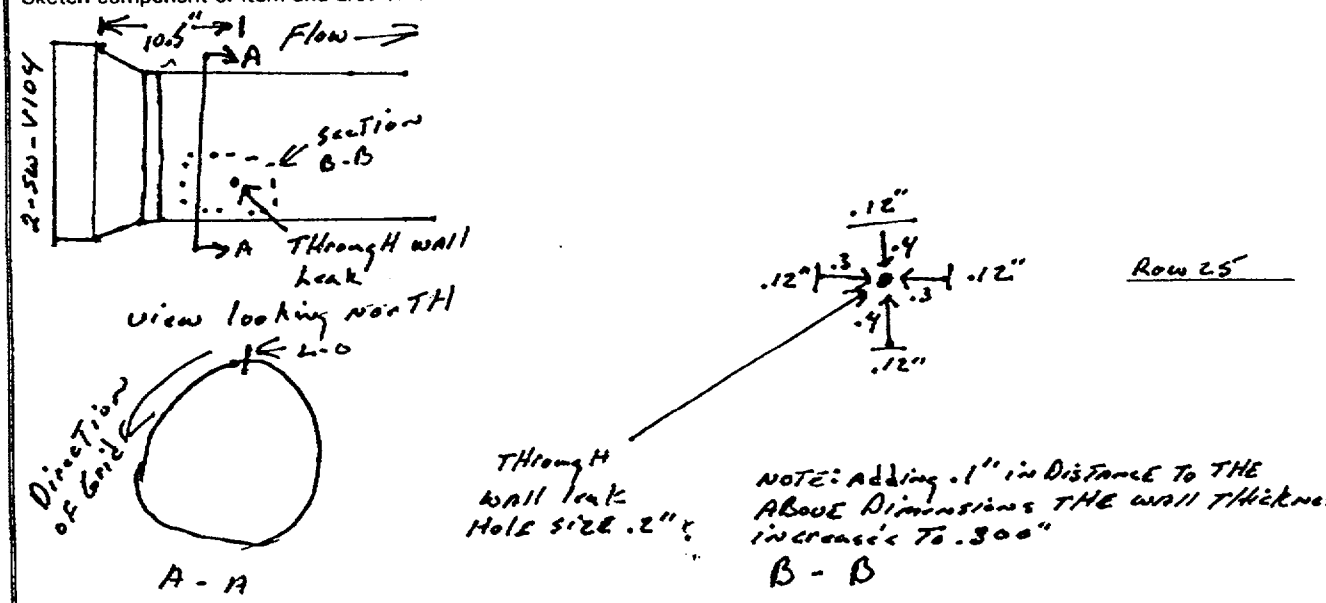
Transducer

Mfg. Panametrics Model D791-Rm S/N 59695 Diameter .312 Freq. 5.0 MHz ☐ Single ☒ Dual

Other Test Conditions High Temp: ☐ Yes ☒ No Inst. Receiver Gain Setting 53 dB

.1" step cal standard lowest thickness available

Sketch component or item and area tested. Include thickness data.



Inspector	Certification Level	Date
[signature]	II / 1 LTD	11-8-01
Reviewed By (If Required)	Title	Date

NGGM-PM-0011 APPENDIX A

RECEIVED BY BNP

FEB 15 1999

NUCLEAR DOCUMENT CONTROL

ESR 01-00439, REV. 0
ATTACH. C

Notes

[SWEET 16]

--.--- IN L--W

PIXEL AMLITUDES
ZOOM = FALSE
DELAY = 0.000
RANGE = 2.000
DETECTION MARKER = 0
EXTENDED BLANK MARKER = 0
SENSITIVITY MODE = FALSE
AGC WAVEFORM = TRUE
SENSITIVITY = 53
RECTIFICATION = FW

IDENTIFIER THICKNESS UNITS FLAGS SU #

OK

SU #	VEL(/uS)	DIFF	LO-ALM	HI-ALM	EXT-BLANK	UNITS	TRANSDUCER	GAIN dB
1	0.2332	0.000	0.000	10.000	0.000	IN	D790/791	53
2	0.2332	0.000	0.000	10.000	0.000	IN	D790/791	56

OK

Filename: 2SW-V104.TXT
Operator: GEORGE LININGER
Location: U2 RB 50'
Date: 11/9/2001
Time: 00:23
Probe ID: D790/791 for SU# 1
Probe ID: D790/791 for SU# 2
Comments:
PERFORMED READINGS AROUND PIPE AT THROUGH WALL LEAK 10.5" DOWN STREAM OF THE 2SW-V104. GRID SIZE IS 2"

ESR 01-00439, REV 0
ATTACHMENT C

Main Section (0)

Rows : 38 Cols : 1 Direction : Counter Clockwise Offset : 0

	A	RowMx	RowMn	Delta	Ave
1	0.438	0.438	0.438	0.000	0.438
2	0.399	0.399	0.399	0.000	0.399
3	0.383	0.383	0.383	0.000	0.383
4	0.404	0.404	0.404	0.000	0.404
5	0.389	0.389	0.389	0.000	0.389
6	0.382	0.382	0.382	0.000	0.382
7	0.365	0.365	0.365	0.000	0.365
8	0.362	0.362	0.362	0.000	0.362
9	0.370	0.370	0.370	0.000	0.370
10	0.370	0.370	0.370	0.000	0.370
11	0.373	0.373	0.373	0.000	0.373
12	0.365	0.365	0.365	0.000	0.365
13	0.378	0.378	0.378	0.000	0.378
14	0.349	0.349	0.349	0.000	0.349
15	0.350	0.350	0.350	0.000	0.350
16	0.341	0.341	0.341	0.000	0.341
17	0.361	0.361	0.361	0.000	0.361
18	0.347	0.347	0.347	0.000	0.347
19	0.400	0.400	0.400	0.000	0.400
20	0.331	0.331	0.331	0.000	0.331
21	0.351	0.351	0.351	0.000	0.351
22	0.380	0.380	0.380	0.000	0.380
23	0.357	0.357	0.357	0.000	0.357
24	0.370	0.370	0.370	0.000	0.370
25	0.109 *	0.109	0.109	0.000	0.109
26	0.350	0.350	0.350	0.000	0.350
27	0.361	0.361	0.361	0.000	0.361
28	0.342	0.342	0.342	0.000	0.342
29	0.336	0.336	0.336	0.000	0.336
30	0.359	0.359	0.359	0.000	0.359
31	0.374	0.374	0.374	0.000	0.374
32	0.386	0.386	0.386	0.000	0.386
33	0.376	0.376	0.376	0.000	0.376
34	0.356	0.356	0.356	0.000	0.356
35	0.378	0.378	0.378	0.000	0.378
36	0.383	0.383	0.383	0.000	0.383
37	0.397	0.397	0.397	0.000	0.397
38	0.401	0.401	0.401	0.000	0.401

	A
ColMx	0.438
ColMn	0.109
Delta	0.329
Ave	0.364

* THROUGH WALL leak

Section Summary

Maximum Reading = 0.438 (1, A) Average = 0.364

ESR 01-00439, REV. 0
ATTACH. C

R.L. 11-9-01 4 of 5

Main Section (0) (cont.)

Rows : 38 Cols : 1 Direction : Counter Clockwise Offset : 0

Minimum Reading = 0.109 (25, A) Standard Deviation = 0.048

Total Readings = 38

ESR 01-00439, REV. 0 ATTACH. C

UT-408A Rev 1 **CAROLINA POWER & LIGHT COMPANY**
A-SCAN UT THICKNESS CALIBRATION SHEET

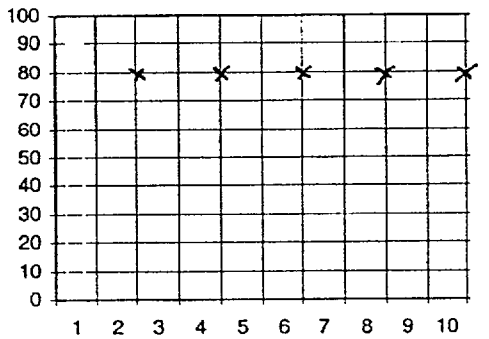
Report No. N/A
Page 5 of 5

Plant/Unit BNP 2 Project/Job/Work Order/Other/No. 191080-02
Component(s) to Which This Sheet is Applicable: LINE 2-SW-103-24-157P; VALVE 2-SW-V104 *
Material: ☒ C/S Type A106GRB ☐ S/S Type N/A ☐ (Specify) N/A

Calibration Reference Standard
Block #1 S/N CPL-545m (SW545) ☒ C/S ☐ S/S
Block #2 S/N N/A ☐ C/S ☐ S/S
☐ Test Item Mic./Caliper S/N N/A

Couplant ultragel II BATCH 99-125
Procedure No. NDEP 408 Rev. 10 I/C Ø

Instrument Data
Mfg. KRAUTKRAMER BRANSON
Model USK-70
S/N 32810-894 (UT-1)
Range Course .50
Fine N/A
Sweep Course 235.2"/ms
Fine N/A
Gain Course 50
Fine N/A
Delay 3.7μs
Rep. Rate PRF High/Pulser Dual
Reject 7%
Resolution Fixed
Filter N/A
Video N/A
Note: Enter N/A in blank only if not present on inst. used



Calib. Thickness Range: .1" to .5"
Each Minor Screen Division = .01"

Search Unit Data
Mfg. KBA Size .25
Model GAMMA Freq. 5.0MHz
S/N 005T9K ☐ Single ☒ Dual
Special shoes, delay element ☒No ☐Yes (Explain in comments)

Cal/Exam Technique
☒ Single Echo
☒ Multiple Echo
☐ Other (Explain in Comments or Report Summary)

Calibration Checks	Time
Initial Calibration	22:25
Intermediate	
Intermediate	
Intermediate	
Intermediate	
Final Calibration	23:55

Cable Connector Data
☒ Cable Permanent to Search Unit
☐ Cable Interchangeable to Search Unit
If interchangeable cable, Type:
☐ RG-58 ☐ RG-62 ☐ RG-174 ☐
Cable Length N/A Connector Type at: Xdcer N/A Inst. N/A Intermediate N/A

Temperature Conditions
☒ Std. Range ☐ High Temp
Cal Block/Test Item ± 25°F
☒ Yes
☐ No (Explain in Comments Below or Report Summary)

Comments: * THROUGH WALL leak - Performed SCAN AROUND THROUGH WALL

Examiner [signature]	Level II	Date 11-8-01
Examiner [signature]	Level I-LTD	Date 11-8-01
Reviewed By (If Required)	Title	Date

NGGM-PM-0011 APPENDIX A

ESR 01-00439, REV. Ø ATTACH. D

Attachment 1
Screeh

Identification No. 01-1402 ☒ **BNP** ☐ **CR3** ☐ **HNP** ☐ **RNP** Revision 0

Implementing Document No. ESR 01-00439 Revision 0

Implementing Activity Description:

On 11/08/01, a through wall leak was identified on the Unit 2 Nuclear Service Water header supply to B-Loop RHR Service Water on line 2-SW-103-24-157. The leak is in the piping spool piece between 2-SW-V104 and 2-SW-V105. The leak is approximately 10.5" downstream of the 2-SW-V104 flange and is located on the bottom north side of the pipe. AR 00051158 was written to document the leak. Ultrasonic testing of the area around the leak was completed to characterize the remaining wall thickness of the pipe around the hole. ESR 01-00439 provides an evaluation to demonstrate that the structural integrity of this piping is acceptable per STSI criteria and meets the acceptance criteria of USNRC Generic Letter 90-05.

SECTION 1: Predetermination

		Yes	No
1a	Is a change to the Technical Specifications or Operating License necessary to implement the proposed activity?	☐ Initiate a change in accordance with applicable procedure and go to Section 2	☒ Continue to the next question
1b	Is the proposed activity fully bounded by a previously completed screen or evaluation performed in accordance with REG-NGGC-0010?	☐ Enter the Reference below and go to Section 4	☒ Go to Section 2
	Or		
1c	Has the proposed activity been formally approved by the NRC?		

Reference:

ESR 01-00439, REV. 0 ATTACHMENT D

Attachment 1
Screen

SECTION 2: Applicability of Regulatory Processes Other Than 10 CFR 50.59

Address the questions below for all aspects of the activity. If the answer is "Yes" for any portion of the activity, complete the associated attachment (e.g. Question 3 and Attachment 3). Note that it is not unusual to have more than one process apply to a given activity.

		Yes	No
2	Does the proposed activity involve a change to the equipment, procedures, or other processes related to the Emergency Preparedness Program? (Attachment 2)	☐	☒
3	Does the proposed activity involve a change to the Security Plan, the Safeguards Contingency Plan or the Security Personnel Training and Qualification Plan? (Attachment 3)	☐	☒
4	Does the proposed activity involve a change to the Quality Assurance Program Description? (Attachment 4)	☐	☒
5	Does the proposed activity involve a change to the Fire Protection Program? (Attachment 5)	☐	☒
6	Does the proposed activity involve a change to the licensed operator requalification program? (Attachment 6)	☐	☒
7	Does the proposed activity involve a change in thermal or chemical effluents, involve a change to the Environmental Protection Plan, or involve a significant change to land use that could impact the environment? (Attachment 7)	☐	☒
8	Does the proposed activity involve a change to the Emergency Response Data System? (Attachment 8)	☐	☒
9	[RNP] Does the implementing activity affect the ISFSI? (Attachment 9)	☐	☐
	Are all aspects of the activity controlled by one or more of the Regulatory Processes listed above or does the activity involve a change to the Technical Specifications or Operating License?	☐ Complete the required attachments and go to Section 4	☒ Complete the required attachments and go to Section 3

ESR 01-00439, REV. 0 ATTACHMENT D

Attachment 1
Screen

SECTION 3: 10 CFR 50.59 Screen

		Yes	No
10a	Does the proposed activity involve a change to an SSC that adversely affects any FSAR-described design function?	☐	☒
10b	Does the proposed activity involve a change to a procedure that adversely affects how any FSAR-described SSC design functions are performed or controlled?	☐	☒
10c	Does the proposed activity involve revising or replacing any FSAR-described evaluation methodology that is used in establishing the design bases or used in the safety analyses?	☐	☒
10d	Does the proposed activity involve a test or experiment not described in the FSAR, where an SSC is utilized or controlled in a manner that is outside the reference bounds of the design for that SSC or is inconsistent with analyses or descriptions in the FSAR?	☐	☒
	Are any of these questions (10a, 10b, 10c, or 10d) answered "Yes?"	☐ Complete and attach Attachment 10 and go to Section 4	☒ Enter Justification and References below and go to Section 4

Justification:

ESR 01-00439 provides a structural integrity evaluation for a through wall leak on Service Water line 2-SW-103-24-157. This piping is ASME Code Class 3, which was originally designed to USAS B31.1-'67. This ESR evaluation determinted that the structural integrity of this line is acceptable and that the stresses in the piping remain within the USAS B31.1-'67 allowables. Additionally, the flaw was evaluated using the conservative methodology and acceptance criteria given in USNRC Generic Letter 90-05, and was found acceptable. UFSAR section 3.9.1.4 provides a Short Term Structural Integrity (STSI) criteria which can be used to accept and establish the operability of temporary degraded conditions. The through wall leak evaluated in ESR 01-00439 does not result in pipe stresses which exceed that allowed by the original code of construction, and the stresses are well below those accepted by the UFSAR STSI criteria. The flaw is positioned on a short pipe spool piece located between the 2-SW-V104 and 2-SW-V105 valves on the Nuclear Service Water supply to the B-Loop RHR Service Water. Currently, the leakage from the piping is approximately 100 to 200 dpm. It is not credible that the leakage from this flaw could increase to more than a few gpm. The hydraulic analysis of the Service Water system (Analysis ID G0050A-12) has considerable margin and demonstrates that the system can fullfil it's design basis function with minor leakage from this piping.

There are no changes to the design, function, or method of performing the function of the Service Water system, and the system will continue to meet it's design basis and licensing requirements. Consequently, this activity is not a change to the facility as described in the SAR. Additionally, a structural integrity evaluation does not constitute a special test/experiment or a change to procedures as described in the SAR.

References:

UFSAR sections 3.2.2, 3.9.1.4, 3.9.3, 3.9.6, 6.6, 9.2 and Chapter 15

ESR 01-00439, REV. 0, ATTACH. D

Attachment 1
Screen

SECTION 4: Signatures and Distribution

Evaluator: Thomas Sherrill (Print/Sign) Date: 11/9/01

Reviewer: EM HARRELSON (Print/Sign) Date: 11/9/01

Supervisor: FA JEFFERSON (Print/Sign) Date: 11/9/01

Additional Reviews (if required)

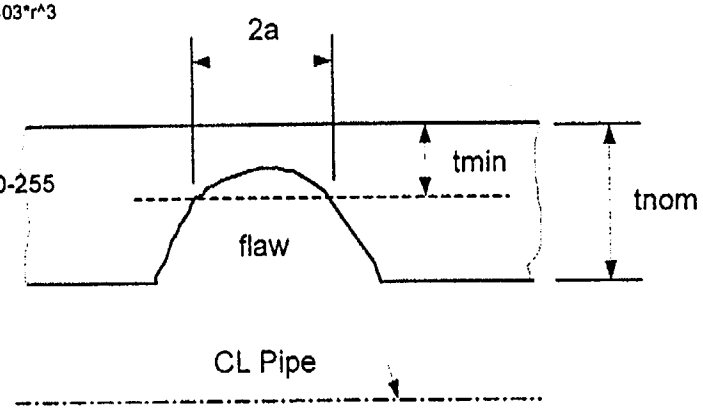
Reviewer: _____ (Print/Sign) Date: _____

Reviewer: _____ (Print/Sign) Date: _____

Reviewer: _____ (Print/Sign) Date: _____

Generic Letter 90-05 - Enclosure 1 (Section 3.c.a) - "Through Wall Flaw Approach"

	tmin	.3tnom	
Design Press (psig) =	150	150	Enter design pressure for component under evaluation
Matrl =	CS	CS	Enter either SS for stainless or CS for carbon (not applicable for CR-MO or CU-NI)
Sh (psi) =	15000	15000	Allowable stress of component material
O.D. (in) =	24	24	O.D. = outside diameter of pipe
tnom (in) =	0.375	0.375	tnom= nominal pipe wall thickness of the piping
S (psi) =	6900	6900	S= combined bending stresses (DW+SLP+Thermal+Seismic) See Attachment F, Page 5
Flaw Size 2a (in) =	1		2a - entry required only if flaw size known - if no entry then maximum flaw size is assumed (max 2a)
tp =		0.1125	predicted wall thickness at next inspection - if entry is made, then this is used as tmin or .3tnom
max 2a (in) =	3.000	3.000	2a= length of the flaw which is less than tmin NOTE: 2a can not exceed 3in or 15% of circumference of pipe.
15%circum (in) =	11.310	11.310	
Rmean (in) =	11.813	11.813	Rmean = OD-tnom/2
a (in) =	0.500	1.500	a= 2a/2
tmin | .3tnom (in) =	0.120	0.113	tmin= minimum pipe wall required for internal pressure (Note: GL90-05 assumes entire section at this thickness)
r (in) =	98.831	105.000	r =R/tmin
c=	0.013	0.040	c= a/(3.1416*Rmean)
A=	983.262	1209.136	A=-3.26543 + 1.52784*r -0.072698*r^2 + 0.0016011*r^3
B=	-2513.794	-3091.980	B=11.36322 - 3.91412*r + 0.18619*r^2 - 0.004099*r^3
C=	2479.559	3048.028	C=-3.18609 + 3.84763*r - 0.18304*r^2 + 0.00403*r^3
F=	2.485	9.851	F= 1+ A*c^1.5 + B*c^2.5 + C*c^3.5
K (ksi in^.5) =	30.092	206.571	K= [1.4*S*F*(3.1416*a)^0.5]/1000



COMMENTS

Pipe stress due to Emergency condition is based on stresses from calculation SA-SW-250-255 which are intesified due to flow in the pipe. For detail calcualtion see Attachemnt F.

CONCLUSION

tmin	Since	30	<=	35	ksi (in)^.5	OK
tmin	Since	2a	<= 3in & 15% of pipe circumference - OK			
.3tnom	Since	207	>	35	ksi (in)^.5	FAIL
.3tnom	Since	2a	<= 3in &15% of pipe circumference - OK			

Prepared By: [signature] Date: 11.09.2001

Verified By: C. Ezmes / [signature] Date: 11/9/01

Method: [✓]Design Review [ ]Alternate Calculation [ ]Qual Testing

Prepared By: [illegible] Date: 11-9-2001 Calculation Number: N/A

Verified By: [illegible] Date: 11/9/01

Method: [✓] Design Review [ ] Alt Calc [ ] Qual Testing

Note: User Inputs Items (1) to (7) only

(1) Thickness/Wear Data (Filename) $M := \text{READPRN}(\text{"0100439.txt"})$ (filename.prn)

(2) Months to next inspection $\text{months} := 16$

(3) Component Wear Rate in/yr (note: enter 0.999 to read data from Filename column 2) $\text{wear} := 0.020$

(4) Internal Design Pressure - psig $P := 150$

(5) Pipe Properties $OD := 24.0\ \text{in}$ $Tnom := 0.375\ \text{in}$

(6) Allowable Stress $Sh := 15000\ \text{psi}$

(7) Instrument Error $IE := 0.019\ \text{in}$ 5% of nominal

Define range of subscripted variables

$t := M^{\langle 1 \rangle}$ $\quad wr := \text{if}\left(|\text{wear}| = 0.999, M^{\langle 2 \rangle}, \text{wear}\right)$ $\quad \text{Points} := \text{length}(t)$ $\quad i := 1..\text{Points}$ $\quad \text{Points} = 37$

Determine angles for use in calculation

$$\text{Arc\_degree} := \frac{360}{\text{Points}} \cdot \frac{\pi}{180}$$

$$\text{Angle} := \frac{\text{Arc\_degree}}{2} \qquad \text{Arc\_degree} = 0.170$$

Define outside radius

$$R := \frac{OD}{2}$$

Define inside radius

$$Ri_i := \begin{cases} R - \left[\left(t_i - IE\right) - \frac{\text{months}}{12} \cdot wr_i\right] & \text{if wear} = 0.999 \\ R - \left[\left(t_i - IE\right) - \frac{\text{months}}{12} \cdot wr\right] & \text{otherwise} \end{cases}$$

Total metal area of section (Am)

$$Am := \sum_{i=1}^{\text{Points}} \left[R^2 - \left(Ri_i\right)^2\right] \cdot \text{Angle} \qquad Am = 23.482\ \text{in}^2$$

Pressure area of section (At)

$$At := \sum_{i=1}^{\text{Points}} \left(Ri_i\right)^2 \cdot \text{Angle} \qquad At = 428.907\ \text{in}^2$$

Center of Pressure

$$xp := \frac{\sum_{i=1}^{\text{Points}} \frac{2}{3} \cdot Ri_i \cdot \frac{\sin(\text{Angle})}{\text{Angle}} \cdot \left[\left(Ri_i\right)^2 \cdot (\text{Angle})\right] \cdot \sin[[\text{Arc\_degree} \cdot (i-1)] + \text{Angle}]}{At} \qquad xp = -0.020\ \text{in}$$

$$yp := \frac{\sum_{i=1}^{\text{Points}} \frac{2}{3} \cdot Ri_i \cdot \frac{\sin(\text{Angle})}{\text{Angle}} \cdot \left[\left(Ri_i\right)^2 \cdot (\text{Angle})\right] \cdot \cos[[\text{Arc\_degree} \cdot (i-1)] + \text{Angle}]}{At} \qquad yp = -0.032\ \text{in}$$

The angle (radians) to the center of pressure

$$\theta cp := \text{if}\left[\left(|yp| > 0.0001\right), \text{atan}\left(\frac{xp}{yp}\right), 0.0\right] \qquad \theta cp = 0.570$$

The angle (radians) to the center of the pipe wall

$$\theta c := \theta cp + \pi \qquad \theta c = 3.711$$

Centroid (inches) of the pipe metal area

$$xm := \frac{At}{Am} \cdot xp \qquad xm = 0.370$$

$$ym := \frac{At}{Am} \cdot yp \qquad ym = 0.578$$

Prepared By: [illegible] Date: 11-9-01 Calculation Number: N/A

Verified By: Charles H. [illegible] Date: 11/9/01 Revision: 0

Method: [X]Design Review [ ]Alt Calc [ ]Qual Testing

Metal Area Moment of Inertia About Original Axis

$$Ix := \sum_{i=1}^{Points} \frac{R^4 - (Ri_i)^4}{4} \cdot \left[\frac{Arc\_degree \cdot i}{2} - \frac{1}{4} \cdot \sin(2 \cdot Arc\_degree \cdot i) - \frac{Arc\_degree \cdot (i-1)}{2} - \frac{-1}{4} \cdot \sin[2 \cdot Arc\_degree \cdot (i-1)] \right]$$

$Ix = 1611.381$

$$Iy := \sum_{i=1}^{Points} \frac{R^4 - (Ri_i)^4}{4} \cdot \left[\frac{Arc\_degree \cdot i}{2} + \frac{1}{4} \cdot \sin(2 \cdot Arc\_degree \cdot i) - \frac{Arc\_degree \cdot (i-1)}{2} + \frac{-1}{4} \cdot \sin[2 \cdot Arc\_degree \cdot (i-1)] \right]$$

$Iy = 1678.685 \quad in^4$

$$Ixy := \sum_{i=1}^{Points} \frac{R^4 - (Ri_i)^4}{4} \cdot \left[\frac{1}{2} \cdot \sin(Arc\_degree \cdot i)^2 - \frac{1}{2} \cdot \sin[Arc\_degree \cdot (i-1)]^2 \right]$$

$Ixy = -45.432 \quad in^4$

Metal Area Moment of Inertia About Neutral Axis

$Ixp := Ix - Am \cdot ym^2$ $\quad Iyp := Iy - Am \cdot xm^2$ $\quad Ixyp := Ixy - Am \cdot xm \cdot ym$

$Ixp = 1603.531 \quad in^4$ $\quad Iyp = 1675.467 \quad in^4$ $\quad Ixyp = -50.458 \quad in^4$

Minimum Principal Moment of Inertia with Respect to Neutral Axis

$$Imin := \frac{Ixp + Iyp}{2} - \sqrt{\left(\frac{Ixp - Iyp}{2}\right)^2 + Ixyp^2}$$

$Imin = 1577.533 \quad in^4$

Maximum Distance from the Extreme Pipe Outside Surface to the Centroid of the Pipe Wall

$$Rmax := R + \sqrt{xm^2 + ym^2}$$

$Rmax = 12.687$

Carolina Power & Light Company
Pipe Wall Thickness Acceptance Criteria

Structural Evaluation of UT Inspected Components

Prepared By: [illegible] Date: 11/9/2001 Calculation Number: 01A

Verified By: [illegible] Date: 11/9/01 Revision: 0

Method: [ ]Design Review [ ]Alt Calc [ ]Qual Testing

CONCLUSIONS

Average Longitudinal Pressure Stress

$$Spave := \frac{P \cdot At}{Am}$$

$$Spave = 2740 \text{ psi}$$

Pressure Moment Stress

$$Mp := \pi \cdot R^2 \cdot P \cdot \left(\sqrt{xm^2 + ym^2}\right) \qquad Spb := \frac{Mp \cdot Rmax}{Imin}$$

$$Mp = 46589 \text{ in} - \text{lbs} \qquad Spb = 375 \text{ psi}$$

Section Modulus of Nominal Wall Section

$$Znom := \frac{\pi}{32} \cdot \frac{OD^4 - (OD - 2 \cdot Tnom)^4}{OD}$$

$$Znom = 161.8 \cdot in^3$$

Minimum Section Modulus Reduced Section

$$Zmin := \frac{Imin}{Rmax}$$

$$Zmin = 124.347 \text{ in}^3$$

Longitudinal Bending Stress Increase Factor

$$\gamma := \frac{Znom}{Zmin} \qquad \gamma = 1.302$$

Total Factored Longitudinal Pressure Stress

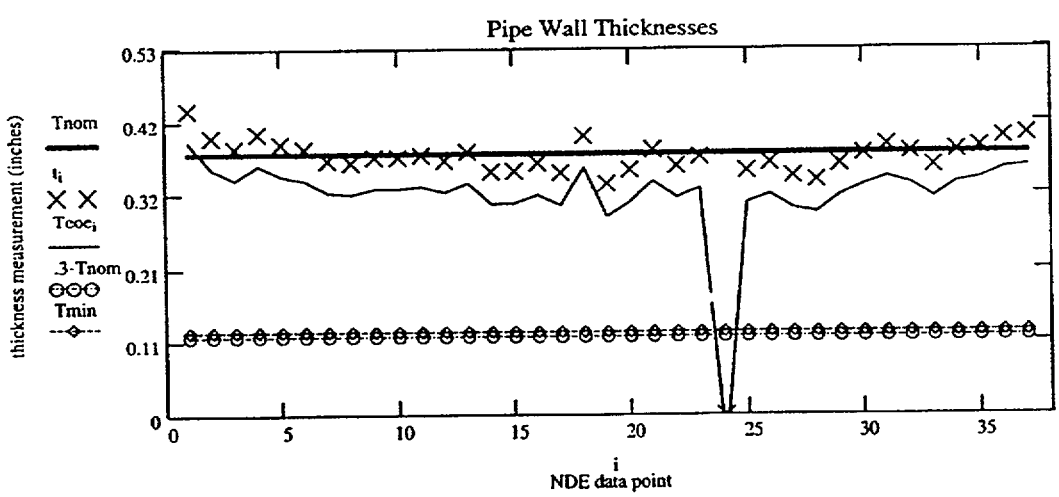
$$Spave + Spb = 3114$$

NOTE: If the average component thickness is less than manufacturer's minimum thickness, then the above Longitudinal Bending Stress Increase Factor must be increased by the SIF ratio of the component (SIFtavg/SIFtnom).

Hoop Wall Thickness

$$Tmin := \frac{P \cdot OD}{2 \cdot (Sh + P \cdot 0.4)} \qquad Tmin = 0.120$$

$Teoe_i := R - Ri_i$ *(end of evaluation period pipe wall thickness with considerations for wear and instrument error)*



reference: AN UPDATE ON THE SECTION XI APPROACH FOR EVALUATION OF PIPING THINNING DUE TO FLOW ACCELERATED CORROSION by Deardorff, Randall and Chexal Presented at the 1993 ASME Pressure Vessel and Piping Conference, July 25-29, Denver, Colorado

Prepared By: [illegible] Date: 11-09-01 Calculation Number: N/A

Verified By: [illegible] Date: 11/09/01 Revision: 0

Method: [ ]Design Review [ ]Alt Calc [ ]Qual Testing

INPUT ECHO

$$M = \begin{pmatrix} 0.438 \\ 0.399 \\ 0.383 \\ 0.404 \\ 0.389 \\ 0.382 \\ 0.365 \\ 0.362 \\ 0.370 \\ 0.370 \\ 0.373 \\ 0.365 \\ 0.378 \\ 0.349 \\ 0.350 \\ 0.361 \\ 0.347 \\ 0.400 \\ 0.331 \\ 0.351 \\ 0.380 \\ 0.357 \\ 0.370 \\ 0.000 \\ 0.350 \\ 0.361 \\ 0.342 \\ 0.336 \\ 0.359 \\ 0.374 \\ 0.386 \\ 0.376 \\ 0.356 \\ 0.378 \\ 0.383 \\ 0.397 \\ 0.401 \end{pmatrix}$$

The inspection data shown in the Input Echo, is extracted from Attachment C NDE Inspection Report.
The Erosion rate used in this evaluation was calculated based on assumption that pipe was installed 20 years ago (actually Unit 2 became operational in 1976) at nominal wall of 0.375"
The review of the inspection data for flawed band, shows no corrosion process in the pipe.
The flaw in the pipe was modeled as a 2" long pipe segment with 0" wall thicknes to asure conservative approach for above structural evaluation.

1. Component Properties

Pipe

Component ID:	24"NPS std wall
Line Number:	2-SW-103-24-157
Drawing No.	2-FP-60865
Design Pressure (psig)	150
Operating Temp. (deg F)	105
Material	A106 GR B
Welded Attachment	N/A

Pipe OD	24.000	in
Tnom	0.375	in - Nom Wall
Thoop	0.120	in - Code Wall
0.3Tnom	0.113	in
Tmin/Tnom	0.120/0.375	in
Tmfg	0.328	in -Man Min Wall
Tmeas	0.120	in - Min Meas
Wear Rate	0.020	in/yr

2. Component Classification

Safety Related (Q-A)	Non-Q, Seismic	Non-Q
x		

3. Stress / Design Information Reference

Pipe stresses were extracted from calculation SA-SW-250-255 for Line 2-SW-103-24-157 segment between valves SW-V104 & SW-V105, nodal points 3390-3440, and represents maximum enveloped values.

4. Stress Increase Calculation

Stress Multipliers based on: [x] Uniform Thinning [ ] Variable Thinning (include pressure bending)

Loading Condition	Exist Stress (psi)	Multiplier	Code Wall	Revised Stresses (psi)
Pressure Stress (Slp)	1068	NR	3114.00	3114
Deadweight (DW)	1455	1.31	N/A	1906
OBE	937	1.31	N/A	1227
DBE	1411.00	1.31	N/A	1848

5. Stress Combinations

Loading Combination	Total Stress (ps	Allowable Stress (psi)	
EQ. 11 Slp + DW	5020	Sh =	15000
EQ. 12U, Slp + DW + OBE In	6248	1.2Sh =	18000
EQ. 12E, Slp + DW + DBE+DBE	6868	1.8Sh =	27000

6. Conclusion

Minimum Acceptable Pipe Wall Thickness = see comments inches

Based on:
[X] Structural Review
[ ] Hoop Stress
[ ] Longitudinal Stress
[ ] Thickness Criteria
[ ] Tmin/Tnom > 0.55 (Q-D)
[ ] Tpred > 0.55Tnom (Q-D)

COMMENTS

For B31.1 Code equation pipe stress loading conditions and pipe stresses see calcualtion SA-SW-250-255

filename: strueval.xls