Tennessee Valley Authority, Post Office Box 2000, Soddy-Daisy, Tennessee 37384-2000

June 14, 2003

10 CFR 50.50(a)(3)(ii)

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

Gentlemen:

In the Matter of Tennessee Valley Authority — Docket No. 50-327

SEQUOYAH NUCLEAR PLANT (SQN) - UNIT 1 - REQUEST FOR RELIEF FROM AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME) CODE FOR REPLACEMENT OF ASME CODE CLASS 3 PIPING

This letter provides a request for relief to delay repair on a section of ASME Code Class 3 piping within SQN's essential raw cooling water (ERCW) system. At the present time, a pin-hole leak exists on an 8-inch diameter carbon steel pipe in the essential raw cooling water (ERCW) header 1B return piping to the 1B ERCW discharge header on Unit 1.

TVA has evaluated the operability of the ERCW system with regards to: (1) the structural integrity of the pipe, (2) effects of spray on adjacent equipment, and (3) ERCW flow rate requirements. TVA's evaluation for operability indicates that the ERCW system will perform its design basis function and surrounding equipment is not adversely affected.

Leakage from the pipe is currently less than one gallon per minute. The small amount of leakage has been evaluated and does not impact system function or plant operation. TVA will monitor the leakage weekly in accordance with SQN's Generic Letter (GL) 90-05 program. A mechanical pipe clamp to limit leakage will not be installed at this time.

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TVA will replace the affected section of pipe prior to startup from the Unit 2 Cycle 12 refueling outage (scheduled to begin November, 2003). Until pipe replacement is completed, performance of a weekly visual and a quarterly ultrasonic examination will be performed to assess the pipe degradation rate.

This relief request is being submitted under 10 CFR 50.55(a)(3)(ii) and is provided in accordance with the guidance of NRC GL 90-05. However, it should be pointed out that Unit 1 is currently in mode 3, starting up from the cycle 12 refueling outage. NRC approval of this request is requested by June 14, 2003, to support entry into mode 2 and above.

Enclosure 1 provides the request for relief. Enclosure 2 provides TVA commitments contained in this letter. Enclosure 3 provides the TVA evaluation. This letter is being sent in accordance with NRC RIS 2001-05. If you have any questions about this change, please telephone me at (423) 843-7170 or J. D. Smith at (423) 843-6672.

Sincerely,

Pedro Salas
Licensing and Industry Affairs Manager

Enclosures
cc (Enclosures):
Mr. Michael L. Marshall, Jr., Senior Project Manager
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ENCLOSURE 1
SEQUOYAH NUCLEAR PLANT (SQN)
REQUEST FOR RELIEF - ESSENTIAL RAW COOLING WATER (ERCW)
ENGINEERED SAFETY FEATURES (ESF) HEADER 1B RETURN PIPING

UNIT: SQN Unit 1

COMPONENTS: 8-inch Nominal Pipe Size (NPS), Schedule 40 carbon steel pipe

SYSTEM: ERCW

ASME CODE CLASS: 3

FUNCTION: This section of piping returns cooling water to the 1B ERCW discharge header.

CODE REQUIREMENT: When an American Society of Mechanical Engineers (ASME), Section XI code repair or replacement is performed, it is required to be performed in accordance with ASME, Section XI, IWA-4000 or IWA-7000, respectively, in order to restore the system's structural integrity back to its original design requirements.

BACKGROUND: On June 13, 2003, a through-wall leak was discovered in the ERCW system. The leak is located in an 8-inch diameter carbon steel pipe in the ERCW ESF header 1B return piping to the 1B ERCW discharge header. The leakage from the piping was determined as less than one gallon per minute by the system engineer at the time of discovery. The system engineer has reviewed the design requirements for this system and has determined that this amount of leakage does not affect the operability of the system. The small amount of leakage from the pipe is not spraying on any electrical equipment or causing any flooding concerns. Problem Evaluation Report (PER) 03-008909-000 has been written to document this condition.

NRC Generic Letter 90-05 evaluation requirements were addressed for the through-wall flaw. An ultrasonic examination was performed of the affected area. This information was used to perform the structural

integrity calculation required by NRC GL 90-05 by the through-wall method. The results of this evaluation show that the largest calculated stress intensity factor "K" of 26.3 ksi $(in)^{0.5}$ is less than the 35 ksi $(in)^{0.5}$ criteria for ferritic steel. Based on the above, TVA determined the structural integrity of the ERCW system is not impaired.

The preliminary root cause for the piping degradation is considered to be due to microbiological induced corrosion (MIC). The PER will require examination of the piping once it is removed to confirm the root cause along with any other corrective actions. Since the preliminary root cause is considered to be MIC, no additional areas were examined since MIC cannot be predicted as to its location. SQN has had numerous examples of MIC leakage with no threat to operability or structural integrity. Therefore, no other areas were examined. The leakage has not caused any flooding or spraying onto any adjacent electrical equipment. The amount of leakage does not affect the system flow requirements as well.

SQN is currently completing a refueling outage of lengthy duration due to steam generator replacement. The unit is in Mode 3 and close to completing the surveillance requirements to enter Mode 2. Removing this portion of the ERCW system from service will place Unit 1 in an action statement of 72 hours. Due to the design of the ERCW system, the removal of this portion of the ERCW system will also place Unit 2 in a 72-hour action statement. This is because the ERCW 1B ESF header also supplies ERCW cooling to the Unit 2 Component Cooling System for safety-related cooling loads. Removal of this portion of the ERCW system will result in an unnecessary delay for returning Unit 1 back to service and will necessitate placing Unit 2 into a cold shutdown condition. This is due to the location of the leak in the ERCW piping. The location is in a very congested area with limited access for the craftsman to work. Since discovery of the leak, there has not been sufficient time to adequately review the effected area to determine what scope of work is required to perform an ASME Code repair or replacement.

Without the proper review and planning, the necessary materials cannot be determined and obtained.

PROPOSED TEMPORARY NON-CODE REPAIR:

Based upon the above, TVA requests relief from ASME code. TVA plans to leave the piping "as is." The leakage is negligible and does not present a maintenance or operational problem. Additionally, the pin-hole opening in the pipe usually closes itself, thereby limiting or stopping the leakage, due to the debris associated with river-water systems. The GL 90-05 evaluation shows that this piping still has sufficient strength. Based on the continued monitoring discussed below, TVA will reevaluate the need for additional housekeeping measures as appropriate.

ALTERNATIVE REQUIREMENTS:

Engineering will perform a weekly walkdown and assess the operability of the system. Any changes which affect system operability or structural integrity will be evaluated. An ultrasonic examination will be performed every three months to assess the piping degradation rate. Based upon the weekly walkdowns and ultrasonic examinations, an engineering evaluation will be performed to determine if further remedial measures or corrective actions are needed. An ASME Section XI repair or replacement will be performed before the completion of the Unit 2 Cycle 12 refueling outage which is currently scheduled to start in November 2003.

ENCLOSURE 2

TVA COMMITMENTS

1. TVA will replace the effected piping in accordance with the American Society of Mechanical Engineers code prior to startup from the Unit 2 Cycle 12 refueling outage (currently scheduled to begin November 2003).

2. Engineering will perform a weekly walkdown and assess the operability of the system. Any changes which affect system operability or structural integrity will be evaluated.

3. An ultrasonic examination will be performed every three months to assess the piping degradation rate. Based upon the weekly walkdowns and ultrasonic examinations, an engineering evaluation will be performed to determine if further remedial measures or corrective actions are needed.

ENCLOSURE 3

SEQUOYAH NUCLEAR PLANT (SQN)
TVA EVALUATION

TVAN CALCULATION COVERSHEET/CCRIS UPDATE

Page

REV 0 EDMS/RIMS NO.	EDMS TYPE:	EDMS ACCESSION NO (N/A for REV. 0)
CEB 800425 026	calculations(nuclear)	

Calc Title: SUMMARY OF PIPING ANALYSIS N2-67-3A1

CALC ID	TYPE	ORG	PLANT	BRANCH	NUMBER	CUR REV	NEW REV	REVISION APPLICABILITY
CURRENT	CN	NUC	SQN	CEB	N2-67-3A-1	38	39	Entire calc ☐
NEW	CN	NUC						Selected pages ☒

ACTION	NEW ☐ REVISION ☒	DELETE ☐ RENAME ☐	SUPERSEDE ☐ DUPLICATE ☐	CCRIS UPDATE ONLY ☐ (Verifier Approval Signatures Not Required)	No CCRIS Changes ☐ (For calc revision, CCRIS been reviewed and no CCRIS changes required)

UNITS	SYSTEMS	UNIDS
001&002	067	SQN-2-HEX-070-0015A, SQN-2-HEX-070-0015B, SQN-0-HEX-070-0012A, SQN-0-HEX-070-0012B, SQN-1-HEX-070-0008A, SQN-1-HEX-070-008B, SQN-2-HEX-072-0030

DCN,EDC,N/A	APPLICABLE DESIGN DOCUMENT(S)	CLASSIFICATION
N/A	1,2-47K450-63, -66, -67, -71, -238, -253; 1-47K450-69, -70; 47K450-65 (U2 AC)	E

QUALITY RELATED?	SAFETY RELATED? (If yes, QR = yes)	UNVERIFIED ASSUMPTION	SPECIAL REQUIREMENTS AND/OR LIMITING CONDITIONS?	DESIGN OUTPUT ATTACHMENT?	SAR/TS AFFECTED
Yes ☒ No ☐	Yes ☒ No ☐	Yes ☐ No ☒	Yes ☐ No ☒	Yes ☐ No ☒	Yes ☐ No ☒

PREPARER ID	PREPARER PHONE NO	PREPARING ORG (BRANCH)	VERIFICATION METHOD	NEW METHOD OF ANALYSIS
JCCORNWE	423 843-8230	CEB	DESIGN REVIEW	☐ Yes ☒ No

PREPARER SIGNATURE	DATE	CHECKER SIGNATURE	DATE
J. C. Cornwell [signature]	6/13/03	L. NICHOLSON [signature]	6/13/03
VERIFIER SIGNATURE	**DATE**	**APPROVAL SIGNATURE**	**DATE**
L. NICHOLSON [signature]	6/13/03	[signature] for P. D. Osborne	6/14/03

STATEMENT OF PROBLEM/ABSTRACT

THIS CALCULATION DOCUMENTS THE RIGOROUS ANALYSIS OF SQN ESSENTIAL RAW COOLING WATER SYSTEM PIPING FROM THE STEEL CONTAINMENT VESSEL PENETRATIONS X-59 AND X-63 TO HEADER 1A AND 2B. THIS INCLUDES PIPING FROM THE CONTAINMENT SPRAY HEAT EXCHANGER 1A AND COMPONENT COOLING HEAT EXCHANGERS 0B1, 0B2, 1A1, 1A2, 2A1, AND 2A2.

ALL REQUIREMENTS OF THE APPLICABLE DESIGN CRITERIA ARE MET.

R39 INCORPORATES EVALUATION OF THROUGH WALL FLAW IDENTIFIED ON PER 03-008909-000.

MICROFICHE/EFICHE Yes ☒ No ☐ FICHE NUMBER(S) TVA-F-T000731 AND TVA-F-T000732 (CREATED BY REVISION 33)

☐ LOAD INTO EDMS AND DESTROY
☒ LOAD INTO EDMS AND RETURN CALCULATION TO CALCULATION LIBRARY. ADDRESS:OPS 1B SQN
☐ LOAD INTO EDMS AND RETURN CALCULATION TO:

TVAN CALCULATION COVERSHEET/CCRIS UPDATE

CALC ID	TYPE	ORG	PLANT	BRANCH	NUMBER	REV
	CN	NUC	SQN	CEB	N2-67-3A1	39

ALTERNATE CALCULATION IDENTIFICATION

BLDG	ROOM	ELEV	COORD/AZIM	FIRM	Print Report Yes ☐

CATEGORIES

KEY NOUNS (A-add, D-delete)

ACTION (A/D)	KEY NOUN	A/D	KEY NOUN

CROSS-REFERENCES (A-add, C-change, D-delete)

ACTION (A/C/D)	XREF CODE	XREF TYPE	XREF PLANT	XREF BRANCH	XREF NUMBER	XREF REV
A	P	PR	SQN	MEB	03-006909-000	

CCRIS ONLY UPDATES:
Following are required only when making keyword/cross reference CCRIS updates and page 1 of form NEDP-2-1 is not included:

PREPARER SIGNATURE	DATE	CHECKER SIGNATURE	DATE
PREPARER PHONE NO.	EDMS ACCESSION NO.		

TVAN CALCULATION RECORD OF REVISION	
CALCULATION IDENTIFIER N2-67-3A1	Page i-ab
Title SUMMARY OF PIPING ANALYSIS N2-67-3A1	

Revision No.	DESCRIPTION OF REVISION
39	REVISED T0 ADD EVALUATION OF THROUGH WALL FLAW AS IDENTIFIED ON PER 03-008909-000. Sections 3.7 and 3.9 of the SAR and the Technical Specifications have been reviewed by J. C. Cornwell, and this revision of the calculation package does not directly or indirectly impact the information (text, graphs or tables) in the SAR or in the Technical Specifications. Pages added: R39 cover sheet (2 pages), I-ab, P.1 through P.20 Pages deleted: None Pages replaced: ii Pages revised: iii.1 Total number of pages of the entire calculation = 1584 Total number of pages in this selected page revision (including filing instructions) =26 The last page of the calculation is Z. Prepared: [signature] Date: 6/13/03 Checked: [signature] Date: 6/13/03 Legibility evaluated and accepted for issue. This applies to all pages. ____________________ __________ Signature Date

This page added by revision 39.

TVAN CALCULATION DESIGN VERIFICATION FORM			
Calculation Identifier N2-67-3A1		Revision 39	
Method of design verification used: 1. Design Review ☒ 2. Alternate Calculation ☐ 3. Qualification Test ☐	Design Verifier [signature]	Date 6/23/03	

Comments:

The subject calculation at the revision level noted above has been found to be technically adequate in that computations, judgments, assumptions and logic are in accordance with generally accepted methodologies.

This revision utilizes historical methods established for review of analysis calculations. The calculation conforms to standard RAH and NE procedures for calculation preparation and documentation. This calculation is technically adequate for this revision in its format and content.

This page replaced by revision 39.

TVA

CALCULATION SHEET

Document: N2-67-3A1	Rev: 29	Plant: SQN, UO	Page: iii.1
Subject: Summary of Analysis N2-67-3A1		Prepared By: KAH Date: 12/13/95 Checked By: [illegible] Date: 12/13/95	

TABLE OF CONTENTS

APPENDIX P

EVALUATION OF THROUGH WALL FLAW PER 03-008909-000

This page added by revision 39.

Purpose:
The purpose of this evaluation is to determine the minimum required wall thickness (Tmin) for the existing Essential Raw Cooling Water 8" sch 40 return piping from EBR & MCR A/C coolers. The segment of straight pipe evaluated is located on isometric 1,2-47K450-66 between nodes 892 and 901 at elevation 683'-9". This calculation is in support of U1C12 outage.

Assumptions:
There are no assumptions which require later verification.

Evaluation:

All stress values were retrieved from calculation N2-67-3A1, microfiche TVA-F-T000731 for the permanent condition, nodes 892, 892A, 893, 893A, 893B, 893C, 895, 895A, 895B, 897, 897A, 897B, 899, 900, 901 (members M522, M522A through M522M).
Temporary operating condition does not affect this area and therefore output data on microfiche TVA-F-T000732 does not apply for this evaluation.

Determine the minimum required wall thickness due to 0.3*Tnom (Tmint) and Hoop Stress (Tminh):

$P := 160 \cdot \frac{lbf}{in^2}$ **Design Pressure**

$D := 8.625 \cdot in$ **Outside Diameter of 8" sch 40**

$S_h := 15000 \cdot psi$ **Allowable Stress**

$T_{nom} := 0.322 \cdot in$ **Nominal Pipe Wall Thickness**

$d := D - 2 \cdot T_{nom}$ **Inside Diameter** $d = 7.981\ in$

$Z_{nom} := 0.0982 \cdot \frac{D^4 - d^4}{D}$ **Nominal Section Modulus** $Z_{nom} = 16.813\ in^3$

$R_{nom} := \frac{D}{2} - \frac{T_{nom}}{2}$ **Nominal Mean Radius** $R_{nom} = 4.151\ in$

T_{min} based on .3 X T_{nom}:

$T_{mint} := .3 \cdot T_{nom}$

$T_{mint} = 0.097\ in$

T_{min} based on HOOP Stress:

$T_{minh} := \frac{P \cdot D}{2 \cdot (S_h + 0.4 \cdot P)}$

$T_{minh} = 0.046\ in$

1. Check Equation 8 Stresses based on computer analysis:

$stress_8 := 869 \cdot psi$ **Sustained Stress from TPIPE Post Processor** $S_8 := S_h$

$t_{est8} := 0.040 \cdot in$ $r_{m8} := \dfrac{D - t_{est8}}{2}$ **Mean Radius** $r_{m8} = 4.292\,in$

$d_{min8} := D - 2 \cdot t_{est8}$ $Z_{min8} := 0.0982 \cdot \dfrac{D^4 - d_{min8}{}^4}{D}$ $Z_{min8} = 2.305\,in^3$

$i := 1.000$ $i_{75} := 0.75 \cdot i$ **i_{75} = .75 times i.** $i_{75} = 0.75$

$sif := if(1 > i_{75}, 1, i_{75})$ **sif = The SIF used in code equation comparison (.75i or 1.0 which ever is greater)**

$sif = 1$

$P_{nom} := \dfrac{P \cdot d^2}{D^2 - d^2}$ $P_{nom} = 952.98\,psi$

$M_a := \dfrac{(stress_8) \cdot Z_{nom}}{sif}$ $M_a = 14610.861\,in \cdot lbf$ **Bending Moment due to sustained stresses**

$Eq_8 := \dfrac{P \cdot d_{min8}{}^2}{D^2 - d_{min8}{}^2} + \dfrac{M_a \cdot sif}{Z_{min8}}$ $Eq_8 = 14843.053\,psi$ $SR_8 := \dfrac{Eq_8}{S_8}$ $SR_8 = 0.99$

Equation 8 stresses below allowable of 15000 psi. Therefore, OK.
Minimum required thickness for Eq 8: $t_{est8} = 0.04\,in$

2. Check Equation 11 stresses based on computer analysis:

$S_c := 15000 \cdot psi$ $S_a := 1.25 \cdot S_c + .25 \cdot S_h$ $S_a = 22500\ psi$

$S_{11} := S_a + S_h$ $S_{11} = 37500\ psi$ **Equation 11 allowable stress.**

$stress_{th} := 421 \cdot psi$ **Expansion stress from TPIPE Post Processor.**

$t_{est11} := 0.020 \cdot in$ $r_{m11} := \frac{D - t_{est11}}{2}$ **Mean Radius** $r_{m11} = 4.302\ in$

$d_{min11} := D - 2 \cdot t_{est11}$ $Z_{min11} := 0.0982 \cdot \frac{D^4 - d_{min11}^4}{D}$ $Z_{min11} = 1.161\ in^3$

$i := 1.000$ $i_{75} := 0.75 \cdot i$ **i_{75} = .75 times i.** $i_{75} = 0.75$

$sif := if(1 > i_{75}, 1, i_{75})$ **sif = The SIF used in code equation comparison (.75i or 1.0 which ever is greater)**

$sif = 1$

$Mc_{11} := \frac{stress_{th} \cdot Z_{nom}}{i}$ $Mc_{11} = 7078.449\ in \cdot lbf$ **Bending moment due to thermal stresses.**

$$Eq_{11} := \frac{P \cdot d_{min11}^2}{D^2 - d_{min11}^2} + \left(\frac{M_a \cdot sif}{Z_{min11}}\right) + \frac{Mc_{11} \cdot i}{Z_{min11}} \qquad Eq_{11} = 35816.182\ psi \qquad SR_{11} := \frac{Eq_{11}}{S_{11}} \qquad SR_{11} = 0.955$$

Equation 11 stresses below allowable of 34250 psi. Therefore, OK.
Minimum required thickness for Eq 11: $t_{est11} = 0.02\ in$

· This page added by revision 39.

3. Check Equation 9U stresses based on computer analysis:

$S_{9U} := S_h \cdot 1.2$ **Equation 9U allowable stress.** $S_{9U} = 18000\ psi$

$stress_{9U} := 2985 \cdot psi$ **Occasional (OBE) stress from TPIPE Post Processor.**

$t_{est9U} := 0.083 \cdot in$ $r_{m9U} := \frac{D - t_{est9U}}{2}$ **Mean Radius** $r_{m9U} = 4.271\ in$

$d_{min9U} := D - 2 \cdot t_{est9U}$ $Z_{min9U} := 0.0982 \cdot \frac{D^4 - d_{min9U}^4}{D}$ $Z_{min9U} = 4.712\ in^3$

$i := 1.000$ $i_{75} := 0.75 \cdot i$ **i_{75} = .75 times i.** $i_{75} = 0.75$

$sif := if(1 > i_{75}, 1, i_{75})$ **sif = The SIF used in code equation comparison (.75i or 1.0 which ever is greater)**

$sif = 1$

$M_{b9U} := \frac{(stress_{9U}) \cdot Z_{nom}}{sif}$ $M_{b9U} = 50188.056\ in \cdot lbf$ **Bending moment due to occasional (OBE) stresses.**

$Eq_{9U} := \frac{P \cdot d_{min9U}^2}{D^2 - d_{min9U}^2} + \frac{M_{b9U} \cdot sif}{Z_{min9U}} + \frac{M_a \cdot sif}{Z_{min9U}}$ $Eq_{9U} = 17787.803\ psi$ $SR_{9U} := \frac{Eq_{9U}}{S_{9U}}$ $SR_{9U} = 0.988$

Equation 9U stresses below allowable of 16440 psi. Therefore, OK.
Minimum required thickness for Eq 9U: $t_{est9U} = 0.083\ in$

4. Check Equation 9F stresses based on computer analysis:

$S_{9F} := S_h \cdot 2.4$ **Equation 9F allowable stress.** $S_{9F} = 36000\ \text{psi}$

$stress_{9F} := 5226 \cdot \text{psi}$ **Occasional (SSE) stress from TPIPE Post Processor.**

$t_{est9F} := 0.060 \cdot \text{in}$ $r_{m9F} := \dfrac{D - t_{est9F}}{2}$ **Mean Radius** $r_{m9F} = 4.282\ \text{in}$

$d_{min9F} := D - 2 \cdot t_{est9F}$ $Z_{min9F} := 0.0982 \cdot \dfrac{D^4 - d_{min9F}^{\ 4}}{D}$ $Z_{min9F} = 3.434\ \text{in}^3$

$i := 1.000$ $i_{75} := 0.75 \cdot i$ **i_{75} = .75 times i.** $i_{75} = 0.75$

$sif := if(1 > i_{75}, 1, i_{75})$ **sif = The SIF used in code equation comparison (.75i or 1.0 which ever is greater)**

$sif = 1$

$M_{b9F} := \dfrac{Z_{nom} \cdot (stress_{9F})}{sif}$ $M_{b9F} = 87866.928\ \text{in} \cdot \text{lbf}$ **Bending moment due to occasional (SSE) stresses.**

$Eq_{9F} := \dfrac{P \cdot d_{min9F}^{\ 2}}{D^2 - d_{min9F}^{\ 2}} + \dfrac{M_{b9F} \cdot sif}{Z_{min9F}} + \dfrac{M_a \cdot sif}{Z_{min9F}}$ $Eq_{9F} = 35472.609\ \text{psi}$ $SR_{9F} := \dfrac{Eq_{9F}}{S_{9F}}$ $SR_{9F} = 0.985$

Equation 9F stresses below allowable of 32880 psi. Therefore, OK.
Minimum required thickness for Eq 9F: $t_{est9F} = 0.06\ \text{in}$

5. Check Pipe Rupture stresses based on computer analysis:

Pipe Rupture is not required for this segment of piping

Summary of Tmin Values:

$T_{mint} = 0.097\ in$ **T_{mint} required for 0.3 x Tnom**

$T_{minh} = 0.046\ in$ **T_{minh} required for Hoop Stress**

$t_{est8} = 0.04\ in$ **t_{est8} required for DW Bending Stress**

$t_{est11} = 0.02\ in$ **t_{est11} required for DW + Thermal Stress**

$t_{est9U} = 0.083\ in$ **t_{est9U} required for OBE Bending Stress**

$t_{est9F} = 0.06\ in$ **t_{est9F} required for SSE Bending Stress**

Determine Tmins Based on Actual Piping Stresses

$T_{min} := if(T_{mint} > T_{minh}, T_{mint}, T_{minh})$

$T_{min} := if(T_{min} > t_{est8}, T_{min}, t_{est8})$

$T_{min} := if(T_{min} > t_{est11}, T_{min}, t_{est11})$

$T_{min} := if(T_{min} > t_{est9U}, T_{min}, t_{est9U})$

$T_{min} := if(T_{min} > t_{est9F}, T_{min}, t_{est9F})$

Tmin required equal to the largest of the above values: $T_{min} = 0.097\ in$

Tmin based on 0.3 x Tnom.

Conclusions:

The Tmin for this segment of piping is 0.097" based on Tnom.

MATHCAD ANALYSIS ROUTINE

PART I - NET SECTION PROPERTIES

The following process computes the net elastic section properties for a degraded section on isometric 1,2-47K450-66 for straight pipe between nodes 892 and 901 at elevation 683'-9" This is 8"sch 40 ERCW return piping from EBR & MCR A/C Coolers. This evaluation uses Mathcad software to implement the net section property calculation procedure developed in CEB-CQS-449. The evaluation is done for leakage crack for PER 03-008909-000.

STEP I.1 - INPUT DATA

$Ro := 8.625 \cdot in$ - Pipe Outside Radius

$t_{nom} := 0.322 \cdot in$ - Nominal Pipe Wall Thickness

$n := 20$ - Number of Constant Thickness Arc Segments Used to Model Degradation. The grid as applied to the piping contains 20 divisions.

$j := 1 .. n$

Segment Data:
(where L_j and tr_j are the segment length (in) and remaining thickness (in) of each segment j)

$L_j :=$	$tr_j :=$
2.008·in	0.213·in
0.500·in	0.139·in
0.250·in	0.094·in
0.500·in	0.0·in
0.250·in	0.126·in
2.008·in	0.255·in
2.008·in	0.280·in
2.008·in	0.280·in
2.008·in	0.280·in
2.008·in	0.269·in
1.355·in	0.230·in
1.355·in	0.230·in
1.355·in	0.230·in
1.355·in	0.230·in
1.355·in	0.135·in
0.250·in	0.230·in
1.631·in	0.230·in
1.631·in	0.230·in
1.631·in	0.230·in
1.631·in	0.210·in

The total pipe circumference is:

$$L_C := \sum_j L_j \qquad L_C = 27.097\ \text{in}$$

The total cross section is:

$$L_{M_j} := \text{if}\left(tr_j \le 0.0\cdot\text{in}, L_j, 0\cdot\text{in}\right) \qquad L_{MTi} := \sum_j L_j \qquad L_{MTi} = 27.097\ \text{in}$$

STEP I.2 - <u>FIND THE CENTROID OF THE DEGRADED SECTION</u>

A. Compute the total circumferential length (L_T) and the average thickness (t_{av}) for the section:

$$L_T := \sum_j L_j \qquad L_T = 27.097\ \text{in} \qquad L_T - L_C = 0\ \text{in}$$

If L_T - L_C is zero the length adjustments are mathematically correct.

$$t_{av} := \frac{\left(\sum_j L_j \cdot tr_j\right)}{L_T} \qquad t_{av} = 0.231\ \text{in}$$

B. Compute the starting (i = 1) and ending (i = 2) angles $\Theta_{i,j}$ in radians for each segment j. Note that segment j = 1 <u>starts</u> at 0 radians ($\Theta_{1,1}$)and the ending angle for the last segment $\Theta_{2,n}$) must be 2π radians. The section starting and ending angles are then:

$$\Theta_{1,1} := 0\cdot\text{rad} \qquad \Theta_{2,n} := 2\cdot\pi\cdot\text{rad}$$

$$j := 2..n \qquad \Theta_{1,j} := \left(\Theta_{1,j-1} + \frac{L_{j-1}}{L_T}\cdot 2\cdot\pi\right) \qquad \rho := \frac{360}{2\cdot\pi}$$

$$J := 1..n$$

$$\Theta_{2,j} := \left(\Theta_{1,j} + \frac{L_j}{L_T}\cdot 2\cdot\pi\right)\cdot\text{rad}$$

ANGLES (radians) $\Theta_{1,j}$ =	$\Theta_{2,j}$ =	ANGLES (degrees) $\Theta_{1,j}\cdot\rho$ =	$\Theta_{2,j}\cdot\rho$ =	THICKNESS (inches) $\frac{tr_j}{in}$ =
0.466	0.582	26.677	22.999	0.187
0.582	0.64	33.32	44.061	0.176
0.64	0.755	36.642	65.124	0.077
0.755	0.813	43.284	86.187	0.088
0.813	1.279	46.606	107.25	0.125
1.279	1.745	73.283	128.312	0.062
1.745	2.21	99.961	149.375	0.011
2.21	2.676	126.638	170.438	0.011
2.676	3.141	153.316	191.5	0.141
3.141	3.456	179.993	212.563	0.19
3.456	3.77	197.995	233.626	0.198
3.77	4.084	215.997	254.689	0.213
4.084	4.398	233.999	275.751	0.216
4.398	4.712	252.001	282.031	0.187
4.712	4.77	270.003	290.532	0.196
4.77	5.149	273.325	296.812	0.196

C. Compute the mean radius (Rm_j) for each segment:

$$Rm_j := Ro - \frac{tr_j}{2}$$

D. Compute net cross section metal area (A_{NET}):

$$A_{NET} := \sum_j \left[Rm_j \cdot tr_j \cdot \left(\Theta_{2,j} - \Theta_{1,j} \right) \right] \qquad A_{NET} = 11.472\ in^2$$

E. Compute centroid locations δx and δy in the baseline rectangular coordinate system:

$$\delta x := \frac{\sum_j \left[\left(Rm_j\right)^2 \cdot tr_j \cdot \left(\sin\left(\Theta_{2,j}\right) - \sin\left(\Theta_{1,j}\right) \right) \right]}{A_{NET}} \qquad \delta x = -1.148\ in$$

$$\delta y := \frac{-1 \cdot \left[\sum_j \left[\left(Rm_j\right)^2 \cdot tr_j \cdot \left(\cos\left(\Theta_{2,j}\right) - \cos\left(\Theta_{1,j}\right) \right) \right] \right]}{A_{NET}} \qquad \delta y = 0.288\ in$$

STEP I.3 - <u>DETERMINE MOMENTS OF INERTIA</u>

A. Compute the area (Ix, Iy) and product (Ixy) moments of inertia in the baseline rectangular coordinate system:

$$\Delta\Theta_j := \Theta_{2,j} - \Theta_{1,j}$$

$$\Delta COS_j := \cos\left(\Theta_{2,j}\right) - \cos\left(\Theta_{1,j}\right) \qquad \Delta SIN_j := \sin\left(\Theta_{2,j}\right) - \sin\left(\Theta_{1,j}\right)$$

$$Ix := \sum_j \left(Rm_j\right)^3 \cdot tr_j \cdot \left[\frac{\Delta\Theta_j}{2} - \frac{\sin\left(2\cdot\Theta_{2,j}\right) - \sin\left(2\cdot\Theta_{1,j}\right)}{4} + \frac{2\cdot\delta y\cdot\left(\Delta COS_j\right)}{Rm_j} + \frac{\delta y^2 \cdot \left(\Delta\Theta_j\right)}{\left(Rm_j\right)^2} \right] \quad 46.641\ in^4$$

$$Iy := \sum_j \left(Rm_j\right)^3 \cdot tr_j \cdot \left[\frac{\Delta\Theta_j}{2} + \frac{\sin\left(2\cdot\Theta_{2,j}\right) - \sin\left(2\cdot\Theta_{1,j}\right)}{4} - \frac{2\cdot\delta x\cdot\left(\Delta SIN_j\right)}{Rm_j} + \frac{\delta x^2 \cdot \left(\Delta\Theta_j\right)}{\left(Rm_j\right)^2} \right] \quad 366.726\ in^4$$

$$Ixy := \sum_j \left(Rm_j\right)^3 \cdot tr_j \cdot \left[\frac{\sin\left(\Theta_{2,j}\right)^2 - \sin\left(\Theta_{1,j}\right)^2}{2} + \frac{\delta x \cdot \Delta COS_j - \delta y \cdot \Delta SIN_j}{Rm_j} + \frac{\delta x \cdot \delta y \cdot \Delta\Theta_j}{\left(Rm_j\right)^2} \right] \quad -37.209\ in^4$$

B. Compute the maximum and minimum principal moments of inertia (Imax and Imin):

$$Imax := \frac{Ix + Iy}{2} + \sqrt{\left(\frac{Ix - Iy}{2}\right)^2 + Ixy^2} \qquad Imax = 461.283\ in^4$$

$$Imin := \frac{Ix + Iy}{2} - \sqrt{\left(\frac{Ix - Iy}{2}\right)^2 + Ixy^2} \qquad Imin = 352.084\ in^4$$

STEP I.4 - FIND THE ORIENTATION OF THE PRINCIPAL AXIS

A. Compute the angle β in radians of the maximum principal stress axis with respect to the global X Axis. Note that when 2β approaches + or - $\pi/2$, the tangent of 2β approaches ∞. Therefore, in the formula for β below, the minimum value of the quantity $\Delta I = Ix - Iy$ must be restricted from becoming zero to avoid division of by zero.

$$\Delta I := |Ix - Iy|$$

Set Iy = Ix when ΔI is small

$$Iy := if\left(|\Delta I| < 0.00001 \cdot in^4, Ix, Iy\right)$$

Set ΔI to a small finite number when ΔI is small

$$\Delta I := if\left(\Delta I < 0.00001 \cdot in^4, 1 \cdot 10^{-5} \cdot in^4, \Delta I\right) \qquad \Delta I = 79.915\ in^4$$

Compute a preliminary angle between the Imax axis and the +X axis

$$\beta := 0.5 \cdot atan\left(\frac{-2 \cdot Ixy}{\Delta I}\right) \qquad \beta = 0.375\ rad \qquad \beta = 21.48\ deg$$

B. The equation for β above assumes that Ix > Iy. When Iy > Ix, the value of β when calulated using the above formula changes sign and is measured relative to the +y axis. Therefore to compute the true angle Φ_1 of the Imax axis with the +X axis, the following logic is applied:

$$\Phi_1 := if\left(Iy > Ix, -\beta + \frac{\pi}{2}, \beta\right) \qquad \Phi_1 = 0.375\ rad \qquad \Phi_1 = 21.48\ deg$$

C. The angle Φ_2 between the Imin axis and the +X axis is determined simply by subtracting $\pi/2$ radians:

$$\Phi_2 := \Phi_1 - \frac{\pi}{2} \qquad \Phi_2 = -1.196\ rad \qquad \Phi_2 = -68.52\ deg$$

D. Adjust Φ_1 and Φ_2 to avoid numerical problem with tan $(\pi/2) = \infty$:

$$SGN\Phi_1 := \Phi_1 \cdot \left(|\Phi_1|\right)^{-1} \qquad SGN\Phi_1 = 1$$

$$SGN\Phi_2 := \Phi_2 \cdot \left(|\Phi_2|\right)^{-1} \qquad SGN\Phi_2 = -1$$

$$\Phi_1 := if\left(|tan(\Phi_1)| > 1.58 \cdot 10^5, 1.57079 \cdot SGN\Phi_1, \Phi_1\right) \qquad \Phi_1 = 21.48\ deg$$

$$\Phi_2 := if\left(|tan(\Phi_2)| > 1.58 \cdot 10^5, 1.57079 \cdot SGN\Phi_2, \Phi_2\right) \qquad \Phi_2 = -68.52\ deg$$

STEP I.5 - FIND THE DISTANCE FROM THE NEUTRAL AXIS TO OUTER FIBER

A. Determine the intersection of lines parallel to the principal axes passing through the origin with the orthogonal principal axis.

The equations of the principal axis in the x-y coordinate system are:

$y = m_q x + b_q$; where q = 1 corresponds to the Imax axis and q = 2 corresponds to the Imin axis.

Then:

$q := 1..2 \qquad m_q := \tan(\Phi_q)$

The y axis intercepts of the principal axes are:

$b_q := \delta y - m_q \cdot \delta x$

The equation of the orthogonals to the principal axes passing through the origin are:

$y = -(m_q)^{-1} x$

Adjust m_q when m_q is small to avoid division by zero: $m_q := \mathrm{if}\left(\left|m_q\right| < 1\cdot 10^{-6}, 1\cdot 10^{-6}, m_q\right)$

Solving the two equations simultaneously, the intersection coordinates of the principal axes with their orthogonals passing through the origin are:

$$X_{I_q} := \frac{-1\cdot b_q}{m_q + (m_q)^{-1}} \qquad X_{I_1} = -0.252\,\text{in} \qquad X_{I_2} = -0.896\,\text{in}$$

$$Y_{I_q} := -1\cdot(m_q)^{-1}\cdot X_{I_q} \qquad Y_{I_1} = 0.641\,\text{in} \qquad Y_{I_2} = -0.353\,\text{in}$$

B. Determine the intersection points $(X1,Y1)_q$ & $(X2,Y2)_q$ of the orthogonals to the principal axis passing through the origin with the circle defined by the pipe outside radius:

$$X1_q := Ro\cdot\cos\left(\Phi_q + \frac{\pi}{2}\right) \qquad X1_1 = -3.158\,\text{in} \qquad X1_2 = 8.026\,\text{in}$$

$$X2_q := Ro\cdot\cos\left(\Phi_q - \frac{\pi}{2}\right) \qquad X2_1 = 3.158\,\text{in} \qquad X2_2 = -8.026\,\text{in}$$

$$Y1_q := Ro\cdot\sin\left(\Phi_q + \frac{\pi}{2}\right) \qquad Y1_1 = 8.026\,\text{in} \qquad Y1_2 = 3.158\,\text{in}$$

$$Y2_q := Ro\cdot\sin\left(\Phi_q - \frac{\pi}{2}\right) \qquad Y2_1 = -8.026\,\text{in} \qquad Y2_2 = -3.158\,\text{in}$$

C. Compute the x and y axis components of distance from the neutral axis to the outer fiber:

X - Axis

$XP_q := X1_q - XI_q$ $\quad XP = \begin{pmatrix} -2.906 \\ 8.922 \end{pmatrix} in$ - x distance to 1st intercept pairs

$XN_q := X2_q - XI_q$ $\quad XN = \begin{pmatrix} 3.41 \\ -7.13 \end{pmatrix} in$ - x distance to 2nd intercept pairs

Y - Axis

$YP_q := Y1_q - YI_q$ $\quad YP = \begin{pmatrix} 7.385 \\ 3.511 \end{pmatrix} in$ - y distance to 1st intercept pairs

$YN_q := Y2_q - YI_q$ $\quad YN = \begin{pmatrix} -8.667 \\ -2.806 \end{pmatrix} in$ - y distance to 2nd intercept pairs

D. Compute total distance from neutral axis to mean radius point considering that the mean radius is represented by the average wall thickness (t_{av}):

$$C_{1,q} := \sqrt{\left(XP_q\right)^2 + \left(YP_q\right)^2} - \frac{t_{av}}{2} \qquad C_{1,1} = 7.821\text{ in} \qquad C_{1,2} = 9.472\text{ in}$$

$$C_{2,q} := \sqrt{\left(XN_q\right)^2 + \left(YN_q\right)^2} - \frac{t_{av}}{2} \qquad C_{2,1} = 9.198\text{ in} \qquad C_{2,2} = 7.547\text{ in}$$

E. Compute the minimum section modulus about each principal axis:

$C1_q := C_{q,1} \qquad C2_q := C_{q,2}$

$$Z_{MIN_1} := \frac{Imax}{max(C1)} \qquad Z_{MIN_1} = 50.149\text{ in}^3$$

$$Z_{MIN_2} := \frac{Imin}{max(C2)} \qquad Z_{MIN_2} = 37.169\text{ in}^3$$

F. Compute the offset of the principal axes with respect to the pipe centerline:

$$\delta_{OFF_q} := \sqrt{\left(XI_q\right)^2 + \left(YI_q\right)^2} \qquad \delta_{OFF_1} = 0.688\text{ in} \qquad \delta_{OFF_2} = 0.963\text{ in}$$

PART II - SECTION STRESS ANALYSIS

The following process computes the net section elastic stresses for a degraded pipe section using the previously computed net section properties to implement the stress calculation procedure developed in reference CEB-CQS-449.

STEP II.1 - INPUT STRESS DATA FROM PIPING ANALYSIS

$Sh := 15000 \cdot psi$ - allowable stress for pipe at maximum design temperature

$Sc := 15000 \cdot psi$ - allowable stress for pipe at room temperature

$S_8 := 869 \cdot psi$ - stress from piping equation 8 (normal)

$S_{9U} := 2985 \cdot psi$ - stress from piping equation 9U (upset)

$S_{9F} := 5226 \cdot psi$ - stress from piping equation 9F (faulted)

$S_{10} := 421 \cdot psi$ - stress from piping equation 10 (thermal expansion)

$SIF := 1.0$ - stress intensification factor at point in question

$P := 160 \cdot psi$ - design pressure

STEP II.2 - BACK CALCULATE THE APPLIED BENDING MOMENTS IN THE PIPING ANALYSIS

A. Compute nominal section modulus (Z_{nom}) and pressure stress (σ_{pr}) :

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$$Z_{nom} := \pi \cdot \left(Ro - \frac{t_{nom}}{2}\right)^2 \cdot t_{nom} \qquad Z_{nom} = 72.47\, in^3$$

$$\sigma_{pr} := \frac{P \cdot (Ro - t_{nom})^2}{Ro^2 - (Ro - t_{nom})^2} \qquad \sigma_{pr} = 2.024 \times 10^3 psi$$

B. Determine controlling stress intensification factor (SIF'):

$$SIF' := if(0.75 \cdot SIF \le 1.00, 1.0, 0.75 \cdot SIF) \qquad SIF' = 1$$

C. Compute bending moment (M_8) for sustained mechanical loads:

$$M_8 := \frac{(S_8 - \sigma_{pr}) \cdot Z_{nom}}{SIF'} \qquad M_8 = -8.367 \times 10^4 in \cdot lbf$$

D. Compute bending moment (M_{9U}) for piping Equation 9U:

$$M_{9U} := \frac{(S_{9U} - \sigma_{pr}) \cdot Z_{nom}}{SIF'} \qquad M_{9U} = 6.96712 \times 10^4 in \cdot lbf$$

E. Compute bending moment (M_{9F}) for piping Equation 9F:

$$M_{9F} := \frac{(S_{9F} - \sigma_{pr}) \cdot Z_{nom}}{SIF'} \qquad M_{9F} = 2.321 \times 10^5 in \cdot lbf$$

F. Compute bending moment (M_{10}) for piping Equation 10:

$$M_{10} := \frac{(S_{10}) \cdot Z_{nom}}{SIF} \qquad M_{10} = 3.051 \times 10^4 \, in \cdot lbf$$

STEP II.3 - DETERMINE PRESSURE INDUCED BENDING MOMENT DUE TO NEUTRAL AXIS OFFSET

A. Compute the nominal metal area (A_{NOM}):

$$A_{NOM} := 2 \cdot \pi \cdot t_{nom} \cdot \left(Ro - \frac{t_{nom}}{2} \right) \qquad A_{NOM} = 17.124 \, in^2$$

B. Compute the added pressure area (A_P) due to degradation:

$$A_P := A_{NOM} - A_{NET}$$

C. Compute the axial pressure force (Fx):

$$Fx := P \cdot \left[\pi \cdot (Ro - t_{nom})^2 + A_P \right] \qquad Fx = 3.556 \times 10^4 \, lbf$$

D. Compute the induced bending moment (M_P):

$$M_{P_q} := Fx \cdot \delta_{OFF_q} \qquad M_P = \begin{pmatrix} 2.448 \times 10^4 \\ 3.423 \times 10^4 \end{pmatrix} in \cdot lbf$$

STEP II.4 - DETERMINE A MODIFIED SIF IF COMPONENT SIF IS BASED ON NOMINAL THICKNESS

The location in question is a girth butt weld. Therefore, SIF is not a function of component thickness and:

$$SIF_M := SIF$$

$$SIF'_M := if(0.75 \cdot SIF_M \le 1.0, 1.0, 0.75 \cdot SIF_M) \qquad SIF'_M = 1$$

STEP II.5 - COMPUTE NET SECTION STRESSES

A. Equation 8 stress (σ_8):

$$\sigma_{8_q} := \frac{Fx}{A_{NET}} + SIF'_M \cdot \frac{M_{P_q} + M_8}{Z_{MIN_q}} \qquad \sigma_8 = \begin{pmatrix} 1.919 \times 10^3 \\ 1.769 \times 10^3 \end{pmatrix} psi$$

B. Equation 9U stress (σ_{9U}):

$$\sigma_{9U_q} := \frac{Fx}{A_{NET}} + SIF'_M \cdot \frac{M_{P_q} + M_{9U}}{Z_{MIN_q}} \qquad \sigma_{9U} = \begin{pmatrix} 4.977 \times 10^3 \\ 5.895 \times 10^3 \end{pmatrix} psi$$

C. Equation 9F stress (σ_{9F}):

$$\sigma_{9F_q} := \frac{Fx}{A_{NET}} + SIF'_M \cdot \frac{Mp_q + M_{9F}}{Z_{MIN_q}} \qquad \sigma_{9F} = \begin{pmatrix} 8.215 \times 10^3 \\ 1.026 \times 10^4 \end{pmatrix} psi$$

D. Equation 10 stress (σ_{10}):

$$\sigma_{10_q} := SIF_M \cdot \frac{M_{10}}{Z_{MIN_q}} \qquad \sigma_{10} = \begin{pmatrix} 608.381 \\ 820.832 \end{pmatrix} psi$$

E. Equation 11 stress (σ_{11}):

$$\sigma_{11_q} := \frac{Fx}{A_{NET}} + \frac{SIF'_M \cdot (Mp_q + M_8) + SIF_M \cdot M_{10}}{Z_{MIN_q}} \qquad \sigma_{11} = \begin{pmatrix} 2.528 \times 10^3 \\ 2.59 \times 10^3 \end{pmatrix} psi$$

STEP II.6 - CHECK ALLOWABLES

A. Compute primary stress ratios:

$$SR_8 := \frac{\sigma_8}{Sh} \qquad SR_8 = \begin{pmatrix} 0.128 \\ 0.118 \end{pmatrix}$$

$$SR_{9U} := \frac{\sigma_{9U}}{1.2 \cdot Sh} \qquad SR_{9U} = \begin{pmatrix} 0.276 \\ 0.327 \end{pmatrix}$$

$$SR_{9F} := \frac{\sigma_{9F}}{2.4 \cdot Sh} \qquad SR_{9F} = \begin{pmatrix} 0.228 \\ 0.285 \end{pmatrix}$$

B. Compute secondary and primary plus secondary stress ratios:

$$SR_{10} := \frac{\sigma_{10}}{1.25 \cdot Sc + 0.25 \cdot Sh} \qquad SR_{10} = \begin{pmatrix} 0.027 \\ 0.036 \end{pmatrix}$$

$$SR_{11} := \frac{\sigma_{11}}{1.25 \cdot Sc + 1.25 \cdot Sh} \qquad SR_{11} = \begin{pmatrix} 0.067 \\ 0.069 \end{pmatrix}$$

C. Find maximum stress ratio.

Primary Stresses:

$P_1 := \max(SR_8)$ $\qquad P_1 = 0.128$

$P_2 := \max(SR_{9U})$ $\qquad P_2 = 0.327$

$P_3 := \max(SR_{9F})$ $\qquad P_3 = 0.285$

$i := 1..4$ $\qquad P_{max} := \max(P)$ $\qquad P_{max} = 0.327$

This page added by revision 39.

Secondary and Primary plus Secondary Stresses:

$Q_1 := \max(SR_{10}) \qquad Q_2 := \max(SR_{11})$

$Q_1 := \mathrm{if}(Q_1 \geq Q_2, Q_1, Q_2)$

$S_{max} := \max(Q) \qquad\qquad S_{max} = 0.069$

Worst Case Stress Ratio:

$SR_{max} := \mathrm{if}(S_{max} > P_{max}, S_{max}, P_{max})$

$SR_{max} = 0.327$

Conclusion: Structural Integerity for the portion of 8" ERCW piping listed above has ~~met~~ BEEN with the existing through wall of 1/2"circumferential flaw.

Prepared: [signature] 6/13/09
Checked: [signature] 6/13/09

The following calculation is based on the requirements of GL 90-05, Guidance for Performing Temporary Non-code Repair of ASME Code Class 1, 2 and 3 Piping. This application is for a through wall flaw located on the 8" STD ERCW Train B return piping from the Board Room and Main Control Room A/C coolers, near valve 1-67-5552B. UT examination has idenfied a flaw size of 1" where the wall thickness is less than tmin. A flaw size of 1 1/2" (measured flaw size + 2 times transducer size) is used in this calculation to account for possible inaccuracies due to inaccessibility of the flaw location. The initial limitation to application of this method is the flaw size limit of the lesser of 3" or 15% of the pipe circumference, which in this case is 4.07". Since the bounding flaw size assumed for this evaluation is less than 3", the method applies.

$D_o := 8.625 \cdot in \qquad t := 0.322 \cdot in \qquad R := \dfrac{D_o + (D_o - 2 \cdot t)}{4} \qquad R = 4.151\ in$

$P := 953 \cdot psi \qquad DW := 819 \cdot psi \qquad TH := 421 \cdot psi \qquad SSE := 5226 \cdot psi$

$S := P + DW + TH + SSE \qquad S = 7419\ psi$

$twoa := 1.5 \cdot in \qquad a := \dfrac{twoa}{2} \qquad a = 0.75\ in \qquad tmin := 0.097 \cdot in$

$r := \dfrac{R}{tmin} \qquad r = 42.799$

$c := \dfrac{a}{(3.1416 \cdot R)} \qquad c = 0.058$

$A := -3.26543 + 1.52784 \cdot r - 0.072698 \cdot r^2 + 0.0016011 \cdot r^3 \qquad A = 54.481$

$B := 11.36322 - 3.91412 \cdot r + 0.18619 \cdot r^2 - 0.004099 \cdot r^3 \qquad B = -136.453$

$C := -3.18609 + 3.84763 \cdot r - 0.18304 \cdot r^2 + 0.00403 \cdot r^3 \qquad C = 142.145$

$F := 1 + A \cdot c^{1.5} + B \cdot c^{2.5} + C \cdot c^{3.5} \qquad F = 1.65$

$K1 := 1.4 \cdot S \cdot F \qquad K1 = 1.713 \times 10^4\ psi$

$K2 := (3.1416 \cdot a)^{0.5} \qquad K2 = 1.535\ in^{0.5}$

$K := K1 \cdot K2 \qquad K = 26299.591\ psi \cdot in^{0.5} \qquad Limit := 35000 \cdot psi \cdot in^{0.5}$

Since the value of K is less than the limit of 35000 $psi(in)^{0.5}$ this limit is satisfied and Code requirements for the use of a temporary non-Code repair are met.

This page added by revision 39.

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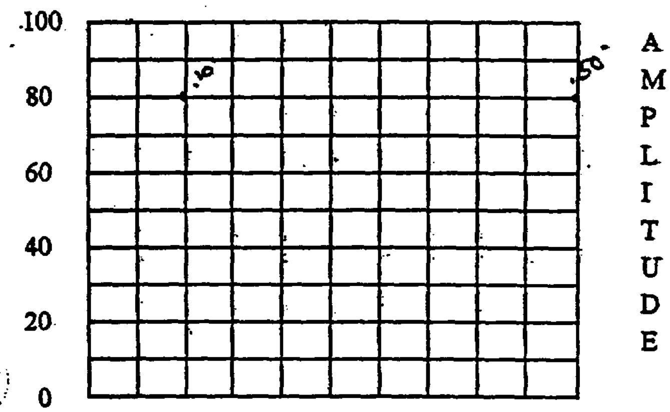
TENNESSEE VALLEY AUTHORITY	DIGITAL ULTRASONIC CALIBRATION DATA SHEET	REPORT NUMBER: Bop # 2367

PROJECT: SQN UNIT: 1 CYCLE: 12	CALIBRATION DATE: 6-13-03
PROC.: N-UT- 26 REV:21 TC:03-01	CALIBRATION BLOCK NO.: Stepwedge TEMP: 77°F
INSTR. MFG: KRAUTKRAMER DUE DATE: 5-27-04	SIMULATOR BLOCK NO: n/a
MODEL/TYPE: USN-52L M & TE NO.: E18501	THERMOMTER S/N: 558273 DUE DATE: 12-09-03
TRANSDUCER MFG: KBA	COUPLANT ULTRAGEL II BATCH: 001225
S/N 009KH2 SIZE: .375 FREQ: 8 MHz	EXAM TYPE: SHEAR ☐ LONG ☒ RL ☐
CABLE TYPE: RG174 LENGTH: 72 inches	ANGLE VERIFICATION
	BLOCK TYPE: NA — S/N: NA
DAC	NOMINAL ANGLE: NA — ACTUAL ANGLE: NA



DISPLAY WIDTH: .5 inches

INSTRUMENT SETTINGS

REFLECTOR SCAN DIRECT.	NTCH	SDE	REFERENCE SENSITIVITY	MEMORY NUMBER
AXIAL	☐	☐	55 dB	1
CIRC	☐	☐	n/a dB	n/a

*FREQ: 2-8 MHz	*REJECT: 0 %
ANGLE: 0 deg	*DAMPING: 1000 ohms
DELAY: 0.00 msec	*PULSER: SING
ZERO: 6.389 msec	FILTER: FIXED
VELOCITY: 2398 msec	*REP RATE: HIGH
RANGE: .5 inches	TOF: ☐ PEAK ☒ FLANK
*DISPLAY MODE: FULL	POWER: BATTERY
DUAL: ☐ ON ☒ OFF	TCG: ☐ ON ☒ OFF

REF. REFLECTOR: N/A GAIN: N/A dB	CALIBRATION TIMES
AMPLITUDE: N/A % METAL PATH: N/A"	INITIAL TIME: 11:30 FINAL TIME: 1310

VERIFICATION TIMES	1)N/A	2)NA	3)NA	4)NA	5)NA	6)NA	7)NA	8)NA	9)NA

*** PDI QUALIFIED INSTRUMENT SETTINGS:**
VERIFY INSTRUMENT SETTINGS AND CALIBRATION SEQUENCE ARE IN ACCORDANCE WITH TABLE 2 OF THE APPLICABLE PDI QUALIFICATION IMPLEMENTATION PROCEDURE !

LINEARITY CHECK

VERTICAL										
SIGNAL 1	100	90	80	70	60	50	40	30	20	
SIGNAL 2	50	45	40	35	30	25	20	15	10	

ATTENUATOR								
GAIN	SET	-6 dB	-12 dB	SET	+12	SET	+6	
AMP	80%	32 TO 48	16 TO 24	20 %	64 TO 96	40%	64 TO 96	
		41	20		80		81	

COMMENTS:	WELDS/ITEMS EXAMINED:
WO# 03-8910-000 See attached data.	8" ERCW return line from B train electrical
Best effort exam due to Location	board room chillers
and access to Piping. Pipe Painted rough	COMPONENT TEMP 98°F

EXAMINER:	EXAMINER:	REVIEWER:	ANII: N/A
Stephen T Williams	D Sam	T. F. McDermott	DATE:
LEVEL: II	LEVEL: II	LEVEL: III DATE: 6/13/03	PG.: OF

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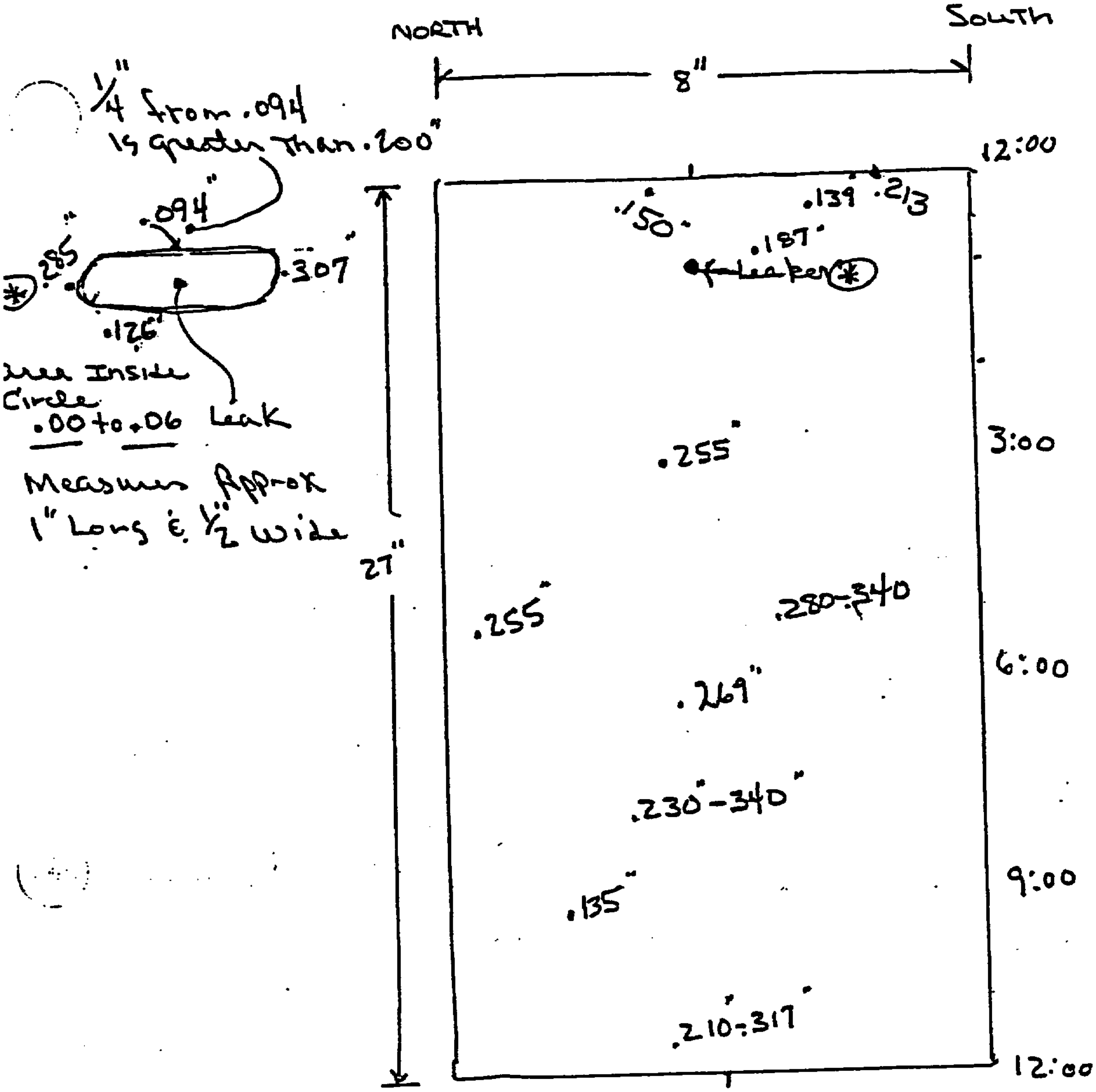

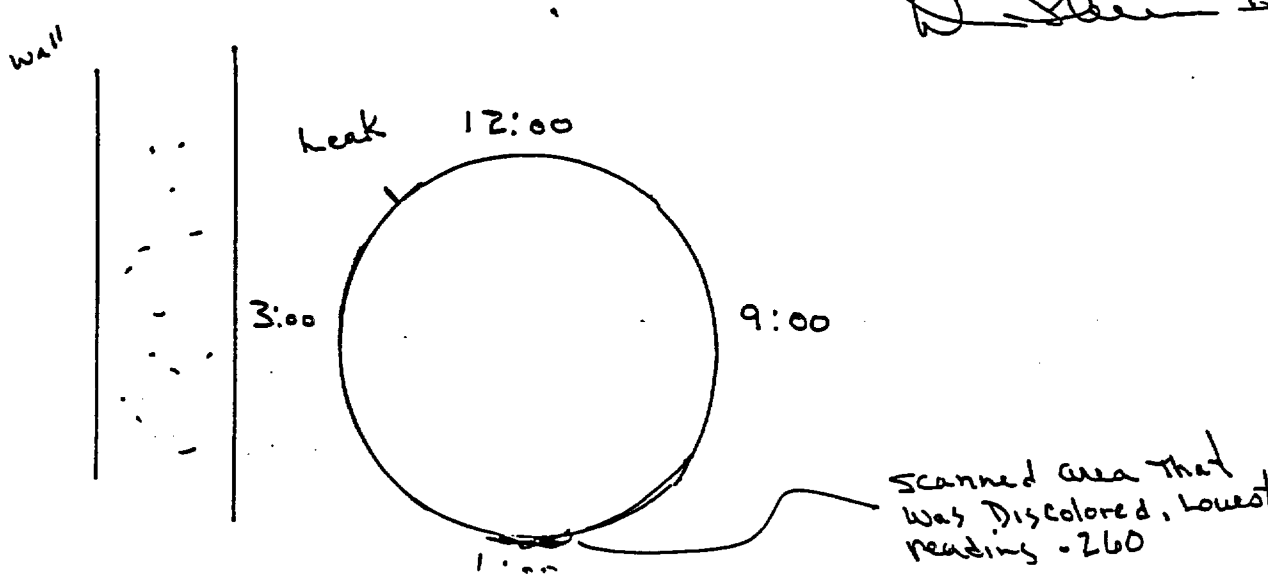

LICENSING TRANSMITTAL TO NRC
SUMMARY AND CONCURRENCE SHEET

THE PURPOSE OF THIS CONCURRENCE SHEET IS TO ASSURE THE ACCURACY AND COMPLETENESS OF TVA SUBMITTALS TO THE NRC.

DATE DUE June 14, 2003 NRC SUBMITTAL PREPARED BY Jim Smith

SUBJECT: American Society Of Mechanical Engineers (ASME) Section XI Inservice Inspection (ISI) Program - Relief Requests

ITR Required? (2) ___ YES XX NO Applicable DCN: ___________

OR

Jim Smith / 06/13/03 ___________ / ___________
Licensing Date ITR Reviewer Date

Verification Required? (3) XX YES ___ NO	Peer Check Required? (4) XX YES ___ NO
Oath or Affirmation Required? ___ YES XX NO	If Yes:
New Commitments? ___ YES XX NO	___________ / ___________
Posting Required? ___ YES XX NO	Peer Checker Date

LICENSING BASIS CHANGE - If this submittal requires a change to the licensing basis, a change has been initiated in accordance with NADP-7. ___________ DATE ___________

A concurrence signature reflects that the signatory has assured that the submittal is appropriate and consistent with TVA Policy, applicable commitments are approved for implementation and supporting documentation for submittal completeness and accuracy has been prepared.

CONCURRENCE (5)

NAME	ORGANIZATION	SIGNATURE	DATE
D. L. Koehl	Plant Manager	N/A [signature]	
D. V. Goodin	SQN Licensing Eng	[signature] for	6/14/03
J. D. Smith	SQN Licensing ~~Supv~~	[signature]	6/14/03
D. L. Lundy	SQN Engineering Mgr	John Thomas for	6/14/03

LICENSING TRANSMITTAL TO NRC
SUMMARY AND CONCURRENCE SHEET

THE PURPOSE OF THIS CONCURRENCE SHEET IS TO ASSURE THE ACCURACY AND COMPLETENESS OF TVA SUBMITTALS TO THE NRC.

DATE DUE June 14, 2003 NRC SUBMITTAL PREPARED BY Jim Smith

SUBJECT: American Society Of Mechanical Engineers (ASME) Section XI Inservice Inspection (ISI) Program - Relief Requests

ITR Required? (2) ___ YES XX NO Applicable DCN: ______

OR

Jim Smith / 06/13/03 — Licensing / Date

______ / ______ — ITR Reviewer / Date

Verification Required? (3) XX YES ___ NO

Oath or Affirmation Required? ___ YES XX NO

New Commitments? ___ YES XX NO

Posting Required? ___ YES XX NO

Peer Check Required? (4) XX YES ___ NO

If Yes:

______ / ______ — Peer Checker / Date

LICENSING BASIS CHANGE - If this submittal requires a change to the licensing basis, a change has been initiated in accordance with NADP-7. ______ DATE ______

A concurrence signature reflects that the signatory has assured that the submittal is appropriate and consistent with TVA Policy, applicable commitments are approved for implementation and supporting documentation for submittal completeness and accuracy has been prepared.

CONCURRENCE (5)

NAME	ORGANIZATION	SIGNATURE	DATE
D. L. Koehl	Plant Manager	Steve Freeman for DLK	6-14-03
D. V. Goodin	SQN Licensing Eng	[signature]	6/14/03
J. D. Smith	SQN Licensing Supv	[signature]	6/14/03
D. L. Lundy	SQN Engineering Mgr	[signature]	6/14/03