Tennessee Valley Authority, Post Office Box 2000, Spring City, Tennessee 37381-2000

FEB 15 2002

10 CFR 50.55a

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

Gentlemen:

In the Matter of	)	Docket No.50-390
Tennessee Valley Authority	)	

WATTS BAR NUCLEAR PLANT (WBN) UNIT 1 - AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME) SECTION XI, INSERVICE INSPECTION - REQUEST FOR RELIEF 1-RR-4

The purpose of this letter is to provide NRC the structural integrity evaluation associated with the subject relief request as requested in electronic mail (e-mail) from the WBN Project Manager, M. Padovan, on January 8, 2002.

This evaluation is provided in the Enclosure. TVA evaluated a through-wall flaw including a fracture mechanics evaluation. The calculation did not assume a flaw size or assume a wall thickness of the degraded area. The calculation used actual data from non-destructive examination (NDE) inspections of twelve locations around the through-wall flaw area to determine a minimum structural wall thickness value for the piping adjacent to the leak and a maximum allowable flaw length. This criteria is used in the augmented inspections. TVA considers this method to provide technical assurance of the structural integrity of the piping. TVA also considers that the enclosed evaluation is consistent with the guidance of Generic Letter 90-05, "Guidance for Performing Temporary Non-Code Repair of ASME Code Class 1, 2, and 3 Piping."

A047

If you have any questions about this change, please contact me at (423) 365-1824.

Sincerely,

P. L. Pace
Manager, Site Licensing
and Industry Affairs

Enclosure
cc (Enclosure):

NRC Resident Inspector
Watts Bar Nuclear Plant
1260 Nuclear Plant Road
Spring City, Tennessee 37381

Mr. L. Mark Padovan, Senior Project Manager
U.S. Nuclear Regulatory Commission
MS 08G9
One White Flint North
11555 Rockville Pike
Rockville, Maryland 20852-2738

U.S. Nuclear Regulatory Commission
Region II
Sam Nunn Atlanta Federal Center
61 Forsyth St., SW, Suite 23T85
Atlanta, Georgia 30303

ENCLOSURE

WATTS BAR NUCLEAR PLANT UNIT 1
RELIEF REQUEST 1-RR-4
TEMPORARY NON-CODE REPAIR OF CLASS 3 PIPING

Calculation N3-PA-091 Attachment A

Prepared By: [signature] 8/2/01 Checked By: [signature] 8/3/01

PURPOSE:

The purpose of this evaluation is to determine the structural adequacy of a location which is leaking. The leaking location is located on ERCW piping at valve 0-ISV-67-528B. The leaking pipe is part of Rigorous Analysis Problem N3-67-09A.

REFERENCES:

1. Inspection Report BOP-R-544.
2. Design Standard DS-C1.2.8.
3. Calculation N3-67-09A, Rev 26, RIMS # T71 010629 802.
4. Drawing 47W450-209.
5. ASME Code Case N-513.

EVALUATION:

The reference 1 inspection data provided readings for the leaking location, as well as, axial along the pipe adjacent to the leaking location. This evaluation will be performed in two parts. Part I will evaluate the leaking location using reference 2, including a fracture mechanics evaluation. Part II will determine a minimum structural wall thickness value for the piping adjacent to the leak.

Part I:

Reviewing the reference 4 isometric drawing, the leaking location is between node points S1 and S3 in the analysis model. The actual piping stresses from the reference 3 analysis will be used in both the structural and fracture mechanics evaluation. The fracture mechanics evaluation will determine a maximum allowable thru-wall flaw based on the existing loadings. Additionally, based on this allowable thru-wall flaw a structural adequacy evaluation will be performed to ensure structural integrity. The maximum stresses between the above node points will be used. No reduction in moment will be made for any modeled SIF's of the span in question (conservative - moments will remain intensified). The following is a list of maximum existing stresses and associated moments node point S1 - S3.

$\sigma_{Pressure}$ = 828 psi σ_{8} = 1,769 psi σ_{9U} = 2,957 psi σ_{9F} = 4,116 psi

σ_{10} = 5,581 psi

M_a = 7,999 lb-in M_{bu} = 10,098 lb-in M_{bf} = 19,950 lb-in M_c = 47,439 lb-in

Calculation N3-PA-091 Attachment A

Prepared By: WRB... 8/2/01 **Checked By:** W. D. Carey 8/3/01

Using the previously tabulated values, a fracture mechanics and structural integrity evaluation was performed in accordance the reference 2 methodology (refer to pages A.98 - A.104). For the fracture mechanics evaluation, the average wall thickness value (0.243" from NDE data) was reduced by 10%. This 10% value is taken as a projected wear rate for the location. The fracture mechanics evaluation determined the maximum allowable crack length of 1.0" (circumferentially). This value was based on the input piping stresses / moments developed on the previous page and the actual NDE inspection data provided by reference 1 (leak occurred at point 6 of the inspection data). With the allowable crack length of 2.2" the evaluation also showed that structural integrity will be maintained for all ASME Code equations with the maximum stress ratio being 0.245. For acceptance the existing crack length cannot exceed 2.2" with the average wall thickness not to be less than 0.219".

Part II:

For this portion of the evaluation the remaining points (1 - 12) from the reference 1 inspection data will be addressed. These points represent the wall thickness values for the piping adjacent to the leak location. Since there is no leak in this portion of the piping only a structural integrity evaluation will be required in accordance with reference 2. The following pages (refer to pages A.93 - A.97) determined a minimum average wall thickness value of 0.051" (360 degrees around the pipe). This value is based on the maximum input bending stresses for the identified locations from the reference 3 piping analysis. From the reference 2 inspection data the following is the average wall thickness for points 1 through 12:

Point 1	0.261"
Point 2	0.258"
Point 3	0.259"
Point 4	0.254"
Point 5	0.262"
Point 6	0.243" (Approximate Leak Location)
Point 7	0.257"
Point 8	0.256"
Point 9	0.254"
Point 10	0.260"
Point 11	0.263"
Point 12	0.257"

For each of the 12 locations inspected, the average minimum wall thickness value exceeds the required value of 0.051". Therefore, the piping adjacent to the leak location is structurally acceptable for the inspected data.

Calculation N3-PA-091 Attachment A

Prepared By: [signature] 8/2/01 Checked By: W. D. Carson 8/3/01

CONCLUSION:

From the above evaluations, at the location of the leak, the maximum allowable flaw length is 2.2" with the minimum average wall thickness not to be less than 0.219". This criteria will ensure that the fracture mechanics and structural integrity criteria are maintained. For the adjacent piping, structural integrity is maintained based on the NDE data exceeding the minimum wall thickness value required by design. No further evaluation is required.

Prepared By: WRBell 8/3/01 **Checked By:** W.D. Carney 8/3/01

STRUCTURAL INTEGRITY EVALUATION

Piping System:	Essential Raw Cooling Water
Grid Number:	Leak at Valve 0-ISV-67-528B
Analysis Problem No:	N3-67-09A Rev 26
Microfiche No:	See Table 8.2-1
Member Name:	S2 - S4
Node Name:	S1 - S3
Isometric:	47W450-209
Flow Diagram:	47W845-2
Pipe Material:	SA 106 Gr B

N3-PA-091 ATTACHMENT A

Prepared By: WRBull 8/3/01 **Checked By:** W. D. Camp 8/3/01

The routine below computes required thickness for a straight pipe (SIF = 1.0) under pressure and moment load using code equations. Seven cases (load combination - allowable stress conditions) are evaluated. Cases 1-4 are primary stress cases (i.e., code equations 8, 9u, 9e and 9f). Case 5 is secondary stress (i.e., code equation 10). Case 6 is sustained primary plus secondary (i.e., code equation 11). Also included is the required thickness for pressure design for piping where the longitudinal joint efficiency is no less than 1.0. This routine is not applicable for high energy piping.

1. **Initialize ksi and psi units:**

$$ksi := 1000 \cdot \frac{lbf}{in^2} \qquad psi := 1 \cdot \frac{lbf}{in^2}$$

2. **Input Pipe Data - Outside Diameter (Do), Nominal Thickness (t_{nom}), Max/Design Pressure (P), Cold Allowable Stress (Sc) and Hot Allowable Stress (Sh):**

$Do := 6.625 \cdot in \qquad t_{nom} := 0.280 \cdot in \qquad P := 160 \cdot psi$

$Sc := 15.0 \cdot ksi \qquad Sh := 15.0 \cdot ksi$

3. **Input Analysis of Record Applied Stress (S) Values for 6 Cases:**

$i := 1..6$

$S_i :=$

1.769·ksi
2.957·ksi
2.957·ksi
4.116·ksi
5.581·ksi
7.350·ksi

where:
i = 1: Equation 8
i = 2: Equation 9u
i = 3: Equation 9e
i = 4: Equation 9f
i = 5: Equation 10
i = 6: Equation 11

4. **Compute Analysis of Record Allowable Stress (S_{all}) Values for 6 Cases:**

$Sa := 1.25 \cdot Sc + 0.25 \cdot Sh$

$S_{all_i} :=$

Sh
1.2·Sh
1.8·Sh
2.4·Sh
Sa
Sa + Sh

$$S_{all} = \begin{pmatrix} 15 \\ 18 \\ 27 \\ 36 \\ 22.5 \\ 37.5 \end{pmatrix} ksi$$

Prepared By: WRBull 8/3/01 **Checked By:** W. D. Carey 8/3/01

5. **Initialize Thickness Variable (t):**

$t := t_{nom}$

6. **Set Up Inside Diameter (Di), Moment Factor (Fm) and Pressure Factor (Fp) as Functions of Thickness:**

$Di(Do,t) \equiv Do - 2 \cdot t$

$$Fm(Do,Di,t) \equiv \left[\frac{\pi}{32} \cdot \left(\frac{Do^4 - Di(Do,t)^4}{Do}\right)\right]^{-1}$$

$$Fp(Do,Di,t) \equiv \frac{Di(Do,t)^2}{Do^2 - Di(Do,t)^2}$$

7. **Compute Applied Moment (M) for Equations 8, 9u, 9e, 9f and 10:**

$i := 1..4$

$$M_i := \frac{S_i - P \cdot Fp(Do,Di,t)}{Fm(Do,Di,t)}$$

$$M_5 := \frac{S_5}{Fm(Do,Di,t)}$$

$$M = \begin{pmatrix} 666.071 \\ 1.507 \times 10^3 \\ 1.507 \times 10^3 \\ 2.328 \times 10^3 \\ 3.951 \times 10^3 \end{pmatrix} ft \cdot lbf$$

8. **Perform Solve Block Iterations to Determine Required Thickness (tr) for Each Case:**

Case 1 (Equation 8)

Given

$S_{all_1} = M_1 \cdot Fm(Do,Di,t) + P \cdot Fp(Do,Di,t)$

$t := Find(t)$ $tr_1 := t$ $tr_1 = 0.033\, in$

Prepared By: WRBell 8/3/01 **Checked By:** W. D. Cairoy 8/3/01

Case 2 (Equation 9u)

Given

$S_{all_2} = M_2 \cdot Fm(Do, Di, t) + P \cdot Fp(Do, Di, t)$

$t := Find(t)$ $tr_2 := t$ $tr_2 = 0.044\ in$

Case 3 (Equation 9e)

Given

$S_{all_3} = M_3 \cdot Fm(Do, Di, t) + P \cdot Fp(Do, Di, t)$

$t := Find(t)$ $tr_3 := t$ $tr_3 = 0.029\ in$

Case 4 (Equation 9f)

Given

$S_{all_4} = M_4 \cdot Fm(Do, Di, t) + P \cdot Fp(Do, Di, t)$

$t := Find(t)$ $tr_4 := t$ $tr_4 = 0.03\ in$

Case 5 (Equation 10)

Given

$S_{all_5} = M_5 \cdot Fm(Do, Di, t)$

$t := Find(t)$ $tr_5 := t$ $tr_5 = 0.063\ in$

Case 6 (Equation 11 = Eq 8 + Eq 10)

Given

$S_{all_6} = Fm(Do, Di, t) \cdot (M_5 + M_1) + P \cdot Fp(Do, Di, t)$

$t := Find(t)$ $tr_6 := t$ $tr_6 = 0.051\ in$

Prepared By: WRB [signature] 8/3/01 **Checked By:** W. D. Carson 8/3/01

8. **Perform Stress Check Computations:**

$i := 1..3$

$S_{chk_i} := M_i \cdot Fm(Do, Di, tr_i) + P \cdot Fp(Do, Di, tr_i) - S_{all_i}$

$S_{chk_5} := M_5 \cdot Fm(Do, Di, tr_5) - S_{all_5}$

$S_{chk_6} := P \cdot Fp(Do, Di, tr_6) + Fm(Do, Di, tr_6) \cdot (M_5 + M_1) - S_{all_6}$

If S_{chk} equals zero for all cases, the routine is valid:

$$S_{chk} = \begin{pmatrix} -0 \\ -0 \\ -0 \\ 0 \\ -0 \\ -0 \end{pmatrix} psi$$

9. **Determine required thickness (tr_8) for hoop stress:**

$tr_8 := \frac{P \cdot Do}{2 \cdot (Sh + P \cdot 0.4)}$ $tr_8 = 0.035\,in$

10. **Since Equation 11 is governing relative to Equation 10 and, from a required wall thickness perspective, Equation 11 is less restrictive than Equation 10, the required thickness from Case 5 may be disregarded in lieu of the required thickness for Case 6:**

$tr_5 := if(tr_5 > tr_6, tr_6, tr_5)$ $tr_5 = 0.051\,in$ $tr_6 = 0.051\,in$

11. **The Controlling Thickness (t_{req}) is the Maximum Value of tr:**

$t_{req} := max(tr)$ $t_{req} = 0.051\,in$

N3-PA-091 ATTACHMENT A
Prepared By: WRBull 8/3/01 Checked By: W.D. Carney 8/3/01

THIS ROUTINE COMPUTES THE ALLOWABLE FLAW LENGTH PER DS-C1.2.8 USING THE ADJUSTED WALL THICKNESS (t_{adj}) IN AN ITERATIVE PROCESS. ADDITIONALLY, EACH SOLVE BLOCK HAS AN INDEPENDENT CHECKING ROUTINE TO ENSURE ANSWER VALIDITY.

User Defined Units of ksi

$ksi := 1000 \cdot \frac{lbf}{in^2}$

User Defined Input Nominal Pipe Size

$Do := 6.625 \cdot in$ $t_{nom} := 0.280 \cdot in$ 6 inch SCH 40

User Defined Input Material Properties

$E := 27.9 \cdot 10^6 \cdot \frac{lbf}{in^2}$ Modulus of Elasticity

$\mu := 0.3$ Poisson's Ratio

$J_{IC} := 45 \cdot \frac{lbf}{in}$ Fracture Toughness (Minimum Bounding Value From ASME Section XI)

User Defined Input Pressure (Design) and Moments

$p := 160 \cdot \frac{lbf}{in^2}$ Pressure

$Ma := 7999 \cdot in \cdot lbf$ Sustained Mechanical Moment (unintensified)

$Mbu := 10098 \cdot in \cdot lbf$ Upset Moment (unintensified)

$Mbf := 19950 \cdot in \cdot lbf$ Faulted Moment (unintensified)

$Mc := 47439 \cdot in \cdot lbf$ Thermal Expansion + Anchor Movement Moment (unintensified)

N3-PA-091 **ATTACHMENT A**

Prepared By: WRB/HL 8/3/01 **Checked By:** W. D. Carey 8/3/01

Define Functions For Cross Section Dimensions and Properties

$Rm(Do,t) \equiv \frac{Do}{2} - \frac{t}{2}$ Mean Radius

$Ri(Do,t) \equiv \frac{Do}{2} - t$ Inside Radius

$ROT(Do,t) \equiv \frac{Rm(Do,t)}{t}$ Rm / t Ratio

$Z(Do,t) \equiv \frac{\pi}{32} \cdot \frac{Do^4 - (Do - 2 \cdot t)^4}{Do}$ Section Modulus

Compute Expansion Stress

$Pe := \frac{Mc}{Z(Do, t_{nom})}$ $Pe = 5.584 \times 10^3 psi$

Define Functions for Coefficients in Circumferential Flaw Crack Stress Intensity Equation

$$Am(Do,t) \equiv -2.02917 + 1.67763 \cdot ROT(Do,t) - 0.07987 \cdot ROT(Do,t)^2 + 0.00176 \cdot ROT(Do,t)^3$$

$$Bm(Do,t) \equiv 7.09987 - 4.42394 \cdot ROT(Do,t) + 0.21036 \cdot ROT(Do,t)^2 - 0.00463 \cdot ROT(Do,t)^3$$

$$Cm(Do,t) \equiv 7.79661 + 5.16676 \cdot ROT(Do,t) - 0.24577 \cdot ROT(Do,t)^2 + 0.00541 \cdot ROT(Do,t)^3$$

$$Ab(Do,t) \equiv -3.26543 + 1.52784 \cdot ROT(Do,t) - 0.072698 \cdot ROT(Do,t)^2 + 0.0016011 \cdot ROT(Do,t)^3$$

$$Bb(Do,t) \equiv 11.36322 - 3.91412 \cdot ROT(Do,t) + 0.18619 \cdot ROT(Do,t)^2 - 0.004099 \cdot ROT(Do,t)^3$$

$$Cb(Do,t) \equiv -3.18609 + 3.84763 \cdot ROT(Do,t) - 0.18304 \cdot ROT(Do,t)^2 + 0.00403 \cdot ROT(Do,t)^3$$

$TOP(l,Do,t) \equiv \frac{1}{2 \cdot \pi \cdot Rm(Do,t)}$ θ over π Ratio

$$Fm(l,Do,t) \equiv 1 + Am(Do,t) \cdot TOP(l,Do,t)^{1.5} + Bm(Do,t) \cdot TOP(l,Do,t)^{2.5} + Cm(Do,t) \cdot TOP(l,Do,t)^{3.5}$$

$$Fb(l,Do,t) \equiv 1 + Ab(Do,t) \cdot TOP(l,Do,t)^{1.5} + Bb(Do,t) \cdot TOP(l,Do,t)^{2.5} + Cb(Do,t) \cdot TOP(l,Do,t)^{3.5}$$

N3-PA-091 **ATTACHMENT A**
Prepared By: WRB 8/3/01 **Checked By:** W. D. Carey 8/3/01

Compute Critical Fracture Toughness

$K_{IC} := \sqrt{\dfrac{J_{IC} \cdot E}{1 - \mu^2}}$ $K_{IC} = 37.144\,\mathrm{ksi}\cdot\sqrt{\mathrm{in}}$

User Defined Input Start Data to Start Iteration Process For Circumferential Flaws

$l_{guess} := 1 \cdot \mathrm{in}$ Initial Guess Value for Flaw Length (Assumed Initating Value)

$t_{adj} := 0.219 \cdot \mathrm{in}$ Input (Average Wall Thickness From NDE Data - 10% wear rate)

The following solve blocks are iterative processes to determine the through-wall flaw length that satisfies the crack stress intensity equation with the critical fracture toughness computed above Both upset and faulted conditions are considered.

Solve Block Iteration for Upset Condition

$SF_c := 2.77$ Safety Factor for Normal/Upset Conditions

Given

$$K_{IC} = SF_c \cdot \left[\frac{Fm(l_{guess}, Do, t_{adj}) \cdot p \cdot Ri(Do, t_{adj})^2}{2 \cdot Rm(Do, t_{adj}) \cdot t_{adj}} \ldots + Fb(l_{guess}, Do, t_{adj}) \cdot \left(\frac{Ma + Mbu}{\pi \cdot Rm(Do, t_{adj})^2 \cdot t_{adj}} + \frac{Pe}{SF_c} \right) \right] \cdot \sqrt{\frac{\pi \cdot l_{guess}}{2}}$$

Solve for Upset Condition Flaw Length

$lcu := \mathrm{Find}(l_{guess})$ $lcu = 2.233\,\mathrm{in}$

Check Upset Condition Crack Stress Intensity Using Flaw Length from Iteration

$$SF_c \cdot \left[\frac{Fm(lcu, Do, t_{adj}) \cdot p \cdot Ri(Do, t_{adj})^2}{2 \cdot Rm(Do, t_{adj}) \cdot t_{adj}} \ldots + Fb(lcu, Do, t_{adj}) \cdot \left(\frac{Ma + Mbu}{\pi \cdot Rm(Do, t_{adj})^2 \cdot t_{adj}} + \frac{Pe}{SF_c} \right) \right] \cdot \sqrt{\frac{\pi \cdot lcu}{2}} = 37.144\,\mathrm{ksi}\cdot\sqrt{\mathrm{in}}$$

Prepared By: WRB 8/3/01 **Checked By:** W. D. Carson 8/3/01

Solve Block Iteration for Faulted Condition

$SF_e := 1.39$ Safety Factor for Emergency/Faulted Conditions

Given

$$K_{IC} = SF_e \cdot \left[\frac{Fm(l_{guess}, Do, t_{adj}) \cdot p \cdot Ri(Do, t_{adj})^2}{2 \cdot Rm(Do, t_{adj}) \cdot t_{adj}} \ldots + Fb(l_{guess}, Do, t_{adj}) \cdot \left(\frac{Ma + Mbf}{\pi \cdot Rm(Do, t_{adj})^2 \cdot t_{adj}} + \frac{Pe}{SF_e} \right) \right] \cdot \sqrt{\frac{\pi \cdot l_{guess}}{2}}$$

Solve for Faulted Condition Flaw Length

$lcf := Find(l_{guess})$ $lcf = 2.955\,in$

Check Faulted Condition Crack Stress Intensity Using Flaw Length from Iteration

$$SF_e \cdot \left[\frac{Fm(lcf, Do, t_{adj}) \cdot p \cdot Ri(Do, t_{adj})^2}{2 \cdot Rm(Do, t_{adj}) \cdot t_{adj}} \ldots + Fb(lcf, Do, t_{adj}) \cdot \left(\frac{Ma + Mbf}{\pi \cdot Rm(Do, t_{adj})^2 \cdot t_{adj}} + \frac{Pe}{SF_e} \right) \right] \cdot \sqrt{\frac{\pi \cdot lcf}{2}} = 37.144\,ksi \cdot \sqrt{in}$$

Find Controlling Circumferential Length for All Conditions

$lc := if(lcf \geq lcu, lcu, lcf)$ $lc = 2.233\,in$

Note that this is the maximum circumferential length over which remaining thickness can be less than t_{adj}.

Prepared By: WRB [signature] 8/3/01 Checked By: W. D. Carroy 8/3/01

Define Functions for Coefficients in Axial Flaw Crack Stress Intensity Equation

$$\lambda(l, Do, t) \equiv \frac{1}{2\cdot\sqrt{Rm(Do,t)\cdot t}}$$

$$F(l, Do, t) \equiv 1 + 0.072449\cdot\lambda(l,Do,t) + 0.64856\cdot\lambda(l,Do,t)^2 - 0.2327\cdot\lambda(l,Do,t)^3 + 0.038154\cdot\lambda(l,Do,t)^4 + (-0.0023487)\cdot\lambda(l,Do,t)^5$$

Solve Block Iteration

$SF_a := 3.0$ Safety Factor for Normal/Upset Conditions

Given

$$K_{IC} = \frac{SF_a\cdot F(l_{guess}, Do, t_{adj})\cdot p\cdot Rm(Do,t_{adj})}{t_{adj}}\cdot\sqrt{\frac{\pi\cdot l_{guess}}{2}}$$

Solve for Flaw Length

$la := Find(l_{guess})$ $la = 3.231\,in$

Check Crack Stress Intensity Using Axial Flaw Length from Iteration

$$\frac{SF_a\cdot F(la, Do, t_{adj})\cdot p\cdot Rm(Do,t_{adj})}{t_{adj}}\cdot\sqrt{\frac{\pi\cdot la}{2}} = 37.144\,ksi\cdot\sqrt{in}$$

N3-PA-091 **ATTACHMENT A**

Prepared By: WRB WM 8/3/01 **Checked By:** W. D. Carey 8/3/01

Verify t_{adj} Meets Stress Criteria

User Defined Input Stress Data

$Sc := 15000 \cdot \frac{lbf}{in^2}$ Allowable Stress at Minimum Temperature

$Sh := 15000 \cdot \frac{lbf}{in^2}$ Allowable Stress at Maximum Temperature

$i := 1.00$ SIF included in Moments

Compute Stresses

$$\sigma_{hoop} := \frac{p \cdot Do}{2 \cdot t_{adj}} + 0.4 \cdot p \qquad \sigma_{hoop} = 2.484\,ksi$$

$$\sigma_8 := \frac{p \cdot Ri(Do, t_{adj})^2}{\left[\left(\frac{Do}{2}\right)^2 - Ri(Do, t_{adj})^2\right]} + \frac{if(.75 \cdot i \le 1.0, 1.0, 0.75 \cdot i) \cdot Ma}{Z(Do, t_{adj})} \qquad \sigma_8 = 2.262\,ksi$$

$$\sigma_{9u} := \frac{p \cdot Ri(Do, t_{adj})^2}{\left[\left(\frac{Do}{2}\right)^2 - Ri(Do, t_{adj})^2\right]} + \frac{if(.75 \cdot i \le 1.0, 1.0, 0.75 \cdot i) \cdot (Ma + Mbu)}{Z(Do, t_{adj})} \qquad \sigma_{9u} = 3.74\,ksi$$

$$\sigma_{9f} := \frac{p \cdot Ri(Do, t_{adj})^2}{\left[\left(\frac{Do}{2}\right)^2 - Ri(Do, t_{adj})^2\right]} + \frac{if(.75 \cdot i \le 1.0, 1.0, 0.75 \cdot i) \cdot (Ma + Mbf)}{Z(Do, t_{adj})} \qquad \sigma_{9f} = 5.182\,ksi$$

$$\sigma_{11} := \frac{p \cdot Ri(Do, t_{adj})^2}{\left[\left(\frac{Do}{2}\right)^2 - Ri(Do, t_{adj})^2\right]} + \frac{if(.75 \cdot i \le 1.0, 1.0, 0.75 \cdot i) \cdot Ma + i \cdot Mc}{Z(Do, t_{adj})} \qquad \sigma_{11} = 9.205\,ksi$$

Compute Stress Ratios

$S_1 := \frac{\sigma_{hoop}}{Sh}$ $S_1 = 0.166$

$S_2 := \frac{\sigma_8}{Sh}$ $S_2 = 0.151$

$S_3 := \frac{\sigma_{9u}}{1.2 \cdot Sh}$ $S_3 = 0.208$

$S_4 := \frac{\sigma_{9f}}{2.4 \cdot Sh}$ $S_4 = 0.144$

$S_5 := \frac{\sigma_{11}}{1.25 \cdot (Sc + Sh)}$ $S_5 = 0.245$

$S_{max} := \max(S)$ $S_{max} = 0.245$ < 1.0, Therefore i_{adj} OK

N3-PA-091 Attachment A To H.103

WALL THINNING MONITORING PROGRAM
FOR MIC AND GENERAL CORROSION
Page 1 of 1
TECHNICAL EVALUATION OF DEGRADED PIPING

If wall loss exceeds acceptance criteria or a through wall leak is detected, and if piping is located in seismic Category I structures, then, SE-Mechanical/Nuclear will transmit UT data to Civil Engineering requesting analysis of the piping at the specific loading condition.
Please evaluate the attached UT data for the ~~ECRU~~ leak upstream of 0-ISV-067-528B. This is part of PER 01-012757-000 and WO 01-012752-000. ERCW sdf 7/30/2001

Transmitted By: Ed Loope [signature] SE-Mechanical/Nuclear Date: 07/30/2001

RIMS Number N/A

Civil Engineering will transmit a copy of the affected pages from the calculation with the results for the identified component to SE-Mechanical/Nuclear.

Transmitted By: WR BIBB / WRBibb SE-Civil Date: 8/3/01

N/A RIMS Number

N3-PA-091 Calculation Number

SEE ATTACHED ACCEPTANCE CRITERIA FOR FUTURE USE

If wall loss exceeds acceptance criteria or if a through wall leak is detected, and if the piping is located in a building other than a seismic Category I structure, THEN SE-Mechanical/Nuclear will evaluate structural integrity of piping.

INFORMATION ONLY

SE-Mechanical/Nuclear Date:

If analysis cannot establish the structural integrity of the piping, then, SE-Mechanical/Nuclear will initiate a PER in accordance with SPP-3.1.

PER Number Date:

SE-Mechanical/Nuclear

N3-PA-091 Attachment A Pg A.106

TENNESSEE VALLEY AUTHORITY	DMS ULTRASONIC CALIBRATION DATA SHEET	CALIBRATION REPORT NO. BOP-R-544

PROJECT: WBN UNIT: 2
PROC.: N-UT- 26 REV./T.C.: 19/N/A

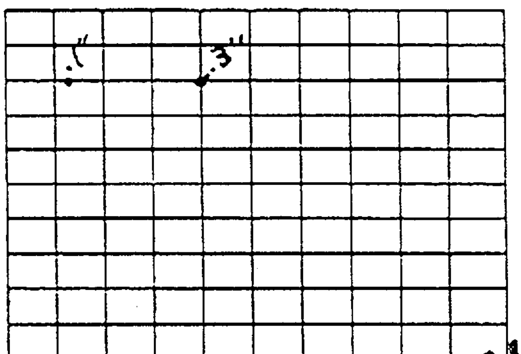
CALIBRATION DATE 7/30/01
CAL BLOCK NO.: 94-5525
TYPE: .5" C/S STEP
CAL BLK. TEMP.: 72F
THERMOMETER S/N: 558273
THERM. CAL DUE DATE: 12/13/01
COUPLANT: ULTRAGEL II
BATCH NO. 00125

INSTRUMENT / TRANSDUCER DATA

INSTRUMENT MANUF.: KBA
SERIAL NO.: E21198 DUE DATE: 12/12/01
TRANSDUCER MANUF.: KBA
SERIAL NO.: 006X1C
SIZE: .38" FREQ.: 8 mhz
CABLE TYPE FIXED LENGTH 72"

INSTRUMENT SETTINGS

PROBE: FH2E
THICK CAL.: 1PT ☐ 2PT ☒
RANGE .75 inches
VELOCITY: .2313 in./uS
GAIN M ☒ D ☐
TCG MODE: SINGLE ☐ DUAL ☒
RECTIFY: POSITIVE ☐ NEGATIVE ☒ FULL ☐
AMPLITUDE: NORMAL ☒ SCALE ☐



AMPLITUDE

DISPLAY WIDTH .75 inches

INFORMATION ONLY

CALIBRATION TIMES

INITIAL CAL TIME: 1000

VERIFICATION TIMES

1) 1030	2)	3)	4)
5)	6)	7)	8)

FINAL CAL TIME: 1100

(1)
REF. REFLECTOR .1" STEP GAIN 70 dB
AMPL [illegible] % METAL PATH: .1 inches

(2)
REF. REFLECTOR .3" STEP GAIN 70 dB
AMPL 80 % METAL PATH: .3 inches

COMPN./GRID(S) EXAMINED	TEMP
PIPING AROUND	70 F
LEAK UPSTREAM	
OF	
0-ISV-067-0528B	

COMMENTS: W.O. 01-012752-000
TOOK READINGS ON SIMULATED
2 " GRID PATTERN 12" UP AND
DOWNSTREAM OF LEAK. (SEE ATTACHED)
REF. PER 01-012757

EXAMINER: [signature] Lvl. II
EXAMINER: N/A Lvl. N/A
REVIEWER: [signature] Lvl. II

ANII: N/A
DATE: N/A

PAGE 1 of 7

[v7.6] ENTERPRISE MPAC - [Work Order 01-012752-000]

File Edit Details Services Links Modules Window Help

01-012752-000

Work Order	01-012752-000	WO Status	PL-To Planning for assignm
Work Request		Department	OPS
		Planner/SUPV	COLLINS, DENNIS
Work Desc	THRU WALL PIPE LEAK - JUST UP STREAM OF VALVE (LOCATED ABOVE U-2 TERRY TURBINE RM) DO NOT INVESTIGATE OR PROBE LEAK WITHOUT OPS		
Problem Desc	THRU WALL PIPE LEAK - JUST UP STREAM OF VALVE (LOCATED ABOVE U-2 TER		
UNID	WBN-0-ISV -067-0528B -B	Category	000000
Asset No	000000000145107	Revision	3
Asset Desc	ERCW FLOOD MODE RET HDR B ISOL		
Location	692A14V		
Asset Status		Initiated By	HAMAN
WO Print Type	RT - Routine WO	Phone No	365-8213
Shutdown	Undetermined	Repair Tag No	
Position		WO Priority	Routine Pri (<7 Days)
Comp Trace		Date Required	07/28/2001
Comp UIC		Parts Due	

Ready

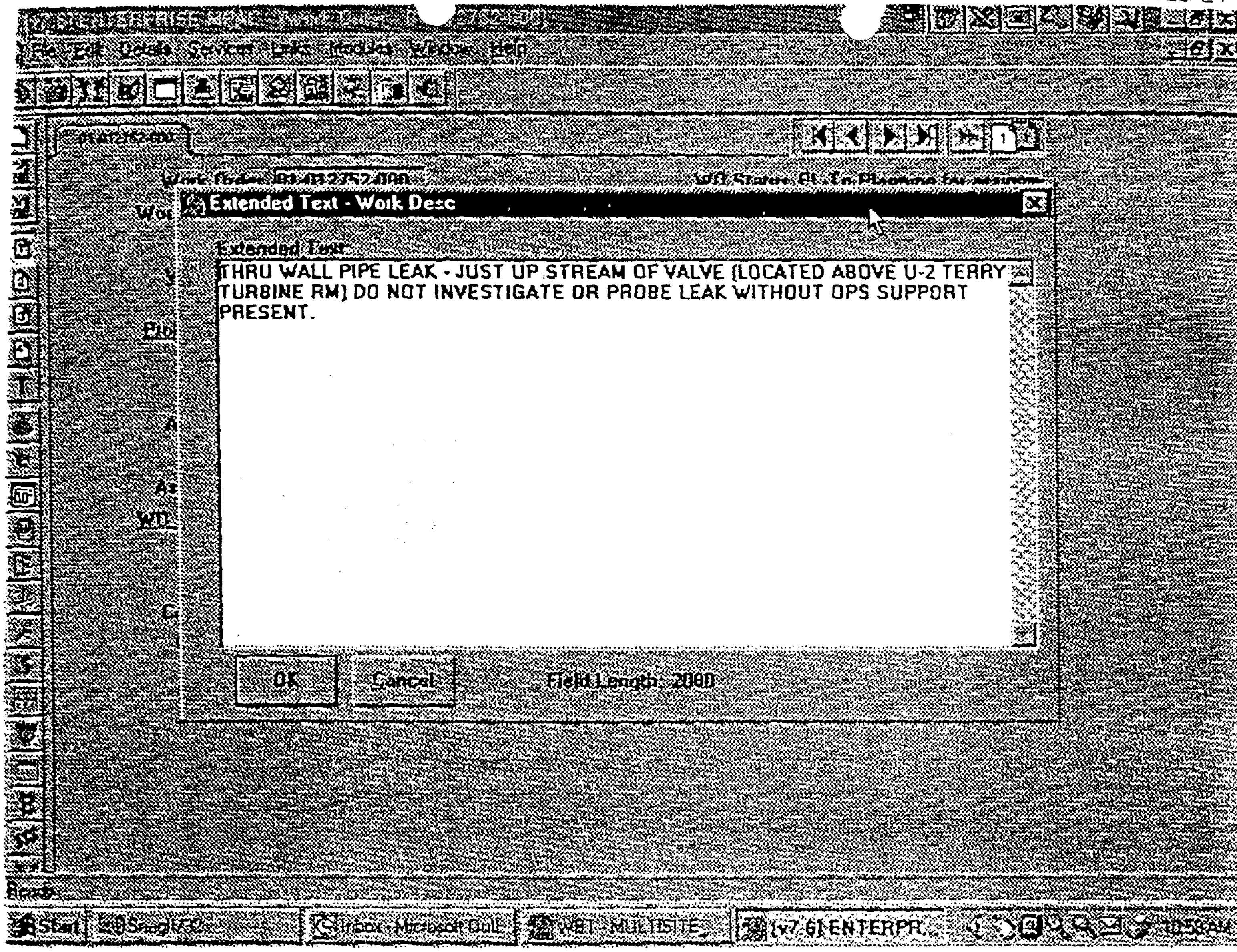
Start | SnagIt/32 | Inbox - Microsoft | WBT - MULTISI | [v7.6] ENTE... | 10:56AM

INFORMATION ONLY

Pg A.107

2 of 7

N3-PA-091



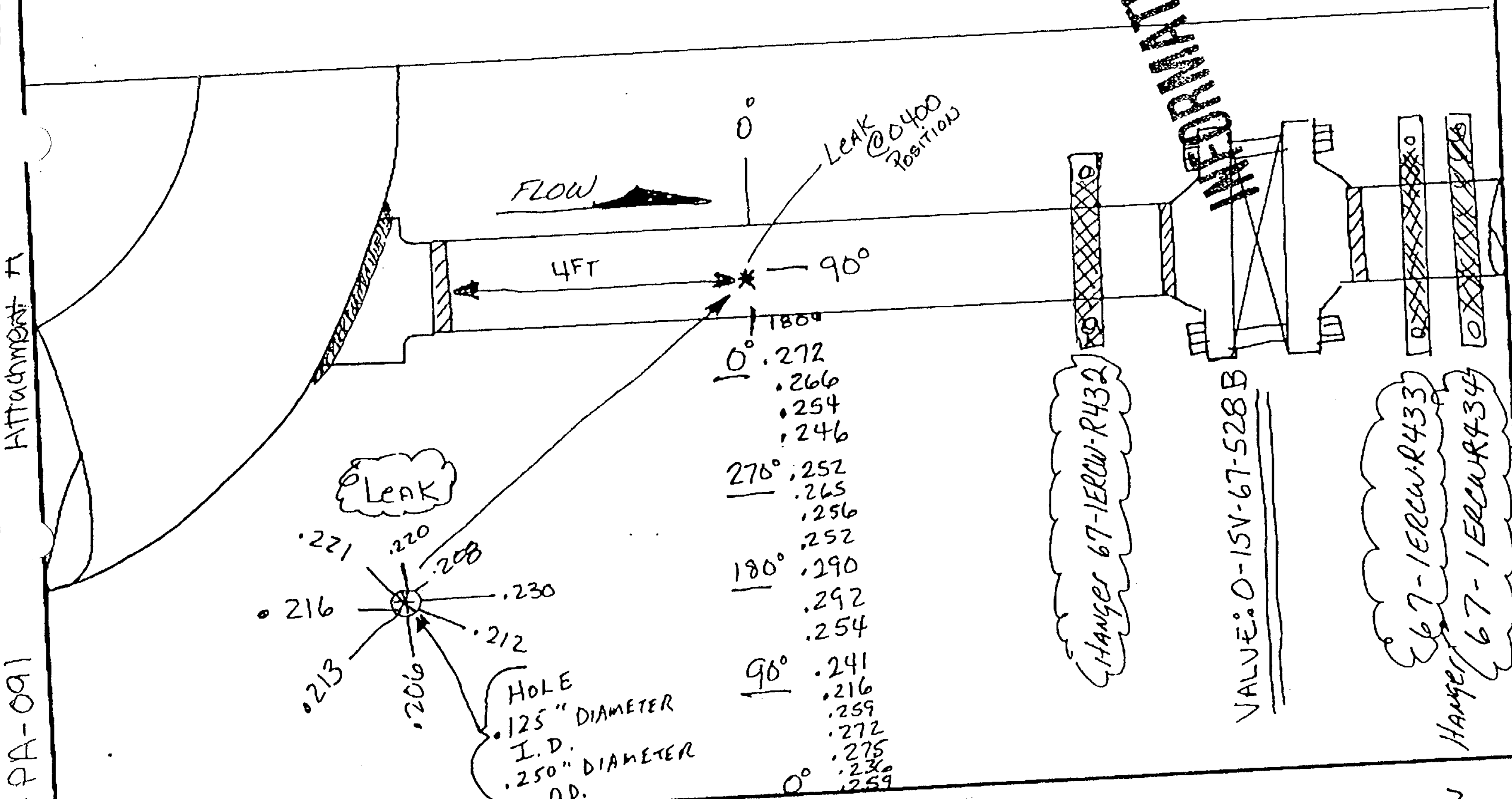
INFORMATION ONLY

Attachment H

N3-PA-001

TVA Office of Nuclear Power	**PROJECT:** Watts Bar **SYSTEM:** 067 **Unit:** 2 **WELD NO.:** Piping	**REPORT NO.:** BOP-R 544

INFORMATION ONLY



BY: [signature] **LEVEL:** II **DATE:** 7-30-01 **PAGE** 4 **OF** 7

N3-PA-091 Attachment A Pg A.110

-----------------------------File Header-----------------------------

P.C. File Name :			BOP-544.utm
Gauge File Name :			ERCW 2 528B
Description :			
Creation Date :			07/30/2001
Date Last Saved :			07/30/2001
Probe :		Cal. Stnd. :	
Inspector :		Company :	
Instrument Type :	DMS	Instrument S.N. :	00700419
Min. Alarm Val. :	0.000	Max. Alarm Val. :	0.000
% Loss Alarm Val. :	0.00	% Growth Alarm Val. :	0.00
Abs. Loss Alarm Val. :	0.000	Abs. Growth Alarm Val. :	0.000
Units :	INCH	Velocity (in/us) :	0.2313

---------------------------File Statistics---------------------------

Number of Readings :	216	Number of Empties :	0
Number of Obstructs :	0	Number of Ascans :	0
Range :	0.117	Mean :	0.258
Median :	0.260	Standard Deviation :	0.018
Minimum Value :	0.201		
Minimum Value Loc. :	4 : J : 1		
Maximum Value :	0.318		
Maximum Value Loc. :	5 : B : 1		
Minimum Value Alarms :	0	Maximum Value Alarms :	0
Percent Loss Alarms :	0	Percent Growth Alarms :	0
Absolute Loss Alarms :	0	Absolute Growth Alarms :	0
% and Abs. Loss Alarms :	0	% and Abs. Growth Alarms:	0

---------------------------File Comments---------------------------

A :	I :
B :	J :
C :	K :
D :	L :
E :	M :
F :	N :
G :	O :
H :	P :

INFORMATION ONLY

r 17

N3-PA-091 Attachment A Pg A.111

BOP-544.utm

	A	B	C	D	E	F	G	H	I	J
1	0.261	0.270	0.242	0.284	0.283	0.267	0.281	0.267	0.244	0.232
2	0.271	0.280	0.249	0.271	0.290	0.273	0.272	0.246	0.244	0.226
3	0.266	0.295	0.225	0.259	0.286	0.277	0.278	0.247	0.245	0.241
4	0.241	0.295	0.231	0.240	0.259	0.276	0.289	0.238	0.270	0.201
5	0.267	0.318	0.262	0.263	0.270	0.276	0.288	0.260	0.256	0.226
6	0.236	0.285	0.244	0.221	0.265	0.289	0.289	0.252	0.255	0.264
7	0.270	0.300	0.233	0.253	0.281	0.281	0.292	0.246	0.255	0.221
8	0.265	0.291	0.232	0.230	0.235	0.275	0.287	0.255	0.246	0.250
9	0.278	0.277	0.213	0.202	0.246	0.272	0.270	0.229	0.246	0.256
10	0.284	0.249	0.228	0.254	0.231	0.276	0.266	0.255	0.256	0.229
11	0.281	0.250	0.223	0.254	0.254	0.275	0.271	0.260	0.265	0.244
12	0.281	0.227	0.211	0.238	0.276	0.242	0.286	0.253	0.262	0.239

Point 6 is area
of leak
WRBell 7/31/01

INFORMATION ONLY

N3-PA-091 Attachment A Pg A.112

BOP-544.utm

	K	L	M	N	O	P	Q	R
1	0.251	0.233	0.260	0.281	0.270	0.259	.0.268	0.250
2	0.248	0.241	0.262	0.251	0.269	0.247	0.254	0.252
3	0.249	0.246	0.250	0.255	0.259	0.267	0.265	0.260
4	0.244	0.259	0.261	0.256	0.238	0.264	0.265	0.245
5	0.255	0.251	0.265	0.237	0.246	0.275	0.246	0.251
6	0.259	0.251	0.253	0.271	0.262	0.268	0.264	0.237
7	0.262	0.246	0.260	0.241	0.256	0.255	0.243	0.238
8	0.261	0.255	0.271	0.252	0.253	0.246	0.246	0.261
9	0.265	0.272	0.265	0.252	0.265	0.242	0.267	0.248
10	0.278	0.283	0.259	0.271	0.245	0.257	0.269	0.285
11	0.272	0.275	0.262	0.253	0.271	0.282	0.259	0.274
12	0.266	0.257	0.253	0.268	0.250	0.283	0.265	0.263

INFORMATION ONLY