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FRAMATOME TECHNOLOGIES

CALCULATION SUMMARY SHEET (CSS)

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TITLE Oconee-2 S/G-A Weld WG58-1 Flaw Evaluation

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PURPOSE AND SUMMARY OF RESULTS:

A subsurface flaw indication has been detected at Oconee Unit 2 Steam Generator A in the WG58-1 upper head-to-tubesheet weld WG58-1. A fracture mechanics assessment is performed according to the rules of the ASME Boiler and Pressure Vessel Code, Section XI, Paragraph IWB-3600, pertaining to analytical evaluation.

The initial 56" long, 0.8" deep circumferential flaw, located virtually halfway through the upper head wall, grew to a flaw depth of 0.8002" during 420 simulated heatup/cooldown and reactor trip loading cycles. Fracture toughness margins at the final flaw size are listed below for the worst case normal/upset loading condition (heatup) and for two emergency/faulted loading conditions. Additional results are presented in Section 9.0.

Fracture toughness margins at the final flaw size (must be greater than 1):

Crack Tip Location	Heatup	LOCA	FWLB
Point 1	5.13	505.	15.5
Point 2	5.90	29.3	12.3

THE FOLLOWING COMPUTER CODES HAVE BEEN USED IN THIS DOCUMENT:

CODE/VERSION/REV	CODE/VERSION/REV

THIS DOCUMENT CONTAINS ASSUMPTIONS THAT MUST BE VERIFIED PRIOR TO USE ON SAFETY-RELATED WORK

○ YES ☑ NO

RECORD OF REVISIONS

Revision	Pages	Description	Date
0	All	Original issue	5/96

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LIST OF FIGURES

1.0 Introduction

A subsurface flaw indication has been detected at Oconee Unit 2 in the WG58-1 upper head-to-tubesheet weld in Steam Generator A. Duke Power Company personnel performed a flaw size evaluation to the acceptance standards of ASME Code, Section XI, IWB-3500 [1], as reported in Appendix B, and found the indication to be rejectable. The purpose of the present analysis is to perform a fracture mechanics assessment according to the rules of ASME Code, Section XI, IWB-3600 [1] for an analytical evaluation. The subsurface flaw indication will be evaluated using available normal/upset and emergency/faulted condition stresses. Fracture toughness margins will be calculated and compared with ASME Code, Section XI, IWB-3612 acceptance criteria for applied stress intensity factors, considering the potential for fatigue flaw growth.

2.0 Assumptions

Listed below are assumptions that are pertinent to the present fracture mechanics evaluation.

1. A conservativly high value of 600 °F is assumed for the hot leg temperature in the area of the upper head-to-tubesheet weld. This temperature is utilized to determine the material yield strength used in calculating the flaw shape parameter Q, which decreases with decreasing yield strength. The conservatism inherent in this assumption arises from the stress intensity factor being inversely proportional to flaw shape parameter.

2. A value of 325 °F is assumed for the crack tip temperature to determine fracture toughness values from ASME Code, Section XI, Appendix A [1]. This is a conservatively low value equal to the LTOP enable temperature [13].

3.0 Geometry of the Upper Head-to-Tubesheet Weld and Indicated Flaw

The area of interest is the upper head-to-tubesheet weld (WG58-1), as depicted in Fig. 1. Included in Fig. 1 is a representation of the subsurface flaw indication looking into a longitudinal, or meridional, section of the steam generator upper head. As depicted in the DPCo Indication Evaluation Report, Appendix B, the indication lies along the circumferential direction, with a length (l) equal to 56". Discussions with the DPCo UT inspector who authored the Appendix B report revealed that the end view illustration depicts only one-half of the indication, and that the indication actually extends an additional 0.2" towards each surface. Thus for analytical purposes, the flaw depth (a) is 0.4", or 2a = 0.8". Also included in Appendix B is the actual thickness of the upper head (t = 8.5"). Other pertinent data from Appendix B is used to derive the distance to the nearest surface dimension (S) and the eccentricity of the flaw (e), as shown in Fig. 1.

Although an assessment of the accuracy of the UT measurements could not be obtained to support the present evaluation, an indication of the sensitivity of the fracture mechanics results to flaw size will be demonstrated by performing calculations for assumed flaw depths up to twice the reported depth.

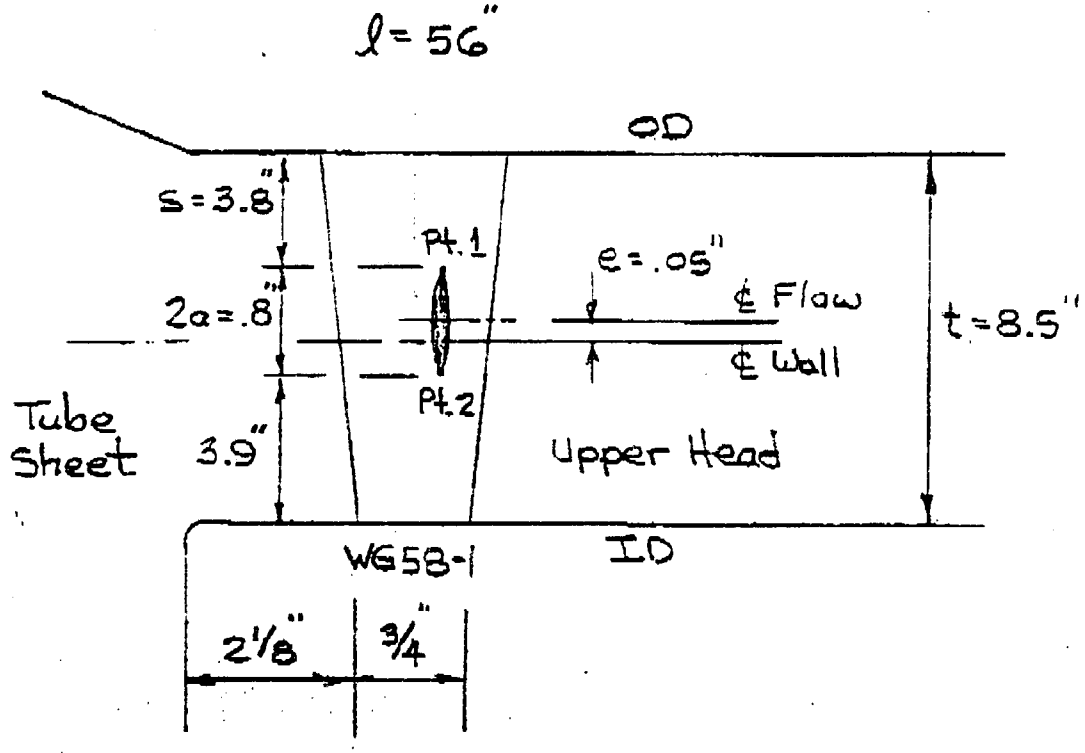


Fig. 1 Geometry of the Upper Head-to-Tubesheet Weld and Indicated Flaw

4.0 Material Properties

The components of interest for the evaluation of the flaw indication in weld WG58-1 are the steam generator upper head and tubesheet. The head is formed from SA-302, Gr-B Mn-$^1/_2$Mo carbon steel plate material [2], and the tubesheet is a carbon steel forging made from A-508-64, Cl-2 material [2]. From ASME Code, Section III, Appendix I [3], the minimum yield strength for these two materials is 50 ksi at room temperature, and 43.8 ksi at 600 °F.

The weld metal where the flaw indication is located is a Mn-Mo-Ni submerged-arc/Linde 80 flux weld. In Ref. 5, a summary table of RTNDT values for all materials is provided. The highest measured RTNDT valuse is 60F. This value was selected for this analysis.

Fracture Toughness

Lower bound fracture toughness curves from ASME Code, Section XI, Fig. A-4200-1 [1] will be used for the weld material. These curves are specified for use with SA-533, Gr-B, Cl-1 and SA-508, Cl-2 materials, but are not specifically designated for use with SA-302, Gr-B material. Since the nominal compositions of SA-302, Gr-B Mn-$^1/_2$Mo and SA-533, Gr-B, Cl-1 Mn-$^1/_2$Mo-$^1/_2$Ni plate materials are similar, these curves should be applicable to the weld between the upper head and tubesheet materials. These curves can be described by the following relationships [4]:

$$K_{Ia} = 26.8 + 1.233 \exp [0.0145 (T - RT_{NDT} + 160\ ^\circ F)]$$

$$K_{Ic} = 33.2 + 2.806 \exp [0.02 (T - RT_{NDT} + 100\ ^\circ F)],$$

where K_{Ia} and K_{Ic} are fracture toughness values for crack arrest and fracture initiation, respectively, T is the crack tip temperature, and RT_{NDT} is the reference nil-ductility temperature. K_{Ia} and K_{Ic} are expressed in terms of ksi$\sqrt{in}$, and T and RT_{NDT} are in °F. Fracture toughness will be limited to an upper shelf, or cut-off value, of 200 ksi$\sqrt{in}$, as indicated by the ASME Code curves.

Table 3-1 of the B&W Owners Group report [5] on fracture mechanics methodology recommends an RT_{NDT} of 60 °F for SA-508, Cl-2 forging materials. This value will be used in the present evaluation for the WG58-1 weld material. As demonstrated later in this analysis, the critical loading condition is heatup to operating temperature. For an assumed crack tip temperature of 325 °F, fracture toughness values are determined to be:

$$K_{Ia} = 200 \text{ ksi}\sqrt{in}$$

$$K_{Ic} = 200 \text{ ksi}\sqrt{in}$$

Fatigue Flaw Growth

Flaw growth due to cyclic loading is calculated using the fatigue crack growth rate model from Article A-4000 of Section XI of the ASME Code [1],

$$\frac{da}{dN} = C(\Delta K)^n ,$$

where ΔK is the range of applied stress intensity factor in terms of ksi$\sqrt{in}$, da/dN is in terms of inches/cycle, and the constants C and n are obtained from Fig. A-4300-1 [1] for a subsurface flaw in an air environment, as follows:

$$C = 2.67 \times 10^{-11}$$
$$n = 3.726$$

5.0 Fracture Mechanics Methodology

The subsurface flaw indication will be analyzed using the stress intensity factor equation of ASME Code, Section XI, Appendix A [1]:

$$K_I = (\sigma_m M_m + \sigma_b M_b)\sqrt{\frac{\pi a}{Q}} ,$$

where

σm	=	membrane stress, ksi,
σb	=	bending stress, ksi,
a	=	minor half-diameter, in.
Q	=	flaw shape parameter,
M_m	=	correction factor for membrane stress,
M_b	=	correction factor for bending stress.

The flaw shape parameter, shown graphically in Fig. A-3300-1 [1], may also be described by [12]:

$$Q = 1 + 4.593(a/l)^{1.65} - 0.212(\sigma/\sigma_y)^2$$

where σ is conservatively taken as the sum of the absolute values of the membrane and bending stresses, and σ_y is the material yield strength. The ratio σ/σ_y is not allowed to exceed unity.

Although the M_m and M_b membrane and bending correction factors are available from Figs. A-3300-2 and A-3300-4 [1], polynomial forms of the ASME Code curves, as derived by Cipolla [6], will be used in the present evaluation.

6.0 Loading Conditions

Loading conditions that contribute to stress in the upper head-to-tubesheet weld are the normal and upset transients listed below from the steam generator stress report [7] and a loss of coolant accident (LOCA), a feedwater line break (FWLB), and a main steam line break (MSLB) described in Ref. [8].

Normal and Upset Transients with Number of Cycles from Ref. [14]

- Heatup from 70 °F to 15% power and cooldown from 15% power to 150 °F (360 cycles)
- Loading from 15% to 100% power and unloading from 100% to 15% power (36000 cycles)
- Step load increase and decrease (16000 cycles)
- Step load reduction to auxiliary load (310 cycles)
- Reactor trip (60 cycles)
- Rapid depressurization (40 cycles)
- Change of flow (412 cycles)
- Rod withdrawal (40 cycles)
- Turbine trip (cycles included in step load reduction cycles above)
- Loss of station power (40 cycles)
- OBE seismic (650 cycles)

Of the above listed transients, only the heatup/cooldown and 15%-100%-15% loading/unloading transients were deemed significant enough for analysis in the stress report [7]. The loading/unloading transient was analyzed in the stress report because of a high number of design cycles (36,000), even though the resulting stresses are small and contributed insignificantly to cumulative fatigue damage. This seems reasonable since the temperature differential for this transient is only about 50 °F as opposed to about 500 °F for the heatup/cooldown transient. Accordingly, the 15%-100%-15% loading/unloading transient is not included in the present fracture mechanics evaluation. The reactor trip transient is addressed, however, by adding its 60 design cycles to the 360 design cycles of the heatup/cooldown transient, for a total of 420 heatup/cooldown cycles.

Analyzed Transients

- Heatup from 70 °F to 15% power and cooldown from 15% power to 150 °F (420 lumped cycles from heatup/cooldown plus reactor trip)

Concerning emergency and faulted conditions, a FWLB bounds a MSLB in the area of the upper head-to-tubesheet weld [8]. Thus emergency/faulted condition stresses are included for both the LOCA and FWLB postulated events.

Consideration of residual stresses is warranted since the analyzed flaw is located in a structural weld. Welding processes generate residual stresses within the welded zone. Subsequent heat treatment reduces the severity of the residual stress levels although complete relief is not

possible. Several attempts have been made to evaluate levels of residual stresses in welded structures. Residual stresses are self-equilibrating across any thickness. However, residual stresses are treated conservatively as having a fixed stress distribution for analysis. Framatome Technologies developed residual stress distribution models [9] based on the work of Ferrill, et. al. [10]. For the case of a circumferential single J-groove weld, the normalized residual stress distribution, σ_y, takes the form

$$\sigma_r/\sigma_y = -0.06 + 0.18(x/t)^2 .$$

Near the center of the wall thickness, t, where the WG58-1 flaw indication is located, the residual stress from this distribution is small or negative. Residual stresses need not, therefore, be considered in the present flaw evaluation.

7.0 Acceptance Criteria

A flaw is acceptable if the applied stress intensity factor satisfies the following criteria from Paragraph IWB-3612 of Section XI of the ASME Boiler and Pressure Vessel Code [1]:

For normal and upset conditions:

$$K_I(a_f) < \frac{K_{Ia}}{\sqrt{10}}$$

For emergency and faulted conditions:

$$K_I(a_f) < \frac{K_{Ic}}{\sqrt{2}}$$

where:

$K_I(a_f)$ = the maximum applied stress intensity factor for the final flaw depth,

K_{Ia} = crack arrest fracture toughness at temperature, and

K_{Ic} = crack initiation fracture toughness at temperature.

Per ASME Code, Section XI, IWB-3610(d)(2) [1], the potential for net section collapse must be analyzed as a separate evaluation condition. This requirement is satisfied by inspection since the associated flaw area is insignificant with respect to the ~~toal~~ total cross-sectional area.

8.0 Analytical Procedure

The upper head-to-tubesheet weld flaw indication will be evaluated by linear elastic fracture mechanics according to the following analytical procedure:

1. Establish an initial flaw depth, a, and eccentricity, e.

2. From curve fits of through-wall stress distributions for normal/upset [11] and emergengy/faulted [8] condition loadings, determine stresses at the two crack tips of the subsurface flaw (Points 1 and 2 in Fig. 1). Develop membrane and bending stress components from these crack tip stresses for each loading condition.

3. Calculate a stress intensity factors, K_I, for the cyclic membrane and bending stresses,

4. Calculate a flaw depth increment, da, and eccentricity increment, de, for twenty heatup/cooldown cycles (dN=20) using the fatigue flaw growth relationship of Section 4.0 by first calculating the growth at Points 1 and 2, daPt1 and daPt2, followed by:

$$da = (daPt1 + daPt2)/2$$
$$de = (daPt1 - daPt2)/2$$

5. Calculate an updated flaw depth, a, and eccentricity, e, from

$$da = a + da$$
$$de = e + de$$

6. Repeat Steps 3 through 5 for all applied load cycles.

7. Calculate normal/upset and emergency/faulted fracture toughness margins, K_I/K_{Ia} and K_I/K_{Ic}, for the final flaw size and compare with the acceptance criteria of Section 7.0.

The analytical procedure outlined above has been implemented in a spreadsheet (Appendix A). Numerical results are also summarized in Section 9.0.

9.0 Summary of Results

A subsurface flaw indication in upper head-to-tubesheet weld WG58-1 at Oconee-2 S/G-A was evaluated according to Section XI, Paragraph IWB-3600 requirements of the ASME Boiler and Pressure Vessel Code [1].

The initial 56" long, 0.8" deep circumferential flaw, located virtually halfway through the upper head wall, grew to a flaw depth of 0.8002" during 420 simulated heatup/cooldown and reactor trip loading cycles. Fracture toughness margins at the final flaw size are tabulated below for the worst case normal/upset loading condition (heatup) and for two emergency/faulted loading conditions.

Fracture Toughness Margins at Final Flaw Size (must be greater than 1)			
Crack Tip Location	$K_{Ia}/\sqrt{10} / K_I$	$K_{Ic}/\sqrt{2} / K_I$	
	Heatup	LOCA	FWLB
Point 1	5.13	505	15.5
Point 2	5.90	29.3	12.3

As a check on sensitivity of these fracture mechanics results to the initial flaw size, additional calculations were performed for 1.2" and 1.6" deep flaws, using the same membrane and bending stresses developed for the more shallow flaw. Although these linearized stresses only appropximate for the new flaw sizes considered, the following results for the critical heatup/cooldown fracture toughness margin show that considerable safety margins exist for larger flaw sizes.

Fracture Toughness Margins for Heatup Loads with Increasing Initial Flaw Size	
Initial Flaw Depth (2a)	$K_{Ia}/\sqrt{10} / K_I$
0.8"	5.13
1.2"	4.05
1.6"	3.38

Conclusion

The Oconee-2 S/G-A WG58-1 flaw indication is considered to be acceptable for the postulated design life of the plant based on ASME Code Section XI rules for evaluation by analysis.

10.0 References

1. ASME Boiler and Pressure Vessel Code, Section XI, 1989 Edition.

2. B&W Dwg. 146454E6, "List of Material," Oconee-2.

3. ASME Boiler and Pressure Vessel Code, Section III, Division 1, Appendices, 1989 Edition.

4. Marston, T.U., Flaw Evaluation Procedures: ASME Section XI, EPRI Report NP-719-SR, Electric Power Research Institute, Palo Alto, California, August 1978.

5. BAW-10046A, Rev. 2, "Methods of Compliance With Fracture Toughness and Operational Requirements of 10 CFR 50, Appendix G," B&W Owners Group Materials Committee Topical Report, June 1986.

6. Cipolla, R.C., FAA-EPRI-75-4-3, April 1975.

7. Duke Power Company Stress Report for Oconee Units 1&2 Steam Generator, (FTI Microfilm Roll Nos. 80-7 and 80-8).

8. B&W Calc. Pkg. 32-1173627-00, "ANO-1 OTSG Flaw Evaluation," November 1988.

9. BAW-1605, "Accident Transients Fracture Analysis for 177-FA Reactor Vessel Beltline Region," January 1980.

10. Ferrill, D.A., Juhl, P.B., and Miller, D.R., "Measurement of Residual Stresses in a Heavy Weldment," Welding Journal, WRC Supplement, Vol. 45, No. 11, November 1966.

11. BWNT Calc. Pkg. 32-1218901-00, "OC-3 OTSG Flaw Evaluation," September 1992.

12. Bloom, J.M., "Assessment of Defects and Design of Components Allowing for Defects," Alliance Research Center Report RDD:92:1420-02-01:01, Rev. 4, Babcock & Wilcox Co., Alliance, Ohio, October 1991.

13. Duke Power Co. Design Basis Specification for Reactor Coolant System, Doc. 0254.00-00-1033, Section 20.2.1.4.

14. BWNT Doc. 18-1130828-04, "Functional Specification for Reactor Coolant System for Oconee Units 1, 2, and 3," May 1993.

Appendix A

Fracture Mechanics Calculations

Stress intensity factors are calculated for a subsurface flaw per ASME Code, Section XI, Appendix A.

Notes: Point 1 is closest to the surface.
Point 2 is farthest from the surface.

Geometry Data

t = 8.5 in.

Initial Flaw Size

a = 0.400 in.
e = 0.050 in.
l = 56.0 in.

Material Data Sy = 43.8 ksi at 600 F

Fracture Toughness

Kia = 26.8 + 1.233 exp [0.0145 (T - RTndt + 160)]

Kic = 33.2 + 2.806 exp [0.02 (T - RTndt + 100)]

Kia and Kic are limited to an upper shelf value of 200 ksi*in^.5

				Fracture Toughness		
				Calc.	Used	
T =	325	F	Kia =	612	200	ksi*in^.5
RTndt =	60	F	Kic =	4187	200	ksi*in^.5
T-RTndt =	265	F				

Fatigue Flaw Growth Parameters

da/dN = C*(dK)^n inches/cycle

C	n
2.67E-11	3.726

Applied Stresses

		Normal/Upset		Emergency/Faulted		
		Heatup	Cooldown	LOCA	FWLB	
Membrane stress:	Sm =	9.7	-0.5	2.6	9.0	ksi
Bending stress:	Sb =	14.0	-26.2	-37.2	-20.3	ksi

Stress Intensity Factor

B2 = 0.5948
B4 = 0.4812 + 0.7861*(e/a) + 1.9502*(e/a)^2
B6 = 0.3963 + 0.4207*(e/a) + 1.8806*(e/a)^2 + 1.6026*(e/a)^3 + 3.1913*(e/a)^4
B8 = 0.3354
BS = 0.3030 for Point 1, 0.0 for Point 2

Note: In the following expressions for Mm and Mb, "a/t" and "e/t" actually designate "2a/t" and "2e/t", respectively, for the case of subsurface flaws.

$$Mm = 1 + B2*(a/t)^2 + B4*(a/t)^4 + B6*(a/t)^6 + B8*(a/t)^8 + BS * [(a/t)/(1-(e/t))]^20 / [1-(e/t)-(a/t)]^0.5$$

$$Mb(Pt1) = 0.84086850 + \{ (e/t)*[1.509002 + (e/t)*(- 0.60377800 + 0.12940970*(a/t)) + (a/t)*(-0.7731469 + 0.04428677*(a/t))] + (a/t)*(0.8841885 - 0.07410377*(a/t)) - 0.8338377 \} / [1-(e/t)-(a/t)]^0.5$$

$$Mb(Pt2) = -0.004378676 + (e/t)*[1.052083 + (e/t)*(- 0.05479575 + 0.3805255*(a/t)) + (a/t)*(-0.08603191 + 0.03725713*(a/t))] + (a/t)*(-0.44208 - 0.1208828*(a/t))$$

Sratio = min{ [abs(Sm)+abs(Sb)]/Sy, 1.0 }

Q = 1 + 4.593*(a/l)^1.65 - 0.212*(Sratio)^2

K = (Sm Mm + Sb Mb) [pi a/Q]^0.5

Fatigue Analysis

$da = dN * C*(dK)^n$

$dN = 20$

daPt = da @ Pts. 1 & 2

da = (daPt1 + daPt2)/2

de = (daPt1 - daPt2)/2

Cycle	a (in.)	e (in.)	Point	Heatup Kmax ksi*(in)^.5	Cooldown Kmin ksi*(in)^.5	daPt (in.)	da (in.)	de (in.)
0	0.40000	0.05000	1	12.31811	-2.54791	6.18E-06	4.93E-06	1.25E-06
			2	10.71619	0.47667	3.68E-06		
20	0.40000	0.05000	1	12.31820	-2.54795	6.18E-06	4.93E-06	1.25E-06
			2	10.71626	0.47668	3.68E-06		
40	0.40001	0.05000	1	12.31829	-2.54799	6.18E-06	4.93E-06	1.25E-06
			2	10.71632	0.47669	3.68E-06		
60	0.40001	0.05000	1	12.31838	-2.54803	6.18E-06	4.93E-06	1.25E-06
			2	10.71638	0.47670	3.68E-06		
80	0.40002	0.05001	1	12.31847	-2.54808	6.18E-06	4.93E-06	1.25E-06
			2	10.71645	0.47671	3.68E-06		
100	0.40002	0.05001	1	12.31856	-2.54812	6.18E-06	4.93E-06	1.25E-06
			2	10.71651	0.47672	3.68E-06		
120	0.40003	0.05001	1	12.31865	-2.54816	6.18E-06	4.93E-06	1.25E-06
			2	10.71658	0.47673	3.68E-06		
140	0.40003	0.05001	1	12.31875	-2.54820	6.18E-06	4.93E-06	1.25E-06
			2	10.71664	0.47674	3.68E-06		
160	0.40004	0.05001	1	12.31884	-2.54824	6.18E-06	4.93E-06	1.25E-06
			2	10.71670	0.47675	3.68E-06		
180	0.40004	0.05001	1	12.31893	-2.54829	6.18E-06	4.93E-06	1.25E-06
			2	10.71677	0.47676	3.68E-06		
200	0.40005	0.05001	1	12.31902	-2.54833	6.18E-06	4.93E-06	1.25E-06
			2	10.71683	0.47677	3.68E-06		
220	0.40005	0.05001	1	12.31911	-2.54837	6.18E-06	4.93E-06	1.25E-06
			2	10.71689	0.47678	3.68E-06		
240	0.40006	0.05002	1	12.31920	-2.54841	6.18E-06	4.93E-06	1.25E-06
			2	10.71696	0.47679	3.68E-06		
260	0.40006	0.05002	1	12.31929	-2.54846	6.18E-06	4.93E-06	1.25E-06
			2	10.71702	0.47680	3.68E-06		
280	0.40007	0.05002	1	12.31938	-2.54850	6.18E-06	4.93E-06	1.25E-06
			2	10.71708	0.47681	3.68E-06		
300	0.40007	0.05002	1	12.31948	-2.54854	6.18E-06	4.93E-06	1.25E-06
			2	10.71715	0.47682	3.68E-06		
320	0.40008	0.05002	1	12.31957	-2.54858	6.18E-06	4.93E-06	1.25E-06
			2	10.71721	0.47683	3.68E-06		
340	0.40008	0.05002	1	12.31966	-2.54863	6.18E-06	4.93E-06	1.25E-06
			2	10.71727	0.47684	3.68E-06		
360	0.40009	0.05002	1	12.31975	-2.54867	6.18E-06	4.93E-06	1.25E-06
			2	10.71734	0.47685	3.68E-06		
380	0.40009	0.05002	1	12.31984	-2.54871	6.18E-06	4.93E-06	1.25E-06
			2	10.71740	0.47686	3.68E-06		
400	0.40010	0.05003	1	12.31993	-2.54875	6.18E-06	4.93E-06	1.25E-06
			2	10.71747	0.47687	3.68E-06		
420	0.40010	0.05003	1	12.32002	-2.54879	6.18E-06	4.93E-06	1.25E-06
			2	10.71753	0.47688	3.68E-06		

Analysis of Emergency/Faulted Condition Stresses at Final Flaw Size

a (in.)	e (in.)	a/l (in.)	Point	e/a	B4	B6	BS
0.40010	0.05003	0.0071	1	0.1250	0.6100	0.4822	0.3030
			2	-0.1250	0.4134	0.3707	0.0000

Point	Mm	Mb
1	1.0053	0.0642
2	1.0053	-0.0348

LOCA Condition:

Sratio Calc.	Sratio Used	Q	Point	K ksi*(in)^.5
0.9087	0.9087	0.8263	1	0.28
			2	4.82

FWLB Condition:

Sratio Calc.	Sratio Used	Q	Point	K ksi*(in)^.5
0.6689	0.6689	0.9065	1	9.12
			2	11.49

Fracture Toughness Margins at Final Flaw Size

Final Flaw Size:

a = 0.40010 in.
e = 0.05003 in.

Fracture Toughness Margins:

	Heatup Kia/3.162 /Ki	LOCA Kic/1.414 /Ki	FWLB Kic/1.414 /Ki
Point 1	5.13	504.7	15.51
Point 2	5.90	29.34	12.31

Appendix B

Indication Evaluation Report

Duke Power Company
Indication Evaluation Report

Station/Unit	Weld/ID No.	ISI Dwg No.	Sheet No.
ONS / 2	2-SGA-WG58-1	ISI-OCN2-003	96020E005

Component Description	Exam Procedure
Steam Gen. A upper head- to- tube sheet weld	NDE-620 Rev. 3

Code/Year/Addenda	Exam Category	Acceptance Standard(Para or Table)	Ref. Report
Sec XI / 1989 / none	B-B	IWB-3510-1	N/A

Flaw Characterization	Nom/Act Wall	Type Material
SLAG LINE	8.5"	C/S

Evaluator	Date	INF	Supp
James J. McArdle	4/30/96		ISI

Calculations/Evaluation

L = 58°, a = 0.4", a/l = 0.00, a/t% = 4.7% REJECTABLE subsurface flaw. Table IWB-3510-1 allows 2% for an aspect ratio of 0.00.

Jim McArdle Level III UT
Phone # 704-875-5227

Comments

This indication was not recorded in previous exams because of the change in recording criteria starting with the 1989 Section XI. The examinations performed this outage are 2.5 time more sensitive.

Technical Review	Date	Non-Technical Review	Date

DUKE POWER COMPANY

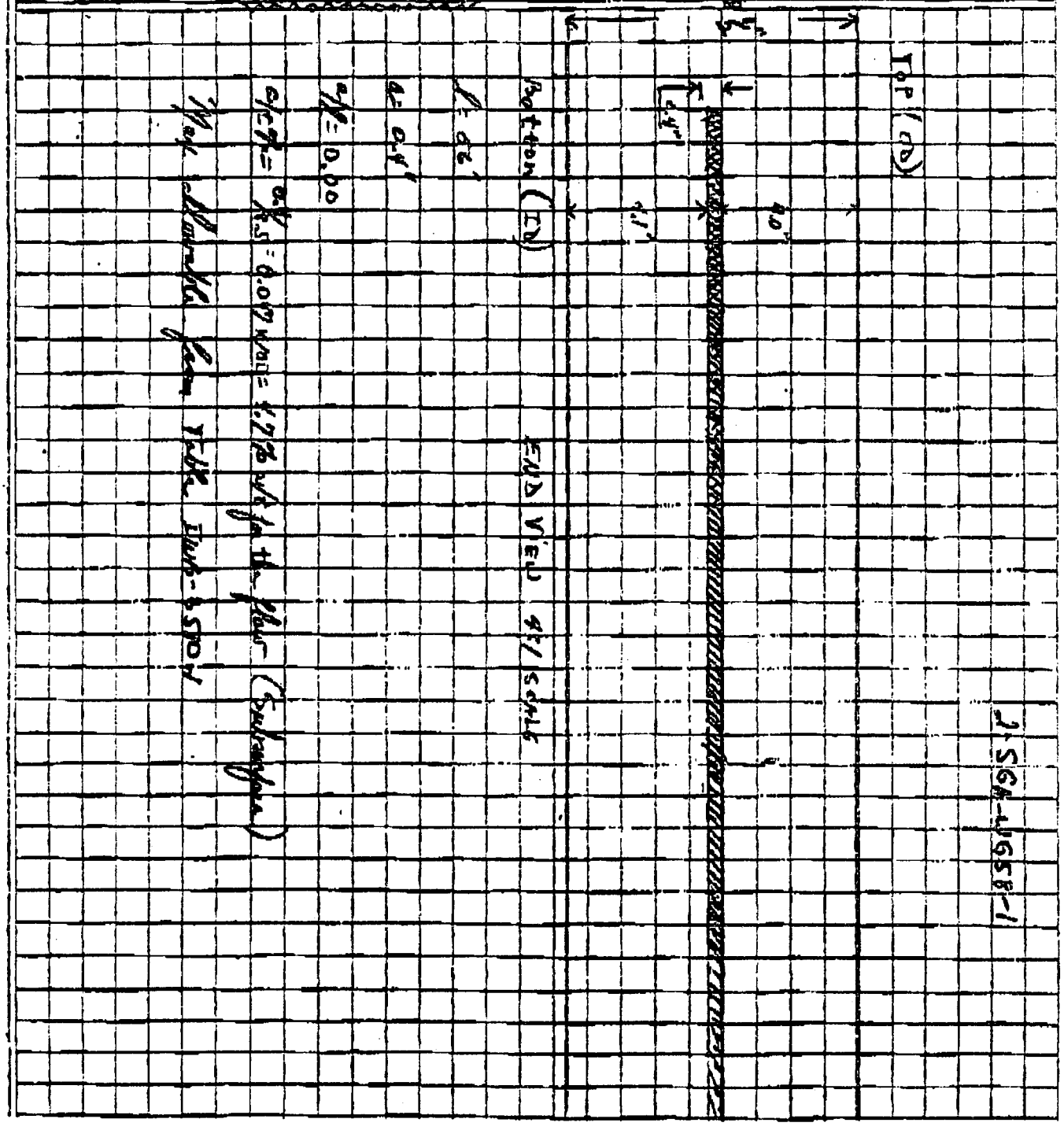
Form 00184 (R4-88)

Station_____ Unit____ Rev.____ File No._____ Sheet____ Of____

Subject_____

_____ By_____ Date_____

Prob No._____ Checked By_____ Date_____



DUKE POWER COMPANY

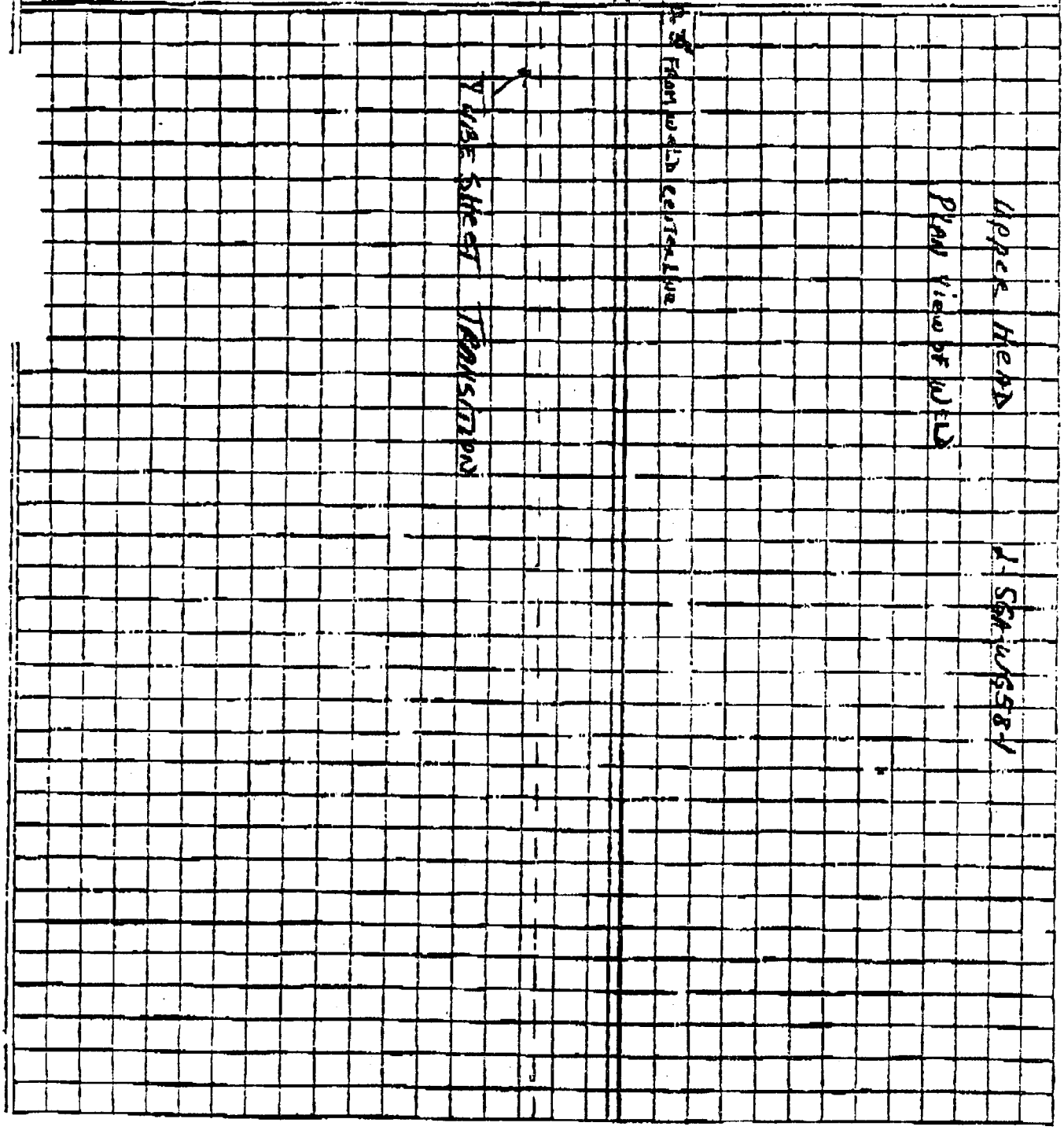
Form 60184 (R4-88)

Station_____ Unit____ Rev.____ File No._____ Sheet____ Of____

Subject _____

_____ By_____ Date _____

Prob No._____ Checked By_____ Date_____



ATTACHMENT 2

OCONEE UNIT 2A STEAM GENERATOR
ULTRASONIC EXAMINATION INFORMATION

DUKE POWER COMPANY

FORM NDE-1E

REVISION 2

ULTRASONIC CALIBRATION SHEET FOR USK-7D INSTRUMENTS

Station: Oconee Nuc. Station	Unit: II	Date: 4-29-96	Sheet Number: 9602089
Procedure: NDE 640 Rev: 1 F/C: 95-18 95-19		Couplant: ULTRA-GEL II	Batch Number: 95395
Examiner: James W Sitzer	Level: III	Calibration Block ID: 40393	Pyrometer S/N: MCNDE27022
Examiner: B. Dale Jolly	Level: I	Calibration Block Temp: 72°	Cal. due: 961003

REFERENCE BLOCK

ID: 798583

Type: IIW Material: c/s

SIMULATOR BLOCK

ID: 798583 Reflector Type: BW

Gain: 12.0 Signal Ampl: 80% Metal Path: 1.0

INSTRUMENT

Manufacturer: Krautkramer

Serial No: 32810-3019

TRANSDUCER

Type: Single ☑ Dual ☐ Size: 1.0" Freq: 2.25 Mhz Wedge INT

Manufacturer: KBA Ser no: K05229 Meas. Δ 0 °

INSTRUMENT SETTINGS

Gain	22.5
Range	10.0
MTVEL	233.0
Delay	0.0
Pulser	Hi Coil
Reject	OFF
Freq	1-5
Zero	.81
Display	Full
PRF	~~Full~~ HIGH JWS

Jack: T ☐ R ☑

CALIBRATION

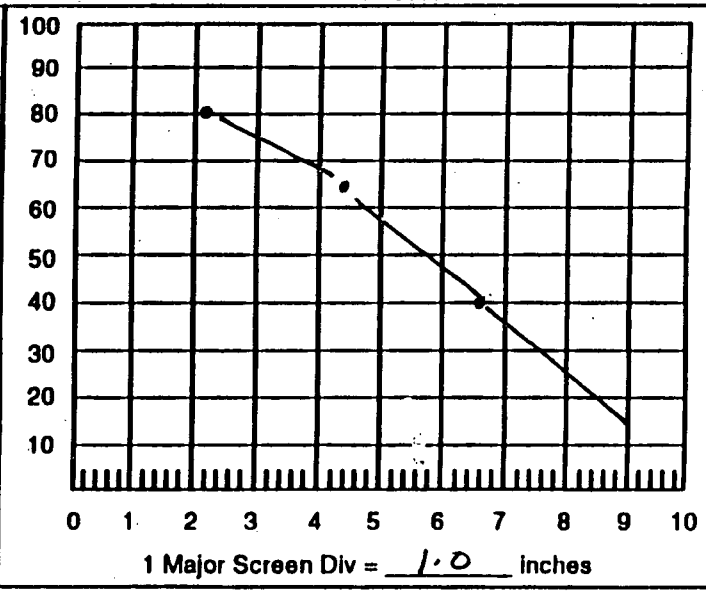
Reflector Type SDH	Amplitude %FSH	Metal Path inches
1 /8 node	80	2.1
2 /8 node	63	4.4
3 /8 node	40	6.6
/8 node		
other		

Cal Direction: axial ☐ circ. ☐

Wave Mode: Long. ☑ shear ☐ surf. ☐

Remarks:

METHOD



1 Major Screen Div = 1.0 inches

CABLES

RG58 ☑

RG174 ☐

Length: 6

Initial Cal Time 0809

Cal Checks

Time	Initials
0930	JWS
1005	JWS
1215	JWS
FINAL	

Item No: B02.040.001

Reviewer:	Level: II	Date: 5/1/96	Authorized Inspector	Date: 5-1-96

DUKE POWER COMPANY

FORM NDE-[illegible]E

REVISION 2

ULTRASONIC CALIBRATION SHEET FOR USK-7D INSTRUMENTS

Station: Oconee Nuc. Station	Unit: II	Date: 4-29-96	Sheet Number: 9602090
Procedure: NDE 620 Rev: 3 F/C: 96-02		Couplant: ULTRA-GEL II	Batch Number: 95395
Examiner: Larry H. Bibb	Level: III	Calibration Block ID: 40393	Pyrometer S/N: MCNDE27022
Examiner: James L Parvel	Level: I	Calibration Block Temp: 72°	Cal. due: 961003

REFERENCE BLOCK

ID: 798583

Type: IIW Material: C/S

SIMULATOR BLOCK

ID: 798583 Reflector Type: Radius

Gain: 18.5 Signal Ampl: 80% Metal Path: 4"

INSTRUMENT

Manufacturer: Krautkramer

Serial No: 32810-1392

TRANSDUCER

Type: Single ☒ Dual ☐ Size: 1.0 Freq: 2.25 Mhz Wedge SWS

Manufacturer: KBA Ser no: F21879 Meas. Δ 35 °

INSTRUMENT SETTINGS

Gain	36.5
Range	20.0
MTVEL	126.0
Delay	9.5
Pulser	HIGH
Reject	OFF
Freq	1-5
Zero	10.43
Display	FULL
PRF	HIGH

Jack: T ☐ R ☒

CALIBRATION

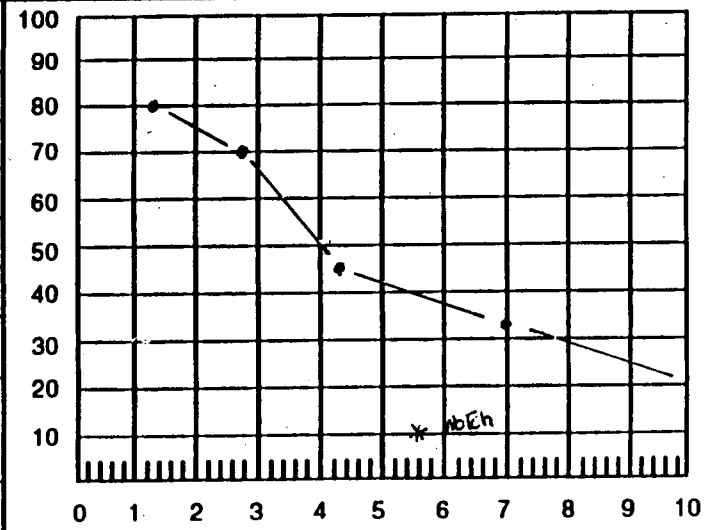
	Reflector Type	Amplitude %FSH	Metal Path inches
	HOLE		
1	1/8 node	80	2.67
2	1/8 node	70	5.51
3	1/8 node	45	8.30
5	1/8 node	32	14.0
other	NOTCH	10	11.3

Cal Direction: axial ☒ circ. ☐

Wave Mode: Long. ☐ shear ☒ surf. ☐

Remarks: 3db diff

METHOD



1 Major Screen Div = 2.0 inches

CABLES

RG58 ☐

RG174 ☒

Length: 6'

Initial Cal Time 0857

Cal Checks

Time	Initials
1041	JCP
1404	JCP
1840	JCP
2228	JCP
2314	JCP

FINAL

Item No: B02.040.001

Reviewer:	Level: II	Date: 5/1/96	Authorized Inspector	Date: 5-1-96

DUKE POWER COMPANY

FORM NDE-[illegible]1E

REVISION 2

ULTRASONIC CALIBRATION SHEET FOR USK-7D INSTRUMENTS

Station: Oconee Nuc. Station	Unit: II	Date: 4-29-96	Sheet Number: 9602091
Procedure: NDE 620 Rev: 3 F/C: 96-02		Couplant: ULTRA-GEL II	Batch Number: 95395
Examiner: DE Hower	Level: II	Calibration Block ID: 40393	Pyrometer S/N: MCNDE27022
Examiner: Gary Moss	Level: II	Calibration Block Temp: 72°	Cal. due: 961003

REFERENCE BLOCK

ID: 798583

Type: IIW Material: C/S

SIMULATOR BLOCK

ID: 798583 Reflector Type: Radius

Gain: 22db Signal Ampl: 80% Metal Path: 4"

INSTRUMENT

Manufacturer: Krautkramer

Serial No: 32810-3015

TRANSDUCER

Type: Single ☒ Dual ☐ Size: 1.0 Freq: 2.25 Mhz Wedge SWS

Manufacturer: KBA Ser no: B07961 Meas. ∠ 45°

INSTRUMENT SETTINGS

Gain	43.5
Range	20.0
MTVEL	126.0
Delay	10.5
Pulser	HIGH
Reject	OFF
Freq	1-5
Zero	12.85
Display	FULL
PRF	HIGH

Jack: T ☐ R ☒

CALIBRATION

Reflector Type Hole	Amplitude %FSH	Metal Path inches
1 /8 node	80	3.15
2 /8 node	71	6.38
3 /8 node	40	9.64
5 /8 node	22	15.9
other NOTch	5	12.95

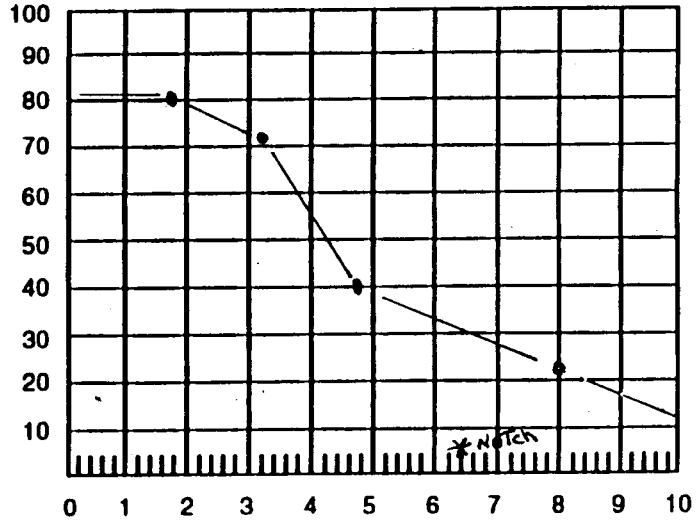
Cal Direction: axial ☒ circ. ☒

Wave Mode: Long. ☐ shear ☒ surf. ☐

Remarks:

Item No: B02.040.001

METHOD



1 Major Screen Div = 2.0 inches

CABLES

RG58 ☐

RG174 ☒

Length: 6'

Initial Cal Time 0841

Cal Checks

Time	Initials
1118	DEH
1402	DEH
1838	DEH
2230	DEH
2305	DEH

FINAL

Reviewer: [signature] Level: II Date: 5/1/96

Authorized Inspector [signature] Date: 5-1-96

DUKE POWER COMPANY

FORM NDE-[illegible]1E

REVISION 2

ULTRASONIC CALIBRATION SHEET FOR USK-7D INSTRUMENTS

Station: Oconee Nuc. Station	Unit: II	Date: 4-29-96	Sheet Number: 9602092
Procedure: NDE 620 Rev: 3 F/C: 96-02		Couplant: ULTRA-GEL II	Batch Number: 95395
Examiner: DE Hoover	Level: II	Calibration Block ID: 40393	Pyrometer S/N: MCNDE27022
Examiner: Gary J. Moss	Level: II	Calibration Block Temp: 72°	Cal. due: 961003

REFERENCE BLOCK

ID: 798583

Type: IIW Material: C/S

SIMULATOR BLOCK

ID: 798583 Reflector Type: RAD

Gain: 26.5 Signal Ampl: 80% Metal Path: 4.0"

INSTRUMENT

Manufacturer: Krautkramer

Serial No: 32810-3015

TRANSDUCER

Type: Single ☑ Dual ☐ Size: 1.0 Freq: 2.25 Mhz Wedge SWS

Manufacturer: KBA Ser no: F21878 Meas. ∠ 60°

INSTRUMENT SETTINGS

Gain	42/49.5
Range	30.0
MTVEL	126.0
Delay	15.4
Pulser	HIGH
Reject	OFF
Freq	1-5
Zero	17.55
Display	Full
PRF	~~Full~~ HIGH JWS

Jack: T ☐ R ☑

CALIBRATION

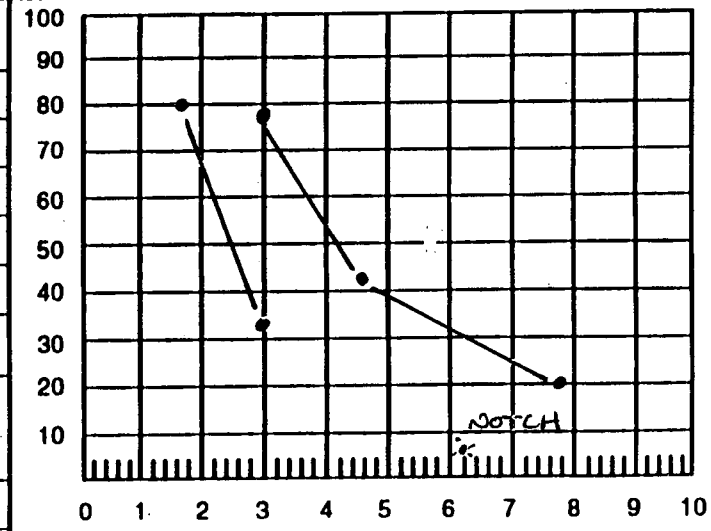
Reflector Type SDH	Amplitude %FSH	Metal Path inches
1 /8 node	80	4.4
2 /8 node	32/78	9.0
3 /8 node	42	14.4
5 /8 node	20	22.7
other NOTCH	5	18.5

Cal Direction: axial ☑ circ. ☑

Wave Mode: Long. ☐ shear ☑ surf. ☐

Remarks:

METHOD



1 Major Screen Div = 3.0 inches

CABLES

RG58 ☐

RG174 ☑

Length: 6

Initial Cal Time 0838

Cal Checks

Time	Initials
0932	DEH
1400	DEH
1800	DEH
1836	DEH
2300	DEH
FINAL	

Item No: B02.040.001

Reviewer: [signature] Level: II Date: 5/1/96

Authorized Inspector [signature] Date: 5-1-96

DUKE POWER COMPANY

ULTRASONIC CALIBRATION SHEET FOR USK-7D INSTRUMENTS

FORM NDE-UT-1E

REVISION 2

Station: Oconee Nuc. Station | Unit: II | Date: 4-29-96 | Sheet Number: 9602093

Procedure: NDE 620 | Rev: 3 | F/C: 96-02 | Couplant: ULTRA-GEL II | Batch Number: 95395

Examiner: Guy L. Bibb | Level: III | Calibration Block ID: 40393 | Pyrometer S/N: MCNDE27022

Examiner: James A Paul | Level: I | Calibration Block Temp: 72° | Cal. due: 961003

REFERENCE BLOCK

ID: 798583

Type: IIW | Material: C/S

SIMULATOR BLOCK

ID: 798583 | Reflector Type: Radius

Gain: 3H | Signal Ampl: 80% | Metal Path: 4"

INSTRUMENT

Manufacturer: Krautkramer

Serial No: 32810-1392

TRANSDUCER

Type: Single ☒ Dual ☐ | Size: 1.0" | Freq: 2.25 Mhz | Wedge SWS

Manufacturer: KBA | Ser no: G12908 | Meas. ∠ 70°

INSTRUMENT SETTINGS

Gain	57.5/62.5
Range	30.0
MTVEL	126.0
Delay	21.2
Pulser	HIGH
Reject	OFF
Freq	1-5
Zero	22.63
Display	Full
PRF	HIGH

Jack: T ☐ R ☒

CALIBRATION

Reflector Type HOLE	Amplitude %FSH	Metal Path inches
1 /8 node	80	6.63
2 /8 node	28/42	14.61
3 /8 node	21	22.4
/8 node		
other NOTCH	3%	28.0

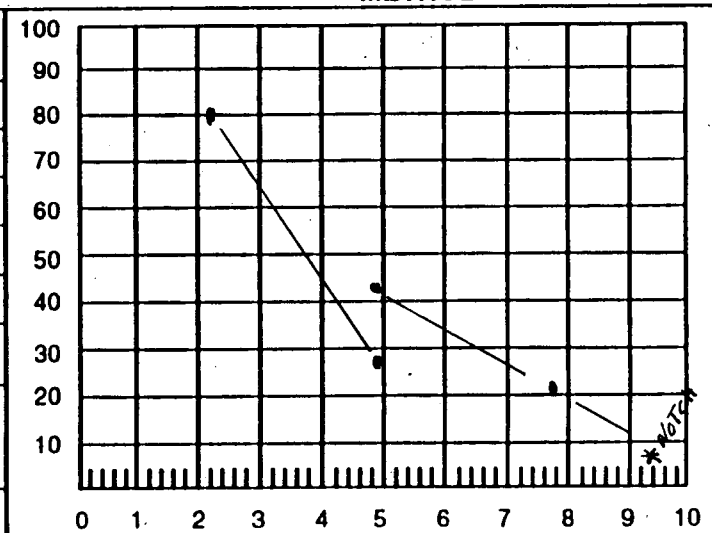
Cal Direction: axial ☒ circ. ☐

Wave Mode: Long. ☐ shear ☒ surf. ☐

Remarks:

Item No: B02.040.001

METHOD



1 Major Screen Div = 3.0 inches

CABLES

RG58 ☐

RG174 ☒

Length: 6'

Initial Cal Time 0905

Cal Checks

Time	Initials
0934	JCP
1039	JCP
1403	JCP
2317	JCP
FINAL	

Reviewer: | Level: II | Date: 5/1/96 | Authorized Inspector MSC | Date: 5-1-96

DUKE POWER COMPANY

FORM NDE-[illegible]1E
REVISION 2

ULTRASONIC CALIBRATION SHEET FOR USK-7D INSTRUMENTS

Station: Oconee Nuc. Station | Unit: II | Date: 4-29-96 | Sheet Number: 9602094

Procedure: NDE 620 | Rev: 3 | F/C: 96-02 | Couplant: ULTRA-GEL II | Batch Number: 95395

Examiner: James W Sitzer | Level: III | Calibration Block ID: 40393 | Pyrometer S/N: MCNDE27022

Examiner: B. Dale Jolly | Level: I | Calibration Block Temp: 72° | Cal. due: 961003

REFERENCE BLOCK

ID: 798583

Type: IIW | Material: C/S

SIMULATOR BLOCK

ID: 798583 | Reflector Type: RAD.

Gain: 37.0 | Signal Ampl: 80% | Metal Path: 4.0"

INSTRUMENT

Manufacturer: Krautkramer

Serial No: 32810-3019

TRANSDUCER

Type: Single ☐ Dual ☒ | Size: 2 (24x42) | Freq: 2.25 Mhz | Wedge: IAT

Manufacturer: RTD | Ser no: 94-694 | Meas. ∠ 60L°

INSTRUMENT SETTINGS

Gain	59/53*
Range	10.0
MTVEL	225.6
Delay	12.0
Pulser	DUAL
Reject	OFF
Freq	1-5
Zero	11.66
Display	FULL
PRF	~~FULL~~ HIGH JWS

Jack: T ☑ R ☑

CALIBRATION

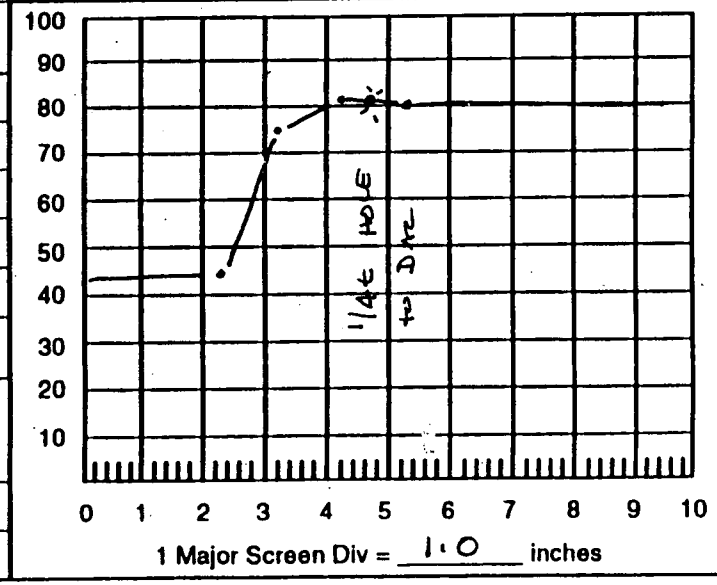
Reflector Type NEAR SURFACE	Amplitude %FSH	Metal Path inches
2 /8 node	44%	2.3
3 /8 node	75%	3.3
4 /8 node	82%	4.3
5 /8 node	80%	5.3
other 1/4 t	80	4.6

Cal Direction: axial ☑ circ. ☑

Wave Mode: Long. ☑ shear ☐ surf. ☐

Remarks: * 1/4 t HOLE TO DAC

METHOD



1 Major Screen Div = 1.0 inches

CABLES

RG58 ☐

RG174 ☑

Length: 6'

Initial Cal Time: 0820

Cal Checks

Time	Initials
1007	JWS
1110	JWS
1222	JWS
FINAL	

Item No: B02.040.001

Reviewer: [signature] | Level: II | Date: 5/1/96 | Authorized Inspector [signature] | Date: 5-1-96

DUKE POWER COMPANY

ULTRASONIC EXAMINATION DATA SHEET FOR PLANAR REFLECTORS

Exam Start: 0930 | Form NDE-UT-2A

Exam Finish: 2230 | Revision 4

Station: Oconee Nuc. | Unit: II | Component/Weld ID: 2 SGA-WG5B-1 | Date: 4-29-96

Weld Length (in.): 424" | Surface Condition: AS GROUND | L0: W Axis | Surface Temperature: 68 °F

Examiner: DE Bowen / Doug A Bibb II/III / B Dale Jolly Level: I | Pyrometer S/N: MCNDE 27022

Examiner: James W Setzer / Gary L Moss III / James L Pond Level: I | Cal Due: 961003

Procedure: NDE 620 Rev: 3 (NDE 640) | FC: 95-18 & 95-19 (NDE-620) 96-02

Calibration Sheet No: 9602089 9602090 9602091 9602092 9602093 9602094

Scans:

45	✓ 57.5 dB	70	✓ 76.5 dB		
45T	✓ 57.5 dB	70T	✓ NA dB		
60	✓ 63.5 dB	0°	✓ 28.5 dB	60 RL	✓ 67 dB
60T	✓ 63.5 dB	60T RL	✓ 67 dB		

Other: 35° 50.5 dB

Configuration: CIRC WELD

1 Flow 2

HEAD to TUBE SHT

Scan Surface: OD

Applies to NDE-680 only

Skew Angle: N/A

IND #	∠	Max % Rel	Mp Max	W Max	L Max	L1	L2	W1	Mp1	W2	Mp2	Beam Dir	Exam surf.	Scan	Damps
	DO IN	NOT WRITE THIS	SPACE			20%dac HMA 50%dac 100% dac	20%dac HMA 50%dac 100% dac	20%dac HMA 50%dac 100% dac	20%dac HMA 50%dac 100% dac	20%dac HMA 50%dac 100% dac	20%dac HMA 50%dac 100% dac	DO IN	NOT THIS	WRITE SPACE	
/	0°		No	RECORDABLE INDICATIONS (UPPER HEAD SIDE ONLY)											
/	70°		No	RECORDABLE INDICATIONS											
1	$60°_S$	125	8.95	7.0	92	0	140"	6.45	8.39	*	*	2	1	AX	No
2	$45°_S$	112	6.07	8.6	91.5	84	140.7	8.3	5.89	9.0	6.31	2	1	AX	No

* DUE TO BREAK ON HEAD W2 & MP2 MEASUREMENTS WERE NOT OBTAINED.

Remarks: "W" MEASUREMENTS TAKEN FROM START OF TAPER. THEREFORE SUBTRACT 2.5" FOR ALL "W" MEASUREMENTS.

Limitations: (see NDE-UT-4) ☐ | 90% or greater coverage obtained: yes ☐ no ☐

Sheet 1 of 36

Reviewed By: | Level: II | Date: 5/1/96 | Authorized Inspector | Date 5-1-96

Item No: B02.040.001

DUKE POWER COMPANY

ULTRASONIC EXAMINATION DATA SHEET FOR PLANAR REFLECTORS (continuation)

Form NDE-8[illegible]2B

Revision 3

Station: OCONEE | Unit: II | Component/Weld ID: 2-SGA-WG 58-1 | Date: 4/29/96

IND #	∠	Max % Ref	W Max	Mp Max	L Max	L1	L2	W1	Mp1	W2	Mp2	Beam Dir	Exam surf.	Scan	Damps
DO NOT WRITE IN THIS SPACE						20%dac HMA 50%dac 100%dac	20%dac HMA 50%dac 100%dac	20%dac HMA 50%dac 100%dac	20%dac HMA 50%dac 100%dac	20%dac HMA 50%dac 100%dac	20%dac HMA 50%dac 100%dac	DO IN	NOT THIS	WRITE SPACE	
2	45°	50%				84.9	140.7	9.45	5.1	10.0	5.5	2	1	AX	NO
↓	↓	↓	↓	↓	↓	85.8	↓	9.6	5.11	10.1	5.48	↓	↓	↓	↓
						86.7		9.6	5.0	10.0	5.4				
						87.6		9.2	4.8	9.6	5.2				
						88.5		9.3	4.85	9.6	5.17				
						89.4		9.3	4.7	9.6	4.99				
						90.3		8.3	3.89	8.6	4.2				
						91.2		8.2	5.4	8.6	5.9				
↓	↓	↓	↓	↓	↓	92.1	↓	8.3	5.8	8.7	6.2	↓	↓	↓	↓

Examiner: ME Howser | Level: II | Examiner: Gary Moss | Level: II

Remarks: MEASUREMENTS ARE TAKEN FROM START OF TAPER INSTEAD OF CENTERLINE OF WELD THEREFORE SUBTRACT 2.5" FROM ALL "W" DIMENSIONS FOR CORRECT MEASUREMENTS

Sheet 2 of 36

Reviewed By: [signature] | Level: II | Date: 5/1/96

Authorized Inspector: [signature] | Date: 5-1-96

Item No: 302.040.001

P. 1

DUKE POWER COMPANY

ULTRASONIC EXAMINATION DATA SHEET FOR PLANAR REFLECTORS (continuation)

Form NDE-8[illegible]2B

Revision 3

Station: OCONEE | Unit: II | Component/Weld ID: 2-SGA-ING 58-1 | Date: 4/29/96

IND #	∠	Max % Ref	W Max	Mp Max	L Max	L1	L2	W1	Mp1	W2	Mp2	Beam Dir	Exam surf.	Scan	Damps
DO NOT WRITE IN THIS SPACE						20%dac HMA 50%dac 100%dac	20%dac HMA 50%dac 100%dac	20%dac HMA 50%dac 100%dac	20%dac HMA 50%dac 100%dac	20%dac HMA 50%dac 100%dac	20%dac HMA 50%dac 100%dac	DO IN	NOT THIS	WRITE SPACE	
2	45°	50%				93.0	140.7	8.3	5.8	8.7	6.2	2	1	AX	No
						93.9		7.7	5.0	8.2	5.3				
						94.8		7.7	4.7	8.35	4.9				
						95.7		7.6	3.5	8.0	4.6				
						96.6		7.8	4.2	8.45	4.7				
						97.5		7.9	4.1	8.5	4.68				
						98.4		8.3	4.6	8.8	5.1				
						99.3		7.5	4.3	8.0	4.6				
						100.2		8.1	4.2	8.5	4.7				

Examiner: DE Howser | Level: II | Examiner: Gary Moss | Level: II

Remarks: MEASUREMENTS ARE TAKEN FROM START OF TAPER INSTEAD OF CENTERLINE OF THE WELD THEREFORE SUBTRACT 2.5" FROM "W" DIMENSIONS FOR CORRECT MEASUREMENTS

Sheet 3 of 36

Reviewed By: [signature] | Level: II | Date: 5/1/96

Authorized Inspector: [signature] | Date: 5-1-96

Item No: B02.040.001

P 2

DUKE POWER COMPANY

ULTRASONIC EXAMINATION DATA SHEET FOR PLANAR REFLECTORS (continuation)

Form NDE-U-2B

Revision 3

Station: OCONEE | Unit: II | Component/Weld ID: 2-SGA-WG 58-1 | Date: 4/29/96

IND #	∠	Max % Ref	W Max	Mp Max	L Max	L1	L2	W1	Mp1	W2	Mp2	Beam Dir	Exam surf.	Scan	Damps
DO NOT WRITE IN THIS SPACE						20%dac HMA 50%dac 100%dac	20%dac HMA 50%dac 100%dac	20%dac HMA 50%dac 100%dac	20%dac HMA 50%dac 100%dac	20%dac HMA 50%dac 100%dac	20%dac HMA 50%dac 100%dac	DO IN	NOT THIS	WRITE SPACE	
2	45°	50%				101.1	140.7	8.2	5.0	8.7	5.4	2	1	AX	NO
↓	↓	↓	↓	↓	↓	102.0	↓	8.2	5.0	8.75	5.4	↓	↓	↓	↓
						102.9		8.2	5.7	8.8	6.2				
						103.8		8.2	5.7	8.7	6.1				
						104.7		8.15	5.78	8.6	6.2				
						105.6		8.20	5.7	8.8	6.15				
						106.5		8.15	5.65	8.7	6.2				
						107.4		8.3	5.9	8.8	6.3				
↓						108.3	↓	8.6	4.3	9.0	5.2	↓	↓	↓	↓

Examiner: NE Houser | Level: II | Examiner: Gary A Moss | Level: II

Remarks: MEASUREMENTS ARE TAKEN FROM START OF TAPER INSTEAD OF CENTERLINE OF THE WELD THEREFORE SUBTRACT 2.5" FROM ALL "W" DIMENSIONS FOR CORRECT MEASUREMENTS

Sheet 4 of 36

Reviewed By: | Level: II | Date: 5/1/96 | Authorized Inspector: MBC | Date: 5-1-96 | Item No: B02.040.001

P-3

DUKE POWER COMPANY

ULTRASONIC EXAMINATION DATA SHEET FOR PLANAR REFLECTORS (continuation)

Form NDE-[illegible]2B

Revision 3

Station: OCONEE | Unit: II | Component/Weld ID: 2-SGA-WG 58-1 | Date: 4/29/96

IND #	∠	Max % Ref	W Max	Mp Max	L Max	L1	L2	W1	Mp1	W2	Mp2	Beam Dir	Exam surf.	Scan	Damps
DO NOT WRITE IN THIS SPACE						20%dac HMA 50%dac 100%dac	20%dac HMA 50%dac 100%dac	20%dac HMA 50%dac 100%dac	20%dac HMA 50%dac 100%dac	20%dac HMA 50%dac 100%dac	20%dac HMA 50%dac 100%dac	DO IN	NOT THIS	WRITE SPACE	
2	45°	50%				109.2	140.7	9.5	4.88	10.0	5.16	2	1	SX	NC
↓	↓	↓				110.1	↓	8.8	4.88	9.25	5.2	↓	↓	↓	↓
						111.0		9.0	5.15	9.5	5.35				
						111.9		8.8	4.5	9.0	4.6				
						112.8		8.6	4.7	9.0	5.2				
						113.7		8.9	5.3	9.3	5.5				
						114.6		7.8	3.6	8.4	3.9				
						115.5		8.2	4.3	9.2	4.9				
↓	↓	↓				116.4	↓	8.2	5.2	8.8	6.0	↓	↓	↓	↓

Examiner: DE Hauser | Level: II | Examiner: Gary Moss | Level: III

Remarks: MEASUREMENTS ARE TAKEN FROM START OF TAPER INSTEAD OF CENTERLINE OF THE WELD THEREFORE SUBTRACT 2.5" FROM ALL "IN" DIMENSIONS FOR CORRECT MEASUREMENTS

Sheet 5 of 36

Reviewed By: [signature] | Level: II | Date: 5/1/96

Authorized Inspector: [signature] | Date: 5-1-96

Item No: B02.040.001

P. 4

DUKE POWER COMPANY

ULTRASONIC EXAMINATION DATA SHEET FOR PLANAR REFLECTORS (continuation)

Form NDE-UT-2B

Revision 3

Station: OCONEE | Unit: II | Component/Weld ID: 2-SGA-WG 58-1 | Date: 4/29/96

IND #	∠	Max % Ref	W Max	Mp Max	L Max	L1	L2	W1	Mp1	W2	Mp2	Beam Dir	Exam surf.	Scan	Damps
DO NOT WRITE IN THIS SPACE						20%dac HMA 50%dac 100%dac	20%dac HMA 50%dac 100%dac	20%dac HMA 50%dac 100%dac	20%dac HMA 50%dac 100%dac	20%dac HMA 50%dac 100%dac	20%dac HMA 50%dac 100%dac	DO IN	NOT THIS	WRITE SPACE	
2	45°	50%				117.3	140.7	8.8	4.4	9.3	4.7	2	1	AX	No
↓	↓	↓				118.2	↓	7.6	5.9	8.8	6.6	↓	↓	↓	↓
						119.1		6.7	4.9	7.8	5.2				
						120.0		7.2	4.4	7.8	4.6				
						120.9		7.8	4.3	8.6	4.7				
						121.8		7.13	5.3	8.0	5.4				
						122.7		7.0	5.1	7.7	5.5				
						123.6		7.5	4.9	8.3	5.5				
↓	↓	↓				124.5	↓	7.6	4.4	8.2	4.8	↓	↓	↓	↓

Examiner: DE Howser | Level: II | Examiner: Gary Moss | Level: III

Remarks: MEASUREMENTS ARE TAKEN FROM START OF TAPER INSTEAD OF CENTERLINE OF THE WELD THEREFORE SUBTRACT 2.5" FROM ALL "IN" DIMENSIONS FOR CORRECT MEASUREMENTS

Sheet 6 of 36

Reviewed By: | Level: II | Date: 5/1/96

Authorized Inspector | Date: 5-1-96

Item No: B02.040.001

DUKE POWER COMPANY

ULTRASONIC EXAMINATION DATA SHEET FOR PLANAR REFLECTORS (continuation)

Form NDE-[illegible]-2B

Revision 3

Station: OCONEE | Unit: II | Component/Weld ID: 2-SGA-WG 58-1 | Date: 4/29/96

IND #	∠	Max % Ref	W Max	Mp Max	L Max	L1	L2	W1	Mp1	W2	Mp2	Beam Dir	Exam surf.	Scan	Damps
DO NOT WRITE IN THIS SPACE						20%dac HMA 50%dac 100%dac	20%dac HMA 50%dac 100%dac	20%dac HMA 50%dac 100%dac	20%dac HMA 50%dac 100%dac	20%dac HMA 50%dac 100%dac	20%dac HMA 50%dac 100%dac	DO IN	NOT THIS	WRITE SPACE	
2	45°	50%				125.4	140.7	7.0	4.4	7.6	4.8	2	1	AX	No
↓	↓	↓				126.3	↓	7.2	4.5	7.85	4.9	↓	↓	↓	↓
						127.2		6.9	4.1	7.9	5.1				
						128.1		6.8	4.7	7.5	4.9				
						129.0		6.8	4.4	7.4	4.8				
						129.9		6.5	4.0	7.0	4.4				
						130.8		7.2	5.0	7.7	5.4				
						131.7		7.1	5.3	7.7	5.8				
↓	↓	↓				132.6	↓	8.2	4.9	8.7	5.2	↓	↓	↓	↓

Examiner: DE Houser Level: II | Examiner: Gary J Moss Level: II

Remarks: MEASUREMENTS ARE TAKEN FROM START OF TAPER INSTEAD OF CENTERLINE OF THE WELD THEREFORE SUBTRACT 2.5" FROM ALL "W" DIMENSIONS FOR CORRECT MEASUREMENTS

Sheet 7 of 36

Reviewed By: [signature] Level: II Date: 5/1/96

Authorized Inspector [signature] Date 5-1-96

Item No: B02.040.001

DUKE POWER COMPANY

ULTRASONIC EXAMINATION DATA SHEET FOR PLANAR REFLECTORS (continuation)

Form NDE-[illegible]-2B

Revision 3

Station: OCONEE | Unit: II | Component/Weld ID: 2-SGA-WG 58-1 | Date: 4/29/96

IND #	∠	Max % Ref	W Max	Mp Max	L Max	L1	L2	W1	Mp1	W2	Mp2	Beam Dir	Exam surf.	Scan	Damps
DO NOT WRITE IN THIS SPACE						20%dac HMA 50%dac 100%dac	20%dac HMA 50%dac 100%dac	20%dac HMA 50%dac 100%dac	20%dac HMA 50%dac 100%dac	20%dac HMA 50%dac 100%dac	20%dac HMA 50%dac 100%dac	DO IN	NOT THIS	WRITE SPACE	
2	45°	50%				133.5	140.7	8.2	4.9	8.7	5.3	2	1	AX	dc
↓	↓	↓				134.4		8.4	4.6	9.7	5.5	↓	↓	↓	↓
						135.3		7.5	5.8	8.3	6.4				
						136.2		4.9	9.2	5.2	10.0				
						137.1		9.0	4.2	9.5	4.5				
						138.0		6.7	4.9	7.3	5.2				
						138.9		6.7	3.9	7.2	4.3				
						139.8		7.2	5.1	7.7	5.5				
↓	↓	↓				140.7	↓	7.2	5.0	7.6	5.4	↓	↓	↓	↓

Examiner: DE Houser | Level: II | Examiner: Gary J Mon | Level: II

Remarks: MEASUREMENTS ARE TAKEN FROM START OF TAPER INSTEAD OF CENTERLINE OF THE WELD THEREFORE SUBTRACT 2.5" FROM ALL "IN" DIMENSIONS FOR CORRECT MEASUREMENTS

Sheet 8 of 36

Reviewed By: [signature] | Level: II | Date: 5/1/96

Authorized Inspector: YMSC | Date: 5-1-96

Item No: B02.040.001

DUKE POWER COMPANY

ULTRASONIC EXAMINATION DATA SHEET FOR PLANAR REFLECTORS (continuation)

Form NDE-U[illegible]2B
Revision 3

Station: Oconee NUC. | Unit: II | Component/Weld ID: 2 SGA-WG 58-1 | Date: 4-29-96

IND #	∠	Max % Ref	W Max	Mp Max	L Max	L1	L2	W1	Mp1	W2	Mp2	Beam Dir	Exam surf.	Scan	Damps
	DO NOT WRITE IN THIS SPACE					20%dac HMA 50%dac 100%dac	20%dac HMA 50%dac 100%dac	20%dac HMA 50%dac 100%dac	20%dac HMA 50%dac 100%dac	20%dac HMA 50%dac 100%dac	20%dac HMA 50%dac 100%dac	DO IN	NOT THIS	WRITE SPACE	
3	45	32	11.5	9.2	148.9	148.5	149.3	11.2	9.0	11.9	9.46	2	1	AX	No
/	45/60s	No	OTHER RECORDABLE			INDICATIONS		IN AXIAL DIRC.							
/	45/60s	No	RECORDABLE INDICATIONS		IN	CIRC	DIRECTION.								
4	60 RL	25	2.2	4.8	104.2	104.0	104.5	2.0 *	4.5	2.35*	4.9	2	1	AX	No
/	60 RL	No	OTHER RECORDABLE		INDICATIONS	IN	AXIAL	DIRECTION.							
/	60 RL	No	RECORDABLE		INDICATIONS	IN	CIRC	DIRECTION.							
5	35	31	8.7	4.5	86.0	85.9	86.1	8.6	4.42	8.8	4.58	2	1	AX	No
6	35	25	7.0	3.85	97.9	97.6	98.1	6.85	3.8	7.2	3.95	2	1	AX	No
7	35	22	7.0	5.1	102.5	102.4	102.8	6.85	5.0	7.3	5.15	2	1	AX	No

Examiner: DE Houser, James W Setzer, Gary Moss, B. Gallagher | Level: II III / II I

Examiner: Guy D Bibb, James A Paul | Level: III / I

Remarks: * THESE W READING WERE TAKEN FROM ℄ OF WELD. ALL OTHERS WERE TAKEN AT THE START OF TAPER. THEREFORE SUBTRACT 2.5" FROM ALL OTHER W READINGS.

Sheet 9 of 36

Reviewed By: [signature] | Level: II | Date: 5/1/96

Authorized Inspector: YMBC | Date: 5-1-96

Item No: Boz.040.001

DUKE POWER COMPANY

ULTRASONIC EXAMINATION DATA SHEET FOR PLANAR REFLECTORS (continuation)

Form NDE-[illegible]2B

Revision 3

Station: Oconee Nuc. | Unit: II | Component/Weld ID: 2-SGA-WG 58-1 | Date: 4-29-96

IND #	∠	Max % Ref	W Max	Mp Max	L Max	L1	L2	W1	Mp1	W2	Mp2	Beam Dir	Exam surf.	Scan	Damps
	DO NOT WRITE IN THIS SPACE					20%dac HMA 50%dac 100%dac	20%dac HMA 50%dac 100%dac	20%dac HMA 50%dac 100%dac	20%dac HMA 50%dac 100%dac	20%dac HMA 50%dac 100%dac	20%dac HMA 50%dac 100%dac	DO IN	NOT THIS	WRITE SPACE	
8	35	25	7.0	5.05	104.85	104.8	105.6	6.85	4.95	7.3	5.15	2	1	AX	No
9	35	56	7.0	4.05	123.9	123.5	124.5	6.8	3.9	7.2	4.20	2	1	AX	No
10	35	28	7.0	3.95	127.8	127.4	128.05	6.8	3.65	7.2	4.20	2	1	AX	No
	INDICATIONS 5-10 ARE FOR SUPPLEMENTAL DATA ONLY FOR INDICATION														
	#2, 45°.														
/	35°	No	RECORDABLE			INDICATIONS	(FOR TUBE SHEET SIDE ONLY ACTING								
								AS A	"0°"	SCAN.)					

Examiner: DE Hoover Level: II

Examiner: Gary L Bibb (James L Paul) Level: III I

Remarks: All WL MEASUREMENTS TAKEN FROM START OF TAPER. THEREFORE SUBTRACT 2.5" FROM ALL WL READINGS.

Sheet 10 of 36

Reviewed By: [signature] Level: II Date: 5/1/96

Authorized Inspector [signature] Date 5-1-96

Item No: B02.040.001

Form 00184 (R4-88)

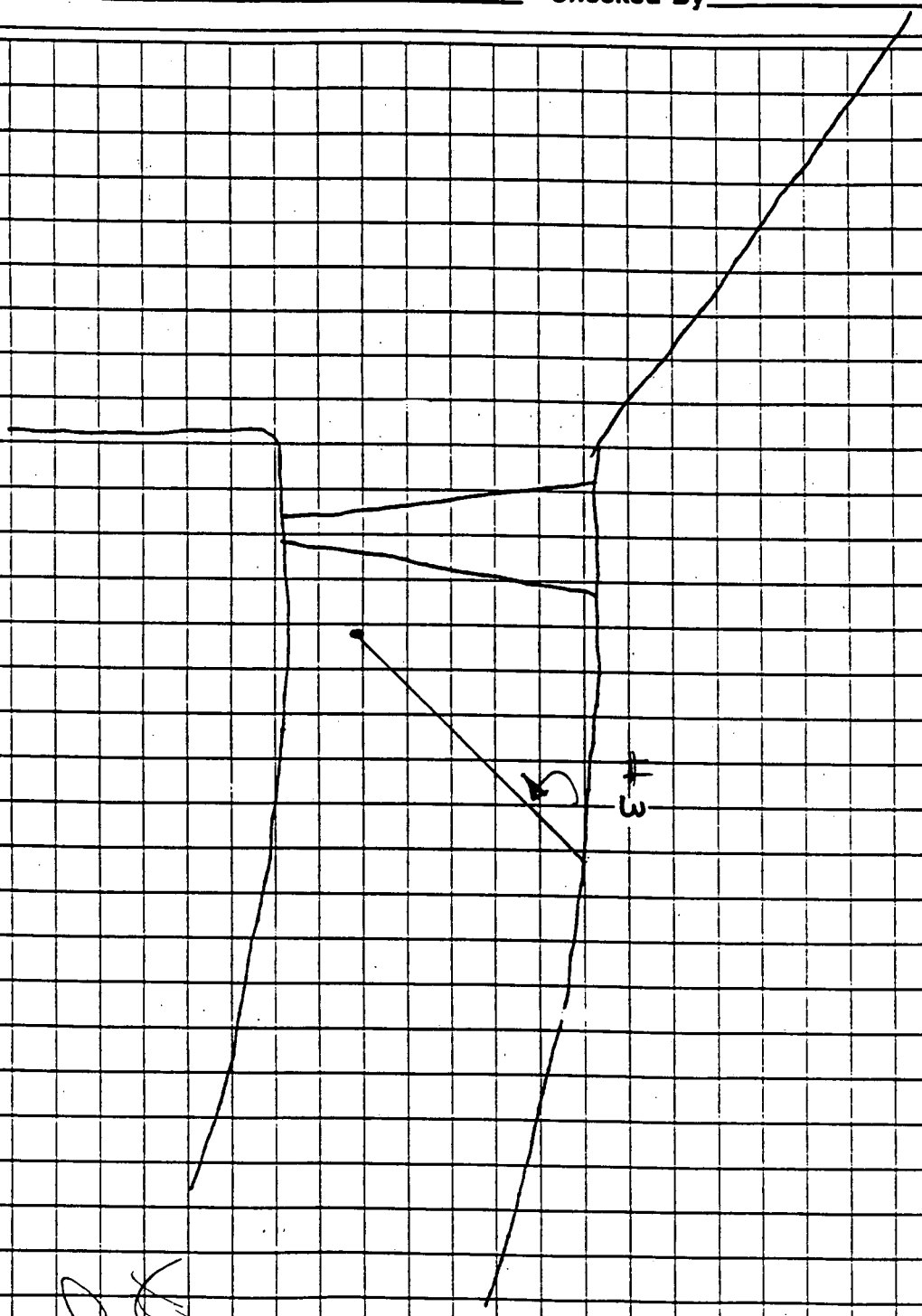
DUKE POWER COMPANY

Station _____ Unit _____ Rev. _____ File No. _____ Sheet _____ Of _____

Subject _____

_____ By _____ Date _____

Prob No. _____ Checked By _____ Date _____



Item # B02040.001
Component # 2-SGA-W058-1
450° Indication # 3

PAGE 11 OF 36

Form 00184 (R4-88)

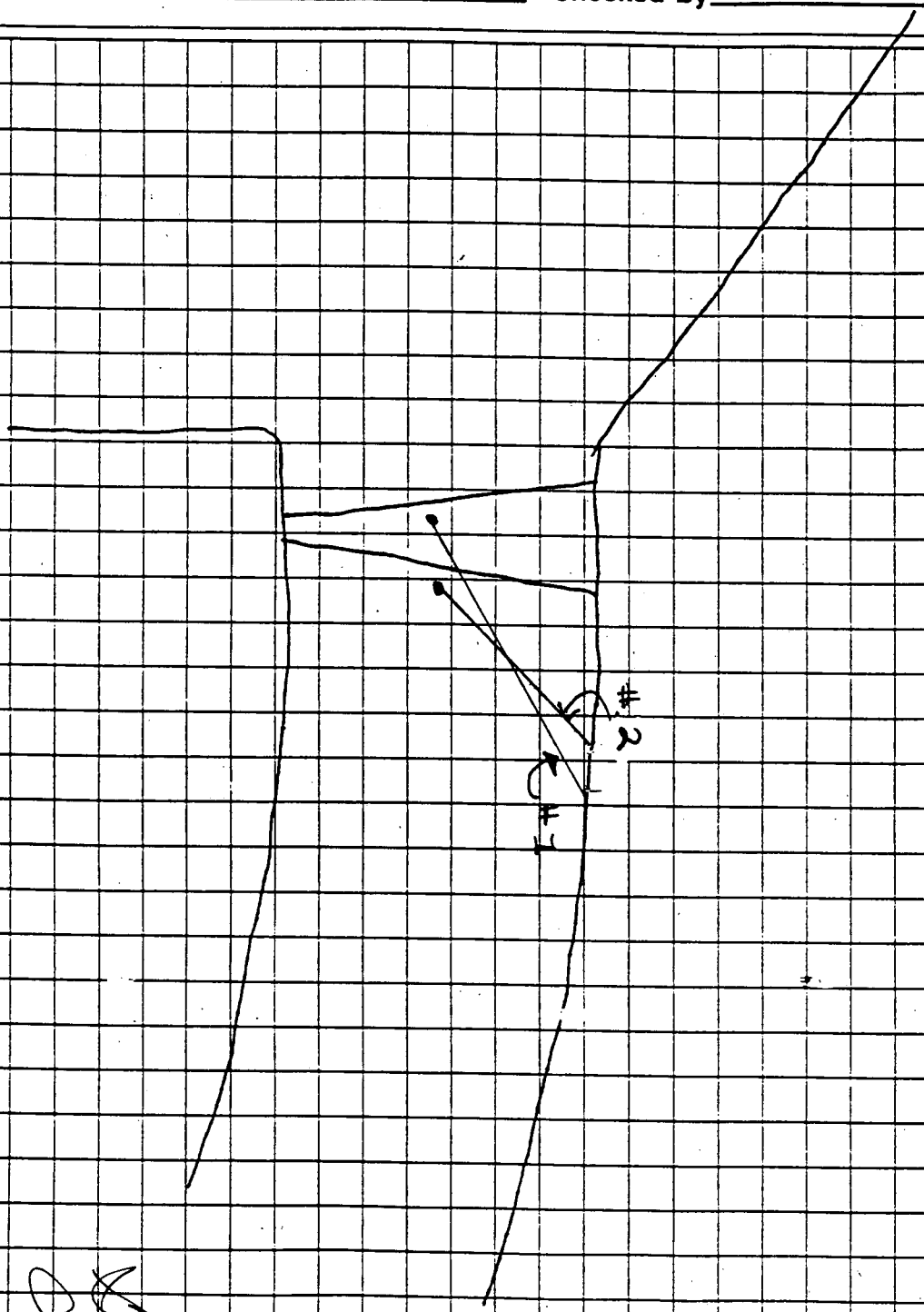
DUKE POWER COMPANY

Station _____ Unit _____ Rev. _____ File No. _____ Sheet _____ Of _____

Subject _____

_____ By _____ Date _____

Prob No. _____ Checked By _____ Date _____



ITEM # B02.040.001
COMPONENT # R-SGA-WG58-I
45° INDICATION #2
60° INDICATION #1

PAGE 12 OF 36

DUKE POWER COMPANY

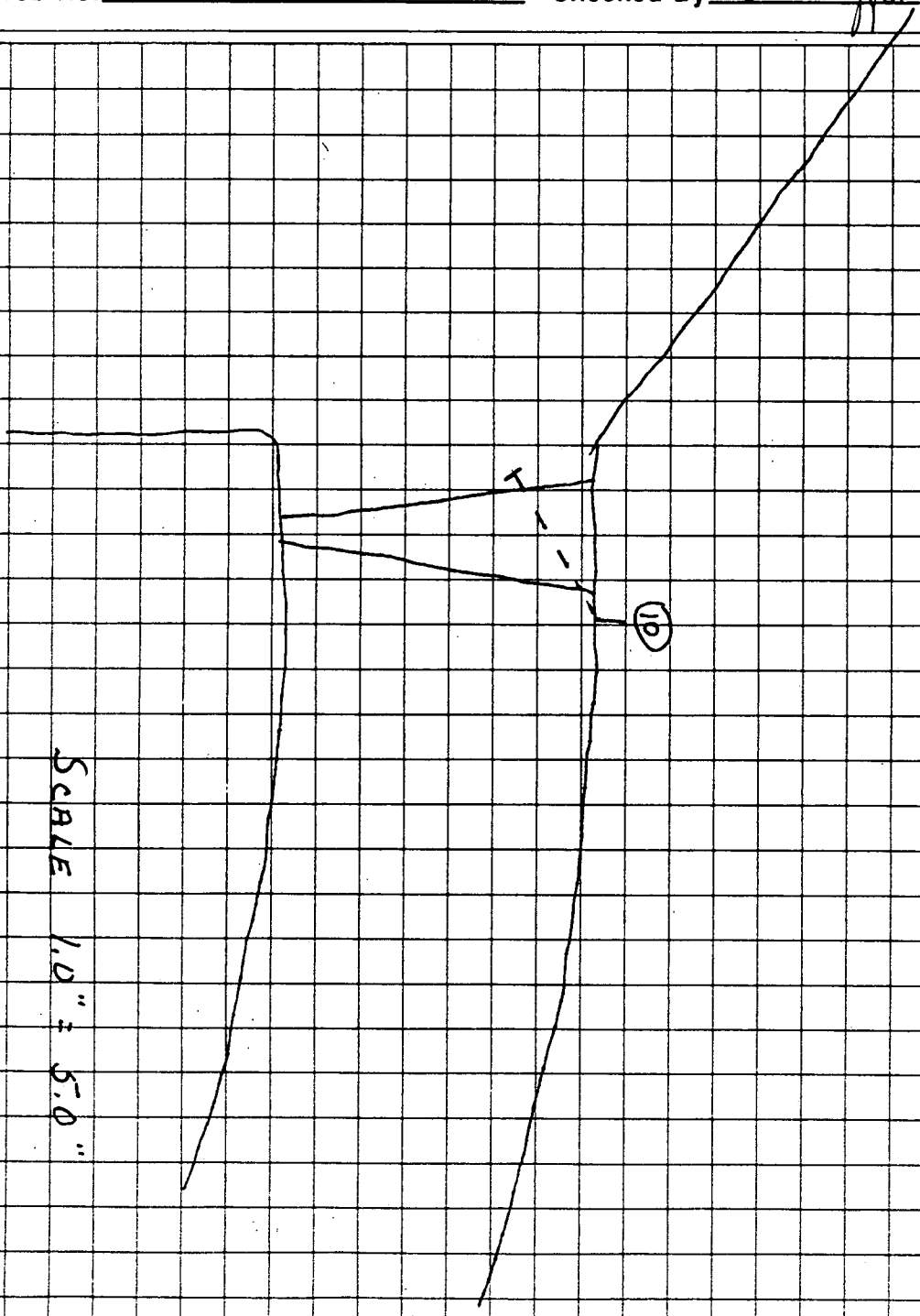
Form 00184 (R4-88)

Station Oconee Unit 2 Rev. ____ File No. ____ Sheet ____ Of ____

Subject Upper Head To Tube Sheet

By Guy L Bibb Date 4-29-96

Prob No. ____ Checked By [signature] Date 5/1/96



SCALE 1.0" = 5.0"

BOZ.040.00
ZSGA-0558-1
PAGE OF

PAGE 13 OF 36

DUKE POWER COMPANY | Form NDE-UT-8

ULTRASONIC INDICATION RESOLUTION SHEET | Revision 1

Acceptance Standard: ASME SECT XI IWB-3510

NOTE: INDICATION #1 IS THE SAME INDICATION AS IS #2. NO TWD'S WERE OBTAINED DUE TO PART GEOMETRY, where the HEAD & FLAT SURFACE MEET.

INDICATION #2. INDICATION #2 IS A SUBSURFACE PLANAR REFLECTOR. $l = .56"$ $a = .4$ $a/l = 0.00$ $a/t = 4.7\%$ MAX ALLOWABLE FOR ASPECT RATIO OF 0.00 IS 2% ∴ FLAW IS REJECTABLE

INDICATION #2 BECAME RECORDABLE WITH THE CHANGE IN RECORDING CRITERIA STARTING WITH THE 1989 SECTION XI. EXAMINATION PERFORMED DURING THIS OUTAGE WERE 2.5 TIMES MORE SENSITIVE THAN BEFORE

INDICATION #3 IS A SUBSURFACE PLANAR REFLECTOR $l = .8"$ $a = .23$ $a/l = .28$, $a/t = 2.7\%$. BY USING LINEAR INTERPOLATION THE MAX ALLOWABLE IS 4.2% ∴ ACCEPTABLE.

INDICATION #4 IS A SUBSURFACE PLANAR REFLECTOR $l = .50$ $a = .10$ $a/l = .20$ $a/t = 1.1\%$ THE MAX ALLOWABLE IS 3.3% ∴ ACCEPTABLE.

Acceptable Indications: # 3 # 4

Rejectable Indications: # 2

These indications have been compared with previous ultrasonic data ☑ yes ☐ No previous data available

Examiner [signature]	**Level:** III	**Date:** 5-1-96	[redacted]	**Sheet** 14 **of** 36
Reviewer: [signature]	**Level:** II	**Date:** 5/1/96	**Authorized Inspector:** [signature]	**Date:** 5-1-96

B02.040.001

DUKE POWER COMPANY

ISI LIMITATION REPORT

FORM NDE- UT-4

Revision 1

Component/Weld ID: 2SGA-WG58-1 Item No: B02.040.001

remarks:

DUE TO MANWAY, TOTAL LENGTH 31".

- [x] NO SCAN
- [ ] LIMITED SCAN

SURFACE: [x] 1 [ ] 2

BEAM DIRECTION: [ ] 1 [x] 2 [ ] cw [ ] ccw

FROM L 4/3" to L 19"

INCHES FROM WO 19.5" to BEYOND

ANGLE: [ ] 0 [ ] 45 [x] 60 other _____ FROM _____ DEG to _____ DEG

DUE TO VENT CONNECTION NO SCAN WAS PERFORMED PAST 8.5"

- [x] NO SCAN
- [ ] LIMITED SCAN

SURFACE: [ ] 1 [x] 2

BEAM DIRECTION: [x] 1 [ ] 2 [ ] cw [ ] ccw

FROM L 39.2" to L 41.5"

INCHES FROM WO 8.5" to 11.5"

ANGLE: [ ] 0 [ ] 45 [ ] 60 other 70° ON TAPER FROM _____ DEG to _____ DEG

DUE TO TAPER A 35° WAS USED TO PRODUCE A 0° IN PART

- [ ] NO SCAN
- [x] LIMITED SCAN

SURFACE: [ ] 1 [x] 2

BEAM DIRECTION: [x] 1 [ ] 2 [x] cw [x] ccw

FROM L _____ to L _____

INCHES FROM WO .75" to 2.0"

ANGLE: [x] 0 [ ] 45 [ ] 60 other FROM 0 DEG to 360 DEG

A 70° WAS USED ON TAPER, A 45° & 60° WAS NOT USED ON TAPER. THE ANGLE THAT WOULD BE PRODUCED IN PART WOULD BE 35° OR LESS

- [x] NO SCAN
- [ ] LIMITED SCAN

SURFACE: [ ] 1 [x] 2

BEAM DIRECTION: [x] 1 [ ] 2 [x] cw [x] ccw

FROM L _____ to L _____

INCHES FROM WO _____ to _____

ANGLE: [ ] 0 [x] 45 [x] 60 other FROM 0 DEG to 360 DEG

Sketch(s) attached [x] yes [ ] no

Prepared By: James W Stepp Level: III Date: 4-24-96

Sheet 15 of 36

Reviewed By: II Date: 5/1/96

Authorized Inspector: MBC Date: 5-1-96

Form 00184 (R4-88)

DUKE POWER COMPANY

20

Station OCONEE Unit 2 Rev. ____ File No. ____ Sheet 1

Subject UPPER HEAD TO TUBE SHEET.

By [signature] Date 4-24-96

Prob No. B02.040.001 Checked By [signature] Date 5/1/96

to DETERMINE AGGREGATE COVERAGE

		VE	VR
Subtotals =	BASE	125424.97	172975.04
	WELD	33024.88	39533.76
	NEAR SURFACE	25181.3	44333.44
TOTAL		183631.1	256842.24

AGG. % = 183631.1 / 256842.24 X 100%

= 71.5%

DUKE POWER COMPANY Limited Examination Coverage Worksheet	NDE-91-1 Revision 0

Examination Volume/Area Defined

Base Metal ☑ Weld ☐ Near Surface ☐ Bolting ☐ Inner Radius ☐

Area Calculation	Volume Calculation
58.28	58.28 x 424 = VR = 24,710.7

Coverage Calculations

Scan #	Angle	Beam Direction	Area Examined (sq.in.)	Length Examined (in)	Volume Examined (cu.in.)	Volume Required (cu.in.)	Percent Coverage
1	0° (35° on Taper)	n/A	49.15	424	20839.6	24,710.7	
2	45/60 (70 on Taper)	1	40.83	424	17311.92 - VENT COND. 74.66 17237.26		
3	45/60	2	56.09	424 MANWAY	23782.16 271.25 23510.91		
4	45	CW	37.64	424	15959.3		
5	45	CCW	37.64	424	15959.3		
6	60	CW	37.64	424	15959.3		
7	60	CCW	37.64	424	15959.3		
	Subtotal			125424.97	24710.7 x 7 = 172975.04		

Pg. 2 of 4 720 Lws

Item No: B02.040.001

Prepared BY: JW Satzler Level: III Date: 4.24.96

Reviewed By: [signature] Level: II Date: 5/1/96

DUKE POWER COMPANY	NDE-91-1
Limited Examination Coverage Worksheet	Revision 0

Examination Volume/Area Defined

Base Metal ☐ Weld ☑ Near Surface ☐ Bolting ☐ Inner Radius ☐

Area Calculation	Volume Calculation
$\frac{6.375}{2} \times (2.5 + .75) =$ 10.36 sq. in.	10.36 sq in. X 424 = 4392.64 cu. in.

Coverage Calculations

Scan #	Angle	Beam Direction	Area Examined (sq.in.)	Length Examined (in)	Volume Examined (cu.in.)	Volume Required (cu.in.)	Percent Coverage
—	0°	—	10.36	424	4392.64	4392.64	
1	45	2	10.36	424	4392.64	4392.64	
2	35 (70° ON TAPER)	1	5.42	424	2298.08 VENT CONN. - 4.32 2293.76	4392.64	
1	60	2	10.36 MANWAY	424	4392.64 - 17.36 4375.28	4392.64	
2	60	1	0	424	0	4392.64	
CW	45	CCW	10.36	424	4392.64	4392.64	
CCW	45	CW	10.36	424	4392.64	4392.64	
CW	60	CCW	10.36	424	4392.64	4392.64	
CCW	60	CW	10.36	424	4392.64	4392.64	
					33024.88 ÷	39533.76 X 100 =	83.54%

Page 3 of ~~17~~ 20

Item No: B02 040.001

Prepared BY: [signature] Level: III Date: 4.24.95

Reviewed By: [signature] Level: II Date: 5/1/95

DUKE POWER COMPANY Limited Examination Coverage Worksheet	NDE-91-1 Revision 0

Examination Volume/Area Defined

Base Metal ☐ Weld ☐ Near Surface ☑ Bolting ☐ Inner Radius ☐

Area Calculation	Volume Calculation
26.14	26.14 X 424 = 11083.36 = VR

Coverage Calculations

Scan #	Angle	Beam Direction	Area Examined (sq.in.)	Length Examined (in)	Volume Examined (cu.in.)	Volume Required (cu.in.)	Percent Coverage
1	60	1/2	17.56	424	7445.4	11083.36	
2	60	2/1	10.33	424	4379.9	}	
CW	60	CW	15.75	424	6678		
CCW	60	CCW	15.75	424	6678	11083.36	
		Sub total			25181.3	44333.44	

(1) 60 RL WAS USED IN PLACE OF A 70° & N/O OSCILLATION FOR CIRC SCAN.

Page 4 of 17 20 Sheets

Item No: B02-040.001

Prepared BY: J W Sikes Level: III Date: 4-24-96

Reviewed By: Level: II Date: 5/1/96

Station OCONEE Unit 2 Rev. ____ File No. ____ Sheet 5 of 20

Subject UPPER HEAD TO TUBE SHEET

ITEM # B02.040.001 By JW Setzer III Date 4.24.96

Prob No. 25GA-WG58-1 Checked By [signature] Date 5/1/96

SUMMARY of LOSS DUE TO LIMITATIONS

TAPER: NO 45° & 60° SCANS WERE DONE, A 70° WAS USED TO PRODUCE A 35° INTO PART. A 35° WEDGE WAS USED TO PRODUCE A 0° INTO PART. NO NEAR SURFACE EXAM WAS DONE ON TAPER

VENT CONNECTION:

35° (70° ON TAPER) SURFACE 2 TO 1

BASE METAL 32.46 sq. in.
LENGTH 2.3 in.
74.6058 = 74.66 cu. in.

WELD METAL 1.88 sq. in.
LENGTH 2.3 in.
4.324 = 4.32 cu. in.

SUPPORT PADS: NO ADDITIONAL LOSS

MANWAY:

60° (SURFACE 1 TO 2)

BASE METAL 8.75 sq. in.
LENGTH 31"
271.25 cu. in.

WELD METAL .56 sq. in.
LENGTH 31"
17.36 cu. in.

WELD LENGTH = 424 in.

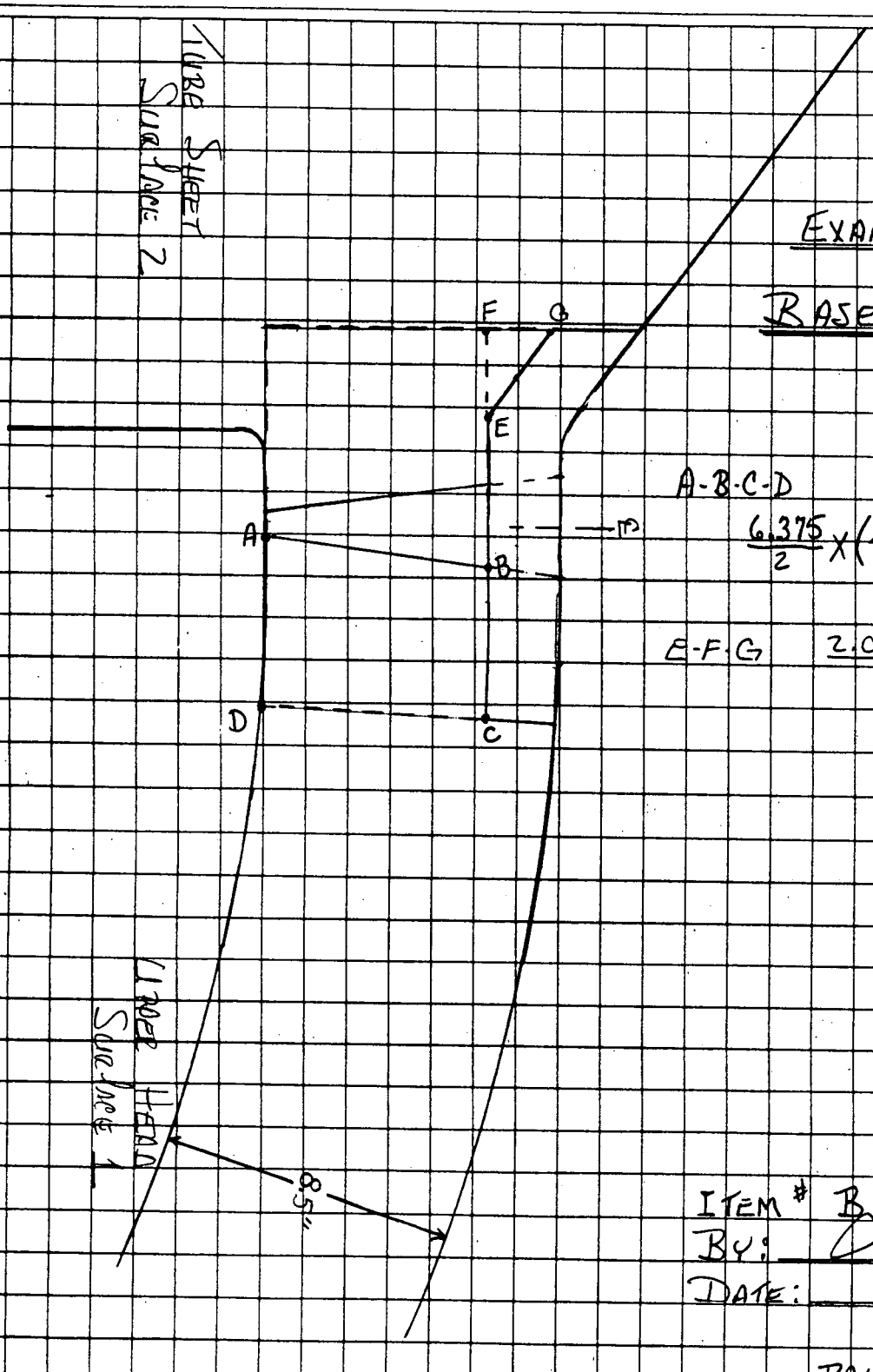
Form 00194 (R4-88)

Station OCONEE Unit 2 Rev. ____ File No. ____ Sheet 6 Of 20

Subject UPPER HEAD TO TUBE SHEET

By JWS III Date 4-24-96

Prob No. 2SGA-WG58-1 Checked By ____ Date ____



EXAM AREA:

BASE METAL

A-B-C-D $\frac{6.375}{2} \times (4.25 + 4.5) = 27.89$ @ SIDE

$\times 2$

55.78

E-F-G $\frac{2.0 \times 2.5}{2} = 2.5$

58.28 SQ. IN.

ITEM # B08.040.001

BY: ____ LEVEL II

DATE: 5/1/96

PAGE 21 OF 36

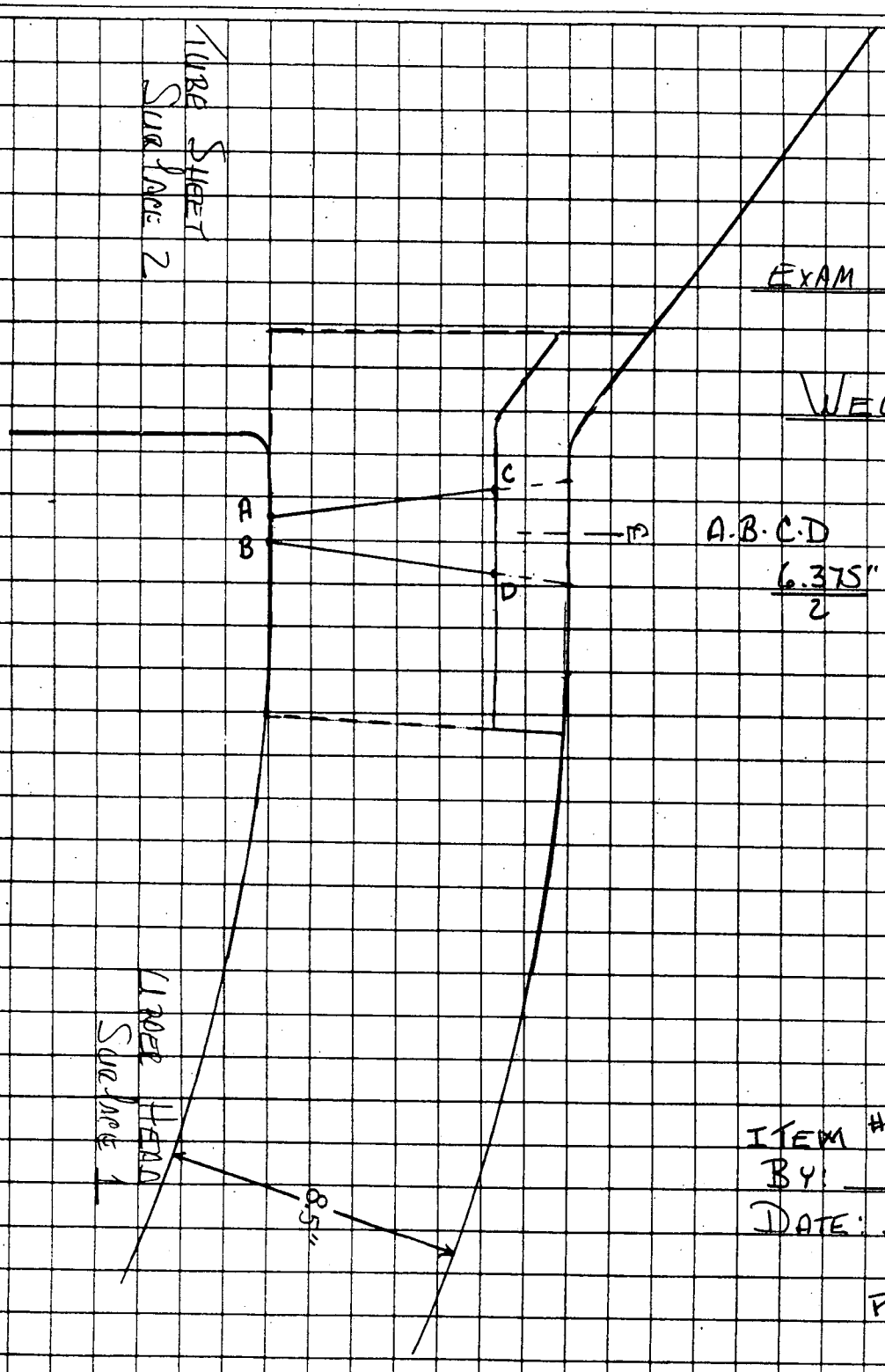
SCALE 1.0" = 5.0"

Station OCONEE Unit 2 Rev. ____ File No. ____ Sheet 7 Of 20

Subject UPPER HEAD TO TUBE SHEET

By J. W. Stiger III Date 4-24-96

Prob No. 2SGA-WG58-1 Checked By ____ Date ____



EXAM AREA:

WELD METAL

A.B.C.D

$\frac{6.375"}{2} \times (2.5 + .75) =$

10.36 SQ IN

ITEM # B04.040.001

BY: ____ LEVEL II

DATE: 5/1/96

PAGE 22 OF 36

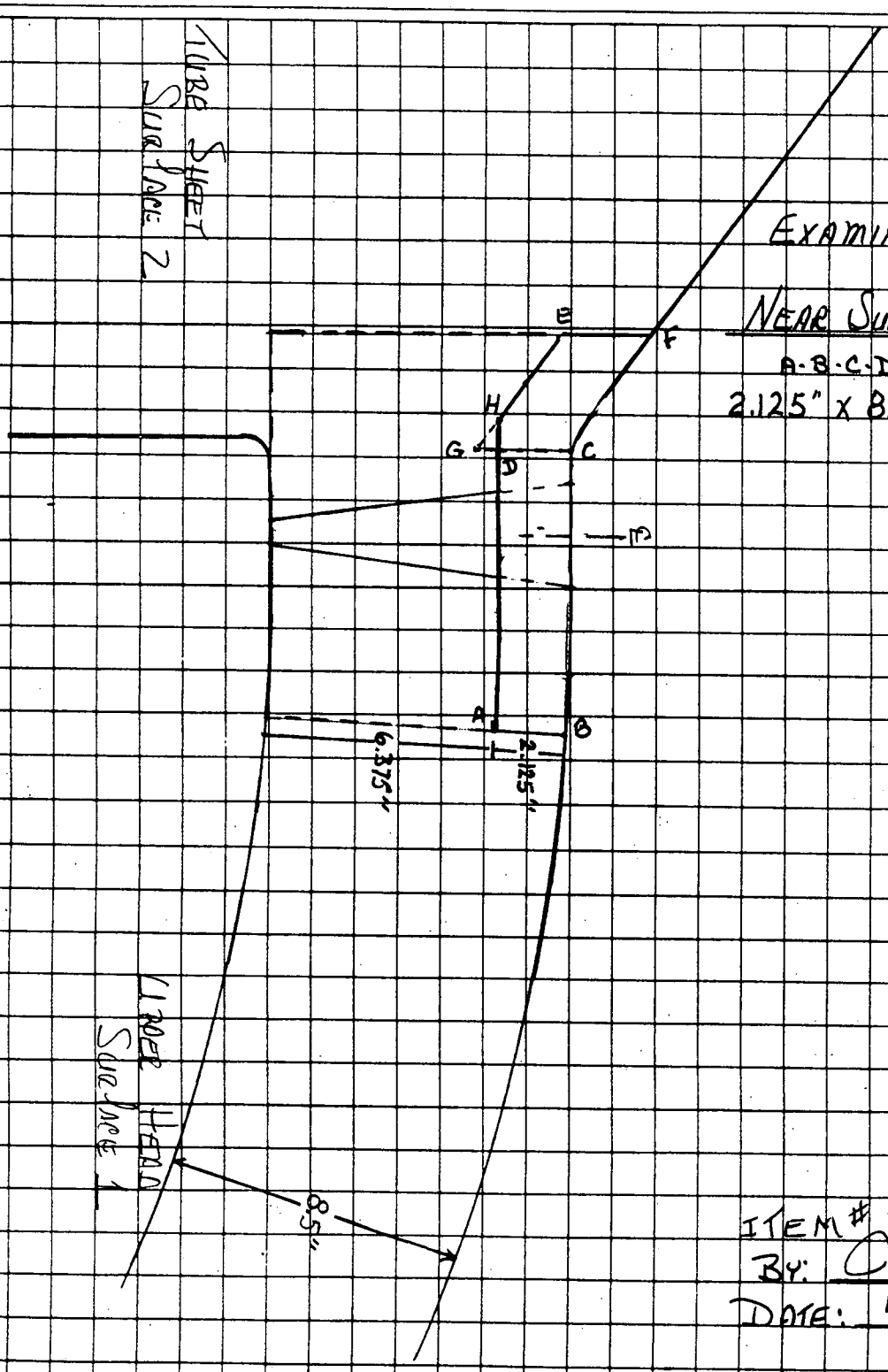
SCALE 1.0" = 5.0"

Station OCONEE Unit 2 Rev. ____ File No. ____ Sheet 8 of 17 sur 20

Subject UPPER HEAD TO TUBE SHEET

By Jim Sotzen III Date 4.21.96

Prob No. 2SGA-WG 58-1 Checked By ____ Date ____



EXAMINATION AREAS:

NEAR SURFACE:

A-B-C-D C-D-E-F D-G-H

$2.125" \times 8.125" + (4.0" \times 2.125" - \frac{1.0 \times .75}{2})$

26.14 SQ. IN.

ITEM # B02.040.001

BY: ____ Level II

DATE: 5/1/96

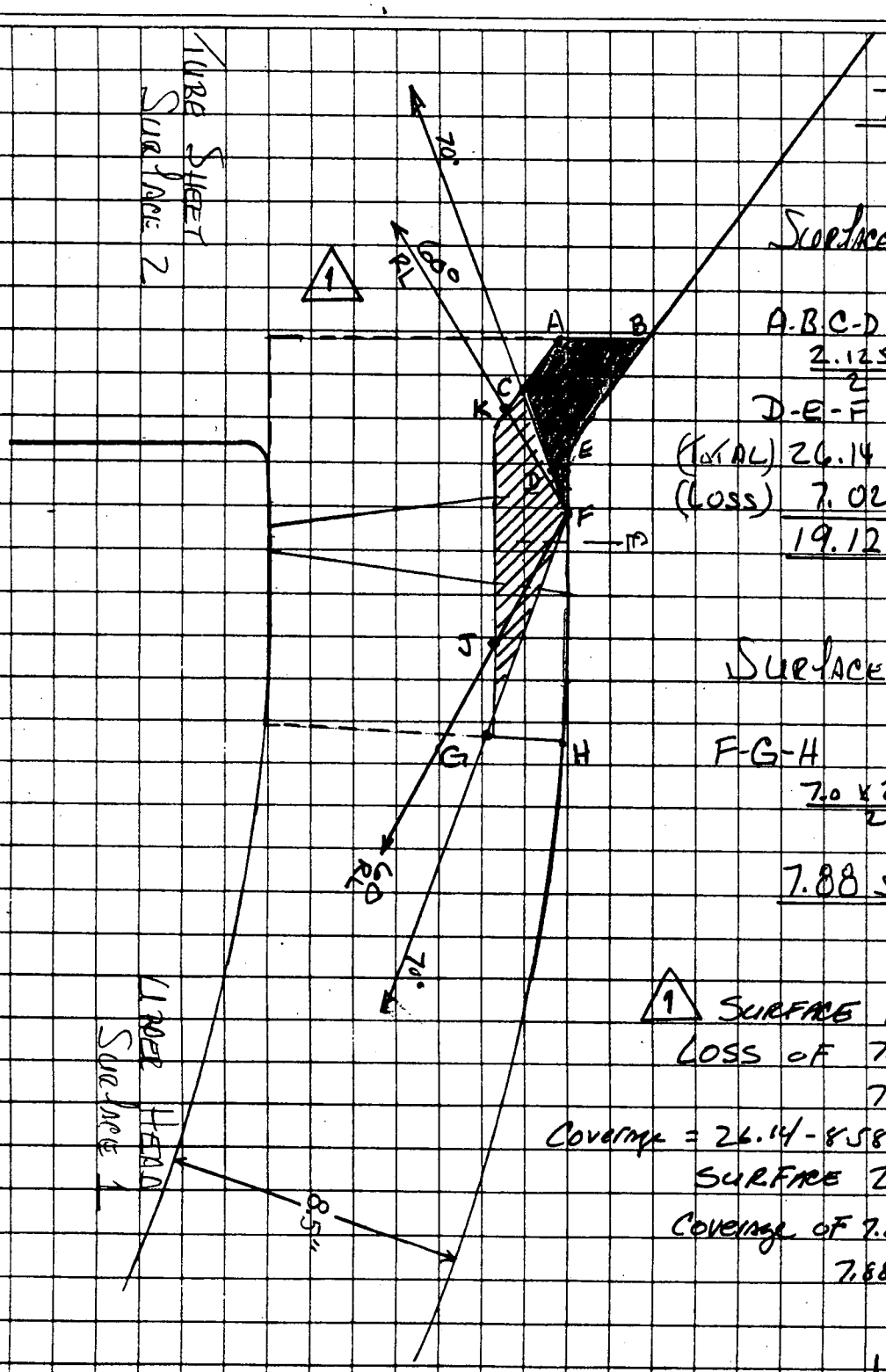
SCALE 1.0" = 5.0"

Station OCONEE Unit 2 Rev. ____ File No. ____ Sheet ~~9~~ 9 of 17 ~~20~~

Subject UPPER HEAD TO TUBE SHEET

By Jw Setzer III Date 4.24.98

Prob No. 2SGA-WG58-1 Checked By ____ Date ____



70° NEAR SURFACE

SURFACE 1 TO 2 COVERAGE

A-B-C-D $\frac{2.125}{2} \times (4.5 + 1.95) = 6.64$ SQ.IN.

D-E-F $\frac{1.5 \times .5}{2} = .38$ SQ. IN.

(TOTAL) 26.14

(LOSS) 7.02

19.12 SQ IN. COVERAGE

SURFACE 2 TO 1 COVERAGE

F-G-H

$\frac{7.0 \times 2.25}{2} = 7.88$ SQ. IN.

7.88 SQ IN COVERAGE

1 SURFACE 1 TO 2

LOSS OF 7.02 + (C, K & F) =

$7.02 + \frac{3.9 \times .8}{2} = 8.58$ SQ.IN.

Coverage = 26.14 - 8.58 = 17.56 SQ.IN.

SURFACE 2 TO 1

Coverage OF 7.88 + (F, J & G)

$7.88 + \frac{7.0 \times .7}{2} = 10.33$ SQ.IN.

SCALE 1.0" = 5.0"

□ - 100% COVERAGE

▨ - LESS THAN 100% COVERAGE

■ - NO COVERAGE

ITEM # B-K.040.001

BY: ____ LEVEL III

DATE: 5/1/98

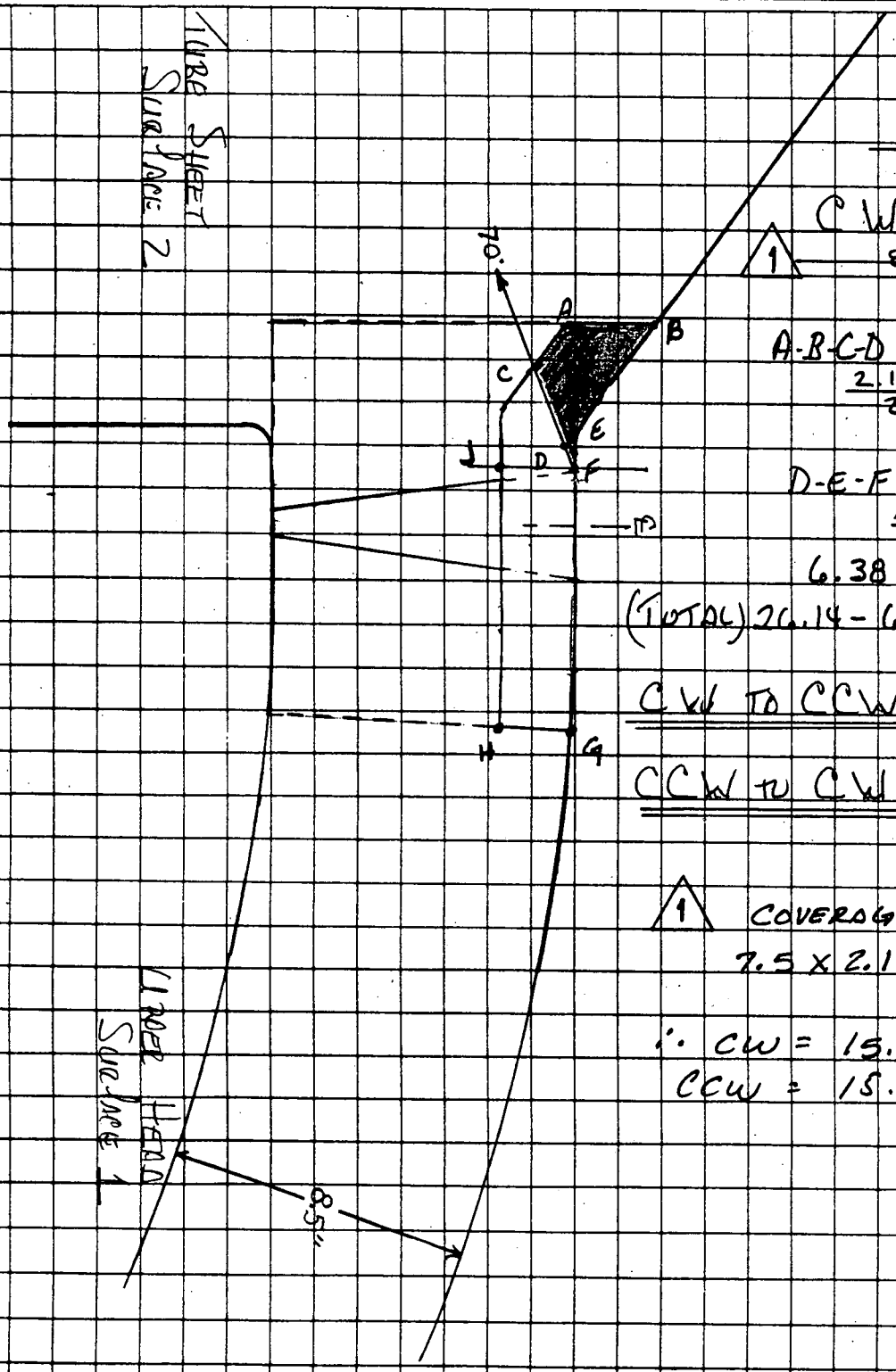
Form 0016d4 (R4-83)

Station OCONEE Unit 2 Rev. ____ File No. ____ Sheet ~~10~~ 10 of ~~17~~ 20

Subject UPPER HEAD TO TUBE SHEET

By JW Setzer III Date 4-24-85

Prob No. 2SGA-WG58-1 Checked By ____ Date ____



70° NEAR SURFACE

CW & CCW SCANS & OSCILLATION

(1)

A-B-C-D

$\frac{2.125}{2} \times (1.5 + 4.5) = 6.38$ sq in.

D-E-F

$\frac{1.0 \times .5}{2} = .25$ sq. in.

6.38 + .25 = 6.63

(TOTAL) 26.14 - 6.63 = 19.51

CW TO CCW COVERAGE 19.51 sq. in.

CCW TO CW COVERAGE 19.51 sq. in.

(1) COVERAGE CW & CCW =

7.5 x 2.1 (F, J, H & G) = 15.75 sq in

∴ CW = 15.75 sq in.

CCW = 15.75 sq in.

SCALE 1.0" = 5.0"

□ - 100% COVERAGE

▨ - LESS THAN 100% COVERAGE

■ - NO COVERAGE

ITEM # B02.040.001

BY: ____ LEVEL II

DATE: 5/1/85

Form 00164 (R-Aug)

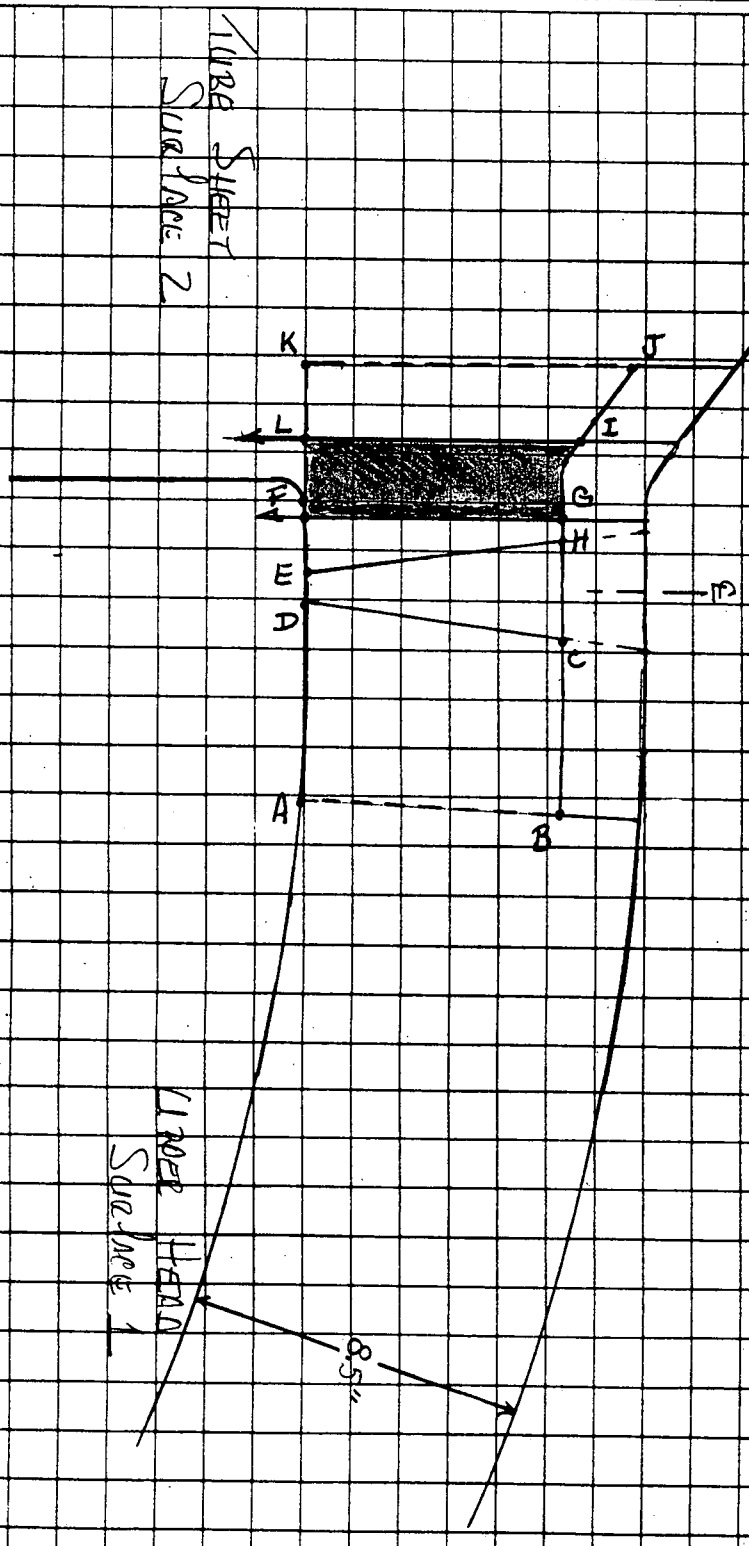
Sub

Station OCONEE Unit 2 Rev. ____ File No. ____ Sheet 8 of 17

Subject UPPER HEAD TO TUBE SHEET 11 20

By JW Schopp III Date 4-24-96

Prob No. 2SGA-WG58.1 Checked By ____ Date ____



0° (35° ON TAPER)

BASE METAL:

A-B-C-D

$\frac{6.375"}{2} \times (4.25 + 4.5) = 27.89$ sq. in.

E-F-G-H

$\frac{6.375"}{2} \times (.5 + .5) = 6.375 = 6.38$ sq in

I-J-K-L

$\frac{2.0"}{2} \times (6.375 + 8.5) = 14.875 = 14.88$ sq in

COVERAGE 49.15 SQ. IN.

WELD METAL

C-D-E-H

$\frac{6.375}{2} \times (2.5" + .75") = 10.36$

COVERAGE 10.36 sq. in.

SCALE 1.0" = 5.0"

□ 100% COVERAGE

▨ LESS THAN 100% COVERAGE

■ NO COVERAGE

ITEM # B02.040.001

BY: ____ LEVEL III

DATE: 5/1/96

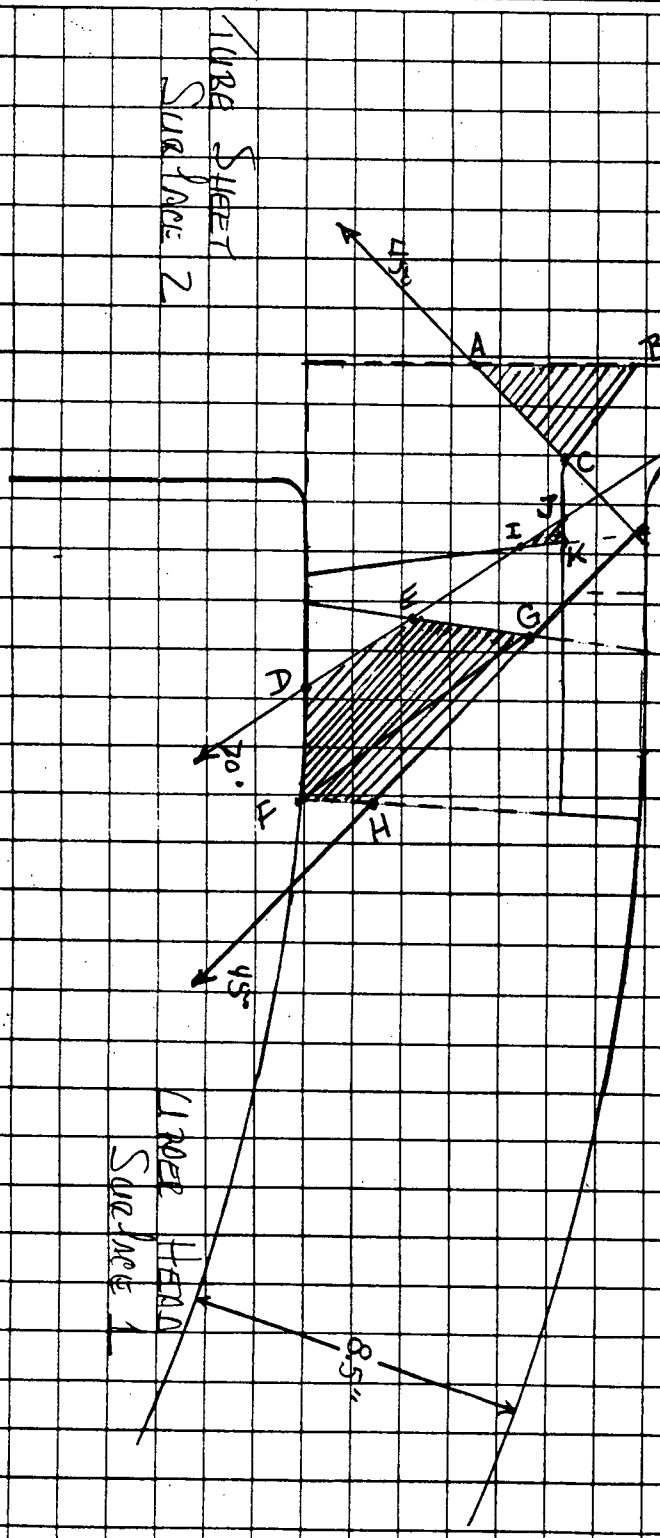
Form 00184

Station OCONEE Unit 2 Rev. ____ File No. ____ Sheet 9 OF 17

Subject UPPER HEAD TO TUBE SHEET 12 20

By Jim Setzer III Date 4-20-94

Prob No. 2SGA-WG58-1 Checked By ____ Date ____



BASE METAL
45° (70° - TAPER = 35°)

SURFACE 1 TO 2 COVERAGE

A-B-C $\frac{4.0" \times 2.25}{2}$ = 4.5 sq. in.

(TOTAL) 58.28 - 4.5 (LOSS) = 53.78 sq. in.

SURFACE 2 TO 1 COVERAGE

I-J-K $\frac{1.5" \times .5}{2}$ = .375 = .38 sq. in.

D-E-F-G

$\frac{2.25}{2} \times (7.5 + 3.5)$ = 12.38 sq. in.

F-G-H $\frac{7.5 \times 1.25}{2}$ = 4.69 sq. in.

(TOTAL) 58.28 - 17.45 (LOSS) = 40.83 sq. in.

SCALE 1.0" = 5.0"

□ 100% COVERAGE

▨ LESS THAN 100% COVERAGE

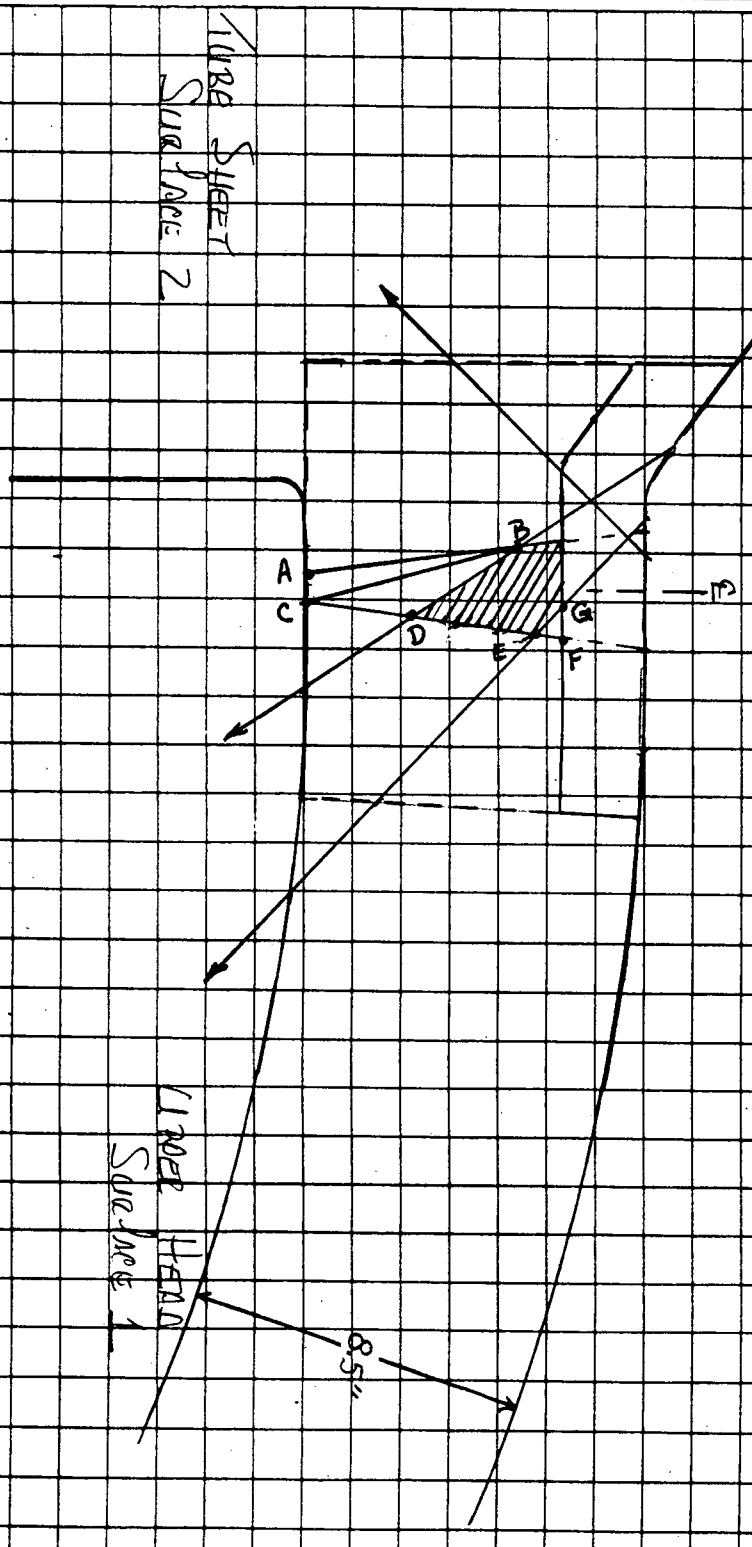
■ NO COVERAGE

ITEM # B-C 2.040.001

BY: ____ LEVEL II

DATE: 5/1/94

Station OCONEE Unit 2 Rev. ____ File No. ____ Sheet 10 OF 17
Subject UPPER HEAD TO TUBE SHEET 13 20
By JW Sitzer III Date 4-24-96
Prob No. 2 SGA-WG58-1 Checked By ____ Date ____



WELD METAL
45° (70° - TAPER = 35°)

Surface 1 to 2 Coverage

100% Coverage = 10.36 sq in.

Surface 2 to 1 Coverage

A-B-C $\frac{5.75 \times .75}{2}$ = 2.16 sq. in.

B-C-D $\frac{5.75 \times 1.0}{2}$ = 2.88 sq. in.

E-F-G = $\frac{1.0 \times .75}{2}$ = .38 sq in.

5.42 sq in.

SCALE 1.0" = 5.0"
□ - 100% COVERAGE
▨ - LESS THAN 100% COVERAGE
■ - NO COVERAGE

ITEM # B02.040.001
BY: ____ LEVEL II
DATE: 5/1/96

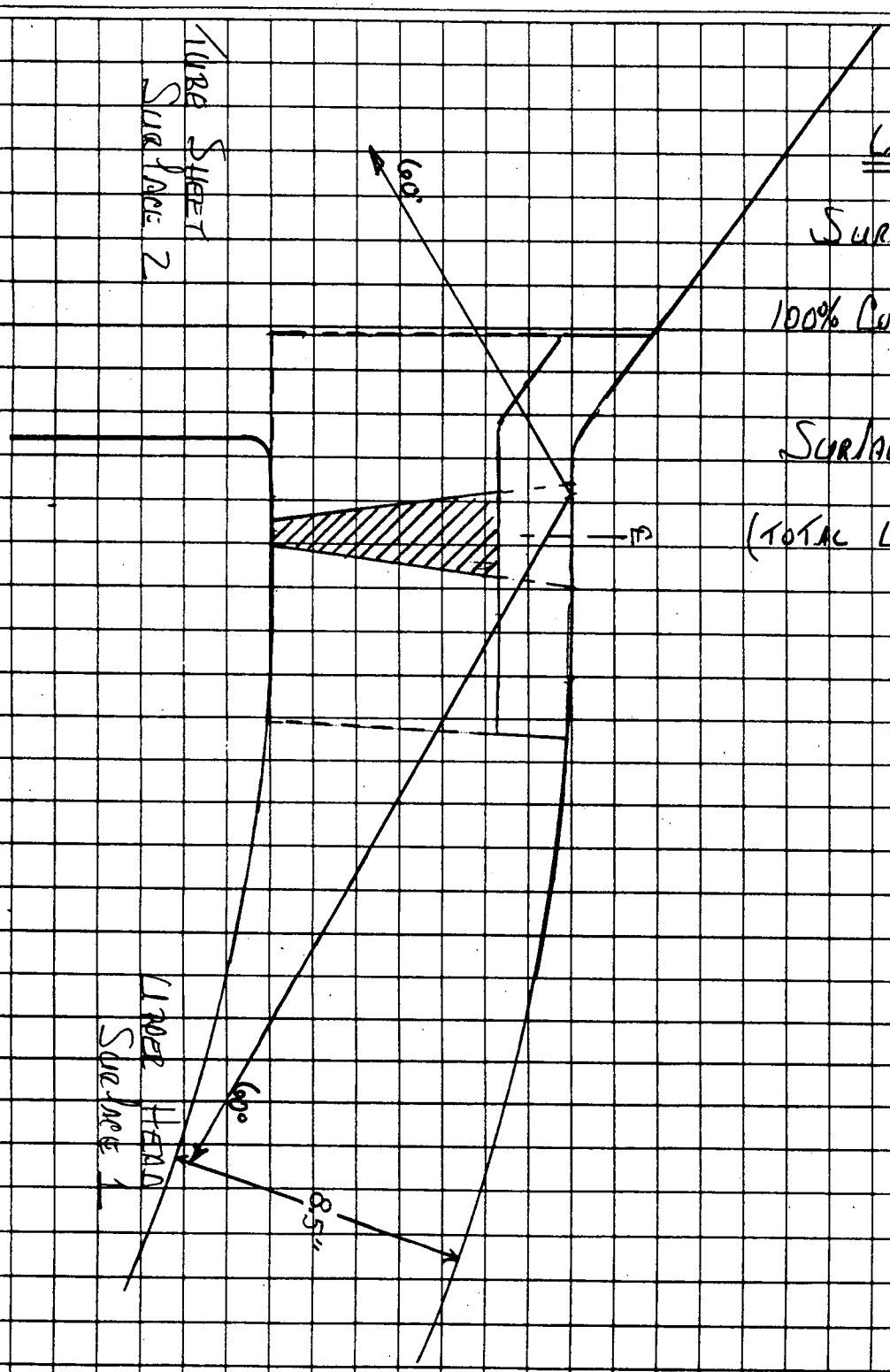
Form 00184 (R4-88)

Station OCONEE Unit 2 Rev. ____ File No. ____ Sheet 11 OF 17

Subject UPPER HEAD TO TUBE SHEET

By Jw Schaefer III Date 4-24-96

Prob No. 2 SGA-WG58-1 Checked By ____ Date ____



WELD METAL

60°

SURFACE 1 TO 2 COVERAGE

100% COVERAGE 10.36 SQ IN

SURFACE 2 TO 1 COVERAGE

(TOTAL LOSS) 0.0 COVERAGE

SCALE 1.0" = 5.0"

□ - 100% COVERAGE

▨ - LESS THAN 100% COVERAGE

■ - NO COVERAGE

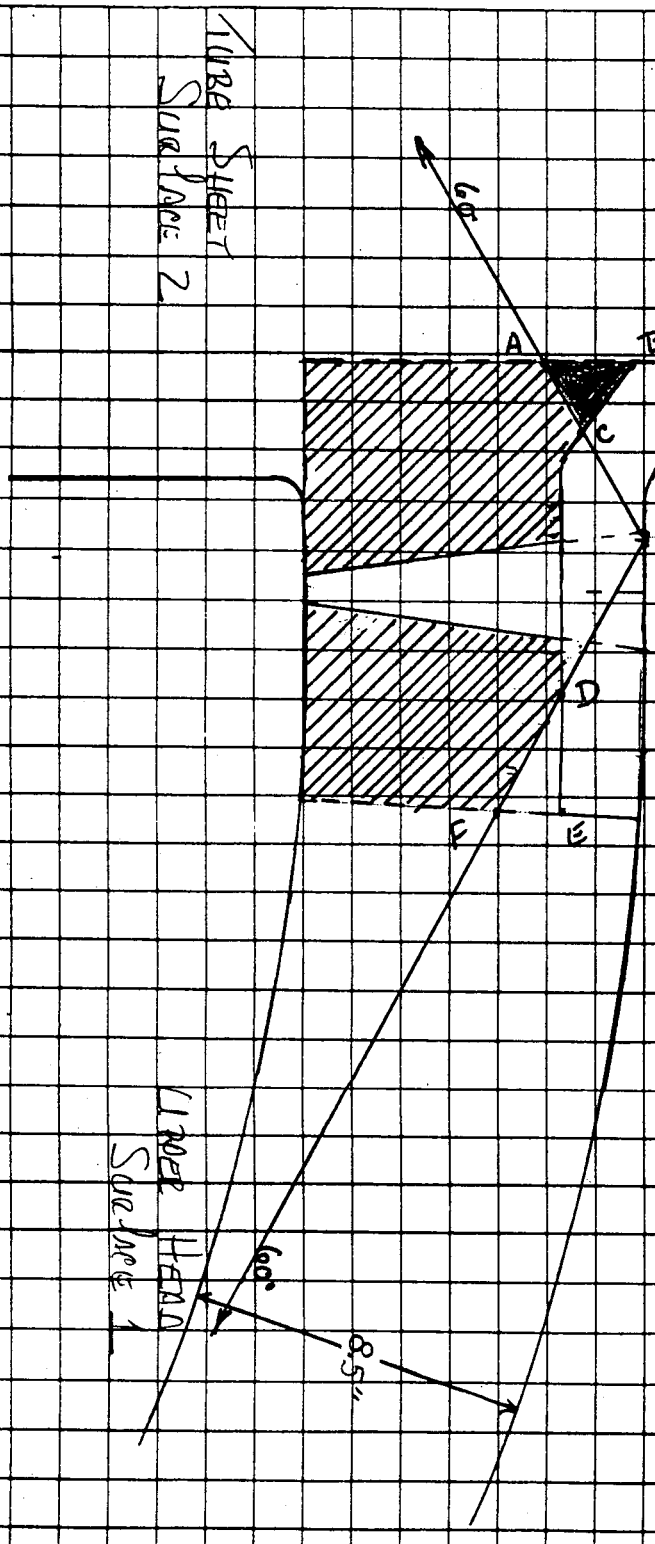
ITEM # B02.040.001

BY: ____ LEVEL II

DATE: 5/1/96

Form QA154 (R4-NS)

Station OCONEE Unit 2 Rev. ____ File No. ____ Sheet 12 of 17
Subject UPPER HEAD TO TUBE SHEET 15 20
By J.W. Sutton III Date 4.24.96
Prob No. 2SGA-WG58-1 Checked By ____ Date ____



BASE METAL

60°

SURFACE 1 TO 2 COVERAGE

A-B-C $\frac{2.5 \times 1.75}{2}$ = 2.19 sq. in.

(TOTAL) 58.28 - 2.19 = 56.09 sq. in.

COVERAGE = 56.09 sq. in.

SURFACE 2 TO 1 COVERAGE

D-E-F $\frac{3.5 \times 1.5}{2}$ = 2.63 sq. in.

COVERAGE = 2.63 sq. in.

SCALE 1.0" = 5.0"

□ - 100% COVERAGE

▨ - LESS THAN 100% COVERAGE

■ - NO COVERAGE

ITEM # B03.040.001

BY: ____ LEVEL III

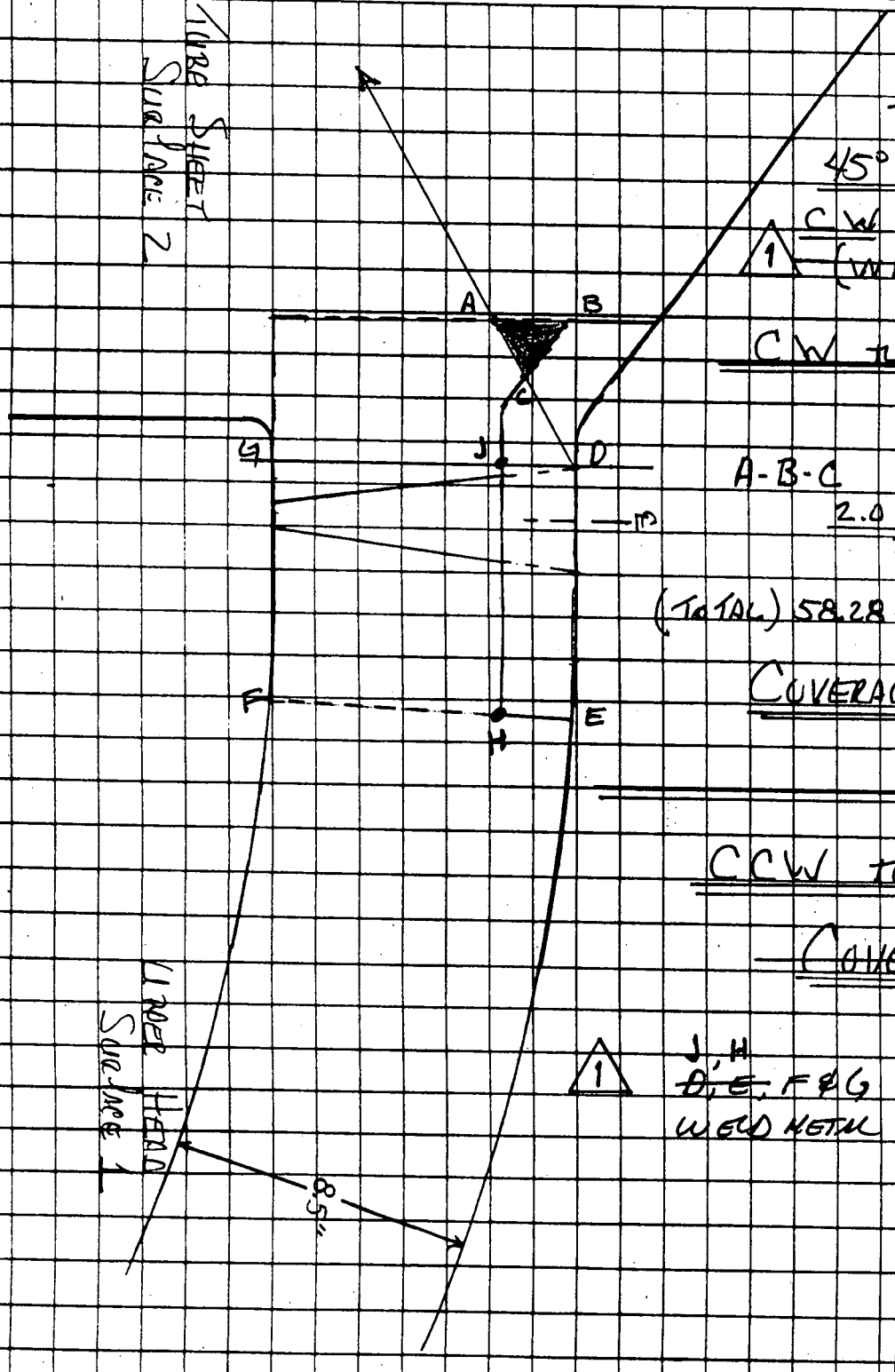
DATE: 5/1/96

Station DCONEE Unit 2 Rev. ____ File No. ____ Sheet 13 of 17 (c 20)

Subject UPPER HEAD TO TUBE SHEET

By Jim Sitzler III Date 4-24-96

Prob No. 2 SGA-WG58-1 Checked By ____ Date ____



BASE METAL

45° S/OR 60°

CW & CCW SCANS

1 (WITH OSCILLATION)

CW TO CCW

A-B-C

$\frac{2.0 \times 1.75}{2} = 1.75$ SQ. IN.

(TOTAL) 58.28 − 1.75 = 56.53 SQ IN.

COVERAGE 56.53 SQ. IN.

CCW TO CW

COVERAGE 56.53 SQ IN.

1 J, H ~~D, E, F & G~~ = COVERAGE - LESS WELD METAL = 7.5 X 6.4 − 10.36 = 37.64 SQ IN CW

37.64 SQ IN. CCW

SCALE 1.0" = 5.0"

□ - 100% COVERAGE

▨ - LESS THAN 100% COVERAGE

■ - NO COVERAGE

ITEM # B02.040.001

BY: ____ LEVEL II

DATE: 5/1/96

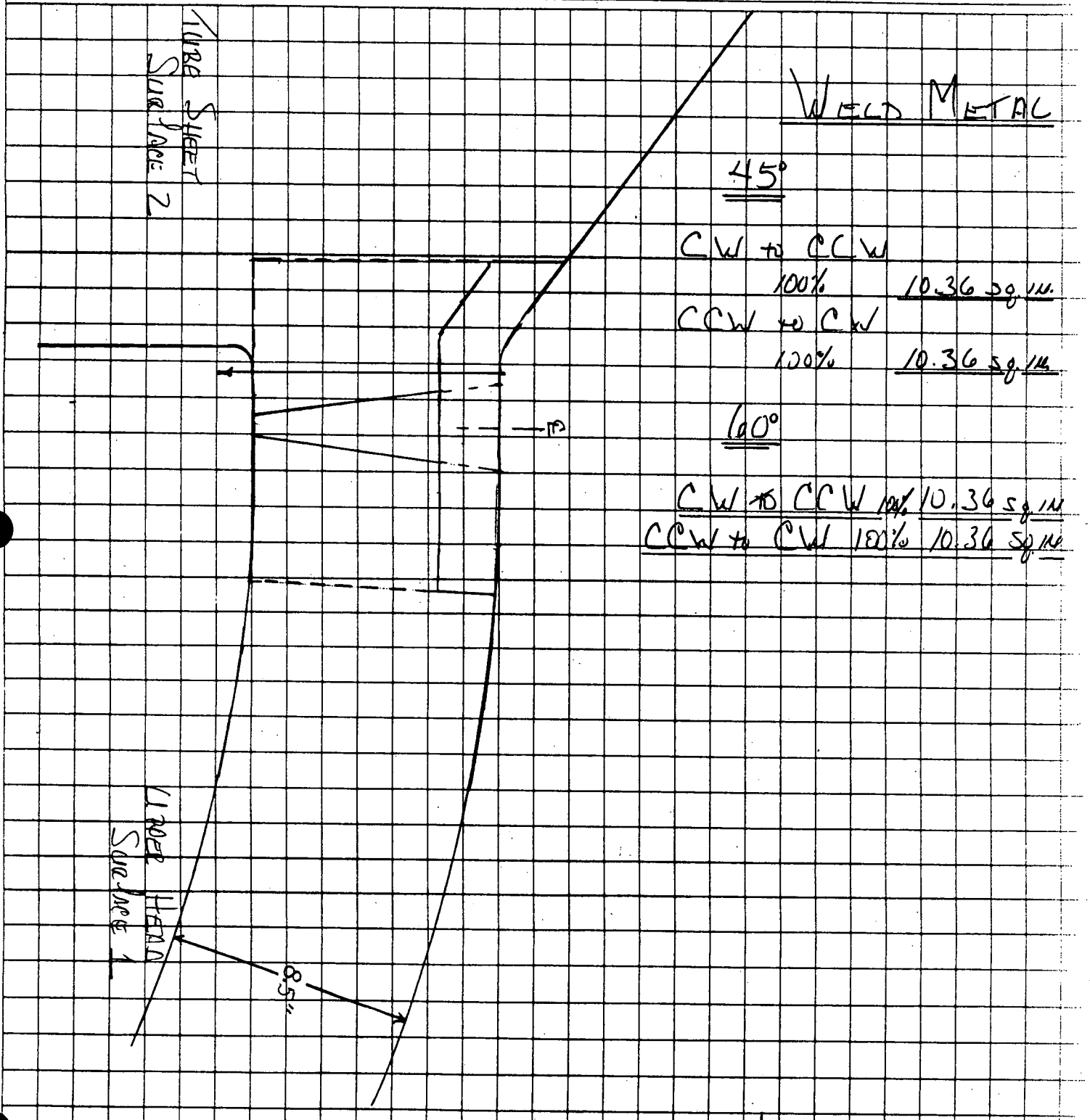
Form 00184 (R-4-88)

Station OCONEE Unit 2 Rev. ____ File No. ____ Sheet 44 of 47 (47 of 20)

Subject UPPER HEAD TO TUBE SHEET

By [signature] Date 4-24-96

Prob No. 2 SGA-WG58-1 Checked By ____ Date ____



WELD METAL

45°

CW to CCW
100% 10.36 sq. in.

CCW to CW
100% 10.36 sq. in.

60°

CW to CCW 100% 10.36 sq. in.

CCW to CW 100% 10.36 sq. in.

SCALE 1.0" = 5.0"

□ - 100% COVERAGE

▨ - LESS THAN 100% COVERAGE

■ - NO COVERAGE

ITEM # B4.040.001

BY: [signature] LEVEL II

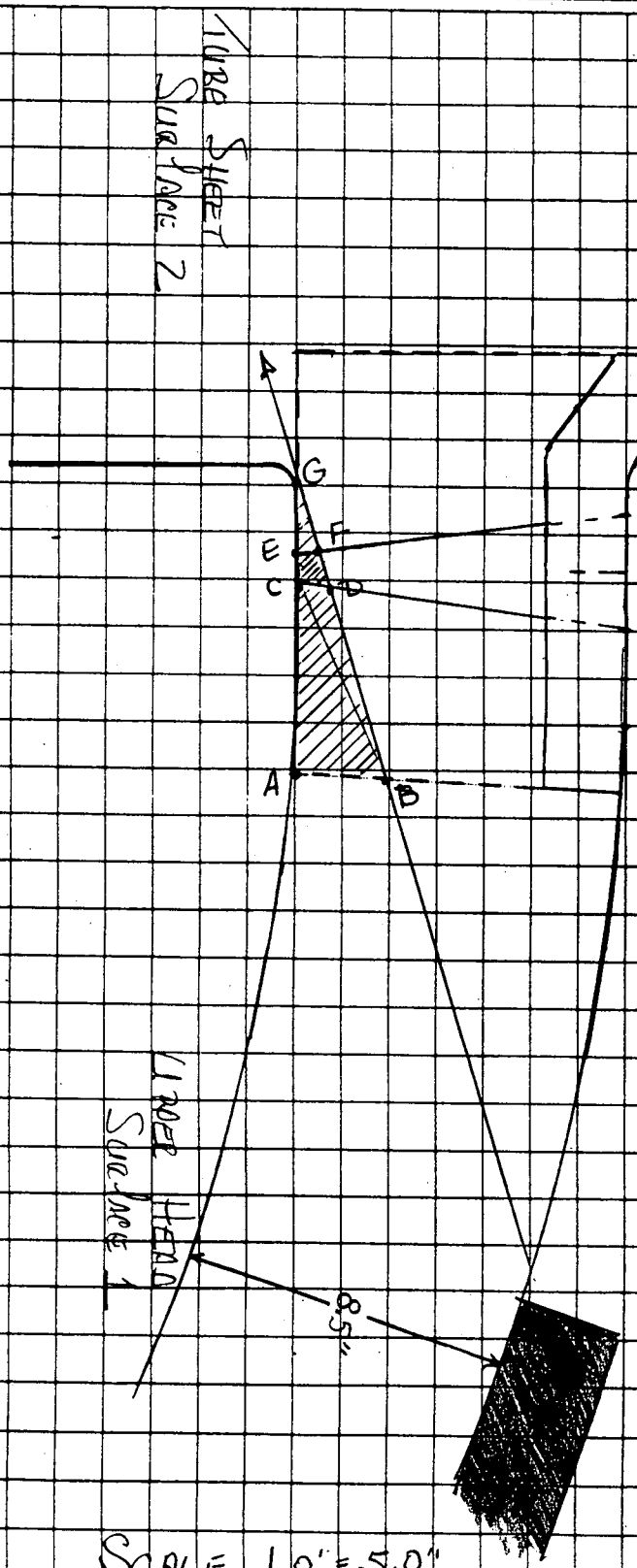
DATE: 5/1/96

Station OCONEE Unit 2 Rev. File No. Sheet 16 Of 17 18 20

Subject UPPER HEAD TO TUBE SHEET

By JW Sokp III Date 4-24-96

Prob No. 2 SGA-WG58-1 Checked By Date



60°
SURFACE 1 TO 2
LIMITATION DUE
TO MAN WAY

BASE METAL LOSS:

A-B-C $\frac{2.5 \times 5.0}{2}$ = 6.25 sq. in

B-C-D $\frac{5.5 \times .75}{2}$ = 2.06 sq. in

E-F-G $\frac{1.75 \times .5}{2}$ = .44 sq. in

8.75 sq. in.

WELD METAL LOSS:

C-D-E-F $\frac{.75}{2} \times (.5 + 1.0) = .56$ sq. in

THIS LIMITATION WAS 31" LONG

SCALE 1.0" = 5.0"

□ - 100% COVERAGE

▨ - LESS THAN 100% COVERAGE

■ - NO COVERAGE

ITEM # B02.040.001

BY: LEVEL II

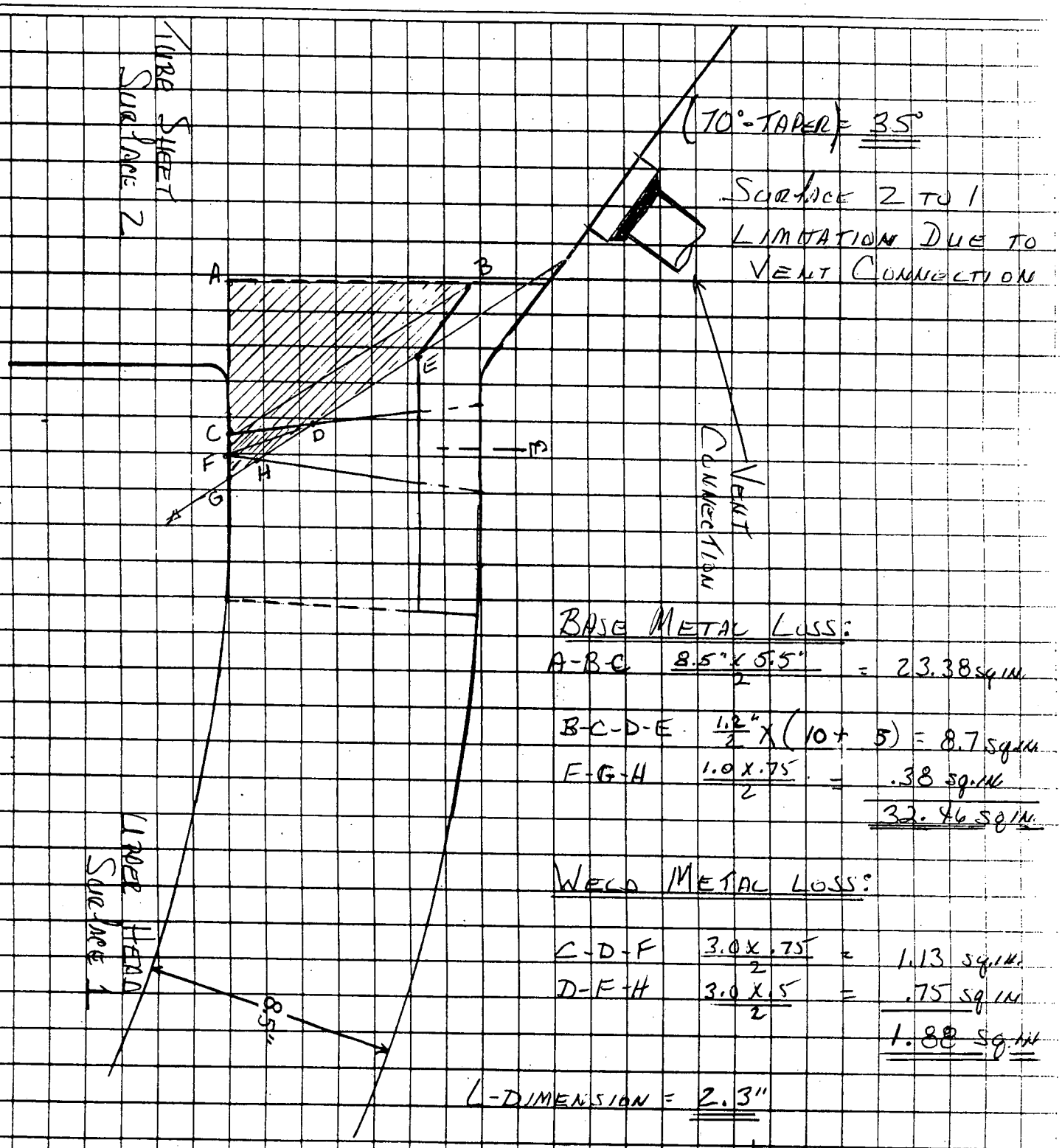
DATE: 5/1/96

Station OCONEE Unit 2 Rev. ____ File No. ____ Sheet 16 of 17 (19 of 20)

Subject UPPER HEAD TO TUBE SHEET

By James W Sikes III Date 4-24-86

Prob No. 2SGA-WG58-1 Checked By ____ Date ____



SCALE 1.0" = 5.0"

□ - 100% COVERAGE

▨ - LESS THAN 100% COVERAGE

■ - NO COVERAGE

BASE METAL LOSS:

A-B-C	$\frac{8.5" \times 5.5"}{2}$	= 23.38 sq.in.
B-C-D-E	$\frac{1.2"}{2} \times (10 + 5)$	= 8.7 sq.in.
F-G-H	$\frac{1.0 \times .75}{2}$	= .38 sq.in.
		32.46 sq.in.

WELD METAL LOSS:

C-D-F	$\frac{3.0 \times .75}{2}$	= 1.13 sq.in.
D-E-H	$\frac{3.0 \times 1.5}{2}$	= .75 sq.in.
		1.88 sq.in.

ITEM # B02.040.001

BY: ____ LEVEL III

DATE: 5/1/86

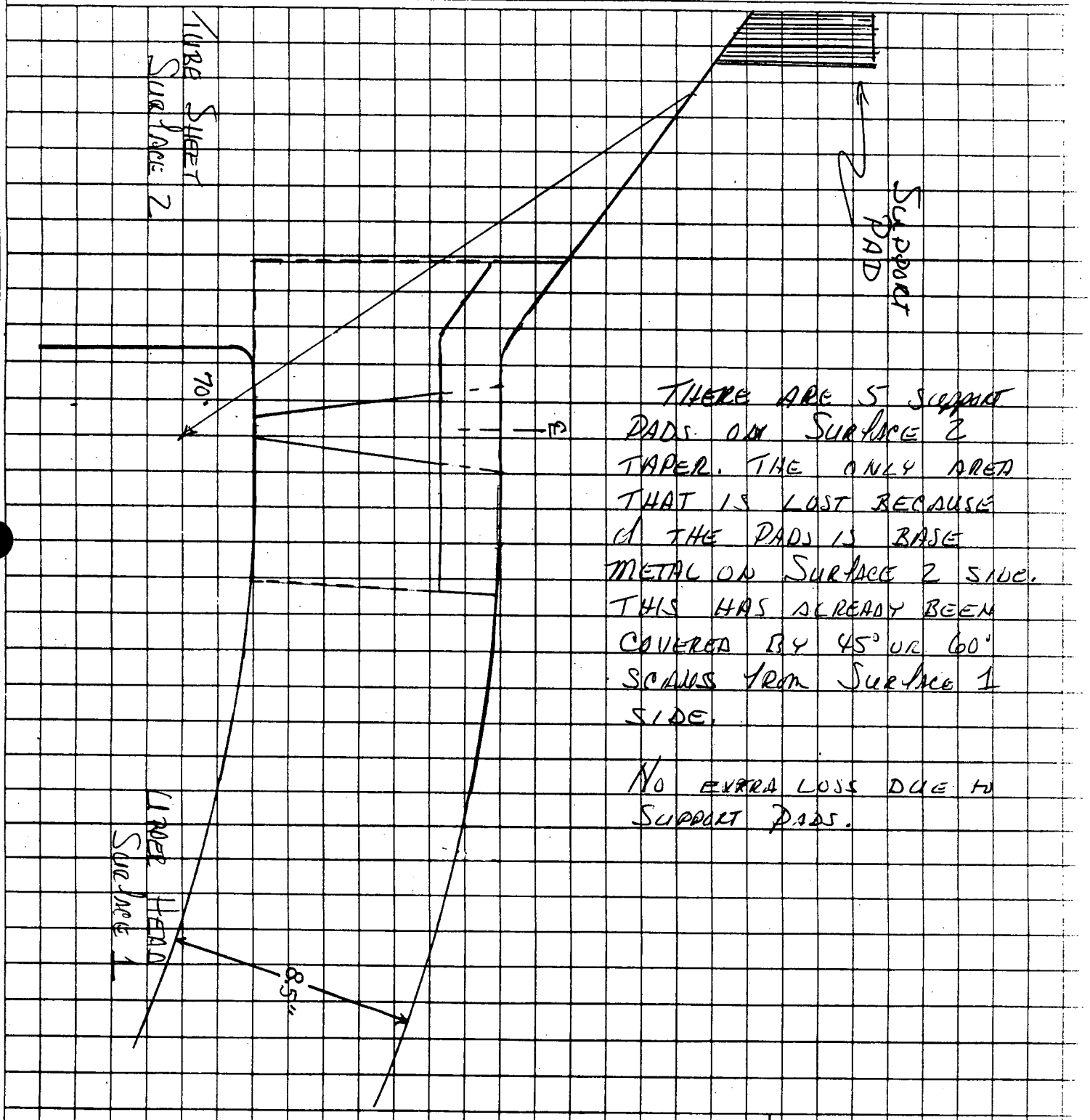
Form 3016 (A-38)

Station OCONEE Unit 2 Rev. ____ File No. ____ Sheet 17 Of 17

Subject UPPER HEAD TO TUBE SHEET 20 20

LIMITED AREA FOR SUPPORT PADS By [signature] Date 4-24-96

Prob No. 2SGA-WG58-1 Checked By ____ Date ____



THERE ARE 5 SUPPORT PADS ON SURFACE 2 TAPER. THE ONLY AREA THAT IS LOST BECAUSE OF THE PADS IS BASE METAL ON SURFACE 2 SIDE. THIS HAS ALREADY BEEN COVERED BY 45° OR 60° SCANS FROM SURFACE 1 SIDE.

NO EXTRA LOSS DUE TO SUPPORT PADS.

SCALE 1.0" = 5.0"

□ - 100% COVERAGE

▨ - LESS THAN 100% COVERAGE

■ - NO COVERAGE

ITEM # B02.040.001

BY: [signature] LEVEL II

DATE: 5/1/96

Duke Power Company
Indication Evaluation Report

Station/Unit	Weld/ID No.	ISO Dwg No.	Sheet No.
ONS / 2	2-SGA-WG58-1	ISI-OCN2-003	96020E005

Component Description	Exam Procedure
Steam Gen. A upper head- to- tube sheet weld	NDE-620 Rev. 3

Code/Year/Addenda	Exam Category	Acceptance Standard(Para or Table)	Ref. Report
Sec XI / 1989 / none	B-B	IWB-3510-1	N/A

Flaw Characterization	Nom/Act Wall	Type Material
SLAG LINE	8.5"	C/S

Evaluator	Date	INF	ISI/PSI
James J. McArdle James J. McArdle	4/30/96		ISI

Calculations/Evaluation

L = 56", a = 0.4", a/l = 0.00, a/t% = 4.7% REJECTABLE subsurface flaw. Table IWB-3510-1 allows 2% for an aspect ratio of 0.00.

Comments

This indication was not recorded in previous exams because of the change in recording criteria starting with the 1989 Section XI. The examinations peformed this outage are 2.5 time more sensitive.

Technical Review	Date	Non-Technical Review	Date
N/A			5/1/96