#7

OSC 1522

Design Report #7

Thermal Mechanical Stress Analysis of High Pressure Injection Nozzle

B&W Contract No. 620-0003-50
Customer: Duke Power Company

FOR INFORMATION ONLY

Prepared By: W.L. Tanksley and Associates, Inc.

Reviewed By: Robert Tornow

Approved By: James ? Butt

Report #7 - "Thermal Mechanical Stress Analysis of High Pressure Injection Nozzle"

Replace entire report with the "Thermal Mechanical Analysis of 2-1/2 Sch 160 make-up and High Pressure Injection Nozzle" for 620-0009-50 as modified in FCA 04-3601-00 (Reference #4), B&W Document 32-1128224-02 (Reference #1), and the changes to the 620-0009-50 report described below:

1. Page iii - Reference A.1 - 150156E-6 should be 131924E-9.

2. Page iii - Reference B.1 - Add "As modfied by FCA 04-3599-00.

REV.	DATE
0	12-69
1	5-72

REVISION PAGE

REV. NO.	PAGE	DESCRIPTION	DATE	BY/APP.
	ALL	INITIAL RELEASE		
		The changes below indicate the modifications required to update the 620-0008-50 analysis to the requirements of 620-0009-50.		
	i	Added last sentence in Scope.		
		Changed 70°-90°F to 70°-95°F in 4th line of Discussion.		
		Eliminate all but 1st sentence in Conclusion.		
0	ii	Omitted primary stress results in Results Section.	6-73	FLB/
	iii	Reference A.1 revised for NSS-9 contract.		
		Reference B.1 revised for NSS-9 contract.		
	1.0	Added explanation for a dimensional change on nozzle.		
	1.1	Added NSS-9 dimensions (asteriked) to nozzle sketch.		
	3-56	Add statement at bottom of page.		
	3-65	Omitted Case-2 earthquake loading.		
	3-66	Omitted all reference to piping reaction stresses.		
	5-21	Omitted all references to earthquake loadings.		
	5-22 to 5-31	Omitted all reference to piping reaction stresses.		
1	ii 5-21 5-24 5-25 5-28 5-29 5-30 5-31	Added note referencing fatigue analysis with pipe loads contained in Section "F".	10/29/73	DMcK/[illegible]

Revisions For B&W Report # 5

[illegible].	Date	Page	Revision Comments	By	A
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INDEX

JMS
8-72

SCOPE:

This report contains the Thermal/Mechanical Analysis of the make-up nozzle and high pressure injection nozzle. These nozzles have the same geometry but are used for different purposes. They are located in the cold legs on the discharge side of the pumps. This report contains the justification of primary plus secondary stress limits and the fatigue analysis as defined in B31.7 "Nuclear Piping Code". Satisfaction of basic pressure sizing criteria and reinforcement calculations are found in Report 1 "Code Sizing Calculation". Piping reaction loads and stresses can be found in Report #4, "Piping Reactions".

DISCUSSION:

The make-up nozzle and high pressure injection nozzles have the same pressure, branch moment loading and run moment loading, but have different temperature distributions. The make-up nozzle is predominately cold in that it has a fairly constant flow and is at a temperature of 70°-95°F. The HPI is only used for a sudden pressure drop condition, and thus is at a temperature consistent with the cold leg temperature, 550°-575°F, when it is shocked with 60°F water. The critical stress location in the make-up nozzle occurs near the nozzle to run pipe intersection whereas the critical stress in the high pressure injection nozzle occurs outside the thermal sleeve in the upper part of the nozzle.

The analysis has essentially the same format for both nozzles. First, the temperature distribution is evaluated for various transient conditions and time-temperature plots for selected nodes are made to select critical times. These times are then used to calculate stresses, and thus stress ranges can be determined for thermal stresses. Secondly, stresses are calculated for pressure loading, and the stresses are then combined to obtain the total stress picture. Finally a fatigue analysis is performed to demonstate acceptable performance during the design duration.

CONCLUSION:

The make-up nozzle and high pressure injection nozzle meet all the requirements of B31.7 1968 Draft.

JMS
8-72

RESULTS

Primary + Secondary Stresses

Branch Intersection Make-Up Nozzle

$S = 21.1$ ksi $< 3\ S_m = 53.4$ ksi

End of HPI Nozzle

$S = 107$ ksi $> 3\ S_m = 51.3$ ksi

An elastic plastic analysis was performed. Range of primary + secondary stresses occurring more than 250 cycles.

$S = 9.85$ ksi $< 3\ S_m = 51.3$ ksi

Fatigue Usage Factors

Branch Intersection make-up nozzle

$U = .045 < 1.0$

End of HPI Nozzle

$U = .953 < 1.0$

NOTE: This fatigue analysis includes thermal and mechanical discontinuity stresses only. For inclusion of stresses due to run and branch pipe motions, see Section "F".

0005190283

D.MCK.
10/29/73
REV. 1

REFERENCES

A. Drawings

1. Babcock and Wilcox Drawing 150156E-6 "Assembly and Detail for 2-1/2" Pressure Injection Nozzle".

B. Codes and Specs.

1. General Functional Specifications for Reactor Coolant System Components, CS(F)-3-92/NSS-9/0372.
2. Nuclear Power Piping, USAS B31.7, 1968 Draft.

C. Computer Programs

1. 91167 - "Temperature Distribution"
2. 91032 - "Temperature Interpolation"
3. 169 - "Ring Thermal Stresses"
4. 91079 - "Thermal Stresses and Motions from a Radial Temperature Gradient In a Long Cylinder, Short Cylinder, or Spherical Segment"
5. 91191 - "Annular Plate Thermal Motions"
6. 91060 - "Interaction Analysis"

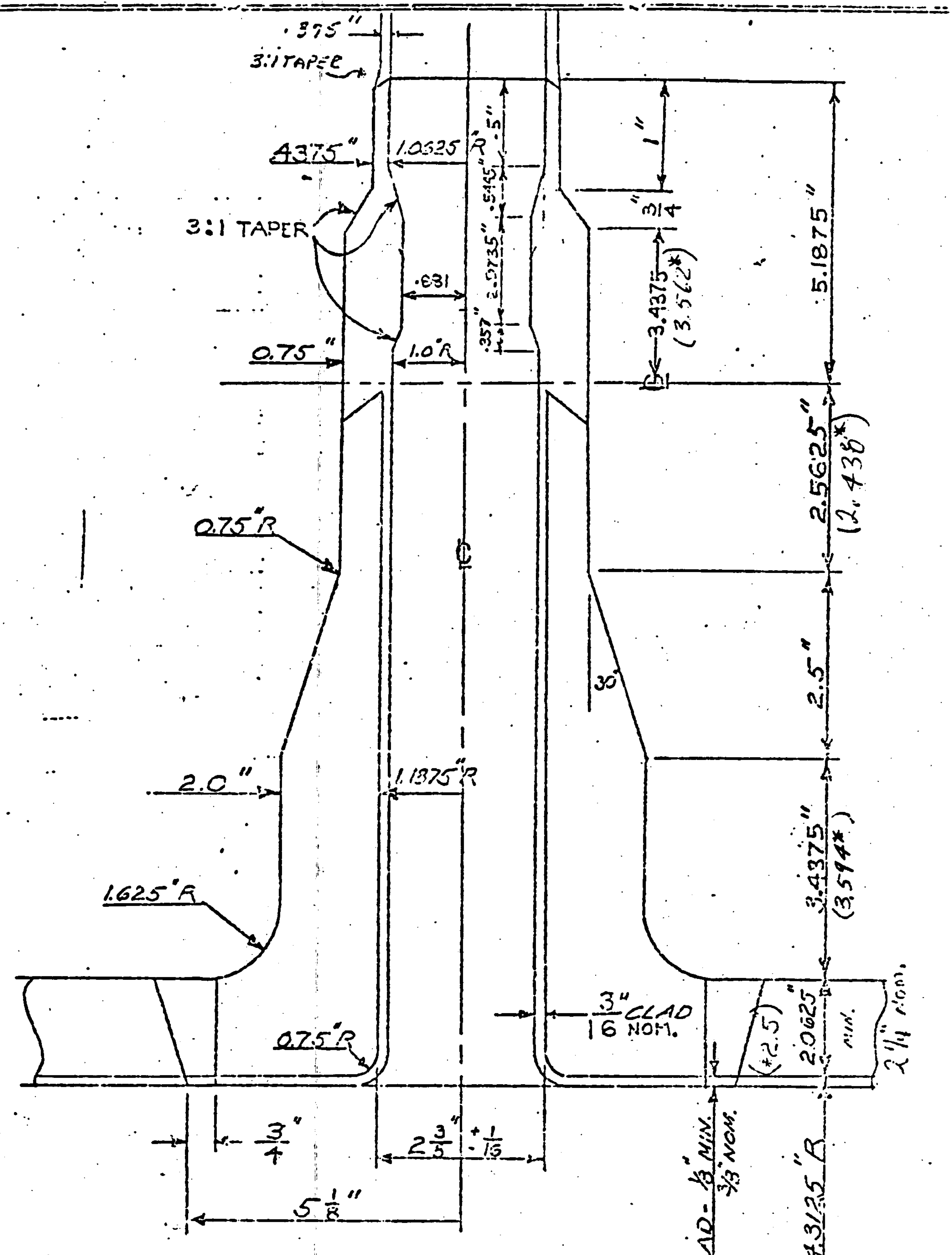
D. General

1. Tentative Structural Design Basis for Reactor Pressure Vessels, U.S. Department of Commerce, Office of Technical Service.
2. Stress Concentration Design Factors, By R.E. Peterson, John Wiley and Sons, 1966.

SECTION 1

This section contains a sketch of the make-up nozzle (identical to high pressure injection nozzle) demonstrating dimensions used in the analysis. This sketch appears on Page 1-1. The dimensions with asteriks are those for the NSS-9 nozzle, which are different from those analyzed. The change will have little effect on the final stress results. This reasoning is justified by a review of similar geometry nozzles, using the dimensions with asteriks, which were analyzed for similar thermal transients. The results indicate that a small change in piping dimensions have a negligible effect on the stress levels. The ratio of actual stress to allowable stress for the nozzle to pipe intersection is 0.395 which allows for a reasonable increase in stresses due to a change in geometry.

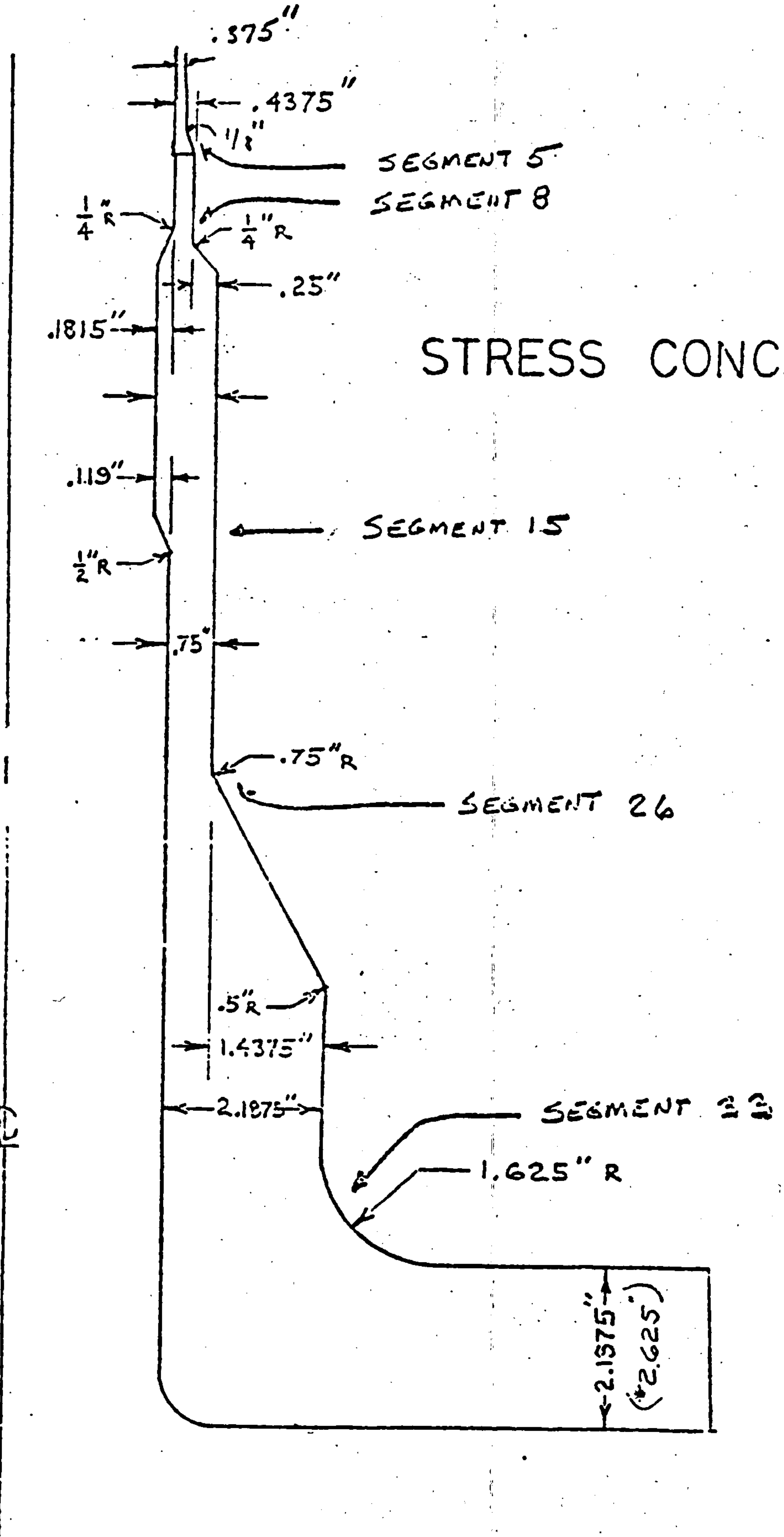
Stress concentration factors are also determined in this section.



REFERENCE: B&W DWG. 15015 6E6

2½" SCH. 160 PRESSURE INJECTION

BABCOCK & WILCOX	
DEPARTMENT ______ BY C. W. ZINN	DATE 10-29-7
2½" SCH 160 HIGH PRESSURE INJECTION NOZZLE	JOB NO.
23 IN. I.D. PIPE	SHEET 1-1

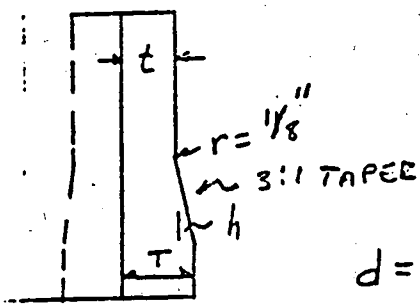


STRESS CONCENTRATION FACTOF

BABCOCK & WILCOX
DEPARTMENT
BY C.W. ZINN
DATE 11-19-70
STRESS CONCENTRATION FACTORS
JOB NO. 620-000
SHEET 2

SEGMENT 5
(OUTSIDE)

REF: SEE PAGE 1-10



$t = .375$ $T = .4375$

$h = .0625$ $\beta = 72°$

$d = 2t = .75$ $D = 2T = .875$

$D/d = 1.167$ $r/d = .167$ $K_o^{TENSION} = 1.53$ $K_o^{BENDING} = 1$

$$\frac{K'-1}{K_o-1} = 1 - \left[\frac{\beta-\alpha}{90-\alpha}\right]^{1+2.4\sqrt{r/h}}$$

$$\alpha = \sin^{-1}\left[1 - h/r\right] = \sin^{-1}\left[1-.5\right] = 30°$$

$$K'-1/K_o-1 = 1 - \left[\frac{42}{60}\right]^{1+2.4\sqrt{2}} = .79$$

$K'_{TEN} = 1 + .53(.79) = 1.42$ OUTSIDE

$K'_{BEN} = 1 + .48(.79) = 1.38$ OUTSIDE

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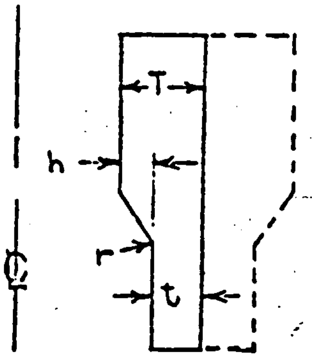
SEGMENT 15

(INSIDE)



USE SAME REFERENCES AS ON PREVIO[US] PAGE

$h = .119''$ $r/d = .3$

$T = .869''$ $D/d = 1.16$

$t = .75''$

$r = .5$ FROM FIG. 57 & 60 OF REF.

$\beta \approx 72°$ $K_o^T = 1.39$ $K_o^B = 1.34$

FROM REF. 1 A.7.2.4-2

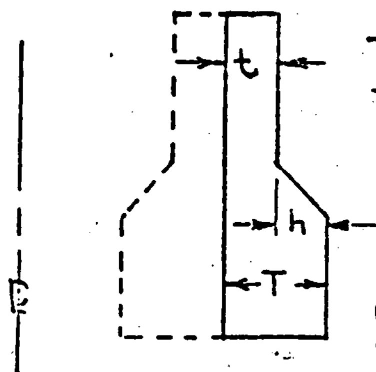
$$\left[\frac{K'-1}{K_o-1}\right] = 1 - \left[\frac{\beta-\alpha}{90-\alpha}\right]^{1+2.47\sqrt{r/h}} \qquad \alpha = \sin^{-1}\left[1-\frac{h}{r}\right]$$

$$\alpha \approx 49.7° \qquad \left[\frac{K'-1}{K_o-1}\right] = 1-\left[.5533\right]^{5.92} \qquad K' = 1 + .97(\ldots$$

$\therefore$ $K_o^T = 1.38$ $K_o^B = 1.33$

SEGMENT 26

(OUTSIDE)



$T = 2.1875''$

$t = .75''$ FROM FIG. A.7-1 OF REF. 1

$h = 1.438''$ $K_o^T = 1.52$ $K_o^B = 1.29$

$r = .75''$

$\beta \approx 70°$ FROM FIG. A.7-2 OF REF. 1

$\beta/90 = .78$ $\left[\frac{K'-1}{K_o-1}\right] = .48$ $K' = 1 + .48(K_o-1)$

$r/d = .5$ $r/t = 1.0$ $\therefore$ $K_o^T = 1.25$ $K_o^B = 1.14$

$D/d = 2.92$ $r/h = .522$

BABCOCK & WILCOX

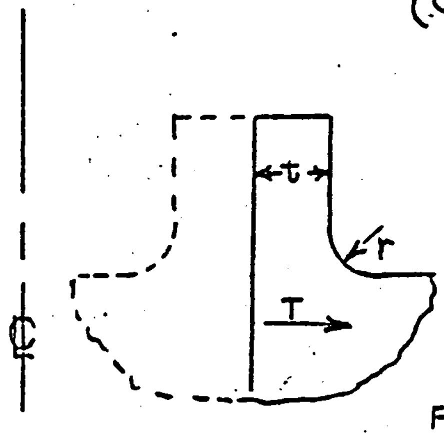
DEPARTMENT BY C. W. [illegible] DATE 11-20-7[illegible]

STRESS CONCENTRATION FACTORS JOB NO. 620-[illegible]

SHEET [illegible]

SEGMENT 33-7

(OUTSIDE)



$t = 2.1875''$ $r/t = .74$

$r = 1.625''$

$D = 2T$

$d = 2t$

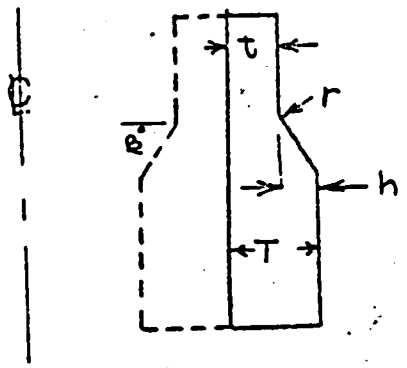
FROM FIG. A.7-1 OF REFERENCE 1

$K_o^T = 1.63$ $K_o^B = 1.37$

-247

SEGMENT 8

(OUTSIDE)



REF: 1. "TENTATIVE STRUCTURAL DESIGN BA
FOR REACTOR PRESSURE VESSELS",
U.S. DEPT. OF COMMERCE, OFFICE OF
TECHNICAL SERVICE.

2. "STRESS CONCENTRATION DESIGN FAC
BY R. E. PETERSON

$t = .4375''$ $d = 2t = .875''$
$T = .75''$ $D = 2T = 1.5''$
$r = .25''$ $r/d = .286$
$h = .25''$ $D/d = 1.71$
$\beta \approx 72°$ $\beta/90 = .8$
$r/h = 1.0$

FROM REF. 2 FIGURES 57 & 60

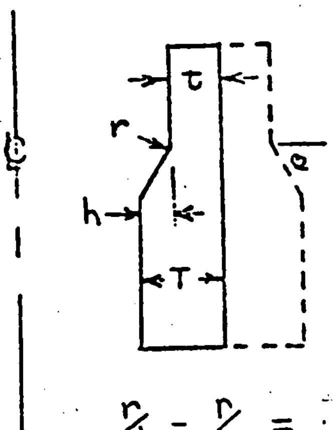
$K_o^T = 1.6$ $K_o^B = 1.36$

FROM REF. 1 FIGURE A.7-2

$\left[\frac{K'-1}{K_o-1}\right] = .53$ $K' = 1 + .53(K_o - 1)$

$\therefore K'_T = 1.32$ $K'_B = 1.19$

(INSIDE)



$t = .4375''$
$T = .5565''$
$h = .119''$
$r = .25''$
$\beta \approx 72°$

FROM REF. 2 FIGURES 57 & 6

$K_o^T = 1.48$ $K_o^B = 1.35$

FROM REF. 1 ARTICLE A.7.2.

FOR $r > h$ $\left[\frac{K'-1}{K_o-1}\right] = 1 - \left[\frac{\beta-\alpha}{90-\alpha}\right]^{1+2.4\sqrt{r/h}}$ where $\alpha = \sin$

$r/d = r/2t = .286$
$D/d = 2T/2t = 1.27$
$r/h = 2.1$
$\beta/90 = .8$

$\alpha = 31.5°$ $\left[\frac{K'-1}{K_o-1}\right] = 1 - \left[\frac{72° - 31.5°}{90° - 31.5°}\right]^{4.48}$ $K' = 1 +$

$\therefore K'_T = 1.39$ $K'_B = 1.28$

SATISFICATION OF PRIMARY STRESS LIMITS

— AT NOZZLE END —

LONGITUDINAL PRESSURE MEMBRANE STRESS

$$= \frac{PR}{2t} = \frac{2500(2.275)}{4(.375)} = 4.8 \text{ KSI} < 1.5 S_m \text{ @ } 650°F$$ 376 TP

$$= 1.5(16.6) = 24.9 \text{ KSI}$$

— AT BRANCH INTERSECTION —

CIRCUMFERENTIAL PRESSURE MEMBRANE STRESS IN RUN PIPE $= \frac{PR}{t} = \frac{2500(16.5625)}{2.25} = 18.4$ KSI

ALLOWABLE STRESS $= 1.5 S_m = 1.5(17.4) = 26.1$ KSI A-105-

$18.4 \text{ KSI} < 26.1 \text{ KSI}$

000619029

SECTION 2

This section contains temperature transient analysis of the make-up nozzle. A survey of the functional specification was made and a composite transient curve developed for the cold leg fluid and the make-up fluid. Of primary importance was to select transients which would reflect maximum temperature differentials in the nozzle. This differential is dependent upon temperatures of the corresponding fluid, rates of change of the fluids, and flow rates.

The make-up nozzle has two predominant temperatures 95°F (normal operation and essentially constant for all transients) and 70°F (For the feed and bleed operation). It has a predominant flow rate of 13 GPM but can go as high as 100 GPM or as low as 1.5 GPM. In particular it has a flow rate of 40 GPM during feed and bleed when the fluid temperature is 70°F.

The cold leg fluid goes through several changes in temperature but the most predominant temperatures are 555°F for 8% and 100% power levels and 575°F for 15% power. The temperature does go as high as 590 for the reactor trip.

Consequently the temperature transient curve was made to reflect these variations in fluid temperature and flow rates. The pictorial diagram is shown on the following page.

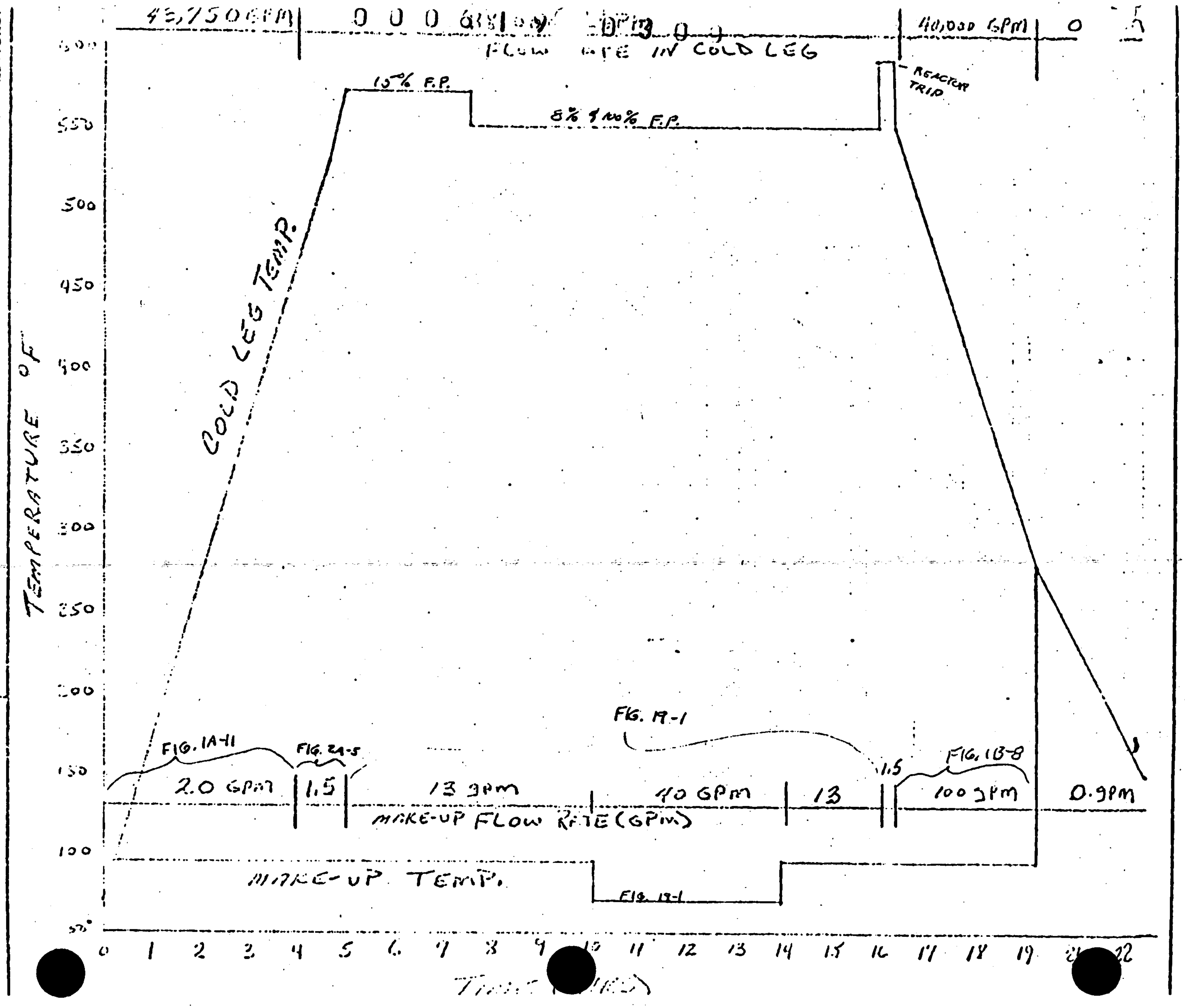
CUSTOMER

SUBJECT MAKE-UP NOZZLE FLOW TRANSIENT

JOB NO.

BY

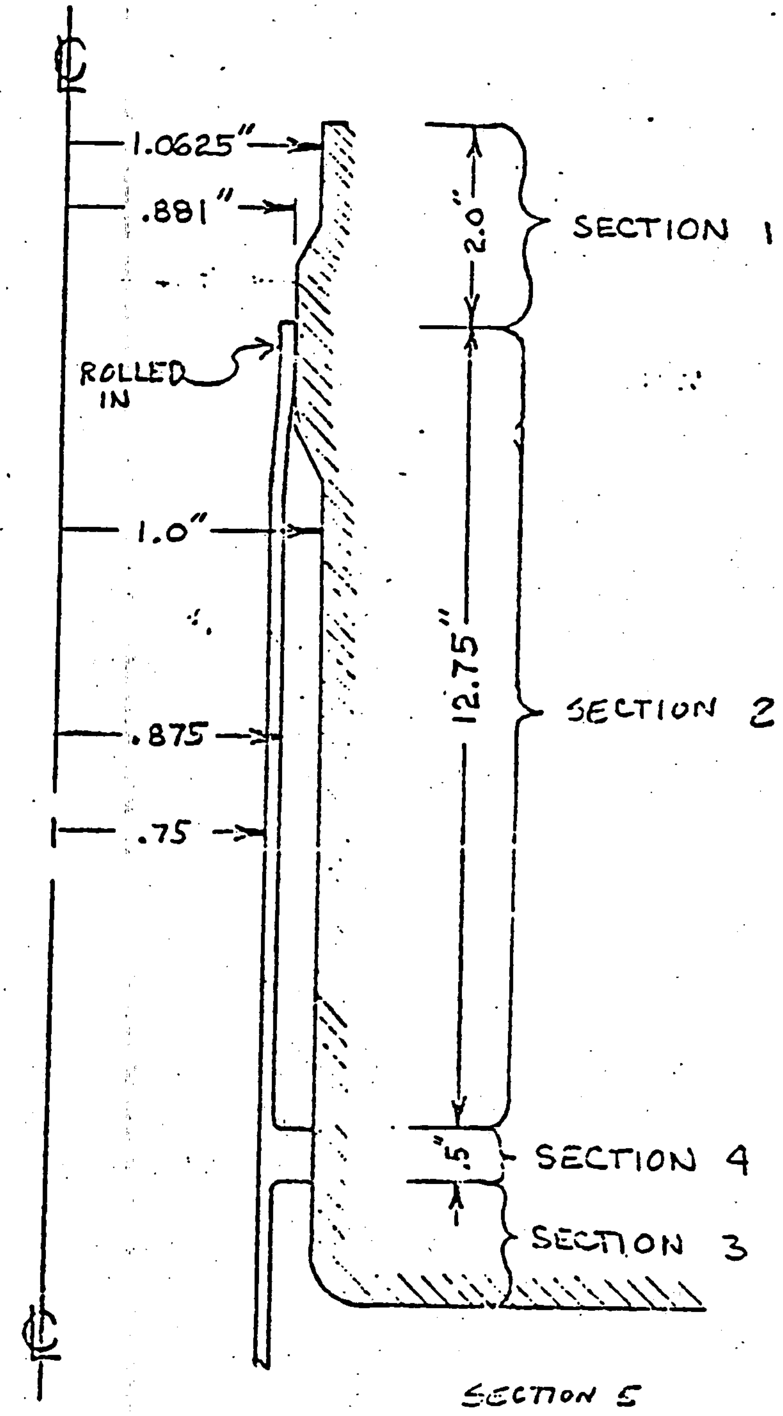
DATE



FILM COEFFICIENTS

The film coefficients will be calculated assuming turbulent flow in the cold leg and nozzle. They are calculated for three different cases: 1.) in the cold leg 2.) in the branch pipe and 3.) within the thermal sleeve because of the smaller diameter. In addition the small area of contact of the fluid with the nozzle on the inside of the thermal sleeve ring (see figure on Page 2-3 marked Section 3) was assumed to have a film coefficient of 200 BTU/HR-°F-Ft.^{2} when there was a flow in the cold leg run pipe and 100 when there was no flow in the run pipe. The 100 BTU/HR-°F-Ft.^{2} value was also used as a natural convection value for the run pipe (Cold Leg) when there was no flow during cool-down when decay removal starts.

The film coefficient for no flow in the nozzle was assumed to be 35 BTU/HR-°F-Ft.^{2} This smaller value was chosen because of the smaller diameter and that the water would be closer to stagnant within the nozzle. The thermal model of the nozzle includes water blocks behind the sleeve. It is felt that there will be little or no flow behind the sleeve because of the very small gap between the sleeve and nozzle at the top of the nozzle plus the "Vena Contracta" effect of the flow going from a larger diameter to a smaller diameter at the transition from the branch pipe to the nozzle. Thus only conduction is assumed between the sleeve and the inside of nozzle. At Section 4 metal to metal conduction is assumed but a contact resistance coefficient of 100 BTU/HR-°F-Ft.^{2}. This value results in essentially metal to metal conduction. The rolled-in portion of sleeve is assumed to have metal to metal conduction even though a small gap may exist at certain times within the transient.



THERMAL SLEEVE GEOMETRY

BABCOCK & WILCOX

DEPARTMENT BY C.W. ZINN DATE [illegible]

GEOMETRY FOR FILM COEFFICIENTS JOB NO. [illegible]

FILM COEFFICIENTS

NOZZLE OUTSIDE SLEEVE

FLOW (GPM)	$hD^{.2}$ FROM GRAPH (FOLLOWING PAGE)	$D^{.2}$ = .71	h BTU/HR-FT²-°F
20	290		410
1.5	35		50
13	210		300
40	520		730
100	1100		1550
0	—		35

0 — BECAUSE OF LOW TEMPERATURE OF WATER AND THE SMALL DIAMETER A SMALL VALUE FOR NATURAL CONVENTION WILL BE USED — 35

NOZZLE INSIDE SLEEVE

		$D^{.2}$ = .66	h
1.5	65		100
13	350		530
40	880		1330
100	1800		2730
0	—		35
20	520		790

INLET PIPE

		$D^{.2}$ = 1.18	
43,750	3500		3000
88,000	7000		5900
40,700	3800		3200
0			100

0 — BECAUSE OF LARGER DIAMETER NATURAL CONVECTION VALUE OF 100 WILL BE USED — 100

BABCOCK & WILCOX
DEPARTMENT: _______ BY _______ DATE _______
TABULATION OF FILM COEFFICIENTS — JOB NO. _______

00061903

FILM COEFFICIENTS

CONVERSION FROM GAL/MIN TO Lbs/FT²-HR.

$$Lbs/FT^2\text{-}HR = (GAL./MIN)(60\ MIN/HR)(8.347\ Lbs/GAL)/AREA$$

SECTION 5 $AREA_{INLET} = \pi(14)^2 = 615.75\ IN^2$ OR $4.28\ FT^2$

SECTION 1 (WITHOUT SLEEVE) $AREA_{HPI} = \pi(1.0625)^2 = 3.547\ IN$ OR $.025\ FT^2$

SECTION 2 (WITH SLEEVE) $AREA_{H.P.I.} = \pi(.75)^2 = 1.767\ IN^2$ OR $.0123\ FT^2$

SECTION 1 OUTSIDE SLEEVE — H.P.I. NOZZLE FLOW — SECTION 2 INSIDE SLEVE

259090	⊗ x 13 GPM	x 40,510 +	= 526,630	Lbs/FT²-HR
797200	⊗ x 40 GPM	x 40510 +	= 1,620,400	Lbs/FT²-HR
1993000	⊗ x 100 GPM	x 40,510 +	= 4,051,000	Lbs/FT²-HR
29895	⊗ x 1.5 GPM	x 40,510 +	= 60770	lbs/FT²-HR
398,600	⊗ x 20 GPM	x 40,510	810,200	"

INLET PIPE FLOW SECTION 5

310°F	43,750 GPM	x 107.0*	= 4,681,250	Lbs/FT²-HR
575°F	88,000 GPM	x 83.4	= 7,339,755	Lbs/FT²-HR
400°F	40,000 GPM	x 99.7	= 3,988,000	Lbs/FT²-HR

CONVERSION COEFFICIENTS

@ 95°F + (60 MIN/HR)(8.304 Lbs/GAL)/(.0123 FT²) = 40,510 Lbs-MIN/HR-GAL

@ 95°F ⊗ (60 MIN/HR)(8.304 Lbs/GAL)/(.025 FT²) = 19,930 Lb-MIN/HR-GA

AT 310° * (60 MIN/HR)(7.618 Lbs/GAL)/(4.28 FT²) = 107 LbS-MIN/HR-GAL

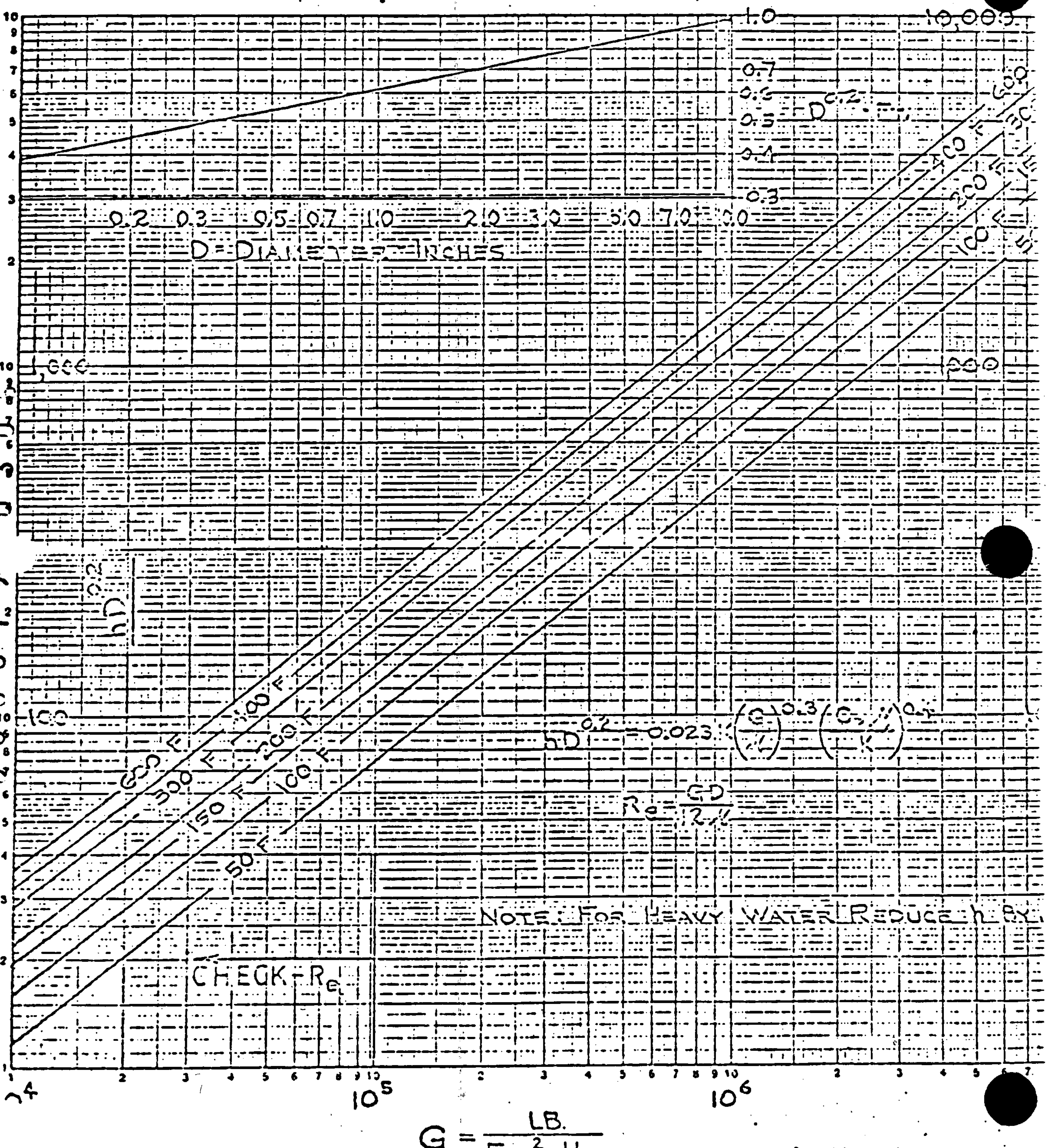
REYNOLD'S NUMBER FOR 29895 LBS/FT²HR FLOW

$$Re = \frac{GD}{12\mu} = \frac{(29895)(.0625)2}{(12)(1.25)} = 2862 > 2100$$

THEREFORE GRAPH ON THE FOLLOWING PAGE IS ACCEPTABLE FOR THE FLOW CONDITIONS

BABCOCK & WILCOX DEPARTMENT — BY C. W. ZINN — DATE 11-18-72

FILM COEFFICIENTS — JOB NO. 620-0000 — SHEET 2-5 OF



WATER FILM COEFFICIENT FOR REYNOLDS NUMBERS ABOVE 2100: FROM H.T. 41-1

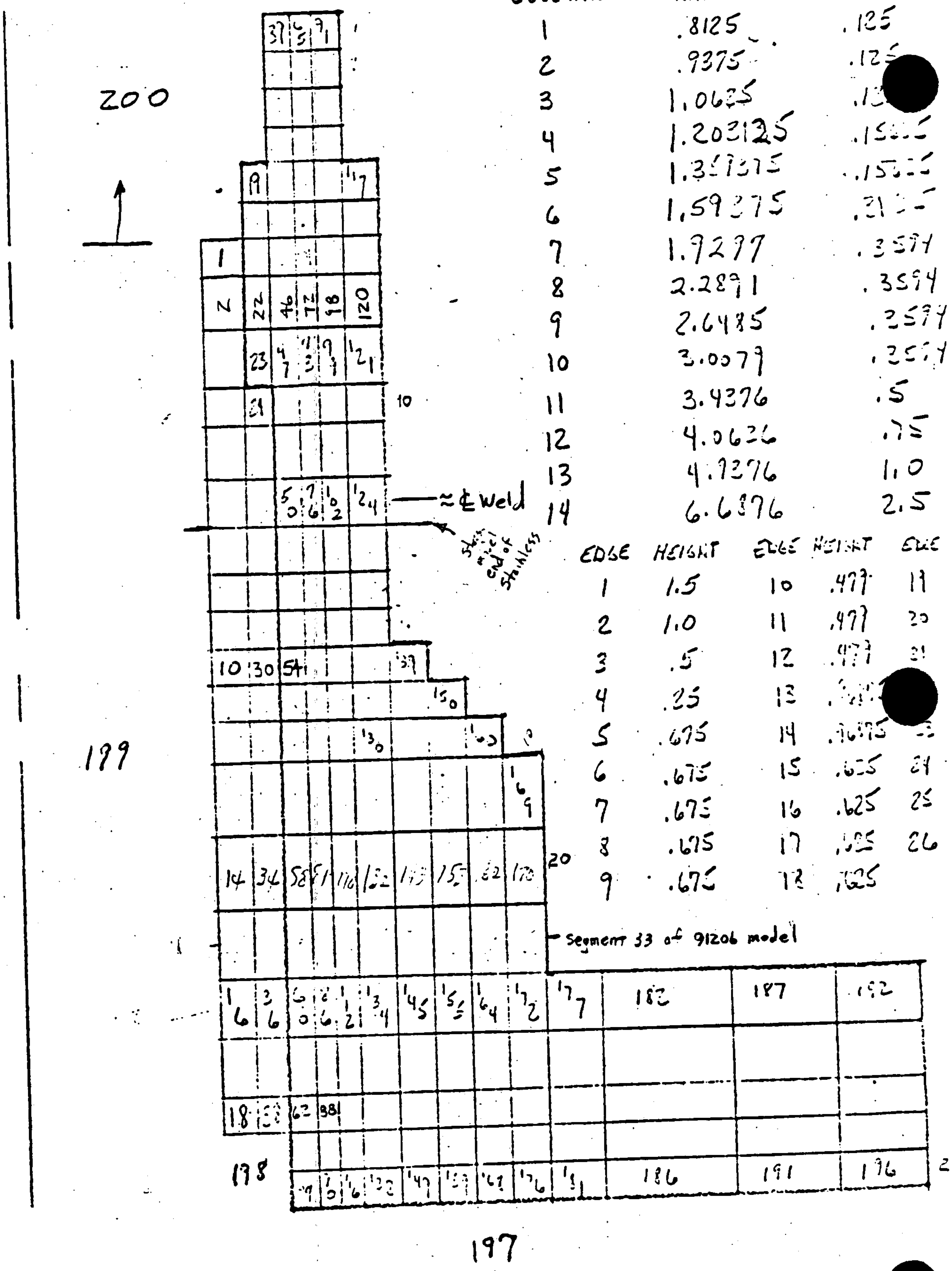
JOB No. DD-2
MANUAL-2A35

TEMPERATURE DISTRIBUTION

The temperature distribution of the nozzle was obtained using B&W Thermal Program 91167 which performs a transient temperature distribution by solving internally generated heat balance equations as a function of time.

The grid for this program is shown on Page 2-8 and the computer output which follows depicts the input items. A heat balance equation sample is shown on pages 2-15, 2-19.

Pages 2-20, 2-22 show a graphical representation, temperatures vs. time, of selected nodes and this is finally followed by the computer print-out giving the actual temperatures at the selected critical times for stress analysis.



Column	Mean Radius	Width
1	.8125	.125
2	.9375	.12[illegible]
3	1.0625	.1[illegible]
4	1.203125	.15[illegible]
5	1.359375	.15[illegible]
6	1.59375	.31[illegible]
7	1.9297	.3594
8	2.2891	.3594
9	2.6485	.3594
10	3.0079	.3594
11	3.4376	.5
12	4.0626	.75
13	4.9376	1.0
14	6.6376	2.5

Edge	Height	Edge	Height	Edge
1	1.5	10	.477	19
2	1.0	11	.477	20
3	.5	12	.477	21
4	.25	13	[illegible]	[illegible]
5	.675	14	.96875	[illegible]
6	.675	15	.625	24
7	.675	16	.625	25
8	.675	17	.625	26
9	.675	18	.625	

BABCOCK & WILCOX

DEPARTMENT BY

HPI Nozzle Thermal Grid

DATE

JOB NO.

SHEET 2-8

0 0 0 6 1 9 0 3 0 3

GENERAL INPUT DATA

NO SOLID BLOCKS	NO FLUID BLOCKS	NO OF EDGES	NO OF LINES	NO OF CYCLES
196	4	26	14	8

BASE TEMP	STARTING TEMP	STARTING TIME	STARTING ITER	PUNCH CARD TIME
300.0	70.0	0.00000	0	0.00000

TIME IS IN HOURS

GEOMETRY OF THE COLUMNS

ROW NO	BLOCK NO. LOW	HI	ADJ	RADIAL DIMS	MEAN RADIUS	LOW EDGE NO	ROW NO	BLOCK NO. LOW	HI	ADJ	RADIAL DIMS	MEAN RADIUS	LOW EDGE NO
1	1	18	16	.12500	.81250	7	2	19	38	36	.12500	.93750	5
3	39	64	60	.12500	1.06250	1	4	65	90	86	.15625	1.20313	1
5	91	116	112	.15625	1.35938	1	6	117	138	134	.31250	1.59375	5
7	139	149	145	.35940	1.92970	16	8	150	159	155	.35940	2.28910	17
9	160	168	164	.35940	2.64850	18	10	169	176	172	.35940	3.00790	19
11	177	181	177	.50000	3.43760	22	12	182	186	182	.75000	4.06260	22
13	187	191	187	1.00000	4.93760	22	14	192	196	192	2.50000	6.68760	22

SERIES NO	BLOCK NO. FLUID	FIRST	LAST	SIDE NO	SERIES NO	BLOCK NO. FLUID	FIRST	LAST	SIDE NO	SERIES NO	BLOCK NO. FLUID	FIRST	LAST	S
1	[illegible]	[illegible]	[illegible]	2	2	197		90	2	3	197	116	116	2
4	197	138	138	2	5	197	149	149	2	6	197	159	159	2
7	197	168	168	2	8	197	176	176	2	9	197	181	181	2
10	197	186	186	2	11	197	191	191	2	12	197	196	196	2
13	198	63	64	1	14	198	18	18	2	15	198	38	38	2
16	199	1	18	1	17	200	19	20	1	18	200	1	1	4
19	200	19	19	4	20	200	39	42	1					

AXIAL DIMENSION PER EDGE

EDGE	DIMENSION	EDGE	DIMENSION	EDGE	DIMENSION	EDGE	DIMENSION	EDGE	DIMENSION	EDGE	DIMENSION
1	1.50000	2	1.00000	3	.50000	4	.25000	5	.67500	6	.67500
7	.67500	8	.67500	9	.67500	10	.47900	11	.47900	12	.47900
13	.96875	14	.96875	15	.62500	16	.62500	17	.62500	18	.62500
19	1.25000	20	1.25000	21	1.25000	22	.37500	23	.37500	24	.50000
25	.50000	26	.50000								

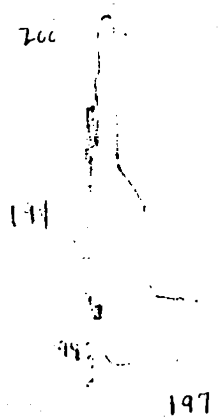
CONDUCTANCE OF TWO ADJACENT BLOCKS WITHOUT COMPLETE BOND - NO OF SUBDIVISIONS 2

FIRST BLOCK NO	LAST BLOCK NO	ADDED CONDUCT H	BLOCK SIDE	FIRST BLOCK NO	LAST BLOCK NO	ADDED CONDUCT H	BL S
38	38	100.000	3	62	62	100.000	

0006190310

MATL NO	LAST BLOCK	MATL NO	LAST BLOCK	MATL NO	LAST BLOCK	MATL NO	LAST BLOCK	MATL NO	LAST BLOCK	MATL NO	LAST BLOCK	MATL NO	LAST BLOCK
4	[illegible]	10	37	4	76	1	[illegible]	4	102	1	116	[illegible]	[illegible]
1	196												

FLUID BLOCK	FILM COEF.							
197	3000.00	5900.00	5900.00	5900.00	5900.00	5900.00	3200.00	100.00
198	200.00	200.00	200.00	200.00	200.00	200.00	200.00	100.00
199	790.00	100.00	530.00	1330.00	530.00	100.00	2730.00	35.00
200	410.00	50.00	300.00	730.00	300.00	50.00	1550.00	35.00
	↑ to 3.2 based on makeup flow of 20 gpm	↑ to 4.95 based on 1.5 gpm.	↑ to 10.0 based on 13. gpm	↑ to 14.0 based on 40 gpm	↑ to 16.0 based on 13. gpm	↑ to 16.2 based on 1.5 gpm	↑ to 19.15 based on 100. gpm	↑ to 22.4



3.8 4.95000 10.00000 14.00000 .00000 1.20000
22.40

000619 0311

TIMES FOR PRINTOUT

TIME LIMIT	TIME MULTIPLE
3.50000	.50000
4.00000	.05000
5.00000	.25000
5.20000	.00833
7.50000	.46000
7.70000	.00833
10.00000	.46000
10.20000	.00278
14.00000	.38000
14.20000	.00278
16.00000	1.10000
16.40000	.00278
18.00000	.16000
19.15000	.57500
19.35000	.00278
22.40000	.31500

POINT N . 97 TYPE 1 0006190312

TIME	0.00000	4.62000	4.95000	7.50000	7.50000	15.90000	15.90000	16.21000	16.21000
TEMP	70.00000	532.00000	575.00000	575.00000	555.00000	555.00000	590.00000	590.00000	555.00000
TIME	19.15000	22.40000	-99.99000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
TEMP	280.00000	150.00000	150.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

POINT NO. 198 TYPE 1

TIME	0.00000	4.62000	4.95000	7.50000	7.50000	15.90000	15.90000	16.21000	16.21000
TEMP	70.00000	532.00000	575.00000	575.00000	555.00000	555.00000	590.00000	590.00000	555.00000
TIME	19.15000	22.40000	-99.99000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
TEMP	280.00000	150.00000	150.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

IME	[illegible]	[illegible]000	10.10000	10.10000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
EMP	95[illegible]	[illegible]000	95.00000	70.00000	70.00000	95[illegible]000	95.00000	280.00000	150.00000	[illegible]

OINT NO. 200 TYPE 1

IME	0.00000	10.10000	10.10000	13.90000	13.90000	19.20000	19.20000	22.40000	-99.99000
EMP	95.00000	95.00000	70.00000	70.00000	95.00000	95.00000	280.00000	150.00000	150.00000

0	1	1.0	.143	199	.009	2	.282	21	.010	200	.557	1
0	2	[illegible]	.143	199	.009	3	.282	22	.009	1	.557	2
0	3	[illegible]	.143	199	.010	4	.282	23	.009	2	.556	3
0	4	1.0	.143	199	.018	5	.022	24	.015	3	.802	4
0	5	1.0	.143	199	.018	6	.022	25	.018	4	.799	5
0	6	1.0	.143	199	.012	7	.022	26	.018	5	.865	6
0	7	1.0	.143	199	.004	8	.022	27	.005	6	.825	7
0	8	1.0	.143	199	.005	9	.022	28	.004	7	.825	8
0	9	1.0	.143	199	.010	10	.022	29	.008	8	.816	9
0	10	1.0	.143	199	.010	11	.022	30	.010	9	.814	10
0	11	1.0	.143	199	.010	12	.022	31	.010	10	.814	11
0	12	1.0	.143	199	.007	13	.022	32	.010	11	.817	12
0	13	1.0	.143	199	.003	14	.022	33	.003	12	.829	13
0	14	1.0	.143	199	.003	15	.022	34	.003	13	.829	14
0	15	1.0	.143	199	.004	16	.022	35	.003	14	.828	15
0	16	1.0	.143	199	.029	17	.022	36	.013	15	.792	16
0	17	1.0	.143	199	.025	18	.022	37	.029	16	.781	17
0	18	1.0	.143	199	.010	198	.282	38	.019	17	.547	18
0	19	1.0	.088	200	.009	20	.279	43	.010	200	.615	19
0	20	1.0	.088	200	.009	21	.279	44	.009	19	.616	20
0	21	1.0	.244	1	.009	22	.279	45	.009	20	.459	21
0	22	1.0	.244	2	.009	23	.279	46	.009	21	.459	22
0	23	1.0	.244	3	.001	24	.279	47	.009	22	.467	23
0	24	1.0	.019	4	.001	25	.022	48	.001	23	.956	24
0	25	1.0	.019	5	.001	26	.022	49	.001	24	.957	25
0	26	1.0	.019	6	.000	27	.022	50	.001	25	.957	26
0	27	1.0	.019	7	.000	28	.022	51	.000	26	.958	27
0	28	1.0	.019	8	.000	29	.022	52	.000	27	.958	28
0	29	1.0	.019	9	.000	30	.022	53	.000	28	.958	29
0	30	1.0	.019	10	.000	31	.022	54	.000	29	.957	30
0	31	1.0	.019	11	.000	32	.022	55	.000	30	.957	31
0	32	1.0	.019	12	.000	33	.022	56	.000	31	.958	32
0	33	1.0	.019	13	.000	34	.022	57	.000	32	.958	33
0	34	1.0	.019	14	.000	35	.022	58	.000	33	.958	34
0	35	1.0	.019	15	.000	36	.022	59	.000	34	.958	35
0	36	1.0	.019	16	.001	37	.022	60	.001	35	.957	36
0	37	1.0	.019	17	.002	38	.022	61	.001	36	.955	37
0	38	1.0	.244	18	.010	198	.027	62	.002	37	.718	38
0	39	1.0	.088	200	.002	40	.246	65	.663	39		
0	40	1.0	.088	200	.005	41	.246	66	.003	39	.657	40

0 0 0 8 1 9 0 3 1 5

0	41	.0	[illegible]	200	[illegible]	[illegible]	[illegible]	[illegible]						
0	42	0	.088	200	.035	43	.246	68	.044	41	.587	42		
0	43	.0	.246	19	.009	44	.246	69	.013	42	.486	43		
0	44	1.0	.246	20	.009	45	.246	70	.009	43	.490	44		
0	45	1.0	.246	21	.009	46	.246	71	.009	44	.490	45		
0	46	1.0	.246	22	.009	47	.246	72	.009	45	.490	46		
0	47	1.0	.246	23	.010	48	.246	73	.009	46	.488	47		
0	48	1.0	.019	24	.018	49	.246	74	.015	47	.702	48		
0	49	1.0	.019	25	.018	50	.246	75	.018	48	.699	49		
0	50	1.0	.019	26	.012	51	.246	76	.018	49	.705	50		
0	51	1.0	.019	27	.004	52	.390	77	.006	50	.580	51		
0	52	1.0	.019	28	.005	53	.390	78	.004	51	.581	52		
0	53	1.0	.019	29	.010	54	.390	79	.008	52	.572	53		
0	54	1.0	.019	30	.010	55	.390	80	.010	53	.570	54		
0	55	1.0	.019	31	.010	56	.390	81	.010	54	.570	55		
0	56	1.0	.019	32	.007	57	.390	82	.010	55	.573	56		
0	57	1.0	.019	33	.003	58	.390	83	.003	56	.584	57		
0	58	1.0	.019	34	.003	59	.390	84	.003	57	.585	58		
0	59	1.0	.019	35	.004	60	.390	85	.003	58	.584	59		
0	60	1.0	.019	36	.029	61	.390	86	.013	59	.548	60		
0	61	1.0	.019	37	.025	62	.390	87	.029	60	.536	61		
0	62	1.0	.024	38	.016	63	.390	88	.019	61	.551	62		
0	63	1.0	.047	198	.016	64	.390	89	.016	62	.530	63		
0	64	1.0	.047	198	.026	197	.390	90	.016	63	.518	64		
0	65	1.0	.174	39	.002	66	.178	91	.646	65				
1	66	1.0	.174	40	.005	67	.178	92	.003	65	.639	66		
0	67	1.0	.174	41	.022	68	.178	93	.011	66	.615	67		
0	68	1.0	.174	42	.035	69	.178	94	.044	67	.569	68		
0	69	1.0	.174	43	.009	70	.178	95	.013	68	.626	69		
0	70	1.0	.174	44	.009	71	.178	96	.009	69	.630	70		
0	71	1.0	.174	45	.009	72	.178	97	.009	70	.630	71		
1	72	1.0	.174	46	.009	73	.178	98	.009	71	.630	72		
0	73	1.0	.174	47	.010	74	.178	99	.009	72	.629	73		
0	74	1.0	.174	48	.018	75	.178	100	.015	73	.615	74		
0	75	1.0	.174	49	.018	76	.178	101	.018	74	.612	75		
0	76	1.0	.174	50	.021	77	.178	102	.018	75	.609	76		
0	77	1.0	.280	51	.013	78	.541	103	.011	76	.155	77		
0	78	1.0	.280	52	.016	79	.541	104	.013	77	.150	78		
0	79	1.0	.280	53	.032	80	.541	105	.025	78	.123	79		
0	80	1.0	.280	54	.032	81	.541	106	.032	79	.116	80		
0	81	1.0	.280	55	.032	82	.541	107	.032	80	.116	81		

0	82	[illegible]	.280	56	.021	83	.541	108	.03?	81	[illegible]	[illegible]
0	83	.0	.280	57	.008	84	.541	109	.011	82	.161	83
0	84	.0	.280	58	.008	8	.541	110	.008	83	.163	84
0	85	1.0	.280	59	.012	86	.541	111	.008	84	.159	85
0	86	1.0	.280	60	.088	87	.541	112	.041	85	.050	86
0	87	1.0	.280	61	.076	88	.541	113	.088	86	.016	87
0	88	1.0	.280	62	.050	89	.541	114	.057	87	.073	88
0	89	1.0	.280	63	.050	90	.541	115	.050	88	.080	89
0	90	1.0	.280	64	.068	197	.541	116	.050	89	.062	90
0	91	1.0	.158	65	.002	92	.840	91				
0	92	1.0	.158	66	.005	93	.003	91	.834	92		
0	93	1.0	.158	67	.022	94	.011	92	.810	93		
0	94	1.0	.158	68	.035	95	.044	93	.753	94		
0	95	1.0	.158	69	.009	96	.118	117	.013	94	.702	95
0	96	1.0	.158	70	.009	97	.118	118	.009	95	.706	96
0	97	1.0	.158	71	.009	98	.118	119	.009	96	.706	97
0	98	1.0	.158	72	.009	99	.118	120	.009	97	.706	98
0	99	1.0	.158	73	.010	100	.118	121	.009	98	.705	99
0	100	1.0	.158	74	.018	101	.118	122	.015	99	.692	100
0	101	1.0	.158	75	.018	102	.118	123	.018	100	.689	101
1	102	1.0	.158	76	.021	103	.118	124	.018	101	.685	102
0	103	1.0	.478	77	.013	104	.358	125	.011	102	.140	103
0	104	1.0	.478	78	.016	105	.358	126	.013	103	.134	104
0	105	1.0	.478	79	.032	106	.358	127	.025	104	.107	105
1	106	1.0	.478	80	.032	107	.358	128	.032	105	.100	106
0	107	1.0	.478	81	.032	108	.358	129	.032	106	.100	107
0	108	1.0	.478	82	.021	109	.358	130	.032	107	.111	108
0	109	1.0	.478	83	.008	110	.358	131	.011	108	.145	109
0	110	1.0	.478	84	.008	111	.358	132	.008	109	.148	110
0	111	1.0	.478	85	.012	112	.358	133	.008	110	.144	111
0	112	1.0	.478	86	.088	113	.358	134	.041	111	.035	112
0	113	1.0	.478	87	.076	114	.358	135	.088	112	-.000	113
0	114	1.0	.478	88	.050	115	.358	136	.057	113	.057	114
0	115	1.0	.478	89	.050	116	.358	137	.050	114	.065	115
0	116	1.0	.478	90	.068	197	.358	138	.050	115	.046	116
0	117	1.0	.050	95	.009	118	.941	117				
0	118	1.0	.050	96	.009	119	.009	117	.932	118		
0	119	1.0	.050	97	.009	120	.009	118	.932	119		
0	120	1.0	.050	98	.009	121	.009	119	.932	120		
0	121	1.0	.050	99	.010	122	.009	120	.930	121		
0	122	1.0	.050	100	.018	123	.015	121	.917	122		

0	124	.0	.050	102	.821	125	.018	123	.911	124		
0	125	.0	.153	103	.013	126	.031	124	.824	125		
0	126	1.0	.153	104	.016	127	.013	125	.818	126		
0	127	1.0	.153	105	.032	128	.025	126	.791	127		
0	128	1.0	.153	106	.032	129	.130	139	.032	127	.654	128
0	129	1.0	.153	107	.032	130	.130	140	.032	128	.654	129
0	130	1.0	.153	108	.021	131	.130	141	.032	129	.665	130
0	131	1.0	.153	109	.008	132	.130	142	.011	130	.699	131
0	132	1.0	.153	110	.008	133	.130	143	.008	131	.702	132
0	133	1.0	.153	111	.012	134	.130	144	.008	132	.698	133
0	134	1.0	.153	112	.088	135	.130	145	.041	133	.589	134
0	135	1.0	.153	113	.076	136	.130	146	.088	134	.554	135
0	136	1.0	.153	114	.050	137	.130	147	.057	135	.612	136
0	137	1.0	.153	115	.050	138	.130	148	.050	136	.619	137
0	138	1.0	.153	116	.068	197	.130	149	.050	137	.601	138
0	139	1.0	.093	128	.032	140	.875	139				
0	140	1.0	.093	129	.032	141	.105	150	.032	139	.739	140
0	141	1.0	.093	130	.021	142	.105	151	.032	140	.749	141
0	142	1.0	.093	131	.008	143	.105	152	.011	141	.784	142
1	143	1.0	.093	132	.008	144	.105	153	.008	142	.786	143
0	144	1.0	.093	133	.012	145	.105	154	.008	143	.782	144
0	145	1.0	.093	134	.088	146	.105	155	.041	144	.673	145
0	146	1.0	.093	135	.076	147	.105	156	.088	145	.638	146
0	147	1.0	.093	136	.050	148	.105	157	.057	146	.696	147
0	148	1.0	.093	137	.050	149	.105	158	.050	147	.703	148
0	149	1.0	.093	138	.068	197	.105	159	.050	148	.685	149
0	150	1.0	.088	140	.032	151	.880	150				
0	151	1.0	.088	141	.021	152	.103	160	.032	150	.755	151
0	152	1.0	.088	142	.008	153	.103	161	.011	151	.790	152
0	153	1.0	.088	143	.008	154	.103	162	.008	152	.792	153
0	154	1.0	.088	144	.012	155	.103	163	.008	153	.788	154
0	155	1.0	.088	145	.088	156	.103	164	.041	154	.679	155
1	156	1.0	.088	146	.076	157	.103	165	.088	155	.644	156
0	157	1.0	.088	147	.050	158	.103	166	.057	156	.702	157
0	158	1.0	.088	148	.050	159	.103	167	.050	157	.709	158
0	159	1.0	.088	149	.068	197	.103	168	.050	158	.691	159
0	160	1.0	.089	151	.021	161	.889	160				
0	161	1.0	.089	152	.008	162	.102	169	.011	160	.790	161
0	162	1.0	.089	153	.008	163	.102	170	.008	161	.792	162
0	163	1.0	.089	154	.012	164	.102	171	.008	162	.788	163

00 0 5 1 9 0 3

0 164	.0	.089	155	.068	165	.102	172	.041	163	.679	164
0 165	.0	.089	156	.076	[illegible]	.102	173	.088	164	.644	165
0 166	1.0	.089	157	.050	[illegible]	.102	174	.057	165	.702	166
0 167	1.0	.089	158	.050	168	.102	175	.050	166	.709	167
0 168	1.0	.089	159	.068	197	.102	176	.050	167	.691	168
0 169	1.0	.090	161	.008	170	.902	169				
0 170	1.0	.090	162	.008	171	.008	169	.894	170		
0 171	1.0	.090	163	.012	172	.008	170	.890	171		
0 172	1.0	.090	164	.088	173	.085	177	.041	171	.696	172
0 173	1.0	.090	165	.076	174	.085	178	.088	172	.661	173
0 174	1.0	.090	166	.050	175	.085	179	.057	173	.719	174
0 175	1.0	.090	167	.050	176	.085	180	.050	174	.726	175
0 176	1.0	.090	168	.068	197	.085	181	.050	175	.708	176
0 177	1.0	.053	172	.088	178	.043	182	.816	177		
0 178	1.0	.053	173	.076	179	.043	183	.088	177	.740	178
0 179	1.0	.053	174	.050	180	.043	184	.057	178	.798	179
0 180	1.0	.053	175	.050	181	.043	185	.050	179	.805	180
0 181	1.0	.053	176	.068	197	.043	186	.050	180	.787	181
0 182	1.0	.024	177	.088	183	.021	187	.867	182		
0 183	1.0	.024	178	.076	184	.021	188	.088	182	.792	183
0 184	1.0	.024	179	.050	185	.021	189	.057	183	.849	184
0 185	1.0	.024	180	.050	186	.021	190	.050	184	.856	185
0 186	1.0	.024	181	.068	197	.021	191	.050	185	.838	186
0 187	1.0	.013	182	.068	188	.008	192	.891	187		
0 188	1.0	.013	183	.076	189	.008	193	.088	187	.816	188
1 189	1.0	.013	184	.050	190	.008	194	.057	188	.873	189
0 190	1.0	.013	185	.050	191	.008	195	.050	189	.880	190
0 191	1.0	.013	186	.068	197	.008	196	.050	190	.862	191
0 192	1.0	.002	187	.088	193	.910	192				
0 193	1.0	.002	188	.076	194	.088	192	.834	193		
0 194	1.0	.002	189	.050	195	.057	193	.891	194		
0 195	1.0	.002	190	.050	196	.050	194	.899	195		
0 196	1.0	.002	191	.068	197	.050	195	.880	196		
0 197	1.0	1.000	197								
0 198	1.0	1.000	198								
0 199	1.0	1.000	199								
0 200	1.0	1.000	200								

DELTA THETA =1.730E-04HRS/ITER   BLOCK 113

0006190319

CUSTOMER

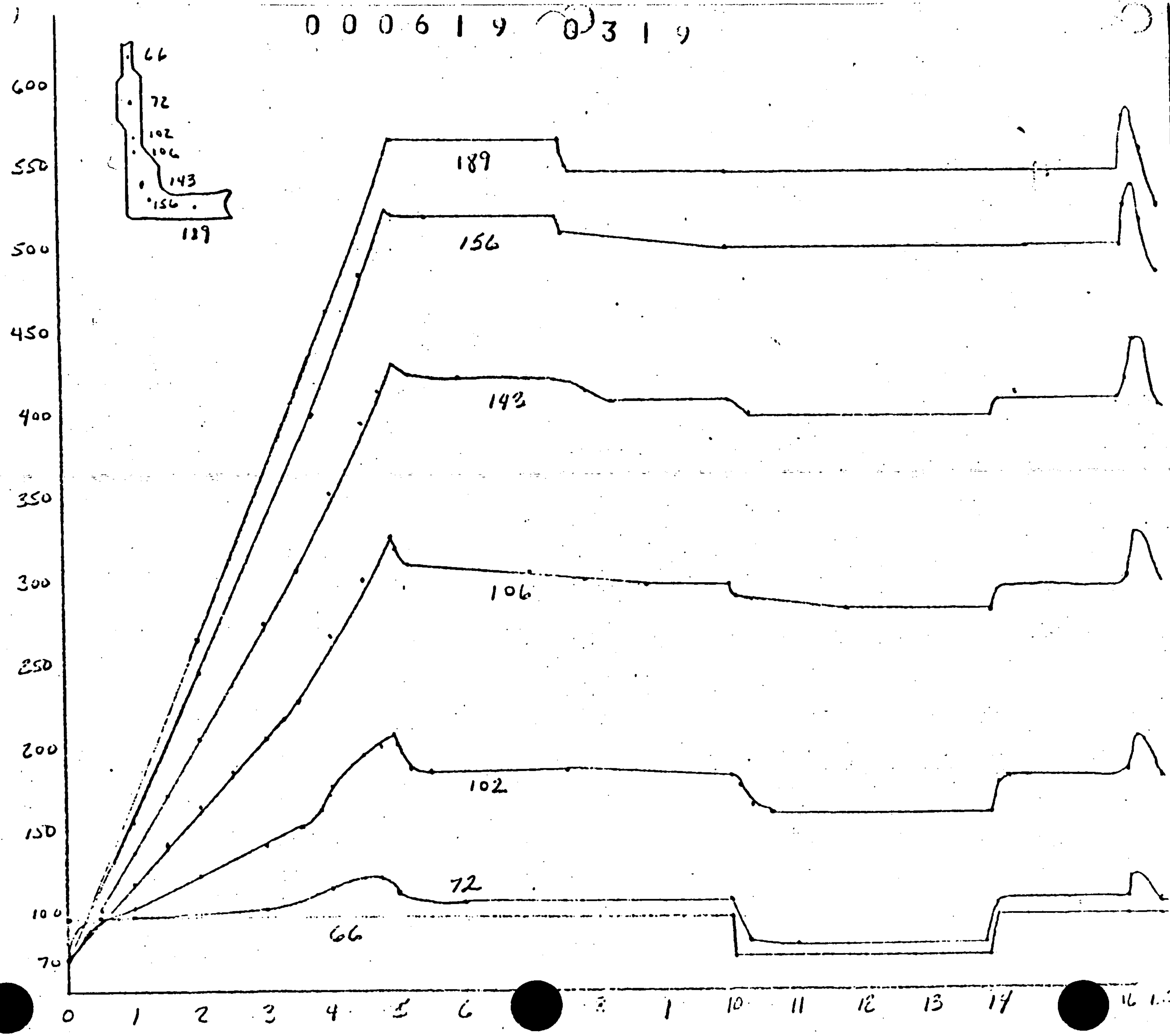
SUBJECT

JOB NO.

BY

DATE

2-20



K&E

0 0 0 6 1 9 0 3 2 0

OSC 1522

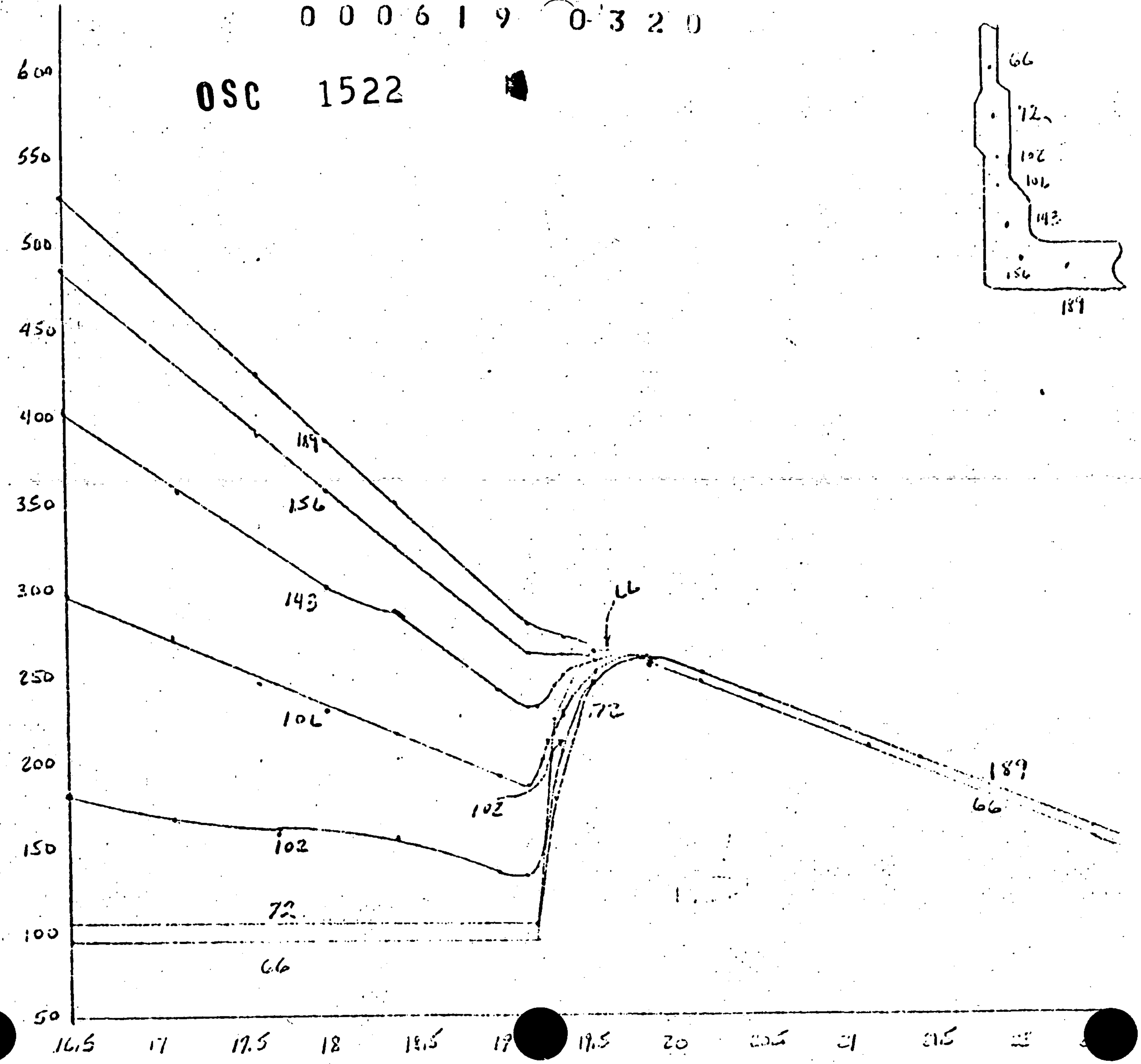
CUSTOMER

SUBJECT

JOB No.

BY

DATE



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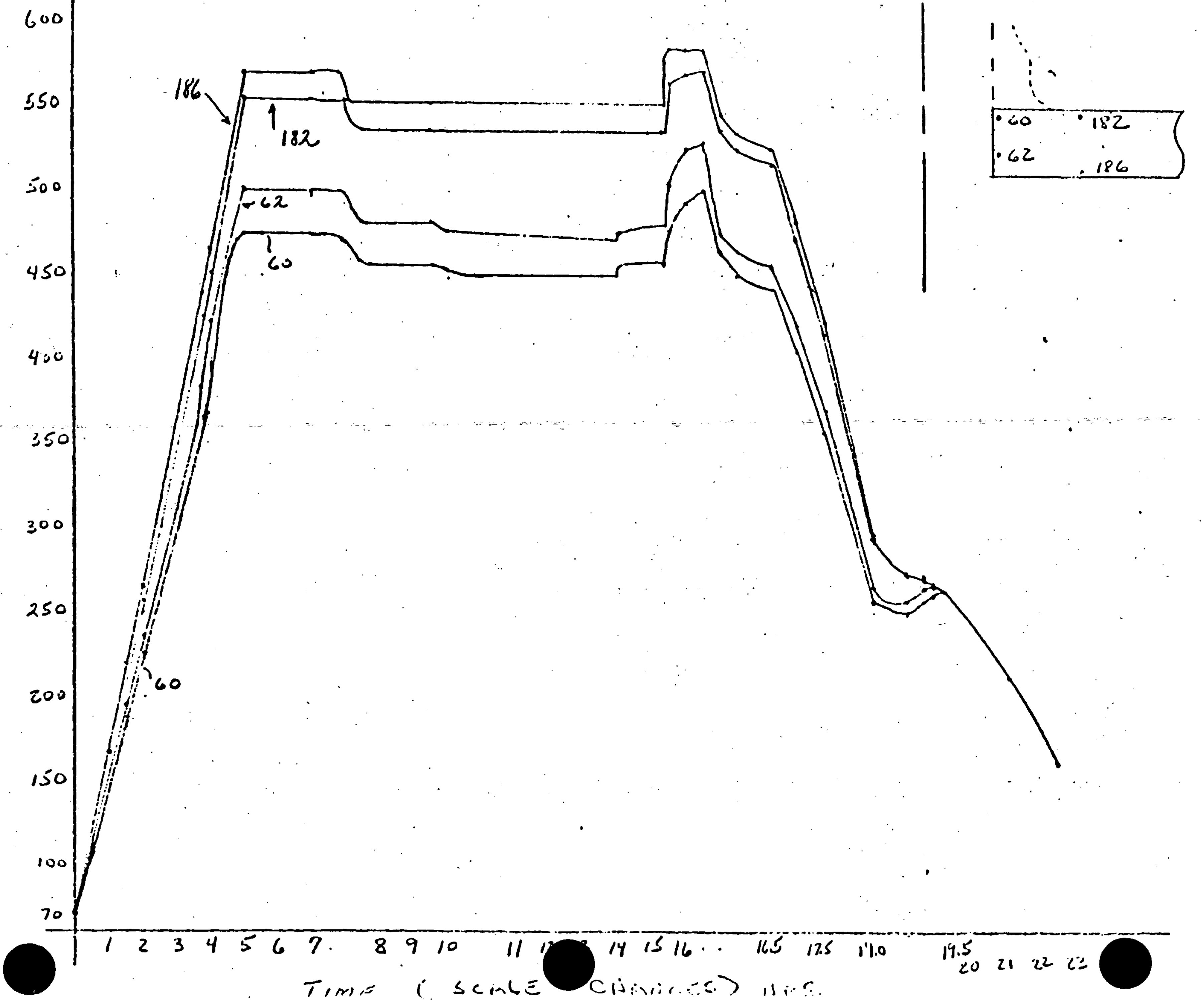

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K&B 10-315

SELECTION OF CRITICAL TIMES

After a study of the preceding graphs the following times were chosen for stress analysis:

ITERATION (TIME, HRS.)	EXPLANATION
28169 (4.95)	This reflects a time near the end of heat-up to 15% power and is essentially equivalent to one of the worst axial gradient cases at 15% power.
41428 (7.5)	Steady state at 15% power. This reflects hottest cold leg temperature for a prolonged time.
52659 (9.66)	Reflects steady state distribution at 8% or 100% power.
75168 (13.9)	Reflects axial gradient at end of feed and bleed.
86960 (16.099)	Reflects maximum temperature of cold leg when trip initiates.
103154 (19.2)	Reflects short time after decay heat removal initiates and a reversal in axial gradient.

The stress analysis of these cases should define an assurance of stress levels in the nozzle and ranges in stress levels such that fatigue criteria can be justified. This will be discussed further in the stress computations portion.

0 0086 11.9 0 3 2137

28169	[illegible]	109	116	120	[illegible]	[illegible]	[illegible]	137	147	157	166	4.[illegible]
28169	1	174	180	189	200	214	236	266	362	103	106	4.[illegible]009
28169	21	110	118	129	139	152	167	186	206	228	247	4.95009
28169	31	263	276	293	315	343	369	389	385	96	97	4.95009
28169	41	99	101	103	107	111	126	137	157	178	201	4.95009
28169	51	229	258	290	319	341	360	384	417	456	485	4.95009
28169	61	499	514	550	566	96	97	99	101	104	107	4.95009
28169	71	112	121	135	158	180	204	232	261	293	322	4.95009
28169	81	345	364	389	422	461	491	505	521	548	565	4.95009
28169	91	96	97	99	101	104	108	113	122	137	160	4.95009
28169	101	181	207	233	261	294	325	348	366	391	424	4.95009
28169	111	464	494	508	524	547	555	105	108	114	123	4.95009
28169	121	139	161	183	208	233	252	296	328	351	370	4.95009
28169	131	394	427	468	498	512	528	548	565	335	356	4.95009
28169	141	374	398	431	472	503	517	532	549	565	362	4.95009
28169	151	379	401	434	476	508	522	536	551	566	384	4.95009
28169	161	404	436	478	514	527	540	554	567	407	437	4.95009
28169	171	480	522	534	545	557	568	540	544	551	560	4.95009
28169	181	569	552	554	558	564	570	561	562	564	567	4.95009
28169	191	572	567	568	569	571	573	575	575	95	95	

0 030 614 9 1 0312 1

[illegible]	1	98	100	105	100	101	103	106	109	113	116	7.[illegible]06
407[illegible]	11	118	120	[illegible]	[illegible]	[illegible]	[illegible]	146	220	96	97	[illegible]006
407[illegible]	21	99	102	109	120	[illegible]	144	160	177	196	214	7.36006
40700	31	228	230	254	274	298	316	324	258	95	95	7.36006
40700	41	95	96	96	97	99	104	113	138	157	179	7.36006
40700	51	206	235	269	299	323	343	369	404	444	474	7.36006
40700	61	487	498	546	566	95	95	95	96	96	98	7.36006
40700	71	100	105	116	139	159	183	209	238	272	303	7.36006
40700	81	328	348	375	410	451	481	495	510	544	565	7.36006
40700	91	95	95	95	96	97	98	101	107	119	140	7.36006
40700	101	161	185	210	239	274	306	331	351	378	413	7.36006
40700	111	455	485	499	516	544	564	97	98	101	108	7.36006
40700	121	121	141	162	187	211	240	275	310	335	355	7.36006
40700	131	382	418	460	491	505	522	545	564	318	341	7.36006
40700	141	361	387	422	466	498	513	529	548	565	348	7.36006
40700	151	366	391	426	471	505	519	535	551	566	372	7.36006
40700	161	394	428	474	512	526	540	554	567	397	430	7.36006
40700	171	476	522	534	546	557	568	541	546	553	561	7.36006
40700	181	570	555	557	561	566	571	565	566	567	570	7.36006
40700	191	573	572	572	573	573	574	575	575	95	95	

41428	1	98	100	105	100	101	103	106	109	113	116	7.50007
41428	11	118	120	123	126	130	134	146	220	96	97	7.50007
41428	21	99	102	109	120	131	144	160	177	196	214	7.50007
41428	31	228	239	254	274	298	316	324	258	95	95	7.50007
41428	41	95	96	96	97	99	104	113	138	157	179	7.50007
41428	51	206	235	269	299	323	343	369	404	444	474	7.50007
41428	61	487	498	546	566	95	95	95	96	96	98	7.50007
41428	71	100	105	116	139	159	183	209	238	272	303	7.50007
41428	81	328	348	375	410	451	481	495	510	544	565	7.50007
41428	91	95	95	95	96	97	98	101	107	119	140	7.50007
41428	101	161	185	210	239	274	306	331	351	378	413	7.50007
41428	111	455	485	499	516	544	564	97	98	101	108	7.50007
41428	121	121	141	162	187	211	240	275	310	335	355	7.50007
41428	131	382	418	460	491	505	522	545	564	318	341	7.50007
41428	141	361	387	422	466	498	513	529	548	565	348	7.50007
41428	151	366	391	426	471	505	519	535	551	566	372	7.50007
41428	161	394	428	474	512	526	540	554	567	397	430	7.50007
41428	171	476	522	534	546	557	568	541	546	553	561	7.50007
41428	181	570	555	557	561	566	571	565	566	567	570	7.50007
41428	191	573	572	572	573	573	574	575	575	95	95	

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	106	109	112	115	[illegible]
[illegible]	11	117	119	[illegible]	[illegible]	[illegible]	[illegible]	143	214	96	97	[illegible]
[illegible]	21	98	102	[illegible]	[illegible]	[illegible]	142	157	173	192	209	[illegible]
[illegible]	31	222	233	248	267	[illegible]	307	315	251	95	95	[illegible]
50268	41	95	96	96	97	99	104	112	136	155	176	9.20019
50268	51	202	229	261	291	314	333	358	391	430	458	9.20019
50268	61	471	481	527	546	95	95	95	96	96	98	9.20019
50268	71	100	105	115	137	156	179	204	232	265	295	9.20019
50268	81	318	338	363	397	436	465	478	493	525	545	9.20019
50268	91	95	95	95	96	96	98	101	106	118	138	9.20019
50268	101	158	181	205	233	266	297	321	340	366	400	9.20019
50268	111	440	469	482	498	525	545	97	98	101	107	9.20019
50268	121	120	140	159	183	206	234	268	301	325	344	9.20019
50268	131	370	404	445	475	488	505	526	545	309	331	9.20019
50268	141	350	375	409	451	481	495	511	529	545	337	9.20019
50268	151	355	379	412	455	488	502	516	532	546	360	9.20019
50268	161	382	414	458	495	508	521	535	548	385	416	9.20019
50268	171	460	504	516	527	538	549	522	527	533	542	9.20019
50268	181	550	536	538	541	546	552	545	546	548	550	9.20019
50268	191	553	552	552	553	554	554	555	555	95	95	

52659	1	97	100	104	100	101	103	106	109	112	115	9.66003
52659	11	117	119	121	125	128	133	143	214	96	97	9.66003
52659	21	98	102	109	119	130	142	157	173	192	209	9.66003
52659	31	222	233	248	267	290	307	315	251	95	95	9.66003
52659	41	95	96	96	97	99	104	112	136	155	176	9.66003
52659	51	202	229	261	291	314	333	358	391	430	458	9.66003
52659	61	471	481	527	546	95	95	95	96	96	98	9.66003
52659	71	100	105	115	137	156	179	204	232	265	295	9.66003
52659	81	318	338	363	397	436	465	478	493	525	545	9.66003
52659	91	95	95	95	96	96	98	101	106	118	138	9.66003
52659	101	158	181	205	233	266	297	321	340	366	400	9.66003
52659	111	440	469	482	498	525	545	97	98	101	107	9.66003
52659	121	120	140	159	183	206	234	268	301	325	344	9.66003
52659	131	370	404	445	475	488	505	526	545	309	331	9.66003
52659	141	350	375	409	451	481	495	511	529	545	337	9.66003
52659	151	355	379	412	455	488	502	516	532	546	360	9.66003
52659	161	382	414	458	495	508	521	535	548	385	416	9.66003
52659	171	460	504	516	527	538	549	522	527	533	542	9.66003
52659	181	550	536	536	541	546	552	545	546	548	550	9.66003
52659	191	553	552	552	553	554	554	555	555	95	95	

0 0 0 6 1 9 0 3 2

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	82	13.9001
[illegible]	[illegible]	83	84	86	88	90	[illegible]	97	150	70	71	13.900
75168	[illegible]	72	75	80	[illegible]	104	[illegible]	[illegible]	148	166	183	13.9
75168	[illegible]	197	208	223	243	266	[illegible]	287	197	70	70	13.90014
75168	41	70	70	71	71	73	71	85	110	130	152	13.90014
75168	51	179	208	241	272	296	316	343	378	419	448	13.90014
75168	61	461	471	524	545	70	70	70	70	71	72	13.90014
75168	71	74	78	88	111	132	[illegible]	182	211	245	277	13.90014
75168	81	301	322	348	364	426	456	470	486	522	544	13.90014
75168	91	70	70	70	70	71	72	74	79	91	113	13.90014
75168	101	133	158	183	212	247	279	304	325	352	388	13.90014
75168	111	430	461	475	492	522	544	71	72	75	81	13.90014
75168	121	93	114	135	160	184	213	248	284	308	329	13.90014
75168	131	356	392	436	467	482	[illegible]	523	544	292	315	13.90014
75168	141	334	361	397	442	475	[illegible]	506	526	544	321	13.90014
75168	151	340	365	401	447	482	497	513	530	546	345	13.90014
75168	161	369	403	450	489	504	[illegible]	533	547	372	404	13.90014
75168	171	452	499	512	524	536	[illegible]	519	524	532	540	13.90014
75168	181	549	535	536	540	545	551	544	545	547	550	13.90014
75168	191	553	552	552	553	553	554	555	555	70	70	

75700	1	96	97	100	97	98	99	100	102	104	106	14.00017
75700	11	107	108	110	112	114	116	121	171	95	95	14.00017
75700	21	96	99	103	113	123	134	149	164	182	198	14.00017
75700	31	211	222	237	256	279	[illegible]	300	215	95	95	14.00017
75700	41	95	95	95	96	97	100	107	128	146	166	14.00017
75700	51	191	218	250	279	302	322	347	382	423	452	14.00017
75700	61	464	474	525	545	95	[illegible]	95	95	95	96	14.00017
75700	71	97	101	110	129	147	[illegible]	193	221	253	283	14.00017
75700	81	307	327	353	388	429	[illegible]	473	488	523	544	14.00017
75700	91	95	95	95	95	95	96	98	102	112	130	14.00017
75700	101	149	171	194	222	255	[illegible]	310	329	356	391	14.00017
75700	111	433	464	477	494	523	544	95	96	98	103	14.00017
75700	121	113	131	150	172	195	[illegible]	256	290	314	333	14.00017
75700	131	360	395	438	469	484	[illegible]	524	544	297	320	14.00017
75700	141	339	364	400	444	477	[illegible]	508	527	545	326	14.00017
75700	151	344	368	403	449	483	[illegible]	513	530	546	349	14.00017
75700	161	372	406	452	491	505	[illegible]	533	547	375	407	14.00017
75700	171	454	500	513	525	537	[illegible]	520	525	532	541	14.00017
75700	181	550	535	537	540	545	551	545	545	547	550	14.00017
75700	191	553	552	552	553	553	554	555	555	95	95	

6946	1	172	179	188	[illegible]	[illegible]	[illegible]	[illegible]	370	99	102	16.09634
6946	2	106	112	122	132	144	[illegible]	178	199	221	242	16.096
6946	31	259	272	291	317	348	376	398	394	95	96	16.09634
6946	41	97	98	100	102	106	114	125	148	167	190	16.09634
6946	51	218	247	280	311	335	355	381	418	462	495	16.09634
6946	61	511	527	564	581	95	96	97	98	100	103	16.09634
6946	71	107	115	127	149	169	193	220	249	283	314	16.09634
6946	81	339	359	386	423	468	501	516	534	562	580	16.09634
6946	91	95	96	97	98	100	103	108	116	129	150	16.09634
6946	101	170	195	220	250	284	316	341	361	388	426	16.09634
6946	111	471	504	519	537	562	580	100	103	108	116	16.09634
6946	121	131	151	172	196	221	251	286	320	345	365	16.09634
6946	131	392	429	475	508	524	541	562	580	328	350	16.09634
6946	141	369	396	433	480	514	529	546	564	580	356	16.09634
6946	151	374	399	436	464	520	534	550	566	581	380	16.09634
6946	161	403	438	487	526	541	555	569	582	405	439	16.09634
6946	171	488	535	548	560	572	583	555	560	567	576	16.09634
6946	181	585	570	572	575	580	586	579	580	582	585	16.09634
6946	191	588	587	587	587	588	589	590	590	95	95	

86960	1	105	111	120	115	119	125	134	144	155	164	16.09898
86960	11	172	179	188	200	216	240	271	370	100	102	16.09898
86960	21	106	113	123	132	144	159	178	199	222	242	16.09898
86960	31	259	273	291	317	348	377	398	394	95	96	16.09898
86960	41	97	98	100	102	107	114	125	148	168	190	16.09898
86960	51	218	247	281	311	335	355	382	419	463	495	16.09898
86960	61	511	527	564	581	95	96	97	98	100	103	16.09898
86960	71	107	115	128	149	169	193	220	250	284	315	16.09898
86960	81	339	359	386	424	468	501	516	534	562	580	16.09898
86960	91	95	96	97	98	100	103	108	116	129	150	16.09898
86960	101	171	195	221	251	285	317	341	361	389	426	16.09898
86960	111	471	504	519	537	562	580	101	103	108	117	16.09898
86960	121	131	151	172	197	222	251	286	321	345	365	16.09898
86960	131	392	430	475	508	524	541	562	560	328	350	16.09898
86960	141	370	396	434	480	514	529	546	564	580	357	16.09898
86960	151	375	400	436	484	520	535	550	566	581	380	16.09898
86960	161	403	438	487	526	541	555	569	582	406	439	16.09898
86960	171	489	536	549	560	572	583	555	560	567	576	16.09898
86960	181	585	570	572	575	580	586	579	580	582	585	16.09898
86960	191	588	587	587	587	588	589	590	590	95	95	

							143	130	138	145		
		[illegible]	155	161	169	177	[illegible]	199	223	96	97	[illegible]
103154	21	99	103	[illegible]	[illegible]	[illegible]	126	136	146	157	167	[illegible]
103154	31	174	181	189	199	211	221	228	228	95	95	[illegible]
103154	41	95	96	96	97	99	103	108	117	125	136	19.20004
103154	51	148	161	175	187	197	204	214	227	241	250	19.20004
103154	61	254	258	266	269	95	95	95	96	96	97	19.20004
103154	71	94	103	109	117	126	137	149	161	176	188	19.20004
103154	81	196	205	216	228	242	251	255	259	265	268	19.20004
103154	91	95	95	95	96	96	97	100	103	109	118	19.20004
103154	101	126	137	149	162	176	189	198	206	216	229	19.20004
103154	111	243	252	256	260	265	268	96	97	100	103	19.20004
103154	121	109	118	127	138	149	162	176	190	200	207	19.20004
103154	131	217	230	244	253	257	201	265	268	193	201	19.20004
103154	141	209	218	231	245	255	258	262	266	268	204	19.20004
103154	151	210	210	232	246	256	250	264	267	269	212	19.20004
103154	161	220	232	247	258	262	255	268	270	221	233	19.20004
103154	171	248	261	265	267	270	271	267	268	270	271	19.20004
103154	181	273	272	273	273	274	275	276	276	276	277	19.20004
103154	191	277	280	280	280	280	280	278	278	95	95	19.20004

103163	1	109	111	115	122	126	130	137	144	152	159	19.20156
103163	11	164	169	175	182	191	202	212	232	106	105	19.20156
103163	21	104	106	111	113	120	127	137	147	158	168	19.20156
103163	31	176	182	190	200	212	222	229	233	103	104	19.20156
103163	41	104	104	101	101	101	104	110	117	126	136	19.20156
103163	51	148	161	175	187	197	204	214	227	241	250	19.20156
103163	61	[illegible]	258	266	269	99	99	99	99	98	99	19.20156
103163	71	100	104	109	117	126	137	149	162	176	188	19.20156
103163	81	198	206	216	228	242	251	255	259	265	268	19.20156
103163	91	96	96	97	97	97	98	100	103	109	118	19.20156
103163	101	127	138	149	162	176	189	199	206	216	229	19.20156
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103163	121	110	118	127	138	149	162	176	190	200	207	19.20156
103163	131	217	230	244	253	257	201	265	268	193	202	19.20156
103163	141	209	218	231	245	255	258	262	266	268	204	19.20156
103163	151	211	220	232	246	256	260	264	267	269	212	19.20156
103163	161	221	232	247	258	262	265	268	270	221	233	19.20156
103163	171	248	251	265	267	270	271	267	268	270	271	19.20156
103163	181	272	272	273	273	274	274	276	276	276	277	19.20156
103163	191	277	280	280	280	280	279	278	278	280	280	19.20156

SECTION III

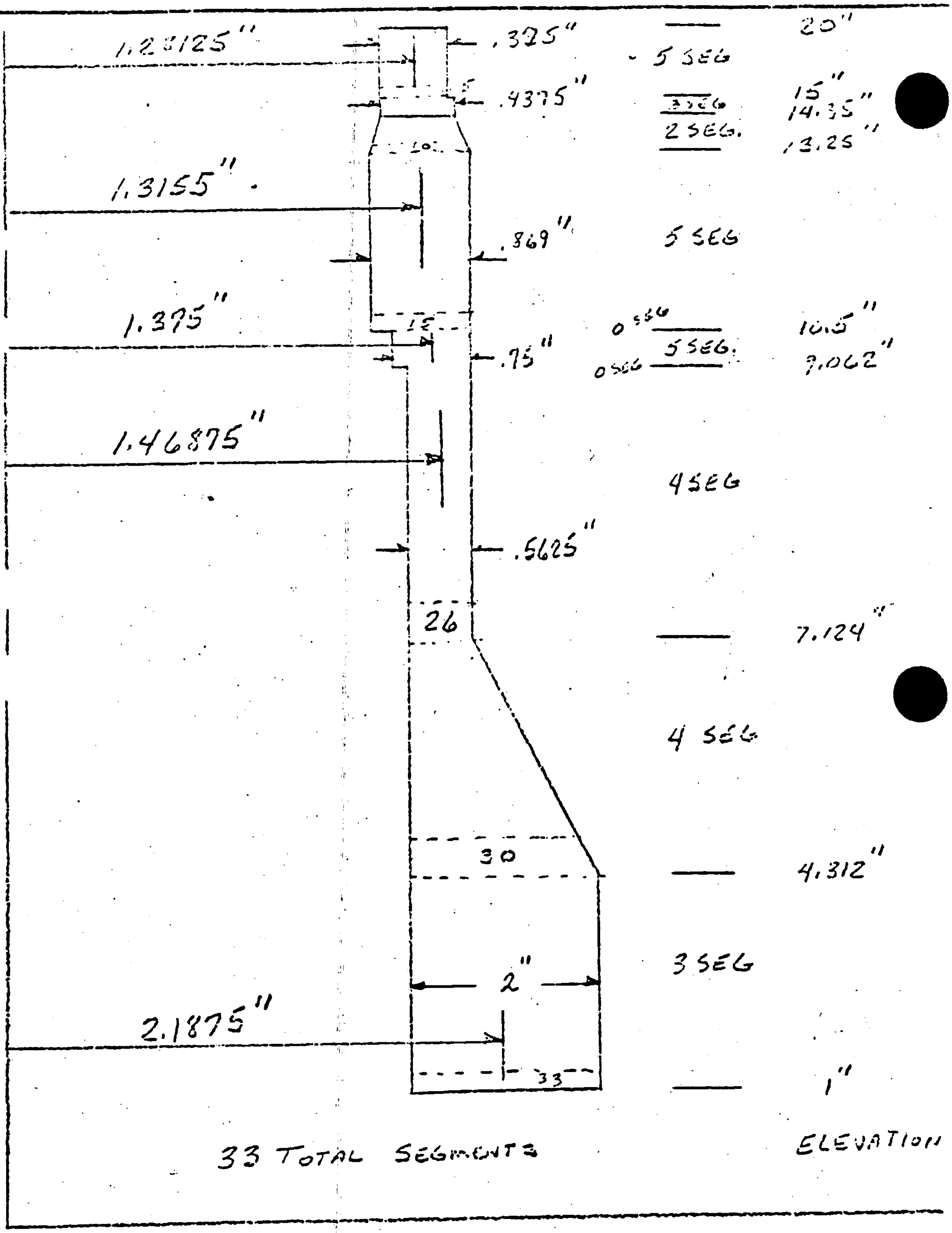
STRESS COMPUTATIONS

This section deals with the actual stress computations and comparison to allowables. The stress calculations are performed by first justifying the nozzle for pressure conditions. This was done on Page 1-7. Secondly, a combination of stress indices from B31.7 and various other literature were obtained and moment loading is defined. Thus, giving the several intensities which is associated with applied loads, i.e. dead weight, earthquake, and thermal expansion. Thirdly, the bulk of this section deals with the calculation of thermal stresses.

The thermal stress calculations are performed using B&W Computer Programs 91206 and 91032. Program 91206 uses the virtual work method to solve axisymmetric shells of revolution (See model on Page 3-1). Program 91032 is a general thermal motion and stress program solving for various shapes using appropriate classical theory. The portion which is used in this analysis is the opening in a cylinder using flat plate theory modified to account for curvature in the circumferential direction.

The stresses were generated by inputting appropriate temperatures and geometry into the programs assuming no reactions at the nozzle to shell intersection. A two element discontinuity analysis was then performed and forces and moments generated were then superimposed on the thermal stresses to give a total thermal stress picture.

Stress concentration factors are obtained by using indices of B31.7 and other sources, and finally a fatigue analysis is performed off the branch.



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CUSTOMER	JOB No.
SUBJECT [illegible]	
	BY
	DATE

K&S 10-5

OSC 1522

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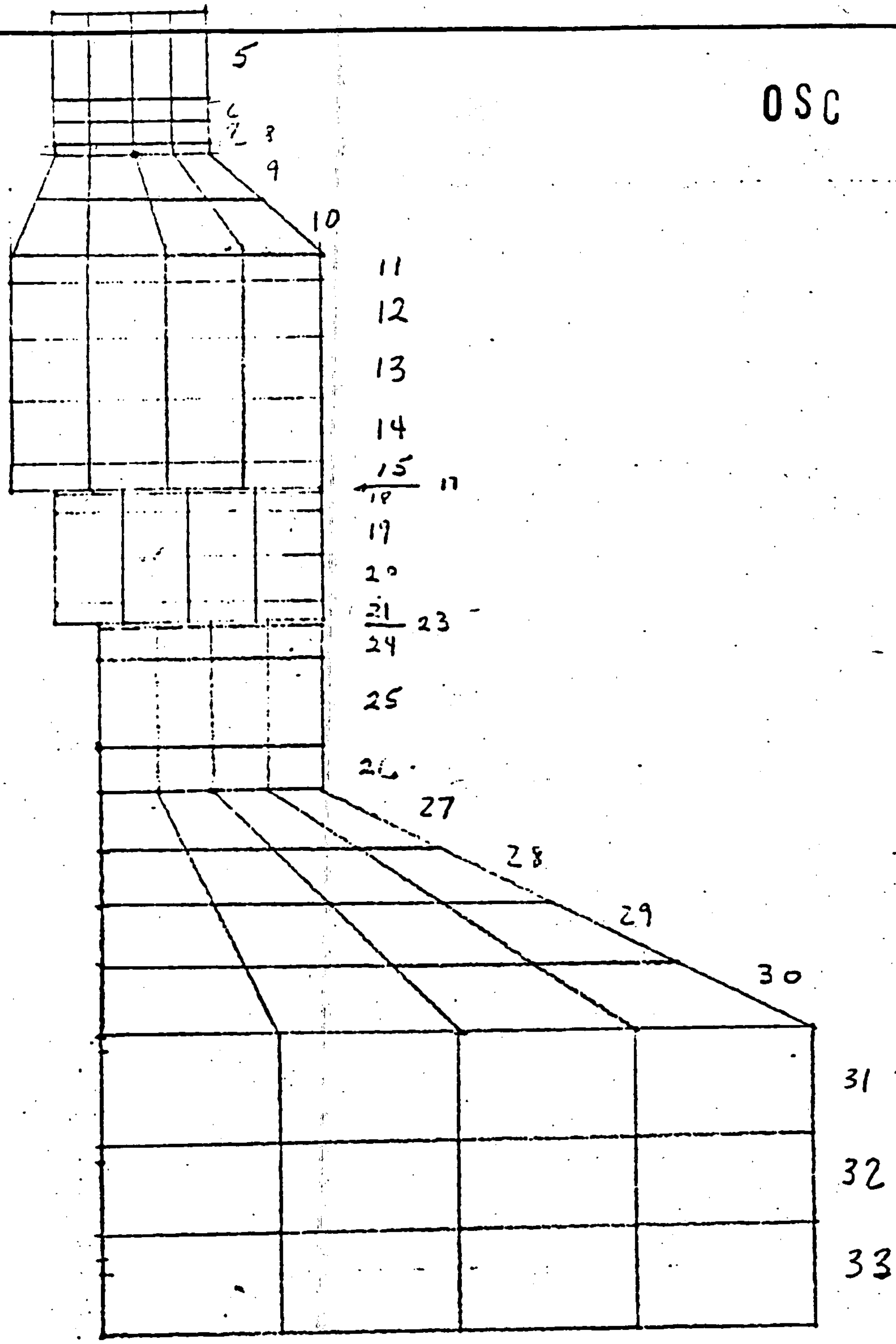


CUSTOMER	JOB No.
SUBJECT 91206 GRID TO SCALE	
LONG. SCALE 4 BLOCKS = 1"	BY
RADIAL SCALE 16 BLOCKS = 1"	DATE

10-5

MID-SURFACE GEOMETRY

AT TOP BOUNDARY, MEAN RADIUS = 1.2813 Z COORDINATE = 20.0000

SEGMENTAL GEOMETRY DATA BY GROUPS

SEGMENT DATA			CENTER OF CURVATURE DATA		
BOTTOM SEG. NO.	MEAN RADIUS	Z COORD.	RADIUS TO CENTER	Z COORD.	CURVATURE IDENTIFIER
5.0	1.281	15.000	-0.000	-0.000	-0.0
6.0	1.281	14.750	-0.000	-0.000	-0.0
7.0	1.281	14.500	-0.000	-0.000	-0.0
8.0	1.281	14.350	-0.000	-0.000	-0.0
10.0	1.316	13.250	-0.000	-0.000	-0.0
11.0	1.316	13.000	-0.000	-0.000	-0.0
14.0	1.316	10.712	-0.000	-0.000	-0.0
15.0	1.316	10.500	-0.000	-0.000	-0.0
16.0	1.375	10.500	-0.000	-0.000	-0.0
17.0	1.375	10.450	-0.000	-0.000	-0.0
18.0	1.375	10.260	-0.000	-0.000	-0.0
20.0	1.375	9.302	-0.000	-0.000	-0.0
21.0	1.375	9.062	-0.000	-0.000	-0.0
22.0	1.469	9.062	-0.000	-0.000	-0.0
23.0	1.469	9.042	-0.000	-0.000	-0.0
24.0	1.469	8.553	-0.000	-0.000	-0.0
25.0	1.469	7.564	-0.000	-0.000	-0.0
26.0	1.469	7.124	-0.000	-0.000	-0.0
30.0	2.188	4.312	-0.000	-0.000	-0.0
33.0	2.188	.999	-0.000	-0.000	-0.0

SEGMENTAL GEOMETRY BY SEGMENTS (K= SEGMENT NO.)

MEAN RADIUS

K	R(K-1)	R(K)	R(K+1)	R(K+2)	R(K+3)	R(K+4)	R(K+5)	R(K+6)	R(K+7)	R(K+8)
1	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.30
11	1.32	1.32	1.32	1.32	1.32	1.32	1.38	1.38	1.38	1.38
21	1.38	1.38	1.47	1.47	1.47	1.47	1.47	1.65	1.83	2.01
31	2.19	2.19	2.19	2.19						

Z COORDINATE

K	Z(K-1)	Z(K)	Z(K+1)	Z(K+2)	Z(K+3)	Z(K+4)	Z(K+5)	Z(K+6)	Z(K+7)	Z(K+8)
1	20.00	19.00	18.00	17.00	16.00	15.00	14.75	14.50	14.35	13.80
11	13.25	13.00	12.24	11.47	10.71	10.50	10.50	10.46	10.26	9.78
21	9.30	9.06	9.06	9.04	8.55	7.58	7.12	6.42	5.72	5.01
31	4.31	3.21	2.10	1.00						

SEGMENT THICKNESS DATA BY GROUPS

TOP SEG. NO.	BOTTOM SEG. NO.	TOP THICK. OF TOP SEG.	BOTTOM THICK. OF BOTTOM SEG.
1.00	5.00	.38	.38
6.00	8.00	.44	.44
9.00	10.00	.44	.87
11.00	15.00	.87	.87
16.00	16.00	-0.00	-0.00
17.00	21.00	.75	.75
22.00	22.00	-0.00	-0.00
23.00	26.00	.56	.56
27.00	30.00	.56	2.00
31.00	33.00	2.00	2.00

OSC 1522

[illegible]MENTAL THICKNESS BY SEGMENTS

THICKNESS AT TOP OF SEGMENT (HA)

K	HA(K)	HA(K+1)	HA(K+2)	HA(K+3)	HA(K+4)	HA(K+5)	HA(K+6)	HA(K+7)	HA(K+8)	HA(K+9)
1	.38	.38	.38	.38	.38	.44	.44	.44	.44	.65
11	.87	.87	.87	.87	.87	0.00	.75	.75	.75	.75
21	.75	0.00	.56	.56	.56	.56	.55	.92	1.28	1.64
31	2.00	2.00	2.00							

THICKNESS AT BOTTOM OF SEGMENT (HB)

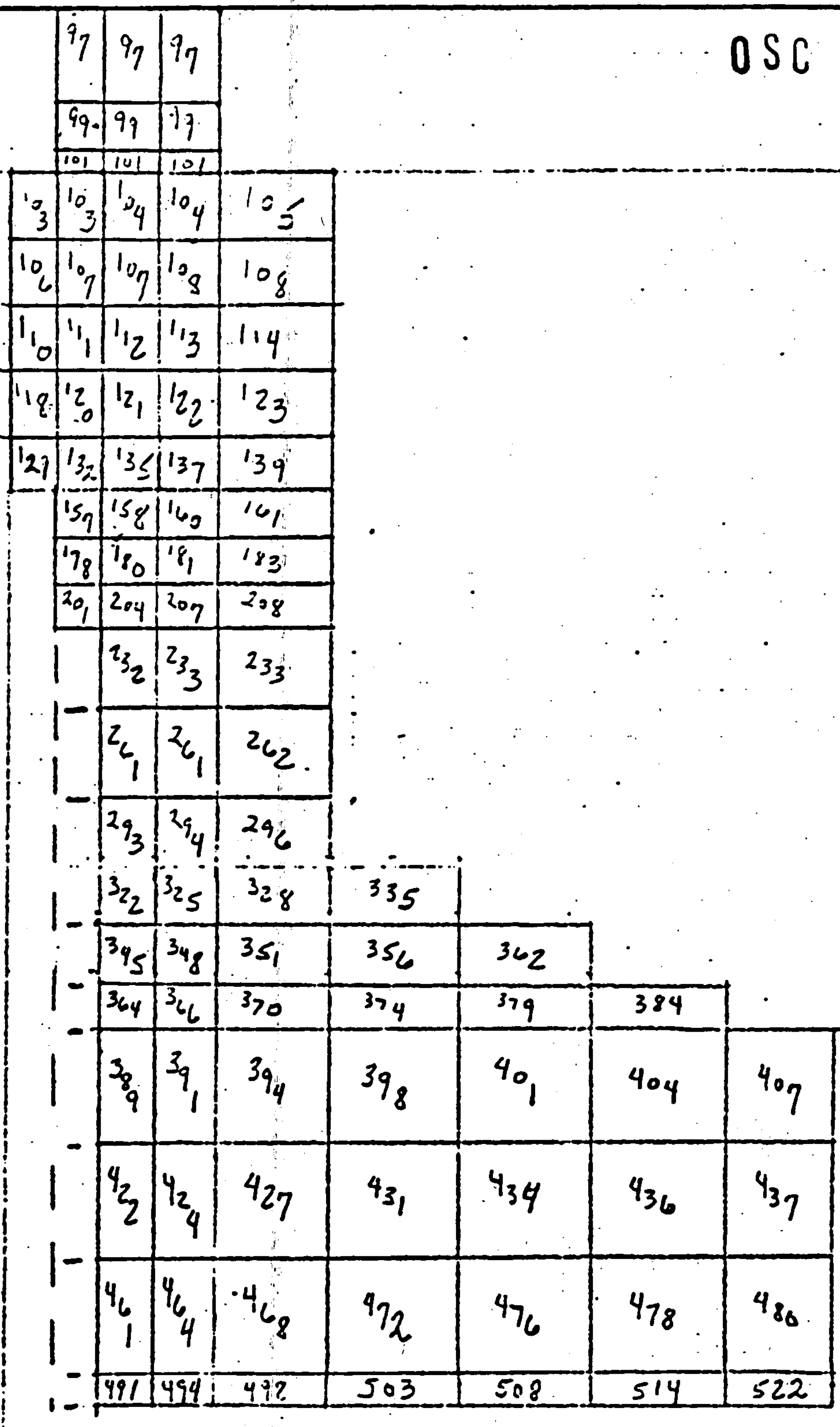
K	HB(K)	HB(K+1)	HB(K+2)	HB(K+3)	HB(K+4)	HB(K+5)	HB(K+6)	HB(K+7)	HB(K+8)	HB(K+9)
1	.38	.38	.38	.38	.38	.44	.44	.44	.65	.87
11	.87	.87	.87	.87	.87	0.00	.75	.75	.75	.75
21	.75	0.00	.56	.56	.56	.56	.92	1.28	1.64	2.00
31	2.00	2.00	2.00							

FLEXIBILITY MATRIX OF ASSEMBLY AS IN PROGRAM 91060
(THIS MATRIX ONLY IS ON A PER RADIAN BASIS)

	M(O)	Q(O)	M(N)	Q(N)
ROTATION(O)	3.138385E-06	8.041817E-07	-4.768053E-19	1.402074E-18
DEFLECTION(O)	8.041817E-07	5.054773E-07	7.682228E-20	6.538833E-19
ROTATION(N)	-4.768053E-19	7.662228E-20	4.137258E-08	2.476880E-08
DEFLECTION(N)	1.402074E-18	6.538833E-19	2.476880E-08	5.410859E-08

NOTE: THE +1 SIGN CONVENTION IS USED IN THE MATRIX PRINTED HERE. IF IT IS DESIRED TO USE THE -1 SIGN CONVENTION THEN THE SIGNS MUST BE CHANGED ON ALL OF THE OFF-DIAGONAL ELEMENTS.

OSC 1522



0006100335

ITER 2.8169 TEMPERATURE DIST.

CUSTOMER

JOB No.

SUBJECT 91167 GRID TO SCALE

LONGITUDINAL SCALE 4 BLOCKS = 1"

BY

RADIAL SCALE 16 BLOCKS = 1"

DATE 3-7

TEMPERATURES PER SEGMENT USED IN PEAK PRINCIPLE ANALYSIS

SEGMENT	OUTSIDE T1	T2	T3	T4	INSIDE T5
1	27	27	27	27	27
2	27	27	27	27	27
3	27	27	27	27	27
4	27	27	27	27	27
5	27	27	27	27	27
6	27	27	27	27	27
7	28	28	28	28	28
8	29	29	29	29	29
9	33	33	32	31	31
10	36	36	35	34	34
11	38	38	37	36	36
12	49	48	46	45	44
13	59	57	56	53	52
14	70	67	65	62	60
15	80	77	75	72	70
16	80	77	77	76	75
17	80	77	77	76	75
18	122	120	115	112	110
19	131	129	125	122	120
20	140	137	135	132	130
21	150	147	145	142	140
22	150	150	150	150	150
23	150	150	150	150	150
24	165	163	162	161	160
25	195	194	193	192	190
26	213	211	210	207	205
27	245	242	241	238	236
28	276	274	272	269	267
29	308	305	304	301	299
30	340	337	335	332	330
31	373	368	353	360	330
32	407	399	392	387	383
33	440	430	420	415	410

2-0

PEAK FORCES AND MOTIONS
****

OSC 1555

POSITIVE DIRECTIONS (+) ARE AS FOLLOWS

TOP OF SEGMENT NO.1		BOTTOM OF REMAINING SEGMENTS	
RADIAL------	TO THE LEFT	RADIAL------	TO THE RIGHT
ROTATIONAL--	CLOCKWISE	ROTATIONAL--	COUNTERCLOCKWISE
AXIAL-------	UPWARD	AXIAL-------	DOWNWARD

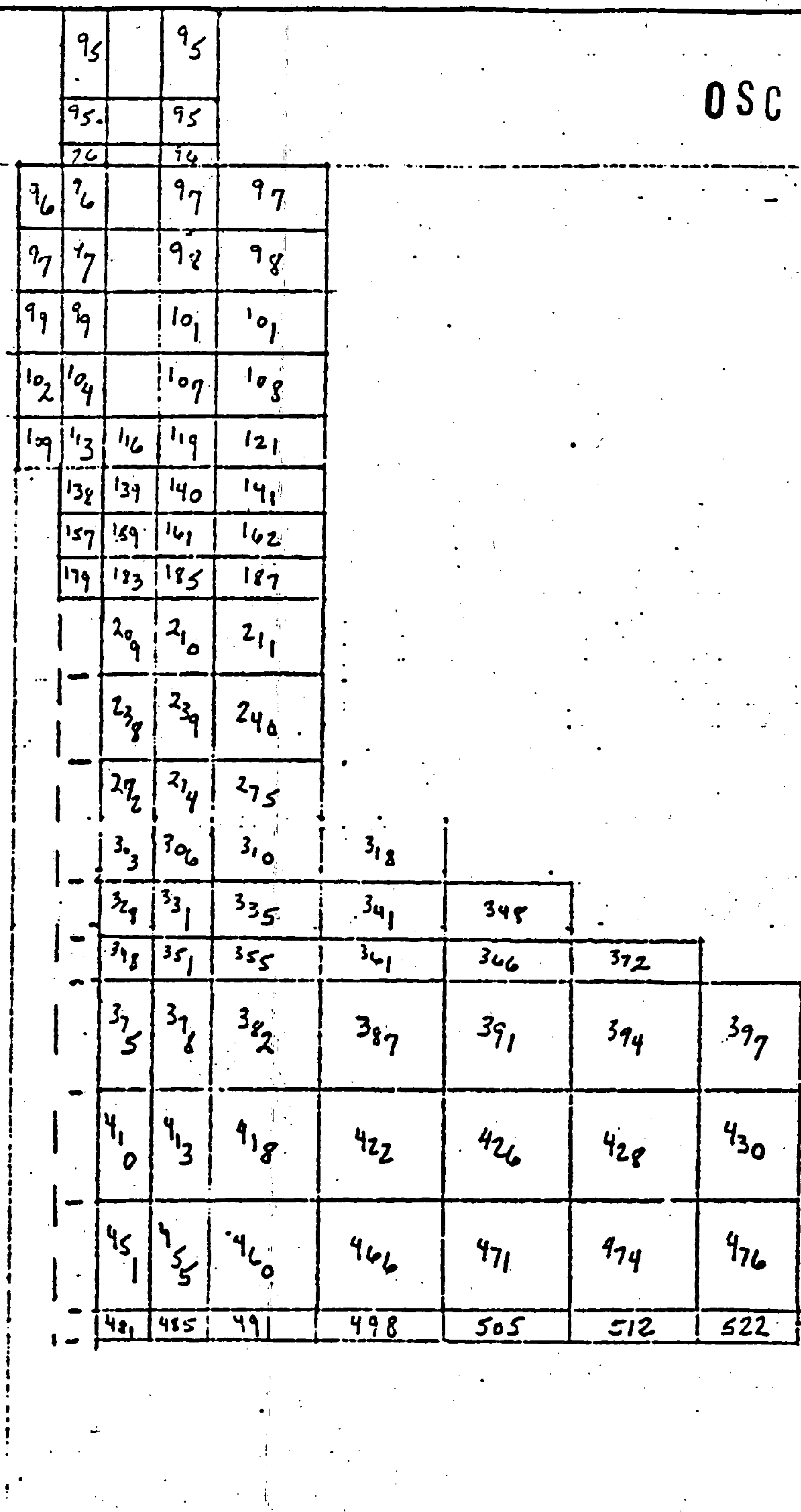
** SIGN CONVENTIONS ARE FOR A RIGHT HAND VIEW **

SEG. NO.	LOC.	RADIAL FORCE	MOMENT	AXIAL FORCE	LOC.	RADIAL MOTION	ROTATION	AXIAL MOTION
1	TOP	0.	-2.9212E-03	0.	TOP	-3.1832E-04	6.6174E-24	0.
1	BOT.	-7.4229E-03	-8.6319E-03	0.	BOT.	3.1831E-04	-5.7149E-09	2.4844E-04
2	BOT.	-2.8156E-01	1.4224E-01	0.	BOT.	3.1831E-04	3.5026E-08	4.9688E-04
3	BOT.	2.3696E+00	-4.7788E-01	0.	BOT.	3.1844E-04	6.4591E-08	7.4531E-04
4	BOT.	-9.8380E-01	-4.4384E+00	0.	BOT.	3.1767E-04	-2.3426E-06	9.9375E-04
5	BOT.	-1.2180E+02	5.6382E+01	0.	BOT.	3.1573E-04	1.2573E-05	1.2429E-03
6	BOT.	-1.3178E+02	8.9514E+01	0.	BOT.	3.1912E-04	2.3506E-05	1.3052E-03
7	BOT.	-1.5387E+02	1.2402E+02	0.	BOT.	3.2573E-04	3.9537E-05	1.3687E-03
8	BOT.	-2.1354E+02	1.5104E+02	0.	BOT.	3.3168E-04	5.2172E-05	1.4085E-03
9	BOT.	-6.6127E+02	3.9588E+02	0.	BOT.	3.6995E-04	8.7224E-05	1.5641E-03
0	BOT.	-9.0937E+02	8.8518E+02	0.	BOT.	4.2136E-04	1.0664E-04	1.7341E-03
1	BOT.	-8.4535E+02	1.1071E+03	0.	BOT.	4.4550E-04	1.1500E-04	1.8177E-03
2	BOT.	-1.7556E+03	2.0739E+03	0.	BOT.	5.3352E-04	1.6263E-04	2.1160E-03
3	BOT.	-2.6600E+03	4.0869E+03	0.	BOT.	6.6758E-04	2.7263E-04	2.4834E-03
4	BOT.	4.7045E+03	4.2631E+03	0.	BOT.	9.5034E-04	4.2818E-04	2.9026E-03
5	BOT.	9.1787E+03	2.7727E+03	0.	BOT.	1.0669E-03	4.4408E-04	3.0324E-03
6	BOT.	9.1787E+03	2.7727E+03	0.	BOT.	1.1088E-03	4.4408E-04	3.0060E-03
7	BOT.	9.7746E+03	2.3938E+03	0.	BOT.	1.1334E-03	4.5153E-04	3.0333E-03
8	BOT.	9.2970E+03	3.5340E+02	0.	BOT.	1.2588E-03	4.5547E-04	3.2142E-03
9	BOT.	2.1891E+03	-2.2878E+03	0.	BOT.	1.4962E-03	3.0934E-04	3.7668E-03
0	BOT.	-3.0965E+03	-2.1127E+03	0.	BOT.	1.5917E-03	1.1027E-04	4.3557E-03
1	BOT.	-7.7989E+03	-8.5530E+02	0.	BOT.	1.5861E-03	4.3983E-05	4.6787E-03
2	BOT.	-7.7989E+03	-8.5530E+02	0.	BOT.	1.6752E-03	4.3983E-05	4.6746E-03
3	BOT.	-7.4426E+03	-7.0288E+02	0.	BOT.	1.6728E-03	3.8979E-05	4.6928E-03
	BOT.	-1.3819E+03	1.3255E+03	0.	BOT.	1.6444E-03	6.2437E-05	5.1687E-03
	BOT.	-2.9337E+02	1.5327E+03	0.	BOT.	1.8140E-03	3.3124E-04	6.2904E-03
	BOT.	-1.2941E+03	1.9368E+03	0.	BOT.	1.9913E-03	4.7541E-04	6.9033E-03
	BOT.	-1.6020E+03	3.4759E+03	0.	BOT.	2.6266E-03	5.8482E-04	7.8586E-03
	BOT.	8.1339E+02	4.7784E+03	0.	BOT.	3.3500E-03	5.9876E-04	8.9549E-03
	BOT.	4.8234E+03	4.1337E+03	0.	BOT.	4.1241E-03	5.7607E-04	1.0208E-02

30	BOT.	3.8895E+03	2.2815E+03	0.	BOT.	4.9221E-03	5.4106E-04	1.1634E-02
31	BOT.	-1.4549E+03	3.6190E+03	0.	BOT.	5.5010E-03	4.5891E-04	1.4294E-02
32	BOT.	3.8147E+03	3.4049E+03	0.	BOT.	6.0012E-03	3.9970E-04	1.7191E-02
33	BOT.	-0.	-0.	-0.	BOT.	6.3834E-03	2.6999E-04	2.0346E-02

(FORCE AND MOTION OUTPUT IS IN GLOBAL DIRECTIONS R AND Z)

OSC 1522



0006103340

ITER 41428 TEMP. DIST.

CUSTOMER	JOB NO.
SUBJECT 91167 GRID TO SCALE	
[illegible] = 1"	BY
[illegible] = 1"	DATE 3-11

TEMPERATURES PER SEGMENT USED IN PEAK PRINCIPLE ANALYSIS

	OUTSIDE			INSIDE	
SEGMENT	T1	T2	T3	T4	T5
1	25	25	25	25	25
2	25	25	25	25	25
3	25	25	25	25	25
4	25	25	25	25	25
5	25	25	25	25	25
6	25	25	25	25	25
7	25	25	25	25	25
8	26	26	26	26	26
9	26	26	26	26	26
10	27	27	27	27	27
11	28	28	28	28	28
12	36	35	34	32	30
13	45	43	39	36	33
14	53	50	45	40	35
15	63	60	55	50	45
16	63	60	60	59	58

	OUTSIDE			INSIDE	
SEGMENT	T1	T2	T3	T4	T5
17	63	60	60	59	58
18	72	71	70	68	67
19	96	93	90	88	86
20	120	115	110	107	105
21	125	120	115	112	110
22	125	120	115	115	115
23	125	120	115	115	115
24	142	141	140	139	138
25	171	171	170	169	168
26	189	188	187	186	186
27	218	217	215	213	212
28	248	246	243	240	233
29	277	276	272	268	264
30	307	305	300	295	290
31	355	350	343	337	330
32	402	395	387	378	370
33	450	440	430	420	410

PEAK FORCES AND MOTIONS

POSITIVE DIRECTIONS (+) ARE AS FOLLOWS

TOP OF SEGMENT NO.1	BOTTOM OF REMAINING SEGMENTS
RADIAL------ TO THE LEFT	RADIAL------ TO THE RIGHT
ROTATIONAL-- CLOCKWISE	ROTATIONAL-- COUNTERCLOCKWISE
AXIAL------- UPWARD	AXIAL------- DOWNWARD

** SIGN CONVENTIONS ARE FOR A RIGHT HAND VIEW **

SEG. NO.	LOC.	RADIAL FORCE	MOMENT	AXIAL FORCE	LOC.	RADIAL MOTION	ROTATION	AXIAL MOTION
1	TOP	0.	-6.3159E-04	0.	TOP	-2.9465E-04	1.6544E-24	0.
1	BOT.	-3.0941E-03	-6.9560E-04	0.	BOT.	2.9465E-04	-7.9682E-10	2.2997E-04
2	BOT.	-3.5258E-02	2.2260E-02	0.	BOT.	2.9465E-04	6.6059E-09	4.5995E-04
3	BOT.	4.1391E-01	-1.1213E-01	0.	BOT.	2.9467E-04	-3.0283E-09	6.8992E-04
4	BOT.	-9.2703E-01	-4.3826E-01	0.	BOT.	2.9452E-04	-3.3750E-07	9.1990E-04
5	BOT.	-1.6094E+01	9.0903E+00	0.	BOT.	2.9452E-04	2.4802E-06	1.1500E-03
6	BOT.	-1.2384E+01	1.2911E+01	0.	BOT.	2.9522E-04	4.1137E-06	1.2075E-03
7	BOT.	-3.9001E+01	1.7910E+01	0.	BOT.	2.9632E-04	6.4956E-06	1.2657E-03
8	BOT.	-9.8800E+01	2.7717E+01	0.	BOT.	2.9712E-04	8.8376E-06	1.3015E-03
9	BOT.	-5.0376E+02	1.9253E+02	0.	BOT.	3.0593E-04	2.4596E-05	1.4356E-03
10	BOT.	-8.7152E+02	6.0746E+02	0.	BOT.	3.2335E-04	4.8673E-05	1.5724E-03
11	BOT.	-9.4566E+02	8.3657E+02	0.	BOT.	3.3357E-04	6.2669E-05	1.6365E-03
12	BOT.	-1.9954E+03	1.9956E+03	0.	BOT.	3.8211E-04	1.1129E-04	1.8584E-03
13	BOT.	-2.6554E+03	4.0894E+03	0.	BOT.	4.6567E-04	1.8898E-04	2.1231E-03
14	BOT.	2.9129E+03	4.7240E+03	0.	BOT.	6.5146E-04	2.8482E-04	2.4182E-03
15	BOT.	5.6630E+03	3.7838E+03	0.	BOT.	7.2738E-04	2.9142E-04	2.5128E-03
16	BOT.	5.6630E+03	3.7838E+03	0.	BOT.	7.5900E-04	2.9142E-04	2.4954E-03
17	BOT.	5.7446E+03	3.5558E+03	0.	BOT.	7.7497E-04	3.0546E-04	2.5179E-03
18	BOT.	5.8462E+03	2.3730E+03	0.	BOT.	8.6229E-04	3.5753E-04	2.6393E-03
19	BOT.	4.1295E+03	-1.9811E+02	0.	BOT.	1.0623E-03	3.5631E-04	2.9995E-03
0	BOT.	-1.1902E+03	-1.1333E+03	0.	BOT.	1.2367E-03	2.2426E-04	3.4590E-03
1	BOT.	-5.6943E+03	-3.1463E+02	0.	BOT.	1.2672E-03	1.5544E-04	3.7226E-03
2	BOT.	-5.6943E+03	-3.1463E+02	0.	BOT.	1.3358E-03	1.5544E-04	3.7080E-03
3	BOT.	-5.3533E+03	-2.0435E+02	0.	BOT.	1.3366E-03	1.4984E-04	3.7220E-03
4	BOT.	-3.1249E+02	9.7231E+02	0.	BOT.	1.3721E-03	1.4477E-04	4.1106E-03
5	BOT.	-4.0547E+02	9.3992E+02	0.	BOT.	1.5810E-03	3.0178E-04	5.0844E-03
6	BOT.	-1.9807E+03	1.4871E+03	0.	BOT.	1.7384E-03	4.0744E-04	5.6258E-03
7	BOT.	-5.3764E+03	4.4528E+03	0.	BOT.	2.2741E-03	5.4323E-04	6.4851E-03
8	BOT.	-7.6851E+03	1.0221E+04	0.	BOT.	2.9182E-03	6.1452E-04	7.4645E-03
9	BOT.	-6.1871E+03	1.7358E+04	0.	BOT.	3.6438E-03	6.4647E-04	8.5706E-03

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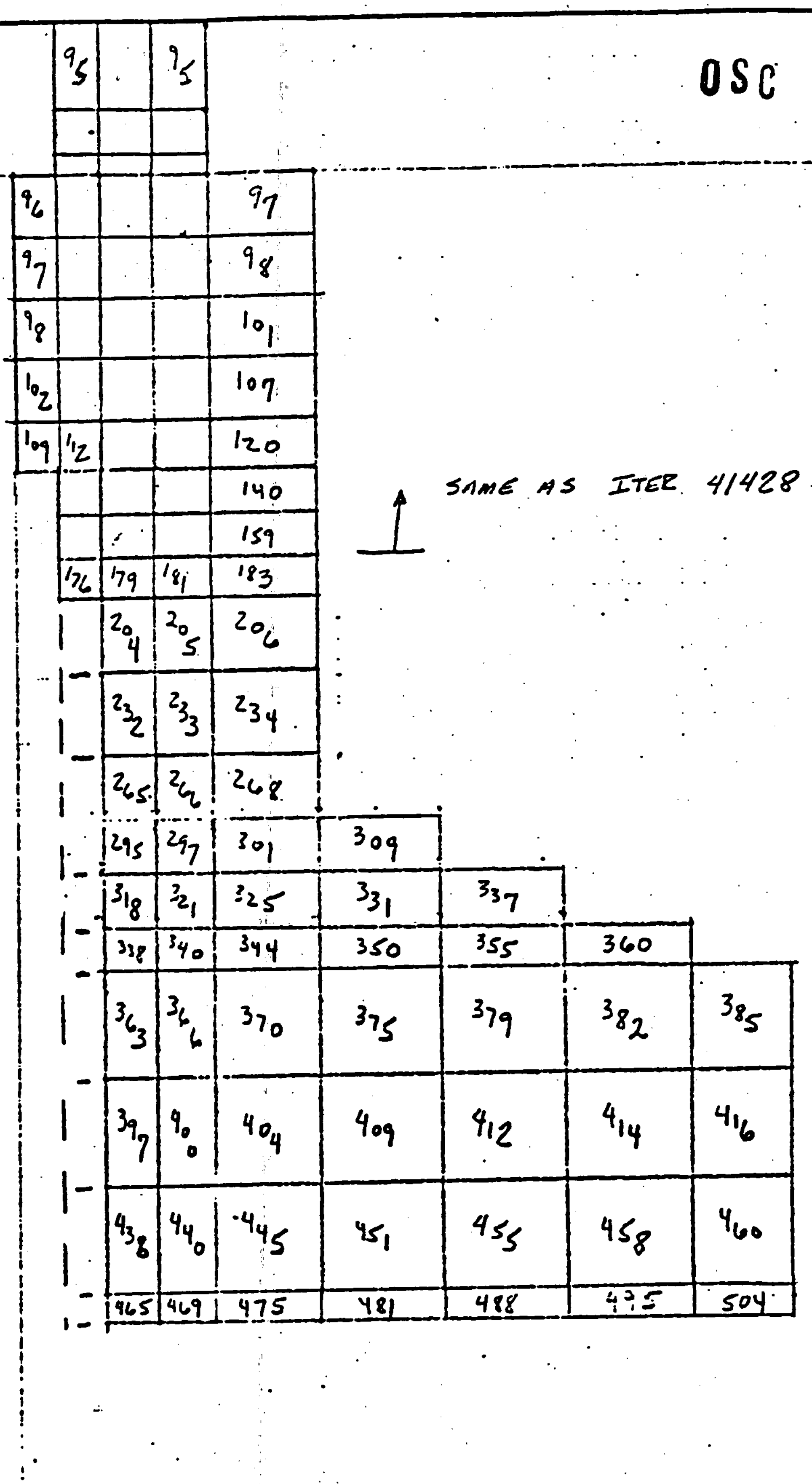
BOT.	-2.1524E+02	2.3130E+04	0.	BOT.	4.4350E-03	6.4504E-04	9.8107E-03
BOT.	6.7521E+03	2.0795E+04	0.	BOT.	5.1583E-03	6.2906E-04	1.2237E-02
BOT.	1.3098E+04	9.8460E+03	0.	BOT.	5.8613E-03	5.4850E-04	1.5024E-02
BOT.	-0.	-0.	-0.	BOT.	6.4164E-03	3.9259E-04	1.8195E-02

(FORCE AND MOTION OUTPUT IS IN GLOBAL DIRECTIONS R AND Z)

OSC 1522



0006198 44

ITER 52659 TEMP. DIST.

CUSTOMER	JOB No.
SUBJECT [illegible]	
[illegible]	BY
[illegible]	DATE 3-15

TEMPERATURES PER SEGMENT USED IN PEAK PRINCIPLE ANALYSIS

SEGMENT	OUTSIDE T1	T2	T3	T4	INSIDE T5
1	25	25	25	25	25
2	25	25	25	25	25
3	25	25	25	25	25
4	25	25	25	25	25
5	25	25	25	25	25
6	25	25	25	25	25
7	25	25	25	25	25
8	26	26	26	26	26
9	26	26	26	26	26
10	27	27	27	27	27
11	28	28	28	28	28
12	36	35	34	32	30
13	45	43	39	36	33
14	53	50	45	40	35
15	63	60	55	50	45
16	63	60	60	59	58
17	63	60	60	59	58
18	72	71	70	68	67
19	93	91	90	88	86
20	115	112	110	107	105
21	120	117	115	112	110
22	120	117	115	112	110
23	120	117	115	112	110
24	138	137	136	135	133
25	165	164	163	162	160
26	180	179	178	176	175
27	210	209	208	206	205
28	240	239	238	236	235
29	270	269	268	266	265
30	300	299	298	296	295
31	343	339	335	331	327
32	387	380	373	365	358
33	430	420	410	400	390

PEAK FORCES AND MOTIONS
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POSITIVE DIRECTIONS (+) ARE AS FOLLOWS

TOP OF SEGMENT NO.1		BOTTOM OF REMAINING SEGMENTS	
RADIAL------	TO THE LEFT	RADIAL------	TO THE RIGHT
ROTATIONAL--	CLOCKWISE	ROTATIONAL--	COUNTERCLOCKWISE
AXIAL-------	UPWARD	AXIAL-------	DOWNWARD

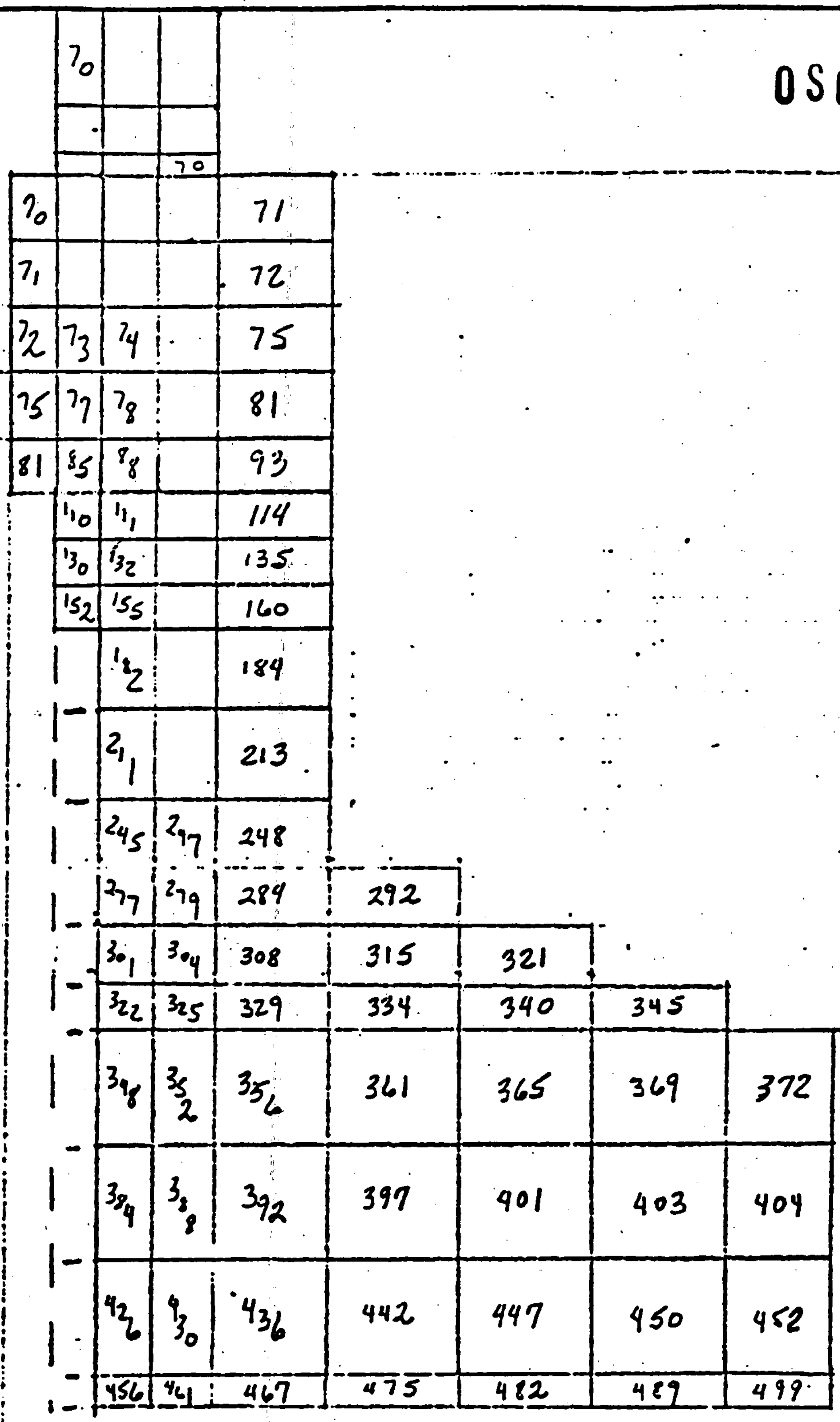
** SIGN CONVENTIONS ARE FOR A RIGHT HAND VIEW **

SEG. NO.	LOC.	RADIAL FORCE	MOMENT	AXIAL FORCE	LOC.	RADIAL MOTION	ROTATION	AXIAL MOTION
1	TOP	0.	-6.1883E-04	0.	TOP	-2.9465E-04	1.6544E-24	0.
1	BOT.	-2.9868E-03	-7.1802E-04	0.	BOT.	2.9465E-04	-7.9385E-10	2.2997E-04
2	BOT.	-3.5313E-02	2.2054E-02	0.	BOT.	2.9465E-04	6.5012E-09	4.5995E-04
3	BOT.	4.0849E-01	-1.0959E-01	0.	BOT.	2.9467E-04	-2.4574E-09	6.8992E-04
4	BOT.	-8.8684E-01	-4.4503E-01	0.	BOT.	2.9453E-04	-3.3574E-07	9.1990E-04
5	BOT.	-1.6075E+01	8.9993E+00	0.	BOT.	2.9451E-04	2.4372E-06	1.1500E-03
6	BOT.	-1.2617E+01	1.2643E+01	0.	BOT.	2.9520E-04	4.0595E-06	1.2075E-03
7	BOT.	-3.9711E+01	1.7955E+01	0.	BOT.	2.9628E-04	6.4412E-06	1.2657E-03
8	BOT.	-9.9924E+01	2.7899E+01	0.	BOT.	2.9708E-04	8.7954E-06	1.3015E-03
9	BOT.	-5.0762E+02	1.9406E+02	0.	BOT.	3.0585E-04	2.4679E-05	1.4358E-03
10	BOT.	-8.7852E+02	6.1224E+02	0.	BOT.	3.2332E-04	4.6944E-05	1.5725E-03
11	BOT.	-9.5578E+02	8.4312E+02	0.	BOT.	3.3359E-04	6.3047E-05	1.6366E-03
12	BOT.	-1.9805E+03	2.0016E+03	0.	BOT.	3.8261E-04	1.1205E-04	1.8584E-03
13	BOT.	-2.5471E+03	4.0505E+03	0.	BOT.	4.6734E-04	1.8886E-04	2.1226E-03
14	BOT.	3.1773E+03	4.5282E+03	0.	BOT.	6.5331E-04	2.7800E-04	2.4173E-03
15	BOT.	5.9471E+03	3.5269E+03	0.	BOT.	7.2831E-04	2.8088E-04	2.5117E-03
16	BOT.	5.9471E+03	3.5269E+03	0.	BOT.	7.5992E-04	2.5029E-04	2.4950E-03
17	BOT.	[illegible]	[illegible]	0.	BOT.	[illegible]	2.9374E-04	2.5174E-03
18	BOT.	6.1471E+03	2.0511E+03	0.	BOT.	[illegible]	3.3925E-04	2.6388E-03
19	BOT.	4.2351E+03	-6.1622E+02	0.	BOT.	1.0710E-03	3.2947E-04	2.9975E-03
20	BOT.	-1.4235E+03	-1.5274E+03	0.	BOT.	1.2140E-03	2.0953E-04	3.4520E-03
21	BOT.	-6.1747E+03	-6.2402E+02	0.	BOT.	1.2410E-03	1.5470E-04	3.7129E-03
22	BOT.	-6.1747E+03	-6.2402E+02	0.	BOT.	1.3007E-03	1.5470E-04	3.6984E-03
23	BOT.	-5.8344E+03	-5.0392E+02	0.	BOT.	1.3102E-03	1.4784E-04	3.7119E-03
24	BOT.	-7.3729E+02	9.0174E+02	0.	BOT.	1.3343E-03	1.2211E-04	4.0891E-03
25	BOT.	-6.0431E+02	1.2203E+03	0.	BOT.	1.5174E-03	2.9581E-04	5.0260E-03
26	BOT.	-1.4772E+03	1.7309E+03	0.	BOT.	1.6703E-03	4.1981E-04	5.5397E-03
27	BOT.	-2.4678E+03	3.5065E+03	0.	BOT.	2.2242E-03	5.4265E-04	6.3469E-03
28	BOT.	-1.9796E+03	5.9797E+03	0.	BOT.	2.8746E-03	5.8679E-04	7.2842E-03
29	BOT.	4.7655E+02	7.9132E+03	0.	BOT.	3.5923E-03	5.9942E-04	8.3628E-03

0	BOT.	2.0307E+03	8.7653E+03	0.	BOT.	4.3593E-03	5.9597E-04	9.5934E-03
1	BOT.	1.1882E+03	9.1053E+03	0.	BOT.	5.0222E-03	5.7956E-04	1.1978E-02
2	BOT.	6.8736E+03	5.5491E+03	0.	BOT.	5.6422E-03	4.9691E-04	1.4666E-02
3	BOT.	-0.	-0.	-0.	BOT.	6.1266E-03	3.4069E-04	1.7653E-02

(FORCE AND MOTION OUTPUT IS IN GLOBAL DIRECTIONS R AND Z)

OSC 1522



0006103 4 3

ITER 75168 TEMP. DIST.

CUSTOMER	JOB No.
SUBJECT [illegible]	
[illegible] SCALE [illegible] = 1"	BY
[illegible] SCALE [illegible] = 1"	DATE 2-19

TEMPERATURES PER SEGMENT USED IN PEAK PRINCIPLE ANALYSIS

SEGMENT	T1	T2	T3	T4	T5
1	0	0	0	0	0
2	0	0	0	0	0
3	0	0	0	0	0
4	0	0	0	0	0
5	0	0	0	0	0
6	0	0	0	0	0
7	0	0	0	0	0
8	0	0	0	0	0
9	0	0	0	0	0
10	0	0	0	0	0
11	0	0	0	0	0
12	8	7	6	5	4
13	17	15	12	10	7
14	25	22	18	15	11
15	30	30	30	28	21
16	30	30	30	30	30
17	30	30	30	30	30
18	45	44	42	41	40
19	70	65	64	62	60
20	95	89	87	83	80
21	103	97	95	91	88
22	103	97	95	95	95
23	103	97	95	95	95
24	115	114	113	112	112
25	145	144	143	142	142
26	165	164	163	162	162
27	195	191	187	183	180
28	225	218	211	204	198
29	256	245	235	225	216
30	287	272	259	246	234
31	335	320	308	295	283
32	382	369	356	343	331
33	430	417	405	392	380

PEAK FORCES AND MOTIONS
****

POSITIVE DIRECTIONS (+) ARE AS FOLLOWS

TOP OF SEGMENT NO.1		BOTTOM OF REMAINING SEGMENTS	
RADIAL------	TO THE LEFT	RADIAL------	TO THE RIGHT
ROTATIONAL--	CLOCKWISE	ROTATIONAL--	COUNTERCLOCKWISE
AXIAL-------	UPWARD	AXIAL-------	DOWNWARD

** SIGN CONVENTIONS ARE FOR A RIGHT HAND VIEW **

EG. O.	LOC.	RADIAL FORCE	MOMENT	AXIAL FORCE	LOC.	RADIAL MOTION	ROTATION	AXIAL MOTION
1	TOP	0.	1.8231E-03	0.	TOP	4.5546E-11	-3.3087E-24	0.
1	BOT.	1.5596E-02	-3.4145E-03	0.	BOT.	8.0507E-10	3.4311E-10	-6.9289E-11
2	BOT.	-1.2536E-02	-2.6397E-02	0.	BOT.	-4.3707E-09	-1.4746E-08	-7.6657E-11
3	BOT.	-7.5671E-01	3.6342E-01	0.	BOT.	-1.4331E-08	8.4481E-08	4.2869E-09
4	BOT.	5.8706E+00	-1.0623E+00	0.	BOT.	3.3556E-07	2.2026E-07	-2.5249E-08
5	BOT.	7.5753E-01	-1.2426E+01	0.	BOT.	-1.5252E-06	-6.0946E-06	-5.9308E-08
6	BOT.	-3.6160E+01	-8.5334E+00	0.	BOT.	-3.3886E-06	-7.5493E-06	6.9576E-08
7	BOT.	-1.0493E+02	8.5318E+00	0.	BOT.	-5.8767E-06	-7.3474E-06	3.4582E-07
8	BOT.	-1.6400E+02	2.8604E+01	0.	BOT.	-7.5070E-06	-5.3941E-06	6.0528E-07
9	BOT.	-5.4282E+02	2.2031E+02	0.	BOT.	-1.0866E-05	1.2626E-05	2.2458E-06
0	BOT.	-9.3325E+02	6.6347E+02	0.	BOT.	-3.9967E-06	3.9281E-05	3.8895E-06
1	BOT.	-8.7300E+02	8.9713E+02	0.	BOT.	4.0180E-06	5.4004E-05	4.4731E-06
2	BOT.	-1.5294E+03	1.7703E+03	0.	BOT.	5.0521E-05	1.0655E-04	3.0592E-05
3	BOT.	-2.4617E+03	3.5502E+03	0.	BOT.	1.3560E-04	1.8730E-04	1.0325E-04
4	BOT.	2.2532E+03	4.3393E+03	0.	BOT.	3.2132E-04	2.9819E-04	2.1074E-04
5	BOT.	4.6130E+03	3.5791E+03	0.	BOT.	3.9908E-04	3.2771E-04	2.5438E-04
6	BOT.	4.6130E+03	3.5791E+03	0.	BOT.	4.1552E-04	3.2771E-04	2.3488E-04
7	BOT.	4.8301E+03	3.3904E+03	0.	BOT.	4.3225E-04	3.4266E-04	2.4593E-04
8	BOT.	5.4104E+03	2.3390E+03	0.	BOT.	5.2481E-04	3.9650E-04	3.1338E-04
9	BOT.	4.1601E+03	-1.1874E+02	0.	BOT.	7.6198E-04	3.9983E-04	5.5422E-04
0	BOT.	-3.5281E+02	-1.2485E+03	0.	BOT.	9.4381E-04	2.7950E-04	8.9748E-04
1	BOT.	-4.5520E+03	-6.7954E+02	0.	BOT.	9.9209E-04	2.1281E-04	1.1077E-03
2	BOT.	-4.5520E+03	-6.7954E+02	0.	BOT.	1.0484E-03	2.1281E-04	1.0878E-03
3	BOT.	-4.3320E+03	-5.9069E+02	0.	BOT.	1.0508E-03	2.0720E-04	1.0993E-03
4	BOT.	-6.3867E+02	5.2851E+02	0.	BOT.	1.1121E-03	1.7112E-04	1.4134E-03
5	BOT.	-6.2493E+02	6.9907E+02	0.	BOT.	1.3031E-03	2.5593E-04	2.2097E-03
6	BOT.	-3.4445E+03	1.5709E+03	0.	BOT.	1.4197E-03	3.5210E-04	2.6745E-03
7	BOT.	-1.1430E+04	7.2218E+03	0.	BOT.	1.8730E-03	5.3118E-04	3.4310E-03
8	BOT.	-1.8861E+04	1.9721E+04	0.	BOT.	2.4367E-03	6.4437E-04	4.2803E-03
9	BOT.	-1.8908E+04	3.7102E+04	0.	BOT.	3.0979E-03	6.9348E-04	5.2236E-03

W

[illegible]	BOT.	-5.5366E+03	5.2801E+04	0.	BOT.	3.836[illegible]E-[illegible]	[illegible]E-04	6.[illegible]647E-03
[illegible]	BOT.	1.6633E+04	4.6601E+04	0.	BOT.	4.5790E-03	6.2070E-04	8.[illegible]769E-03
[illegible]	BOT.	2.6822E+04	2.0414E+04	0.	BOT.	5.3060E-03	5.0739E-04	1.0890E-02
33	BOT.	-0.	-0.	-0.	BOT.	5.8242E-03	3.1041E-04	1.3833E-02

(FORCE AND MOTION OUTPUT IS IN GLOBAL DIRECTIONS R AND Z)

OSC 1522

	96		96					
	97		97					
	98		98					
100	100		100	101				
102	102		103	103				
106	107		108	108				
113	114		116	117				
123	125		129	131				
	148		150	151				
	168		171	172				
	190	193	195	197				
		220	221	222				
		250	251	251				
		284	285	286				
		315	317	321	328			
		339	341	345	350	357		
		359	361	365	370	375	380	
		386	389	392	396	400	403	406
		429	426	430	434	436	438	439
		468	471	475	480	484	487	489
		501	504	508	514	520	526	536

0006190352

ITER 86960 TEMP. DIST.

CUSTOMER

SUBJECT 91167 [illegible]

[illegible] SCALE [illegible] = 1"

[illegible] SCALE [illegible] = 1"

JOB No.

BY

DATE 2-23

000619 353

TEMPERATURES PER SEGMENT USED IN PEAK PRINCIPLE ANALYSIS

	OUTSIDE				INSIDE
SEGMENT	T1	T2	T3	T4	T5
1	26	26	26	26	26
2	26	26	26	26	26
3	26	26	26	26	26
4	26	26	26	26	26
5	26	26	26	26	26
6	26	26	26	26	26
7	28	28	28	28	28
8	30	30	30	30	30
9	30	30	30	30	30
10	30	30	30	30	30
11	33	32	32	31	31
12	43	41	40	39	37
13	53	51	49	46	44
14	63	60	57	54	50
15	73	70	67	63	60
16	73	70	67	65	65
17	73	70	67	65	65
18	85	83	82	81	80
19	107	104	102	99	98
20	130	126	122	118	115
21	135	131	127	123	120
22	135	131	127	123	120
23	135	131	127	123	120
24	155	154	153	151	150
25	180	180	180	180	180
26	199	198	197	197	196
27	229	228	225	223	221
28	260	258	253	248	245
29	290	288	282	274	270
30	321	318	310	300	295
31	366	360	350	340	333
32	410	403	390	380	372
33	455	445	430	420	410

0 0 0 6 1 9 354

PEAK FORCES AND MOTIONS

POSITIVE DIRECTIONS (+) ARE AS FOLLOWS

TOP OF SEGMENT NO.1		BOTTOM OF REMAINING SEGMENTS	
RADIAL------	TO THE LEFT	RADIAL------	TO THE RIGHT
ROTATIONAL--	CLOCKWISE	ROTATIONAL--	COUNTERCLOCKWISE
AXIAL-------	UPWARD	AXIAL-------	DOWNWARD

** SIGN CONVENTIONS ARE FOR A RIGHT HAND VIEW **

SEG. NO.	LOC.	RADIAL FORCE	MOMENT	AXIAL FORCE	LOC.	RADIAL MOTION	ROTATION	AXIAL MOTION
1	TOP	0.	-5.2727E-03	0.	TOP	-3.0648E-04	1.3235E-23	0.
1	BOT.	-4.3647E-02	8.6891E-03	0.	BOT.	3.0648E-04	-1.4223E-09	2.3921E-04
2	BOT.	1.1257E-02	8.4621E-02	0.	BOT.	3.0649E-04	4.3678E-08	4.7841E-04
3	BOT.	2.2843E+00	-1.0423E+00	0.	BOT.	3.0653E-04	-2.2825E-07	7.1761E-04
4	BOT.	-1.6280E+01	2.5633E+00	0.	BOT.	3.0550E-04	-8.0318E-07	9.5689E-04
5	BOT.	-1.2211E+01	3.6956E+01	0.	BOT.	3.1049E-04	1.7895E-05	1.1963E-03
6	BOT.	8.8652E+01	3.0963E+01	0.	BOT.	3.1592E-04	2.2823E-05	1.2557E-03
7	BOT.	1.0476E+02	1.2414E+00	0.	BOT.	3.2277E-04	2.5164E-05	1.3178E-03
8	BOT.	-4.9294E+01	-5.1441E+00	0.	BOT.	3.2672E-04	2.5770E-05	1.3584E-03
9	BOT.	-8.8815E+02	2.7157E+02	0.	BOT.	3.4271E-04	4.2174E-05	1.5130E-03
10	BOT.	-1.0805E+03	9.0504E+02	0.	BOT.	3.7030E-04	7.7311E-05	1.6660E-03
11	BOT.	-8.1200E+02	1.1437E+03	0.	BOT.	3.8785E-04	9.2725E-05	1.7372E-03
12	BOT.	-1.2676E+03	1.8820E+03	0.	BOT.	4.6386E-04	1.4109E-04	1.9938E-03
13	BOT.	-2.0833E+03	3.3883E+03	0.	BOT.	5.7789E-04	2.1837E-04	2.3134E-03
4	BOT.	2.4276E+03	3.9115E+03	0.	BOT.	7.8813E-04	3.2253E-04	2.6846E-03
5	BOT.	4.8652E+03	3.1143E+03	0.	BOT.	8.7059E-04	3.3533E-04	2.8030E-03
6	BOT.	4.8652E+03	3.1143E+03	0.	BOT.	9.0748E-04	3.3533E-04	2.7831E-03
7	BOT.	5.1332E+03	2.9144E+03	0.	BOT.	9.2458E-04	3.4204E-04	2.8079E-03
8	BOT.	5.6653E+03	1.7949E+03	0.	BOT.	1.0150E-03	3.7136E-04	2.9469E-03
9	BOT.	3.6421E+03	-5.8395E+02	0.	BOT.	1.2337E-03	3.5019E-04	3.3619E-03
0	BOT.	-1.7682E+03	-1.2550E+03	0.	BOT.	1.3777E-03	2.0749E-04	3.8721E-03
1	BOT.	-6.4033E+03	-2.8373E+02	0.	BOT.	1.4013E-03	1.3894E-04	4.1611E-03
2	BOT.	-6.4033E+03	-2.8373E+02	0.	BOT.	1.4775E-03	1.3894E-04	4.1481E-03
3	BOT.	-5.9933E+03	-1.5976E+02	0.	BOT.	1.4777E-03	1.3173E-04	4.1631E-03
4	BOT.	-1.0447E+02	1.0587E+03	0.	BOT.	1.4966E-03	1.1070E-04	4.5859E-03
5	BOT.	-4.5793E+02	9.0048E+02	0.	BOT.	1.6783E-03	2.8366E-04	5.6352E-03
6	BOT.	-2.3818E+03	1.5438E+03	0.	BOT.	1.8213E-03	4.0614E-04	6.2103E-03
7	BOT.	-6.7335E+03	5.1616E+03	0.	BOT.	2.3757E-03	5.5920E-04	7.1226E-03
8	BOT.	-9.8523E+03	1.2389E+04	0.	BOT.	3.0355E-03	6.3430E-04	8.1528E-03
9	BOT.	-8.3848E+03	2.1563E+04	0.	BOT.	3.7760E-03	6.5776E-04	9.3084E-03

ω

30	BOT.	-1.6853E+03	2.9474E+04	0.
31	BOT.	8.6562E+03	2.7328E+04	0.
32	BOT.	1.6715E+04	1.3090E+04	0.
33	BOT.	-0.	-0.	-0.

BOT.	4.5757E-03	6.3727E-04	1.0599E-02
BOT.	5.2713E-03	5.8938E-04	1.3092E-02
BOT.	5.9250E-03	4.7736E-04	1.5926E-02
BOT.	6.3695E-03	2.8523E-04	1.9127E-02

(FORCE AND MOTION OUTPUT IS IN GLOBAL DIRECTIONS R AND Z)

	95		95					
	[illegible]		96					
96			96	96				
97				97				
99	99		100	100				
103			103	103				
107	108		109	109				
	117		118	118				
	125		126	127				
	136		137	138				
		149	149	149				
		161	162	162				
		176	176	176				
		188	189	190	193			
		198	198	200	201	204		
		205	206	207	209	210	212	
		216	216	217	218	219	220	221
		228	229	230	231	232	232	233
		242	243	244	245	246	247	248
		251	252	253	255	256	258	261

0006 1 [illegible] 3 5 5

103154 TEMP. DIST. 3-27

CUSTOMER

SUBJECT [illegible] GRID TO SCALE

[illegible] LONGITUDINAL SCALE 4 [illegible] = 1"

[illegible] SCALE 16 [illegible] = 1"

JOB No.

BY

DATE

TEMPERATURES PER SEGMENT USED IN PEAK PRINCIPLE ANALYSIS

SEGMENT	OUTSIDE T1	T2	T3	T4	INSIDE T5
1	25	25	25	25	25
2	25	25	25	25	25
3	25	25	25	25	25
4	25	25	25	25	25
5	25	25	25	25	25
6	25	25	25	25	25
7	25	25	25	25	25
8	25	25	25	25	25
9	25	25	25	25	25
10	26	26	26	26	26
11	27	27	27	27	27
12	31	31	31	31	31
13	34	34	34	34	34
14	38	38	38	38	38
15	43	43	43	43	43
16	43	43	43	43	43
17	43	43	43	43	43
18	48	48	48	48	43
19	58	58	58	58	58
20	68	68	68	66	68
21	73	73	73	73	73
22	73	73	73	73	73
23	73	73	73	73	73
24	80	80	80	80	80
25	90	90	90	90	90
26	97	97	97	97	97
27	108	107	107	107	106
28	118	117	117	116	116
29	129	128	127	126	125
30	140	138	137	136	135
31	157	154	153	151	150
32	173	171	169	167	165
33	190	187	185	182	180

PEAK FORCES AND MOTIONS

POSITIVE DIRECTIONS (+) ARE AS FOLLOWS

TOP OF SEGMENT NO.1		BOTTOM OF REMAINING SEGMENTS	
RADIAL------	TO THE LEFT	RADIAL------	TO THE RIGHT
ROTATIONAL--	CLOCKWISE	ROTATIONAL--	COUNTERCLOCKWISE
AXIAL-------	UPWARD	AXIAL-------	DOWNWARD

** SIGN CONVENTIONS ARE FOR A RIGHT HAND VIEW **

SEG. NO.	LOC.	RADIAL FORCE	MOMENT	AXIAL FORCE	LOC.	RADIAL MOTION	ROTATION	AXIAL MOTION
1	TOP	0.	7.0211E-04	0.	TOP	-2.9465E-04	-3.3087E-24	0.
1	BOT.	9.8449E-03	-4.4392E-03	0.	BOT.	2.9465E-04	-9.9498E-10	2.2997E-04
2	BOT.	-7.0700E-02	1.1654E-02	0.	BOT.	2.9465E-04	-3.2160E-09	4.5995E-04
3	BOT.	-3.8875E-02	1.6283E-01	0.	BOT.	2.9467E-04	7.6341E-08	6.6992E-04
4	BOT.	4.1011E+00	-1.7502E+00	0.	BOT.	2.9476E-04	-3.4924E-07	9.1987E-04
5	BOT.	-2.6034E+01	3.1766E+00	0.	BOT.	2.9297E-04	-1.7450E-06	1.1500E-03
6	BOT.	-5.5360E+01	1.3273E+01	0.	BOT.	2.9233E-04	-4.2915E-07	1.2076E-03
7	BOT.	-9.1150E+01	3.1703E+01	0.	BOT.	2.9201E-04	3.0376E-06	1.2653E-03
8	BOT.	-1.1205E+02	4.7033E+01	0.	BOT.	2.9223E-04	6.6725E-06	1.2999E-03
9	BOT.	-2.2515E+02	1.4254E+02	0.	BOT.	3.0179E-04	2.1855E-05	1.4281E-03
0	BOT.	-1.4311E+02	2.7309E+02	0.	BOT.	3.1971E-04	3.4593E-05	1.5583E-03
1	BOT.	-1.8517E+01	2.9152E+02	0.	BOT.	3.2866E-04	3.9668E-05	1.6192E-03
2	BOT.	-2.7930E+02	3.6209E+02	0.	BOT.	3.6390E-04	5.8442E-05	1.8230E-03
3	BOT.	-7.2318E+02	8.2201E+02	0.	BOT.	4.1382E-04	9.2482E-05	2.0537E-03
4	BOT.	1.0901E+03	9.6366E+02	0.	BOT.	5.0695E-04	1.4568E-04	2.3067E-03
5	BOT.	2.0218E+03	6.1958E+02	0.	BOT.	5.4432E-04	1.5605E-04	2.3847E-03
6	BOT.	2.0218E+03	6.1958E+02	0.	BOT.	5.6791E-04	1.5605E-04	2.3754E-03
7	BOT.	2.1327E+03	5.3657E+02	0.	BOT.	5.7567E-04	1.5829E-04	2.3911E-03
8	BOT.	2.5149E+03	6.1080E+01	0.	BOT.	6.1622E-04	1.6390E-04	2.4743E-03
9	BOT.	2.0222E+03	-1.1323E+03	0.	BOT.	7.0937E-04	1.3559E-04	2.7089E-03
0	BOT.	-1.0098E+03	-1.5244E+03	0.	BOT.	7.6266E-04	6.7378E-05	2.9928E-03
1	BOT.	-4.1973E+03	-9.2257E+02	0.	BOT.	7.6447E-04	4.3047E-05	3.1560E-03
2	BOT.	-4.1973E+03	-9.2257E+02	0.	BOT.	8.0745E-04	4.3047E-05	3.1520E-03
3	BOT.	-4.0093E+03	-8.4050E+02	0.	BOT.	8.0658E-04	3.8284E-05	3.1605E-03
	BOT.	-6.7363E+02	2.7369E+02	0.	BOT.	7.8832E-04	8.8333E-06	3.3861E-03
	BOT.	1.2108E+02	3.8477E+02	0.	BOT.	8.2081E-04	9.4462E-05	3.9041E-03
	BOT.	-3.2613E+02	4.1673E+02	0.	BOT.	8.8034E-04	1.3676E-04	4.1782E-03
	BOT.	-1.4507E+03	1.1312E+03	0.	BOT.	1.1029E-03	1.7756E-04	4.6094E-03
	BOT.	-2.1806E+03	2.7202E+03	0.	BOT.	1.3527E-03	1.9849E-04	5.0813E-03
	BOT.	-1.7324E+03	4.7157E+03	0.	BOT.	1.6223E-03	2.0837E-04	5.5952E-03

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30	BOT.	1.2423E+02	6.2660E+03	0.	BOT.	1.9247E-03	2.0852E-04	6.1528E-03
31	BOT.	1.8142E+03	5.3611E+03	0.	BOT.	2.1591E-03	2.0618E-04	7.1846E-03
32	BOT.	3.1971E+03	2.4920E+03	0.	BOT.	2.3893E-03	1.8782E-04	8.3342E-03
33	BOT.	-0.	-0.	-0.	BOT.	2.5846E-03	1.5159E-04	9.6060E-03

(FORCE AND MOTION OUTPUT IS IN GLOBAL DIRECTIONS R AND Z)

DAT[illegible] [illegible] MODEL THERMAL MOTIONS 0 0 0 6 1 9 3 6 0 ELEMENT 1

PLATE THICKNESS = 2.1[illegible] MATERIAL CODE ------- 1

OUTSIDE RADIUS -- 7.930 INSIDE RADIUS --- 1.000

AXIAL INCREMENT = .546 RADIAL INCREMENT .693

NO. OF ROWS --------- 5 NO. OF COLUMNS ------ 11

POISSONS VALUE -- .300

E AND ALPHA ARE CALCULATED IN PROGRAM OSC 1522

THE O.D. IS FIXED - DEFLECTION IS CALCULATED IN PROGRAM

```
 :       I-------------------------------COLUMNS-------------------------------I
 :
 :       1                              6                                      11
C :  -  -I-------------------------------I--------------------------------------I-
E :  A  5 I                                                                      I  5
N :  I    I                                                                      I
T :  I    I                                                                      I
E :  I    I                                                                      I
R :  I    I                                                                      I
  :  I    I                                                                      I
L :  I    I                                                                      I
I :  F    I                                                                      I
N :  O   -I----------------------------------------------------------------------I-
E :  G  1 I                                                                      I  3
     F    I                                                                      I
O :  S    I                                                                      I
P :  I    I                                                                      I
E :  I    I                                                                      I
N :  I    I                                                                      I
I :  V    I                                                                      I
N :  -  1-I----------------------------------------------------------------------I-1
G :
  :
...:..................................CENTER LINE OF THE VESSEL..........................................
  :
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-----NOTE:EDGE ONE IS ON THE BOTTOM OF THE PLATE OR INSIDE OF THE VESSEL FOR TEMPERATURES, MOTIONS AND STRESSES-----

DEFLECTION ON OD = 2.5[illegible]E-02 BASED ON TEMP. OF 573

[illegible] HEAT PIPE NODE TEMP [illegible] 0 9 0 6 | 9 [illegible] 3 5 | ELEMENT 1

TEMPERATURE OF NODES PER EDGE FOR ITERATION [illegible] 28)69

COLUMNS

	1	2	3	4	5	6	7	8	9	10	11
5	475	492	502	518	549	557	562	566	567	568	570
4	495	513	523	535	550	560	563	567	568	570	572
3	515	533	540	548	555	562	565	568	569	571	573
2	550	553	556	561	564	567	569	570	571	573	574
1	566	571	572	572	572	573	575	575	574	574	573

OSC 1522

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[illegible] MODEL INTEGRATION 0 0 0 6 1 9 0 3 6 2 ELEMENT 1

DEFLECTION ON OD = 2.[illegible]E-02 BASED ON [illegible]MP. OF 573

ITERATION = [illegible] STRESSES MOTIONS

EDGE	COL	SIGMA R	SIGMA Z	AXIAL DEF	RADIAL DEF	ROTATION
1	1	178.8	2824.	-1.08[illegible]	3.[illegible]	-7.9[illegible]-05
3	1	207.64242	10577.29514	-1.08820E-03	3.77423E-03	-7.95332E-05
5	1	-1915.93717	20199.53704	-1.08460E-03	3.86100E-03	-7.95332E-05
3	2	2[illegible].1[illegible]	[illegible]7.17392	-1.02708E-03	6.02671E-03	1.10875E-04
3	3	[illegible]	[illegible].39240	-9.61054E-04	8.40545E-03	2.16251E-04
3	4	[illegible].30050	2[illegible].09162	-7.80457E-04	1.08414E-02	2.61209E-04
3	5	[illegible]	2100.96594	-5.92621E-04	1.33479E-02	2.80066E-04
3	6	[illegible]	1577.[illegible]	-4.11193E-04	1.58977E-02	2.40359E-04
3	7	[illegible]	1220.57502	-2.62751E-04	1.84649E-02	1.93033E-04
3	8	[illegible]	1101.77270	-1.48572E-04	2.10410E-02	1.42011E-04
3	9	33[illegible].23217	1130.80030	-6.55700E-05	2.36194E-02	9.35333E-05
3	10	[illegible]	1052.07100	-1.[illegible]E-05	2.61971E-02	4.76000E-05
1	11	561.[illegible]	35.49090	7.21045E-16	2.87804E-02	1.26635E-16
3	11	237[illegible].45242	950.25193	7.21045E-16	2.87804E-02	1.26635E-16
5	11	5[illegible]	22[illegible]	7.21045E-16	2.87804E-02	1.26635E-16

DEFLECTION ON OD = 2.90094[illegible]E-02 BASED ON TEMP. OF 576

3
—
3

[illegible] THERMAL [illegible] 0 0 0 6 1 9 [illegible] 0 3 6 3 ELEMENT 1

TEMPERATURE OF NODES PER [illegible] FOR ITERATION [illegible]1424

COLUMNS

	1	2	3	4	5	6	7	8	9	10	11
5	463	485	500	517	550	561	566	571	572	575	578
4	463	507	520	535	553	562	568	571	572	574	576
3	[illegible]	520	534	549	554	565	569	571	573	575	577
2	[illegible]	551	[illegible]	561	566	569	571	573	573	574	575
1	565	570	571	572	574	573	574	575	575	575	575

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[illegible] NOZZLE [illegible] PIPE MODEL THERMAL MOTIONS   MEM[illegible]   ELEMENT 1

0006 1 9 [illegible] 0 3 6 4

DEFLECTION ON OD = 2.90094E-02 BASED ON T[illegible] OF 576

ITERATION = [illegible]   STRESSES   MOTIONS

EDGE	COL	SIGMA R	SIGMA θ	AXIAL DEF	RADIAL DEF	ROTATION
1	1	[illegible]	[illegible]	-1.29571E-03	3.74934E-03	-6.67773E-05
3	1	[illegible]	19526.73561	-1.29571E-03	3.62231E-03	-6.67773E-05
5	1	[illegible]	26507.76917	-1.29571E-03	3.59523E-03	-6.67773E-05
3	2	[illegible]	[illegible]	-1.25237E-03	6.03788E-03	1.55590E-04
3	3	[illegible]	[illegible]	-1.12865E-03	8.41873E-03	2.64206E-04
3	4	[illegible]	[illegible]	-9.11389E-04	1.08694E-02	3.29179E-04
3	5	[illegible]	[illegible]	[illegible]	1.34005E-02	3.25065E-04
3	6	[illegible]	[illegible]	[illegible]	1.59806E-02	2.79588E-04
3	7	[illegible]	[illegible]	-3.10955E-04	[illegible]	2.25594E-04
3	8	[illegible]	[illegible]	-1.74095E-04	2.11806E-02	1.67687E-04
3	9	[illegible]	1601.04634	[illegible]	2.37947E-02	1.11508E-04
3	10	[illegible]	[illegible]	-1.45237E-05	2.63991E-02	5.71165E-05
1	11	[illegible]	[illegible]	-8.60423E-16	2.90094E-02	3.26128E-16
3	11	[illegible]	[illegible]	-8.60423E-16	2.90094E-02	3.26128E-16
5	11	[illegible]	[illegible]	-8.60423E-16	2.90094E-02	3.26128E-16

DEFLECTION ON OD = [illegible] BASED ON TEMP. OF 556

TEMPERATURE OF NODES PER EDGE FOR ITERATION [illegible] 56659

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COLUMNS

EDGE		1	2	3	4	5	6	7	8	9	10	11
	5	446	464	477	500	530	541	547	551	552	555	558
	4	457	482	497	517	534	543	547	551	552	554	556
	3	482	503	516	530	538	545	550	552	553	555	557
	2	538	531	515	542	546	549	551	553	554	555	556
	1	545	551	551	553	553	555	554	554	554	554	553

[illegible] ZERO [illegible]

3

DEFLECTION ON OD = 2.76976E-02 BASED ON TEMP. OF 556

ITERATION = 52659 STRESSES MOTIONS

EDGE	COL	SIGMA [illegible]	SIGMA H	AXIAL DEF	RADIAL DEF	ROTATION
1	1	231.2[illegible]	4519.9[illegible]	-1.31270E-03	3.57785E-03	-6.95026E-05
3	1	2152.9[illegible]	14045.21290	-1.31298E-03	3.65375E-03	-6.95026E-05
2	1	-3263.611[illegible]	20156.90[illegible]	-1.31298E-03	3.72964E-03	-6.95026E-05
3	2	[illegible]	4759.0[illegible]	-1.26975E-03	5.75092E-03	1.61180E-04
3	3	[illegible]	5217.80607	-1.13084E-03	8.00655E-03	2.70439E-04
3	4	[illegible]	2457.10519	-9.11264E-04	1.03509E-02	3.36450E-04
3	5	[illegible]	2119.74909	-6.57493E-04	1.27741E-02	3.26667E-04
3	6	[illegible]	1175.12323	-4.75944E-04	1.52426E-02	2.78504E-04
3	7	[illegible]	1003.49107	-3.04005E-04	1.77268E-02	2.23025E-04
3	8	3777.[illegible]	888.97003	-1.70358E-04	2.02191E-02	1.64535E-04
3	9	[illegible]	1020.47[illegible]	-7.62334E-05	2.27108E-02	1.08699E-04
3	10	3344.71759	1003.15306	-1.89035E-05	2.52017E-02	5.53594E-05
1	11	[illegible]	1112.94109	1.30770E-16	2.76976E-02	3.13985E-16
3	11	3172.[illegible]	888.29003	1.30770E-16	2.76976E-02	3.13985E-16
5	11	9441.60[illegible]	1317.79773	1.30770E-16	2.76976E-02	3.13985E-16

DEFLECTION ON OD = 2.76936E-02 BASED ON TEMP. OF 556

0 0 0 6 1 9 3 6 7 ELEMENT 1

TEMPERATURE OF NODES PER EDGE FOR [ITERATION?] 15160

COLUMNS

	1	2	3	4	5	6	7	8	9	10	11
5	436	462	470	495	530	542	545	550	552	555	558
4	457	484	498	513	531	541	547	550	552	554	557
3	471	505	518	527	538	544	549	552	553	555	557
2	536	529	535	540	545	549	552	553	553	554	555
1	543	551	552	552	553	554	554	555	555	555	555

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7090 [illegible]

0 0 0 6 1 9 3 6 8

[illegible] ELEMENT 1

DEFLECTION ON OD = 2.77094[illegible]E-02 BASED ON TEMP. OF 556

ITERATION = 75[illegible] STRESSES MOTIONS

EDGE	COL	SIGMA R	SIGMA Θ	AXIAL DEF	RADIAL DEF	ROTATION
1	1	3[illegible].[illegible]	5227.93003	-1.36457E-03	3.59000E-03	-7.01372E-05
3	1	[illegible]	21596.1[illegible]	-1.36457E-03	3.66665E-03	-7.01372E-05
5	1	-[illegible]	[illegible]	-1.36457E-03	3.74[illegible]E-03	-7.01372E-05
3	2	[illegible]	[illegible]	-1.3[illegible]E-03	5.752[illegible]E-03	1.63556E-04
3	3	[illegible]	[illegible]	-1.1[illegible]E-03	[illegible].01[illegible]E-03	2.77116E-04
3	4	[illegible]	[illegible]	-9.[illegible]37E-04	1.03[illegible]E-02	3.41[illegible]E-04
3	5	[illegible]	[illegible]	-7.33[illegible]E-04	1.27[illegible]E-02	3.42205E-04
3	6	[illegible]	[illegible]	-[illegible]E-04	1.52[illegible]E-02	2.91[illegible]E-04
3	7	[illegible]	[illegible]	-[illegible]E-04	1.77201E-02	2.36057E-04
3	8	[illegible]	[illegible]	-1.[illegible]E-04	2.02[illegible]E-02	1.76[illegible]E-04
3	9	[illegible]	1132.07750	-8.55550E-05	2.27144E-02	1.20766E-04
3	10	[illegible]	10[illegible]	-2.13[illegible]E-05	2.520[illegible]E-02	6.24511E-05
1	11	[illegible]	5[illegible]	[illegible]E-16	2.77094E-02	2.23779E-16
3	11	[illegible]	[illegible]	[illegible]E-16	2.77094E-02	2.23779E-16
5	11	[illegible]	1[illegible]	[illegible]E-16	2.77094E-02	2.23779E-16

DEFLECTION ON OD = 2.[illegible]E-02 BASED ON TEMP. OF 591

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TEMPERATURE OF NODES PER FOSR FOR ITERATION 86960

COLUMNS

	1	2	3	4	5	6	7	8	9	10	11
5	483	501	513	531	564	576	581	585	587	590	593
4	508	525	536	550	567	577	581	585	587	589	592
3	530	540	554	563	573	579	584	586	587	589	590
2	572	567	571	576	580	584	587	588	588	589	590
1	581	586	580	587	584	589	584	589	589	589	590

(FPO LI

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[illegible] PIPE MODEL THERMAL MOTIONS 0 0 8 6 1 9 [illegible] 0 3 7 0 ELEMENT 1

DEFLECTION ON OD = 2.99871YE-02 BASED ON TEMP. OF 591

ITERATION = [illegible] STRESSES MOTIONS

EDGE	COL	SIGMA R	SIGMA θ	AXIAL DEF	RADIAL DEF	ROTATION
1	1	135.16996	6194.29707	-1.26872E-03	3.86924E-03	-6.86047E-05
3	1	[illegible]	15904.44315	-1.26872E-03	3.94420E-03	-6.86047E-05
5	1	-1592.16201	26137.05071	-1.26872E-03	4.01912E-03	-6.86047E-05
3	2	[illegible]	7331.16276	-1.22665E-03	5.26705E-03	1.43232E-04
3	3	[illegible]	4966.55241	-1.10917E-03	8.73221E-03	2.52190E-04
3	4	[illegible]	1350.07600	-9.02900E-04	1.12620E-02	3.20501E-04
[illegible]	5	-2017.74452	2261.46720	-6.57234E-04	1.35730E-02	3.19136E-04
3	6	[illegible]	1505.55615	-4.42419E-04	1.65344E-02	2.72896E-04
3	7	[illegible]	1164.71516	-3.12743E-04	1.92161E-02	2.20986E-04
3	8	[illegible]	1007.09353	-1.77093E-04	2.19080E-02	1.67736E-04
3	9	[illegible]	1222.91620	-6.97163E-05	2.45997E-02	1.13739E-04
3	10	3576.96515	1200.42032	-2.01563E-05	2.72906E-02	5.89579E-05
1	11	[illegible]	577.22000	2.08167E-16	2.99872E-02	3.19189E-16
3	11	[illegible]	1150.38727	2.08167E-16	2.99872E-02	3.19189E-16
5	11	5435.61079	1600.67010	2.08167E-16	2.99872E-02	3.19189E-16

DEFLECTION ON OD = 1.10599Y3E-02 BASED ON TEMP. OF 283

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3-4

TEMPERATURE OF NODES PER EDGE FOR ITERATION 103154

3-42

COLUMNS

COURSES	1	2	3	4	5	6	7	8	9	10	11
5	247	251	254	259	270	274	277	279	280	281	283
4	253	257	260	265	271	275	277	278	280	281	283
3	254	262	265	268	272	275	277	278	280	281	283
2	266	266	268	271	273	276	276	279	280	281	282
1	269	269	270	271	275	275	277	278	280	281	282

......ZERO LINE..............

W

[illegible] NOZZLE [illegible] PIPE MODEL THERMAL MOTIONS 0006197 0372 ELEMENT 1

DEFLECTION ON OD = 1.10990E-02 BASED ON TEMP. OF 283

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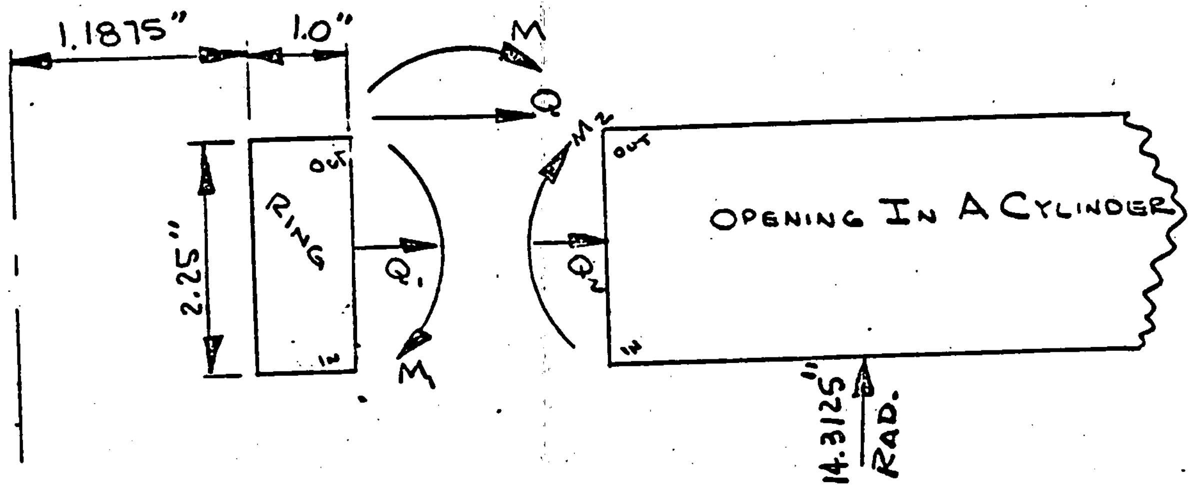
ITERATION = 10315 STRESSES MOTIONS

EDGE	COL	SIGMA R	SIGMA θ	AXIAL DEF	RADIAL DEF	ROTATION
1	1	494.94572	4645.23582	-2.64524E-04	1.46801E-03	-1.22271E-05
3	1	-96.05759	6700.70621	-2.64524E-04	1.48140E-03	-1.22271E-05
5	1	-341.10904	[illegible]	-2.64524E-04	1.49471E-03	-1.22271E-05
3	2	1000.10490	4611.16447	-2.55027E-04	2.33803E-03	3.01739E-05
3	3	2047.12919	2710.57704	-2.22900E-04	3.24502E-03	5.20101E-05
3	4	2365.00940	2221.00420	-1.65270E-04	4.17592E-03	6.76734E-05
3	5	2424.79101	1612.95170	-1.39524E-04	5.13403E-03	6.08275E-05
3	6	2474.40490	1350.05023	-9.64913E-05	6.11168E-03	5.64332E-05
3	7	2244.96272	1110.69545	-6.16011E-05	7.09942E-03	4.49430E-05
3	8	2137.50920	934.77940	-3.42035E-05	8.09353E-03	3.32368E-05
3	9	[illegible]	815.67003	-1.54247E-05	9.09161E-03	2.20189E-05
3	10	[illegible]	657.61311	-3.64117E-06	1.00930E-02	1.12263E-05
1	11	[illegible]	436.92207	2.42861E-17	1.10990E-02	3.29597E-17
3	11	[illegible]	[illegible]	2.42861E-17	1.10998E-02	3.29597E-17
5	11	2271.90343	625.47590	2.42861E-17	1.10998E-02	3.29597E-17

DEFLECTION ON OD = 2.729203E-02 BASED ON TEMP. OF 550

E @ 550°

OSC 1522



INFLUENCE COEFFICIENTS

* RING

$$\theta/M_1 = \frac{12}{t^3 E \ln \frac{R_o}{R_i}} = .065 \times 10^{-6}$$

$$\delta/Q_1 = \frac{R_m}{Et(R_o - R_i)} = .02827 \times 10^{-6}$$

$$\theta/Q_1 = \delta/M_1 = 0.0$$

* OPENING IN A CYLINDER

$$\theta/M_2 = \frac{15.6}{Et^3} = .0516 \times 10^{-6}$$

$$\delta/Q_2 = \frac{1.3}{Et^2} = .00968 \times 10^{-6}$$

$$\theta/Q_2 = \delta/M_2 = 0.0$$

* THESE VALUES BASED ON E @ 550°F

000619 0371

$$\theta_{RING} = \theta_{CYL}$$

$$M_1\left(\frac{\theta}{M_1}\right) = M_2\left(\frac{\theta}{M_2}\right)$$

$$M_1 = \frac{M_2\left(\frac{\theta}{M_2}\right)}{\frac{\theta}{M_1}}$$

say: $\dfrac{\theta/M_2}{\theta/M_1} = K$

$$M_1 = M_2 K$$

$$M = M_1 + M_2$$

$$M_2 = M - M_1$$

$$M_1 = (M - M_1)K$$

$$M_1 = \frac{MK}{1+K}$$

$$\theta = M_1\left(\frac{\theta}{M_1}\right) = \frac{MK}{1+K}\left(\frac{\theta}{M_1}\right) \sim \frac{\theta}{M} = \frac{K}{1+K}\left(\frac{\theta}{M_1}\right)$$

WHERE: E = E FOR CARBON STEEL @ 550° = 26.53×10^6

t = 2.25"

R_0 = 2.1875"

R_1 = 1.1875"

$\therefore \theta/M = .0288 \times 10^{-6}$

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$$\delta_{RING} = \delta_{CYL}$$

$$Q_1\left(\frac{\delta}{Q_1}\right) = Q_2\left(\delta/Q_2\right)$$

$$Q_1 = (Q_2)\left(\frac{\delta/Q_2}{\delta/Q_1}\right) \qquad \text{SAY } \frac{\delta/Q_2}{\delta/Q_1} = N.$$

$$Q_1 = Q_2(N)$$

$$Q = Q_1 + Q_2$$

$$Q_2 = Q - Q_1$$

$$Q_1 = (Q - Q_1)N.$$

$$Q_1 = \frac{QN}{1+N}$$

$$\delta = Q_1\left(\frac{\delta}{Q_1}\right) = \frac{QN}{1+N}\left(\delta/Q_1\right)$$

$$\delta/Q = \frac{N}{1+N}\left(\delta/Q_1\right)$$

WHERE: $R_m = 1.6875''$
$R_o = 2.1875$
$t = 2.25''$
$E = 26.53 \times 10^{-6}$ psi

$$\therefore \delta^s/Q = .0072 \times 10^{-6}$$

0 0 0 6 1 9 0 3 7 5

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$\delta = r\theta \qquad t/2 = r$

$\frac{\delta}{M} = \left(\frac{t}{2}\right)\left(\frac{\theta}{M}\right)$

$\frac{\delta_s}{M} = \left(\frac{2.25}{2}\right)(.0288 \times 10^{-6}) = .0324 \times 10^{-6}$

$\frac{\theta_s}{Q} = \left(\frac{\theta}{m}\right)\frac{t}{2} = .0324 \times 10^{-6}$

ADDITIONAL $\frac{\delta}{Q} = \left(\frac{\theta}{Q}\right)(t/2) = .03645 \times 10^{-6}$

TOTAL $\delta_s/Q = .0072 \times 10^{-6} + .03645 \times 10^{-6} = .04365 \times 10$

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0006199 0377

Influence Coefficients for Nozzle (91206)

$\theta_N/M = +4.137258 \times 10^{-8}$

$\theta_N/Q = -2.47688 \times 10^{-8}$

$\delta_N/M = +2.47688 \times 10^{-8}$

$\delta_N/Q = -5.410859 \times 10^{-8}$

Influence Coefficients for Shell

$\theta_s/M = -2.88 \times 10^{-8}$

$\theta_s/Q = -3.24 \times 10^{-8}$

$\delta_s/M = +3.24 \times 10^{-8}$

$\delta_s/Q = +4.365 \times 10^{-8}$

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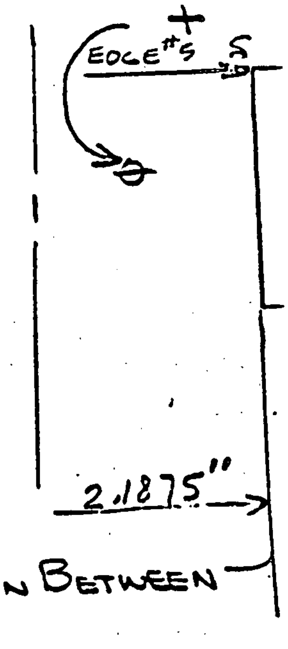
MOTIONS @ NOZZLE TO SHELL JUNCTURE AT THE SHELL (SECONDARY)

+RADIAL δ	+ ROTATION	ITERATION
7.5128×10^{-3}	1.5779×10^{-4}	28169
7.4745×10^{-3}	2.3309×10^{-4}	41428
7.0866×10^{-3}	2.4343×10^{-4}	52659
7.0926×10^{-3}	2.4459×10^{-4}	75168
7.7775×10^{-3}	2.2093×10^{-4}	86960
2.9333×10^{-3}	4.6153×10^{-5}	103154

SIGN CONVENTION

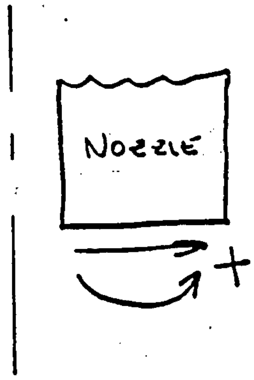


MOTION RATIO PROCEDURE (PROGRAM 21032)

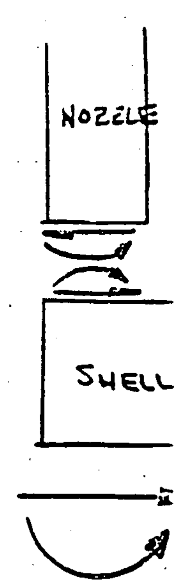
$$\text{MOTION @ JUNCTURE} = \left(\frac{2.1875-1.693}{2.386-1.693}\right) \times \left(\text{MOTIONS @ } 2.386'' - \text{MOTIONS @ } 1.693''\right) + \text{MOTIONS @ } 1.6\ldots$$

MOTIONS @ NOZZLE TO SHELL JUNCTURE AT THE NOZZLE (SECONDARY)

ITERATION	+ RADIAL δ	+ ROTATION
28169	6.3834×10^{-3}	2.6999×10^{-4}
41428	6.4164×10^{-3}	3.9259×10^{-4}
52659	6.1266×10^{-3}	3.4069×10^{-4}
75168	5.8242×10^{-3}	3.1041×10^{-4}
86960	6.3896×10^{-3}	2.8523×10^{-4}
103154	2.5848×10^{-3}	1.5159×10^{-4}



00061 9 379



COMPATIBILITY EQUATIONS

$$\theta^{u}_{TOT} = -2.88\times10^{-8} M - 3.24\times10^{-8} Q + \theta^{S}_{T}$$

$$\theta^{N}_{TOT} = 4.137258\times10^{-8} M - 2.47688\times10^{-8} Q + \theta^{N}_{T}$$

$$\theta^{S}_{TOT} = \theta^{N}_{TOT}$$

$$(-2.88 - 4.137258)(10^{-8})(M) + (-3.24 + 2.47688)(10^{-8})(Q) = \theta^{N}_{T} - \theta$$

1) $-(7.017)(M) - .763 Q = (\theta^{N}_{T} - \theta^{S}_{T})(10^{8})$

$$\delta^{S}_{TOT} = 3.24\times10^{-8} M + 4.365\times10^{-8} Q + \delta^{S}_{T}$$

$$\delta^{N}_{TOT} = 2.47688\times10^{-8} M - 5.410859\times10^{-8} Q + \delta^{N}_{T}$$

$$\delta^{S}_{TOT} = \delta^{N}_{TOT}$$

$$(3.24 - 2.47688)(10^{-8})(M) + (4.365 + 5.410859)(10^{-8})(Q) = \delta^{N}_{T} - \delta^{S}_{T}$$

2) $(.763)(M) + (9.776)(Q) = (\delta^{N}_{T} - \delta^{S}_{T})(10^{8})$

SOLVING SIMO

$$1) \quad -7.017M - .763Q = (\theta_T^N - \theta_T^S)(10^8)$$
$$2) \quad .763M + 9.776Q = (\delta_T^N - \delta_T^S)(10^8)$$

$$1) \quad -7.017M - .763Q = (\theta_T^N - \theta_T^S)(10^8)$$
$$2 \times 9.1966) \quad 7.017M + 89.906Q = 9.1966(10^8)(\delta_T^N - \delta_T^S)$$

$$-90.669Q = (\theta_T^N - \theta_T^S)(10^8) - (9.1966)(10^8)(\delta_T^N - \delta_T^S$$

ITERATION 28169

$$-90.669Q = (2.6999 - 1.8774)(10^{+4}) - (9.1966)(+6.3834 - 7.51$$

$$-90.669Q = 1046613$$

$$Q = -11534 \ \#/\text{RAD}$$

$$1) \quad M = \frac{(2.6999 - 1.8774)10^4 + .763(-11534)}{-7.017} = +82 \ \frac{\text{IN-LB}}{\text{RAD}}$$

ITERATION 41428

$$-90.669Q = (3.9259 - 2.3309)(10^4) - 9.1966(6.4164 - 7.4745)$$
$$= 989042$$
$$Q = -10908 \ \#/\text{RAD}$$

$$1) \quad M = \frac{(3.9259 - 2.3309)(10^4) + .763(-10908)}{-7.017}$$

$$M = -1087 \ \frac{\text{IN-LBS.}}{\text{RAD}}$$

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ITERATION 52659

$$-90.669\,Q = (3.4069-2.4343)(10^4)-(9.1966)(6.1266-7.086$$

$$= 892599.6$$

$$Q = -9845 \ \#/\text{RAD.}$$

1) $$M = \frac{(3.4069-2.4343)(10^4) + .763(-9845)}{-7.017}$$

$$M = -316 \ \frac{\text{IN-LBS}}{\text{RAD.}}$$

ITERATION 75168

$$-90.669\,Q = (3.1041-2.4459)(10^4)-(9.1966)(5.8242-7.0926$$

$$= 1173078$$

$$Q = -12{,}938 \ \#/\text{RAD}$$

1) $$M = \frac{(3.1041-2.4459)(10^4) + (.763)(-12938)}{-7.017}$$

$$M = +469 \ \frac{\text{IN.LBS.}}{\text{RAD}}$$

ITERATION 86960

$$-90.669\,Q = (2.8523-2.2098)(10^4)-9.1966(6.3896-7.7775)($$

$$= 1282821$$

$$Q = -14148 \ \#/\text{RAD}$$

1) $$M = \frac{(2.8523-2.2098)(10^4) + (.763)(-14148)}{-7.017}$$

$$M = 622 \ \frac{\text{IN-LBS}}{\text{RAD}}$$

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000619 6382

ITERATION 10 3 15 4

$$-90.669Q = (1.5159 - .46183)(10^4) - (9.1966)(2.5848 - 2.933$$

10 540

$$= 331042$$

$$Q = -3651 \text{ \#/RAD}$$

1) $M = \dfrac{(1.5159 - .46183)(10^4) + (.763)(-3651)}{-7.017}$

$$M = -1105 \frac{\text{IN. LBS.}}{\text{RAD}}$$

0 0 0 6 1 9 3 8 3

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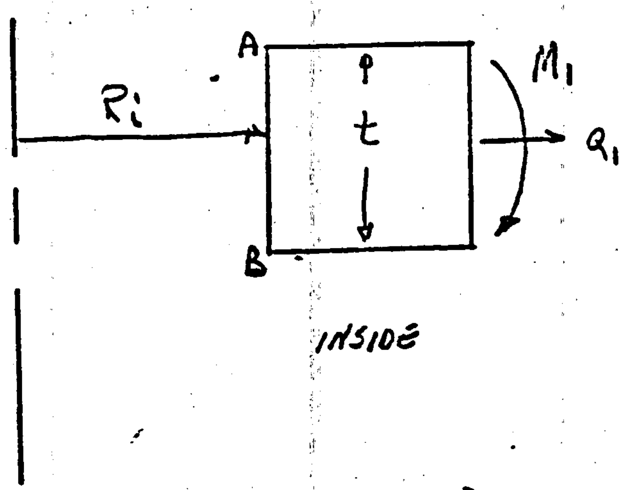
CALCULATE DISCONTINUITY HOOP STRESS IN RING



$M_1 = .49265\left[M + \frac{Qt}{2}\right.$

$Q_1 = .25506\ Q$

$S_A = Q_1\left[S/Q_1\right] + M_1\left[S/M_1\right]$ WHERE: $S/Q_1 = .02827 \times 10^{-6}$

$S_B = Q_1\left[S/Q_1\right] - M_1\left[S/M_1\right]$

$S/M_1 = \left(\frac{g}{M_1}\right) t/2$

$= .065 \times 10^{-6}\left[1.125\right]$

$= .07313 \times 10^{-6}$

$\sigma_H^A = \frac{E S_A}{R_i}$ $\sigma_H^B = \frac{E S_B}{R_i}$ $R_i = 1.1875''$

ITER	Q_1	M_1	$S_A \times 10^{-6}$	$S_B \times 10^{-6}$	$E \times 10^{-6}$	σ_H^A (PSI)	σ_H^B (
28169	-2942	-5707	-500.5	+339.2	27.	-11380	7578
41428	-1272	-5913	-468.4	396.5	27.	-10649	901[illegible]
52659	-1148	-5043	-401.2	336.3	27.	-9122	7646
75168	-1509	-6235	-498.6	413.3	27.2	-11421	946[illegible]
86960	-1650	-6970	-591.7	448.4	26.7	-12180	1008[illegible]
103154	-426	-2307	-180.8	156.7	26.7	-4370	379[illegible]

OSC 1522

TABULATION OF THERMAL STRESSES FROM PROGRAM 91032.

PSI

ITER	σ_H IN	σ_H OUT	σ_R IN	σ_R OUT
28169	2830	24200	180	-1905
41428	4566	26508	-13	-3887
52659	4576	26167	231	-3267
75168	5222	28113	369	-4371
86960	4184	26137	135	-1698
103154	4695	9236	499	-341

TOTAL THERMAL STRESS INTENSITY

COMBINING FREE THERMAL STRESSES WITH DISCONTINUITY STRESS

STRESS INTENSITY IN KSI

ITER	$S_1^{IN} = \sigma_H - \sigma_R$	$S_2^{IN} = \sigma_H$	$S_1^{OUT} = \sigma_H - \sigma_R$	$S_2 = \sigma_H$
28169	10.2	10.4	14.7	12.8
41428	13.6	13.6	19.7	15.7
52659	12.0	12.2	20.3	17.1
75168	14.4	14.7	21.1	16.7
86960	14.2	14.3	15.7	14.0
103154	7.9	8.4	5.2	4.9

$S_{max} = 21.1$ KSI $< 1.5 S_m = 1.5(17.8) = 26.7$ KSI

NOTE: THE FREE BODY THERMAL STRESSES CALCULATED BY PROGRAM 9103 ARE THE RESULT OF NON-LINEAR THERMAL RADIAL GRADIENTS. THE B31.7 PIPING CODE REQUIRES THAT THE PRIMARY + SECON- ARY STRESS VALUE BE DETERMINED USING THE LINEAR PORT OF THE THERMAL RADIAL GRADIENT. THE NON-LINEAR GRA IENT WAS USED IN THIS ANALYSIS, AND SINCE IT IS LARGER MAGNITUDE THAN THE LINEAR PORTION, THE RESULTS ARE CO SERVATIVE.

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DATE 8-72

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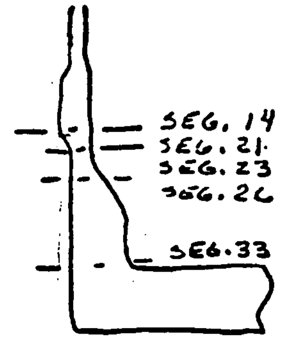
SHEET 3-56

0005190385

THERMAL SECONDARY STRESS SUMMARY OF CRITICAL JUNCTURES

$S_1 = \sigma_L - \sigma_H$ $S_2 = \sigma_H - \sigma_R$ $S_3 = \sigma_R - \sigma_L$



INTENSITIES IN KSI

SEGMENT 14 (STAINLESS)

ITER	time	INSIDE S_1	INSIDE S_2	INSIDE S_3	OUTSIDE S_1	OUTSIDE S_2	OUTSIDE S_3
28169	4.95	-3.6	8.7	-5.1	-4.1	0	4.1
41428	7.50	-3.2	8.9	-5.8	-2.8	-1.1	3.9
52659	9.66	-3.3	8.9	-5.6	-2.7	-1.0	3.7
75168	13.90	-2.4	7.7	-5.3	-2.9	-.9	3.8
86960	16.099	-2.3	7.2	-4.9	-2.7	-.8	3.5
103154	19.2	-.8	2.0	-1.2	-.4	.4	.9

SEGMENT 21 (STAINLESS)

ITER	S_1	S_2	S_3	S_1	S_2	S_3
28169	5.4	-6.5	1.2	5.4	-4.7	-.8
41428	5.5	-4.5	1.0	5.0	-5.0	0
52659	4.3	-5.2	.9	4.6	-4.2	-.4
75168	3.4	-4.4	1.0	4.9	-4.9	0
86960	3.7	-4.3	.5	4.9	-4.8	0
103154	3.9	-5.1	1.2	3.0	-2.1	-.9

SEGMENT 23 (CARBON)

ITER	S_1	S_2	S_3	S_1	S_2	S_3
28169	-7.7	5.9	1.7	-2.8	4.4	-1.6
41428	-7.7	6.4	1.4	-2.4	2.5	0
52659	-8.1	6.7	1.4	-2.0	3.2	-1.1
75168 13.90	-5.6	3.7	1.9	-1.0	1.4	-.4
86960	-9.4	8.6	.7	-2.8	3.3	-.5
103154	-4.8	2.8	2.0	-.8	2.6	-1.7

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STRESS SUMMARY (CONTINUED) OSC 1522

SEGMENT 26 (CARBON)

ITER	INSIDE S_1	INSIDE S_2	INSIDE S_3	OUTSIDE S_1	OUTSIDE S_2	OUTSIDE S_3
28169	2.4	1.8	-4.2	-1.6	-1.9	3.5
41428	3.1	-.1	-2.9	-.8	-1.9	2.7
52659	2.3	1.3	-3.6	-1.6	-1.5	3.1
75168	4.7	-1.7	-3.0	.1	-2.9	2.8
86960	3.5	-.3	-3.2	-.7	-2.1	2.8
103154	1.1	.2	-.9	-.2	-.5	+.8

SEGMENT 33 (CARBON)

	S_1	S_2	S_3	S_1	S_2	S_3
28169	-14.3	14.0	.3	-1.0	.6	.4
41428	-12.2	11.7	.5	1.4	-.6	-.8
52659	-12.6	12.8	-.2	.8	-.5	-.4
75168	-11.8	12.7	-.8	1.6	-1.8	.2
86960	-15.5	16.1	-.6	.2	0	-.1
103159	-3.8	2.9	1.0	.6	0	-.6

MAX. THERMAL STRESS RANGE FOR STAINLESS OCCURS AT JUNCTURE 14 ON INSIDE

$$S_{MAX.} = 8.9 \text{ KSI} < 1.5 S_m = 1.5(17.1) = 25.7$$

MAX. THERMAL STRESS RANGE FOR CARBON IN THE NOZZLE OCCURS AT JUNCTURE 33

$$S_{MAX} = 15.5 \text{ KSI} < 1.5 S_m = 26.7 \text{ KSI}$$

0006190387

[illegible] NOZZLE

0 0 0 6 1 9 3 8 3

OSC 1522

PEAK PRINCIPAL STRESSES

SEG. NO.	OUTSIDE LONG	OUTSIDE HOOP	OUTSIDE RAD.	MIDPLANE LONG	MIDPLANE HOOP	MIDPLANE RAD.	INSIDE LONG	INSIDE HOOP	INSIDE RAD.
1	.0	-.0	-.0	-.0	-.0	-.0	-.1	-.1	-.0
2	-.6	-.2	.0	.0	-.0	.0	.7	.2	.0
3	1.1	2.1	.0	-.1	2.2	.1	-1.3	2.2	.0
4	24.3	-4.9	-.1	-1.4	-14.5	-.6	-27.5	-26.2	-.1
5	-227.9	-91.4	.3	13.7	-17.6	1.6	258.7	59.8	.3
6	-329.8	-65.9	2.0	21.6	38.9	13.7	371.9	163.4	2.0
7	-459.7	-190.1	2.9	31.6	-65.9	19.4	517.6	73.8	2.9
8	-563.4	-322.3	3.1	38.2	-192.0	20.1	633.3	-49.2	3.1
9	-524.8	-396.3	5.4	54.8	-161.1	54.0	634.4	161.2	5.4
10	-544.2	-314.7	15.4	108.8	109.7	170.4	796.8	813.9	15.4
11	-778.2	-373.2	23.2	174.0	102.6	252.6	1045.6	768.8	23.2
12	-1710.9	-1173.6	33.4	225.7	-252.6	294.4	2107.4	1007.2	33.4
13	-3572.5	-1546.8	72.0	404.1	393.2	505.3	4386.7	3239.9	72.0
14	-4101.3	34.2	157.8	500.5	3499.2	1059.5	5080.2	8694.2	157.8
15	-2333.0	491.7	199.5	477.0	3460.4	1350.9	2884.3	7479.4	199.5
17	-3057.4	646.7	117.5	299.3	3246.9	686.5	3164.0	6153.4	117.5
18	-301.2	-4758.3	53.3	547.4	-4209.4	373.3	291.3	-5019.2	53.3
19	2910.8	-2290.7	-16.1	-168.9	-2520.2	-9.5	-3702.1	-3405.9	-16.1
20	2403.8	-2470.7	-21.8	-393.9	-2817.1	-134.6	-3220.4	-3534.9	-21.8
21	644.7	-4727.2	-38.1	-266.3	-5364.4	-318.6	-1164.4	-6511.7	-38.1
23	1560.9	4492.2	25.2	-59.8	5052.0	208.9	-1743.5	5925.7	25.2
24	-3083.3	604.1	43.2	272.0	2630.1	308.6	3318.6	4781.2	43.2
25	-2921.4	-1494.2	41.5	247.0	-328.2	261.2	3590.6	1230.5	41.5
26	-3544.9	-1924.0	40.5	48.7	-505.2	255.4	4149.0	1769.7	40.5
27	-1995.5	-2019.2	85.7	9.4	16.5	558.6	2441.2	3478.6	85.7
28	-1544.6	-2014.9	130.1	113.9	264.5	819.3	2099.8	4383.4	130.1
29	-1154.8	-2391.5	166.3	183.1	-49.7	1001.0	1711.9	4191.7	166.3
30	-1164.6	-3013.4	172.5	190.7	-1051.5	964.9	1632.9	2718.0	172.5
31	-2812.8	-1604.8	98.3	541.9	886.6	569.3	3358.7	4845.7	98.3
32	-4031.8	-1557.7	268.7	1239.4	3437.5	1693.6	4832.6	9919.6	268.7
33	-405.8	550.2	441.0	1213.0	6896.0	2875.0	-306.1	13998.7	441.0

(LONGITUDINAL DIRECTION IS ALONG SHELL MIDSURFACE. RADIAL DIRECTION IS NORMAL TO SHELL MIDSURFACE.)

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PEAK PRINCIPAL STRESSES

SEG. NO.	OUTSIDE LONG	OUTSIDE HOOP	OUTSIDE RAD.	MIDPLANE LONG	MIDPLANE HOOP	MIDPLANE RAD.	INSIDE LONG	INSIDE HOOP	INSIDE RAD.
1	.0	-.0	-.0	-.0	-.0	-.0	-.0	-.0	-.0
2	-.1	-.0	.0	.0	.0	.0	.1	.0	.0
3	.3	.3	.0	-.0	.3	.0	-.4	.2	.0
4	2.9	-1.4	-.0	-.2	-2.7	-.1	-3.3	-4.3	-.0
5	-39.9	-9.3	.1	2.3	2.5	.4	44.1	16.9	.1
6	-47.6	-2.0	.4	3.2	15.0	2.4	53.8	35.3	.4
7	-67.1	-94.7	.2	4.7	-86.2	1.1	74.9	-86.2	.2
8	-107.2	-198.2	-.2	6.1	-194.6	-2.5	118.9	-207.4	-.2
9	-325.7	-214.0	.2	23.9	-166.6	-.9	378.4	-101.0	.2
10	-554.5	-146.1	4.4	59.5	27.6	26.4	692.2	308.0	4.4
	-740.4	-234.6	8.9	99.8	-26.9	56.4	933.0	252.3	8.9
.2	-1565.3	-1140.4	30.7	192.3	-205.4	208.5	2228.7	1455.0	30.7
13	-3244.8	-1792.4	90.8	462.4	403.8	629.7	4655.3	4171.1	90.8
14	-3847.9	-1059.6	184.6	665.5	2648.2	1295.2	5782.9	8921.4	184.6
15	-2739.4	-1464.4	219.1	726.0	1751.7	1554.1	4388.6	6618.7	219.1
17	-4576.2	-1746.8	91.3	398.5	466.3	474.2	4915.5	2759.6	91.3
18	-2626.0	-1672.0	73.1	229.3	-561.6	435.1	3285.1	1060.6	73.1
19	111.7	-2473.2	38.4	187.4	-1535.8	285.8	-645.3	-1449.2	38.4
20	1014.2	-4369.6	10.0	299.7	-3271.6	90.7	-2361.6	-4292.3	10.0
21	-129.1	-5011.0	-2.2	359.8	-3762.0	-5.3	-992.3	-4444.7	-2.2
23	26.5	2459.4	57.1	732.3	5546.0	443.9	-1336.0	6339.2	57.1
24	-2166.7	144.2	49.9	254.2	1508.8	370.7	2524.0	3011.4	49.9
25	-1502.8	-997.4	24.0	140.0	-465.2	174.8	1975.6	378.2	24.0
26	-2739.6	-1899.4	18.1	228.8	-941.2	138.9	2895.0	-120.4	18.1
27	-2755.6	-2562.9	60.9	145.1	-630.1	428.2	3114.0	2264.4	60.9
28	-1021.9	-2772.8	125.0	290.2	-126.2	846.1	3993.0	4595.8	125.0
29	-2945.3	-2798.8	209.2	463.3	341.2	1367.5	4447.9	6780.2	209.2
30	-2351.2	-2428.0	297.4	616.2	605.4	1880.8	4513.3	8408.7	297.4
31	-3642.6	-2352.4	225.9	853.7	1231.1	1471.9	5889.2	7537.6	225.9
32	-3457.2	-1458.4	340.6	969.6	2597.1	2147.7	5508.3	10498.3	340.6
33	815.9	-565.0	440.3	469.3	4257.4	2769.5	-494.8	11679.9	440.3

.ONGITUDINAL DIRECTION IS ALONG SHELL MIDSURFACE. RADIAL DIRECTION IS NORMAL TO SHELL MIDSURFACE.)

PEAK PRINCIPAL STRESSES

SEG. NO.	OUTSIDE LONG	OUTSIDE HOOP	OUTSIDE RAD.	MIDPLANE LONG	MIDPLANE HOOP	MIDPLANE RAD.	INSIDE LONG	INSIDE HOOP	INSIDE RAD.
1	.0	-.0	-.0	-.0	-.0	-.0	-.0	-.0	-.0
2	-.1	-.0	.0	.0	.0	.0	.1	.0	.0
3	.3	.3	.0	-.0	.3	.0	-.4	.2	.0
4	2.9	-1.3	-.0	-.2	-2.6	-.1	-3.3	-4.2	-.0
5	-39.4	-9.4	.1	2.3	2.2	.4	43.6	16.4	.1
6	-47.4	-2.3	.3	3.2	14.5	2.4	53.5	34.6	.3
7	-67.3	-90.5	.2	4.7	-87.1	1.1	75.1	-87.2	.2
8	-107.9	-199.3	-.2	6.2	-195.7	-2.6	119.7	-208.5	-.2
9	-328.3	-219.7	.2	24.1	-167.9	-.9	381.4	-101.6	.2
10	-558.8	-147.4	4.4	59.9	27.6	26.6	697.6	310.0	4.4
[illegible]	-746.2	-275.6	9.0	100.6	-25.9	56.9	940.3	256.2	9.0
[illegible]	-1571.5	-1135.3	30.9	193.2	-195.1	210.1	2236.9	1473.9	30.9
13	-3215.7	-1747.2	91.2	459.5	428.8	632.5	4617.0	4196.1	91.2
14	-3660.9	-1019.9	183.9	647.0	2652.9	1291.6	5572.4	8853.4	183.9
15	-2513.6	-1402.1	216.3	696.0	1746.9	1536.4	4104.9	6520.5	216.3
17	-4271.5	-1660.9	87.4	362.8	459.4	448.5	4545.9	2638.4	87.4
18	-2260.1	-1565.1	68.3	187.4	-619.6	403.3	2840.3	840.2	68.3
19	703.4	-1463.8	26.3	-128.4	-1897.6	186.5	-961.6	-1935.9	26.3
20	1689.8	-3458.8	-15.0	-303.7	-3958.8	-131.2	-2383.9	-4980.2	-15.0
21	433.5	-4177.0	-32.8	-258.7	-4530.7	-283.4	-886.1	-5169.7	-32.8
23	1104.4	3174.5	52.7	-88.7	4762.3	391.9	-1378.4	6706.4	52.7
24	-1997.1	236.0	49.1	213.4	1546.9	343.2	2562.0	3286.3	49.1
25	-2227.0	-1231.4	31.9	179.5	-279.4	193.2	2795.9	1073.0	31.9
26	-3122.4	-1533.0	32.5	136.5	-366.8	214.9	3629.1	1319.1	32.5
27	-2006.7	-1847.9	67.8	65.4	-182.3	469.0	2428.6	2630.0	67.8
28	-1811.3	-1864.0	106.7	137.6	49.8	702.4	2437.7	3697.4	106.7
29	-1565.7	-1491.5	148.5	202.7	29.6	930.1	2358.6	4265.0	148.5
30	-1436.5	-2298.7	178.0	233.1	-372.6	1051.9	2330.1	4087.8	178.0
31	-2686.4	-1593.3	107.3	362.7	758.7	657.0	3914.4	5372.9	107.3
32	-3172.7	-1605.8	277.0	718.8	2550.8	1709.2	4797.0	9982.8	277.0
33	359.5	-470.2	434.2	475.7	4591.8	2718.4	152.0	12755.9	434.2

(LONGITUDINAL DIRECTION IS ALONG SHELL MIDSURFACE. RADIAL DIRECTION IS NORMAL TO SHELL MIDSURFACE.)

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PEAK PRINCIPAL STRE[illegible]

SEG. NO.	OUTSIDE LONG	OUTSIDE HOOP	OUTSIDE RAD.	MIDPLANE LONG	MIDPLANE HOOP	MIDPLANE RAD.	INSIDE LONG	INSIDE HOOP	INSIDE RAD.
1	.0	.0	.0	-.0	.0	.0	-.0	.0	.0
2	.1	-.0	-.0	-.0	-.1	-.0	-.2	-.2	-.0
3	-1.5	-.5	.0	.1	-.1	.0	1.7	.4	.0
4	2.1	5.4	.0	-.1	5.7	.1	-2.5	6.2	.0
5	65.9	-10.0	-.2	-3.9	-35.3	-1.6	-74.5	-66.3	-.2
6	31.8	-48.8	-.6	-2.9	-72.7	-4.8	-36.6	-101.8	-.6
7	-30.8	-105.0	-.6	.6	-120.0	-5.0	33.4	-138.9	-.6
8	-109.1	-154.1	-.4	5.4	-152.5	-3.3	121.2	-152.4	-.4
9	-377.4	-228.6	.6	28.8	-163.0	1.9	439.4	-80.4	.6
10	-604.7	-151.0	4.8	65.6	24.2	28.9	754.3	319.1	4.8
11	-740.4	-109.7	12.1	105.4	175.9	78.8	991.3	594.9	12.1
12	-1500.1	-1045.3	28.6	241.6	-163.4	182.2	1993.7	1061.5	28.6
13	-2945.4	-1626.4	73.3	504.0	370.1	472.1	4021.4	3224.4	73.3
14	-3826.7	-903.6	155.3	749.7	2608.6	1030.1	5279.0	7713.1	155.3
15	-2557.1	-176.0	177.7	186.4	983.5	1038.1	5759.2	5695.0	177.7
17	-3691.5	-224.7	69.7	483.9	1299.3	477.0	4646.3	3227.8	69.7
18	-2615.9	-1514.1	63.6	537.7	-24.3	455.0	3156.0	1293.6	63.6
19	-153.5	-2350.6	44.0	45.8	-1416.6	286.7	-288.6	-959.5	44.0
20	812.4	-4059.2	21.6	-348.2	-3448.6	21.0	-1961.0	-3495.8	21.6
21	-37.0	-4426.3	6.6	-333.4	-4371.0	-151.3	-955.7	-4375.8	6.6
23	353.2	1369.9	36.4	401.0	3512.3	184.5	-1894.1	3752.9	36.4
24	-1256.3	418.3	33.5	153.9	1473.0	215.1	1245.2	2445.8	33.5
25	-1219.4	-1213.4	16.9	143.4	-610.0	138.8	1192.1	-257.8	16.9
26	-2811.2	-2414.1	9.8	223.7	-2211.3	77.3	2963.8	-1733.6	9.8
27	-4977.9	-4765.2	72.5	166.2	-1683.9	475.5	5041.3	2243.5	72.5
28	-6473.8	-5775.6	200.9	521.8	-596.2	1266.6	7164.2	6789.9	200.9
29	-6442.3	-6327.1	382.6	964.2	757.9	2348.4	8257.2	11633.3	382.6
30	-6143.8	-6556.8	594.2	1400.8	2089.4	3556.5	8213.8	15977.6	594.2
31	-7462.7	-5317.1	550.4	1922.7	2045.0	3283.1	10227.0	12532.1	550.4
32	-6113.3	-4375.5	573.2	1716.1	2762.8	3448.0	8631.5	13237.5	573.2
33	-258.8	-1805.8	579.9	805.9	4135.2	3564.2	839.6	12674.6	579.9

(LONGITUDINAL DIRECTION IS ALONG SHELL MIDSURFACE. RADIAL DIRECTION IS NORMAL TO SHELL MIDSURFACE.)

000619 392

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PEAK PRINCIPAL STRESSES

SEG. NO.	OUTSIDE LONG	OUTSIDE HOOP	OUTSIDE RAD.	MIDPLANE LONG	MIDPLANE HOOP	MIDPLANE RAD.	INSIDE LONG	INSIDE HOOP	INSIDE RAD.
1	-.0	-.0	-.0	.0	-.0	-.0	.0	-.0	-.0
2	-.5	.1	.0	.0	.3	.0	.5	.5	.0
3	4.2	1.5	-.0	-.3	.4	-.0	-4.8	-1.0	-.0
4	-3.9	-15.2	-.1	.3	-16.9	-.4	4.5	-19.2	-.1
5	-230.8	21.0	.7	11.8	95.9	4.6	227.1	187.8	.7
6	-115.1	129.3	2.0	9.7	203.9	14.3	131.8	294.5	2.0
7	-10.1	-137.2	.6	4.2	-162.7	4.3	10.5	-207.3	.6
8	4.2	-449.3	-2.4	-2.1	-584.0	-18.5	-10.2	-736.7	-2.4
9	-471.2	-316.9	-1.7	27.3	-247.8	-15.5	545.0	-142.4	-1.7
10	-824.6	-49.6	9.4	88.4	290.9	60.3	1041.0	865.5	9.4
[illegible]	-1117.5	-487.6	25.3	17.2	97.0	162.1	1140.8	918.1	25.3
1	-1711.8	-1257.8	42.2	140.0	-261.0	252.2	2093.3	1214.0	42.2
13	-2931.8	-1654.4	78.3	349.5	210.7	467.9	3897.3	3116.3	78.3
14	-3526.2	-797.5	149.2	536.0	2310.3	934.9	4925.9	7228.3	149.2
15	-3517.7	-1174.6	176.6	451.6	1497.0	1170.8	3420.6	5265.5	176.6
17	-3444.4	-1145.4	102.9	737.3	1856.0	802.2	3259.7	4021.5	102.9
18	-2326.2	-1818.7	74.7	918.5	-488.1	531.9	2492.7	362.4	74.7
19	545.7	-2297.0	31.8	18.1	-1657.3	177.2	-996.5	-1507.9	31.8
20	1444.7	-3496.4	6.9	-98.7	-3651.6	35.2	-2125.3	-3961.9	6.9
21	135.3	-4790.0	-3.9	-10.1	-4284.5	-38.7	-534.4	-4268.8	-3.9
23	539.7	3370.5	77.9	114.8	5871.5	597.1	-736.6	8649.5	77.9
24	-2249.7	61.2	62.6	190.7	1454.1	473.2	2735.7	3228.8	62.6
25	-1530.0	-916.4	20.9	160.5	-552.1	151.9	1756.6	-240.1	20.9
26	-2528.6	-2097.8	13.4	306.2	-1138.4	72.0	3173.9	-336.1	13.4
27	-3175.5	-3009.2	65.5	155.9	-866.7	437.3	3653.4	2416.5	65.5
28	-3584.9	-3351.2	142.5	283.9	-343.8	1006.3	4680.7	5201.3	142.5
29	-3439.8	-3542.1	243.7	457.7	134.7	1725.8	5181.9	7796.4	243.7
30	-2464.0	-3714.2	349.2	614.4	349.9	2447.4	5212.2	9679.7	349.2
31	-4842.5	-2865.0	296.4	1334.4	1557.9	2212.4	7599.3	9472.7	296.4
32	-5043.4	-2519.6	432.1	1815.0	3682.4	3033.3	7816.9	13333.5	432.1
33	117.7	-76.5	567.9	1480.7	6845.8	3914.2	577.9	16082.1	567.9

(GITUDINAL DIRECTION IS ALONG SHELL MIDSURFACE. RADIAL DIRECTION IS NORMAL TO SHELL MIDSURFACE.)

3-63

PEAK PRINCIPAL STRESSES

SEG. NO.	OUTSIDE LONG	OUTSIDE HOOP	OUTSIDE RAD.	MIDPLANE LONG	MIDPLANE HOOP	MIDPLANE RAD.	INSIDE LONG	INSIDE HOOP	INSIDE RAD.
1	.0	.0	-.0	-.0	.0	-.0	-.0	-.0	-.0
2	-.0	-.1	-.0	.0	-.1	-.0	.0	-.1	-.0
3	-.8	.1	.0	.0	.6	.0	1.0	.8	.0
4	6.9	2.9	-.0	-.4	1.0	-.0	-7.8	-1.2	-.0
5	-1.3	-25.2	-.1	.2	-29.8	-.6	1.7	-35.7	-.1
6	-48.6	-50.3	-.0	2.6	-45.0	-.5	54.3	-39.2	-.0
7	-116.5	-71.9	.3	7.0	-47.0	1.8	130.8	-18.0	.3
8	-174.7	-94.8	.8	11.2	-41.4	5.3	196.4	8.5	.8
9	-233.2	-88.2	1.6	20.3	-23.6	10.2	274.7	61.3	1.6
10	-235.7	14.8	4.5	29.4	139.9	30.0	305.8	339.6	4.5
11	-254.7	-34.2	6.1	41.6	66.0	41.3	324.7	192.7	6.1
12	-314.2	-167.6	3.0	44.1	-111.1	17.8	342.8	-56.6	3.0
13	-746.2	-156.4	5.5	82.7	64.2	33.3	696.0	415.0	5.5
14	-907.9	401.6	24.2	122.7	969.0	164.7	1183.3	1957.1	24.2
15	-521.0	161.0	29.8	128.2	515.1	207.9	684.3	915.0	29.8
17	-573.0	286.2	17.7	84.9	652.5	125.6	713.3	1136.3	17.7
18	-70.5	29.6	10.8	38.9	97.3	77.4	92.9	113.5	10.8
19	1263.7	-196.7	-11.6	-117.5	-780.7	-80.0	-1570.5	-1674.2	-11.6
20	1767.7	-1029.6	-42.3	-215.7	-2176.6	-294.1	-2197.0	-3830.2	-42.3
21	917.4	-2062.0	-62.8	-188.4	-3324.8	-455.7	-1205.6	-5078.2	-62.8
23	1747.6	2595.6	5.2	-105.8	2665.8	55.3	-1965.5	2814.2	5.2
24	-794.6	747.8	11.2	66.7	1230.5	89.6	824.3	1824.9	11.2
25	-831.9	-268.1	9.0	75.4	-16.2	63.4	955.3	252.7	9.0
26	-763.6	-526.5	4.1	58.5	-380.9	26.0	869.3	-229.0	4.1
27	-762.4	-740.7	15.8	32.6	-236.9	96.1	793.1	507.1	15.8
28	-972.6	-922.4	36.5	83.7	-53.6	214.4	1063.6	1227.4	36.5
29	-1015.5	-1029.3	64.6	144.9	109.5	368.1	1174.2	1882.9	64.6
30	-945.0	-1123.8	94.8	200.2	215.4	522.2	1148.5	2373.4	94.8
31	-1189.0	-744.0	65.7	269.6	305.9	354.3	1445.2	1804.7	65.7
32	-944.5	-550.1	93.5	178.7	693.5	543.1	1180.2	2648.0	93.5
33	625.2	42.4	117.5	-49.5	1162.9	720.3	-906.4	2922.0	117.5

GITUDINAL DIRECTION IS ALONG SHELL MIDSURFACE. RADIAL DIRECTION IS NORMAL TO SHELL MIDSURFACE.)

FATIGUE ANALYSIS

IT CAN BE SEEN THAT THE HIGHEST STRESSED LOCATION IS AT THE INSIDE OF THE NOZZLE NEAR THE NOZZLE TO RUN PIPE INTERSECTION. THIS IS CARBON STEEL WHICH HAS THE WORST FATIGUE PROPERTIES. THEREFORE, JUSTIFICATION OF THIS POINT WILL JUSTIFY THE ENTIRE VICINITY OF THE BRANCH.

S_{MAX} THERMAL STRESS RANGE = 21.1 KSI (PAGE 3-56)

S_{MAX} PRESSURE STRESS INTENSITY $= \frac{3.3 P R_r}{t_r} = 24.55 P$

WHERE: $R_r = 14.3125 + \frac{2.0625}{2} = 15.344''$ $t_r = 2.0625''$

$S_{PEAK} = 21.1 + 2500(24.55) = 82.5$ KSI

$S_{ALT} = 41.3$ KSI FOR 240 CYCLES [HEAT-UP & COOL-DOWN]

$N_{ALLOW} = 6000$ CYCLES

$U_1 = \frac{240}{6000} = 0.04$

0 0 0 5 1 0 3 9 1

CASE 3

MAX. FLUCTUATION OF THERMAL STRESS EXCLUDING HEAT-UP AND COOL-DOWN VALUES
= 21.1 - 14.7 = 6.4 KSI (SEE PAGE 3-56)

MAX. FLUCTUATION OF PRESSURE EXCLUDING HEAT-UP AND COOL-DOWN = 2500 - 1700 (REACTOR TRIP 8B) = 800 PSI

S_{PEAK} = 6.4 + .8(24.55) = 26.0 KSI

S_{ALT} = 13.0 KSI N_{ALLOW} = 30,000 CYCLES

ACTUAL CYCLES = 160 (TRIP 8B) $U_3 = \frac{160}{30000} = 0.005$

CASE 4

NEXT MAX. PRESSURE RANGE IS LESS THAN 300 PSI FOR ALL OTHER TRANSIENT CONDITIONS.

∴ NEXT LARGEST S_{PEAK} = 6.4 + .3(24.55) = 13.8 KSI

S_{ALT} = 6.9 KSI N_{ALLOW} = ∞   ∴ U = 0.0

CUMULATIVE NOZZLE USAGE FACTOR, $U_{TOT} = U_1 + U_3$
= 0.04 + 0.005 = 0.095

0.095 < 1.0

(O.K.)

BABCOCK & WILCOX
DEPARTMENT
DATE 8-72   BY [signature]
CHECKED DATE   BY
JOB NO.

REVISION

0005193395

SECTION 4

Temperature Distribution of High Pressure Injection Nozzle

The high pressure injection nozzle only has flow through it for two conditions. One is a test condition when 60°F water is injected at 100 gallons per minute for 10 seconds. The second condition is during rapid depressurization when the reactor pressure goes below 1500 psi. This condition is defined as 60°F water injection for 45 sec. with a continuation for 15 minutes at 40°F water. The flow rate is 425 gpm. All other times the nozzle essentially follows the cold leg fluid temperature.

The same thermal model and B&W Program 91167 were used in the analysis of the HPI (See Section 2). The figures showing the transients run are on Pages 43,44 These pages are followed by time-temperatures plots of selected nodes and a discussion of selection of critical times. Finally the actual temperature distribution is shown for the selected times for stress calculation.

FILM COEFFICIENTS

THE COLD LEG FLUID COEFFICIENTS ARE THE SAME AS IDENTIFIED IN SECTION 2. THE HIGH PRESSURE INJECTION FLUID FILM COEFFICIENTS ARE CALCULATED IN THE SAME MANNER FOR TURBULENT FLOW. A FILM COEFFICIENT OF 35 BTU/°F-HR-FT² IS USED FOR THE NO FLOW CONDITION.

FILM COEFFICIENT FOR TEST CONDITION

$$hD^{.2} = .023\,(G/\mu)^{.8}\,(C_p\mu/K)^{.4}$$

WHERE: FOR 60°F WATER AT 100 gpm

$C_p = 1$ $\mu = 2.71$ $K = .344$ 62.34 lbs = 1 cu.ft. OF WAT

IN BRANCH

$D_i = 2.125'' = .177'$ AREA = .0246 FT² $D^{.2} = .707$

$$G = \text{lb}/\text{FT}^2\text{-HR} = 100\ \text{gal}/\text{min} \cdot \frac{60\ \text{min}}{\text{HR}} \cdot \frac{1\ \text{cu.ft.}}{7.481\ \text{gal}} \times \frac{62.34\ \text{lb}}{1\ \text{cu.ft}} \times \frac{1}{.024}$$

$= 2032466$ lb/FT²-HR

$$hD^{.2} = .023(.344)(50124)(2.289) = 906$$

$$h = 906/.707 = 1281 \quad \text{USE } \underline{1300}\ \text{BTU}/\text{HR-°F-FT}^2$$

INSIDE SLEEVE

$D_i = 1.5'' = .125'$ AREA = .01227 $D^{.2} = .66$

$G = 4074871$

$$hD^{.2} = .023(.344)(87441)(2.289) = 1580$$

$$h = 1580/.66 = 2394 \quad \text{USE } \underline{2400}\ \text{BTU}/\text{HR-°F-FT}^2$$

FILM COEFFICIENTS (CONTINUED)

RAPID DEPRESSURIZATION

FOR 60°F WATER: $C_p = 1$ $\rho = 62.34$ lb/cu ft $\mu = 2.71$

$K = .344$

IN BRANCH

$G = 2032466\left(\frac{425}{100}\right) = 8637981$

$hD^{.2} = .01807\left[3187447\right]^{.8} = 2882$

$h = 2882/.707 = 4076$ USE **4100** BTU/HR-°F-FT²

INSIDE SLEEVE

$G = 4074871(4.25) = 17318201$

$hD^{.2} = .01807\left[6390780\right]^{.8} = 5028$

$h = 5028/.66 = 7618$ USE **8000** BTU/HR-°F-FT²

FOR 40°F WATER: $C_p = 1.005$ $\rho = 62.42$ $\mu = 3.75$ $K = .332$

IN BRANCH

$G = 8637981\left[\frac{62.42}{62.34}\right] = 8649066$

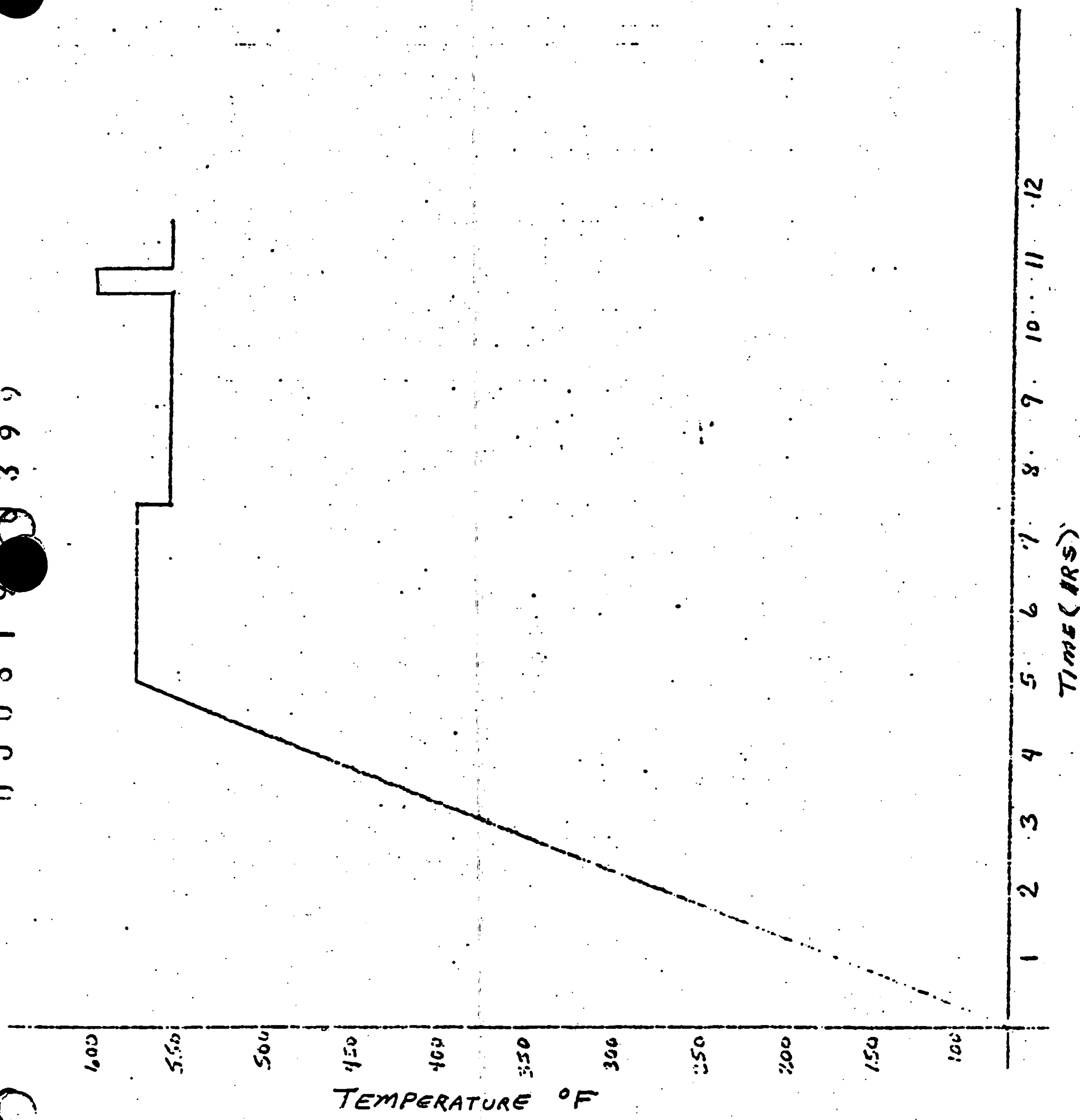
$hD^{.2} = .023(.332)\left[2306418\right]^{.8}\left[2.64\right] = 2482$

$h = 2482/.707 = 3510$ USE **3600** BTU/HR-°F-FT²

INSIDE SLEEVE

$h = 4330/.66 = 6561$ USE **6600** BTU/HR-°F-FT²

OSC 1522



OMER	JOB No.
ECT FLUID TRANSIENT FOR NO FLOW IN	
HIGH PRESSURE INJECTION NOZZLE	BY
	DATE 4-3

000619 0400

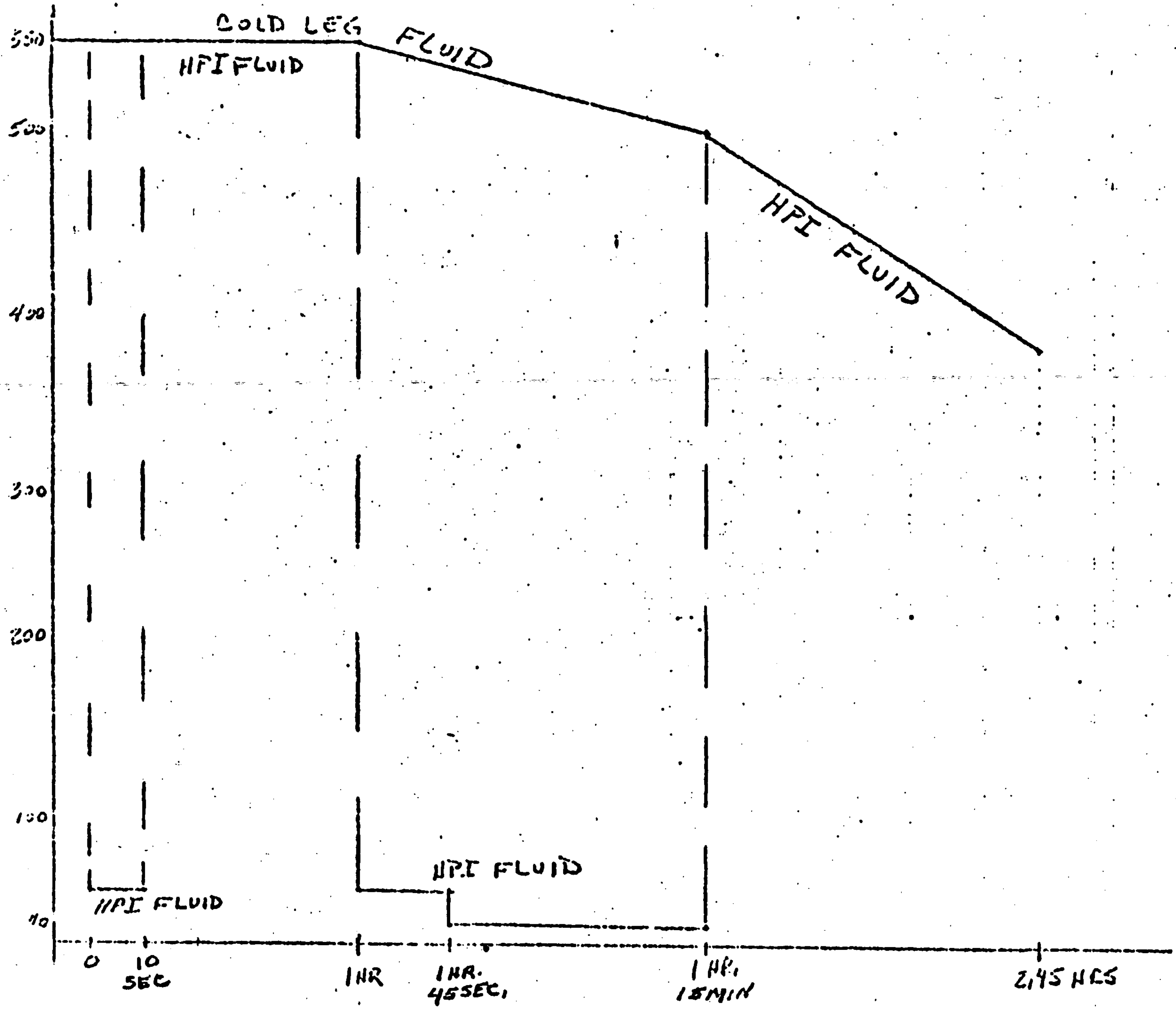
CUSTOMER

SUBJECT TEMPERATURE TRANSIENT FOR TEST TRANSIENT AND RAPID DEPRESSURIZATION

JOB NO.

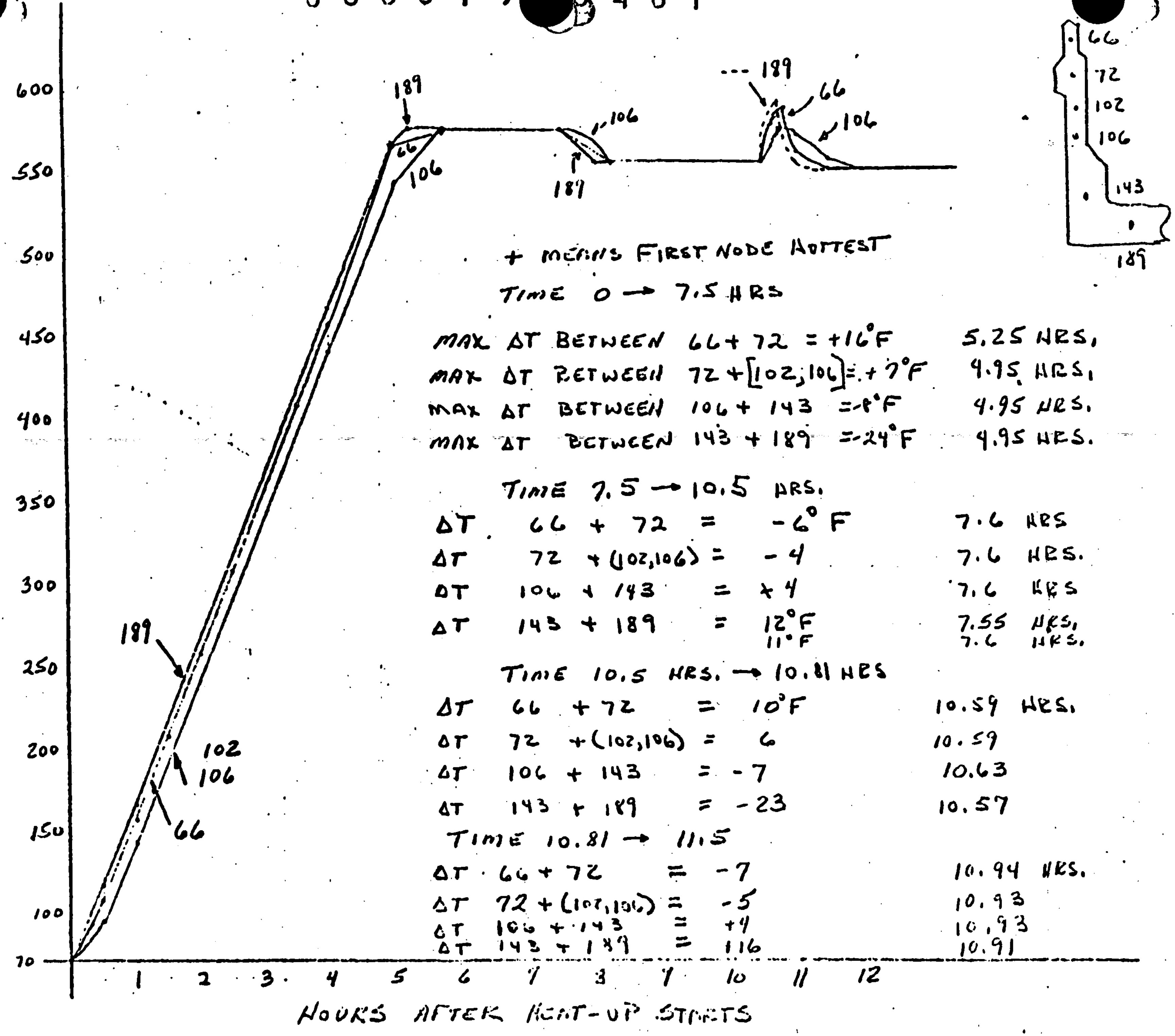
BY

DATE 4-4



000619[illegible]401

CUSTOMER	
SUBJECT	
JOB No.	
BY	
DATE	



+ MEANS FIRST NODE HOTTEST

TIME 0 → 7.5 HRS

MAX ΔT BETWEEN 66 + 72	= +16°F	5.25 HRS.
MAX ΔT BETWEEN 72 + [102, 106]	= +7°F	4.95 HRS.
MAX ΔT BETWEEN 106 + 143	= -8°F	4.95 HRS.
MAX ΔT BETWEEN 143 + 189	= -24°F	4.95 HRS.

TIME 7.5 → 10.5 HRS.

ΔT 66 + 72	= -6°F	7.6 HRS
ΔT 72 + (102, 106)	= -4	7.6 HRS.
ΔT 106 + 143	= +4	7.6 HRS
ΔT 143 + 189	= 12°F 11°F	7.55 HRS. 7.6 HRS.

TIME 10.5 HRS. → 10.81 HRS

ΔT 66 + 72	= 10°F	10.59 HRS.
ΔT 72 + (102, 106)	= 6	10.59
ΔT 106 + 143	= -7	10.63
ΔT 143 + 189	= -23	10.57

TIME 10.81 → 11.5

ΔT 66 + 72	= -7	10.94 HRS.
ΔT 72 + (102, 106)	= -5	10.93
ΔT 106 + 143	= +4	10.93
ΔT 143 + 189	= 116	10.91

THE BABCOCK & WILCOX COMPANY

0006190402

CUSTOMER

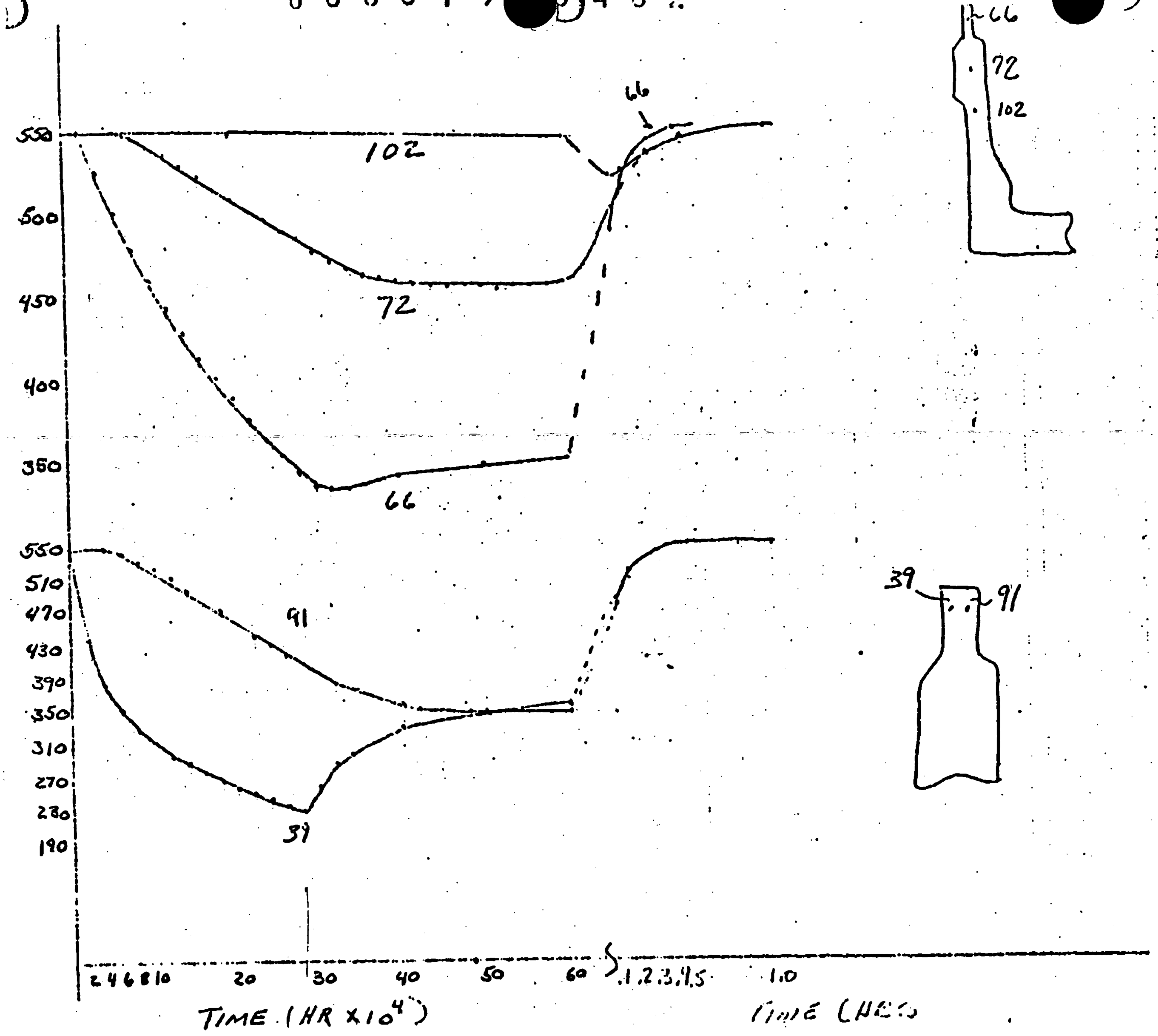
SUBJECT TEST TRANSIENT

TIME- TEMPERATURE PLOT

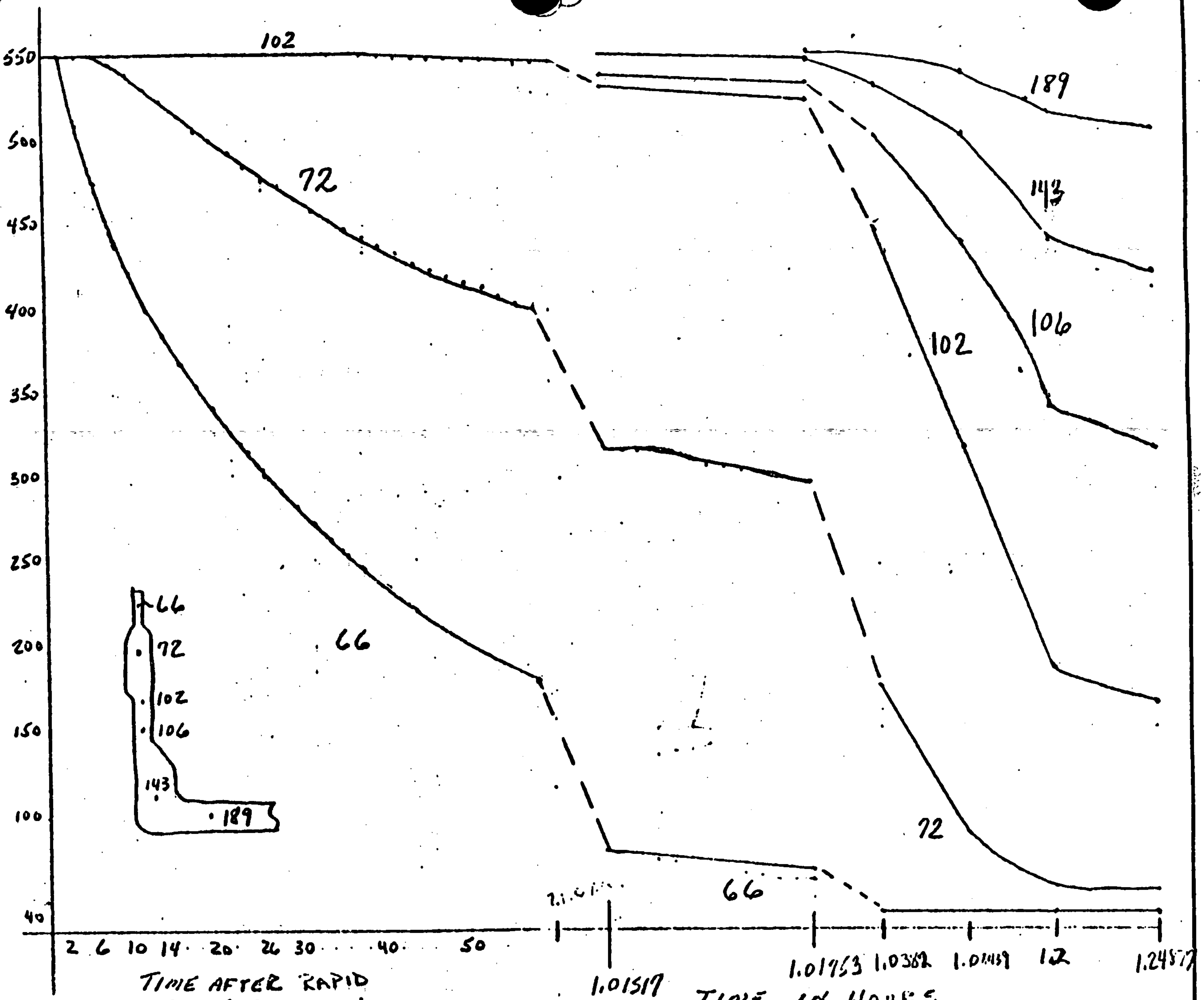
JOB No.

BY

DATE 4-6



0 0 0 6 1 9 [illegible] 4 0 3



CUSTOMER
SUBJECT
JOB NO.
BY
DATE 4-7

THE BABCOCK & WILCOX COMPANY

0 0 0 6 1 9 [illegible] 4 0 4

CUSTOMER

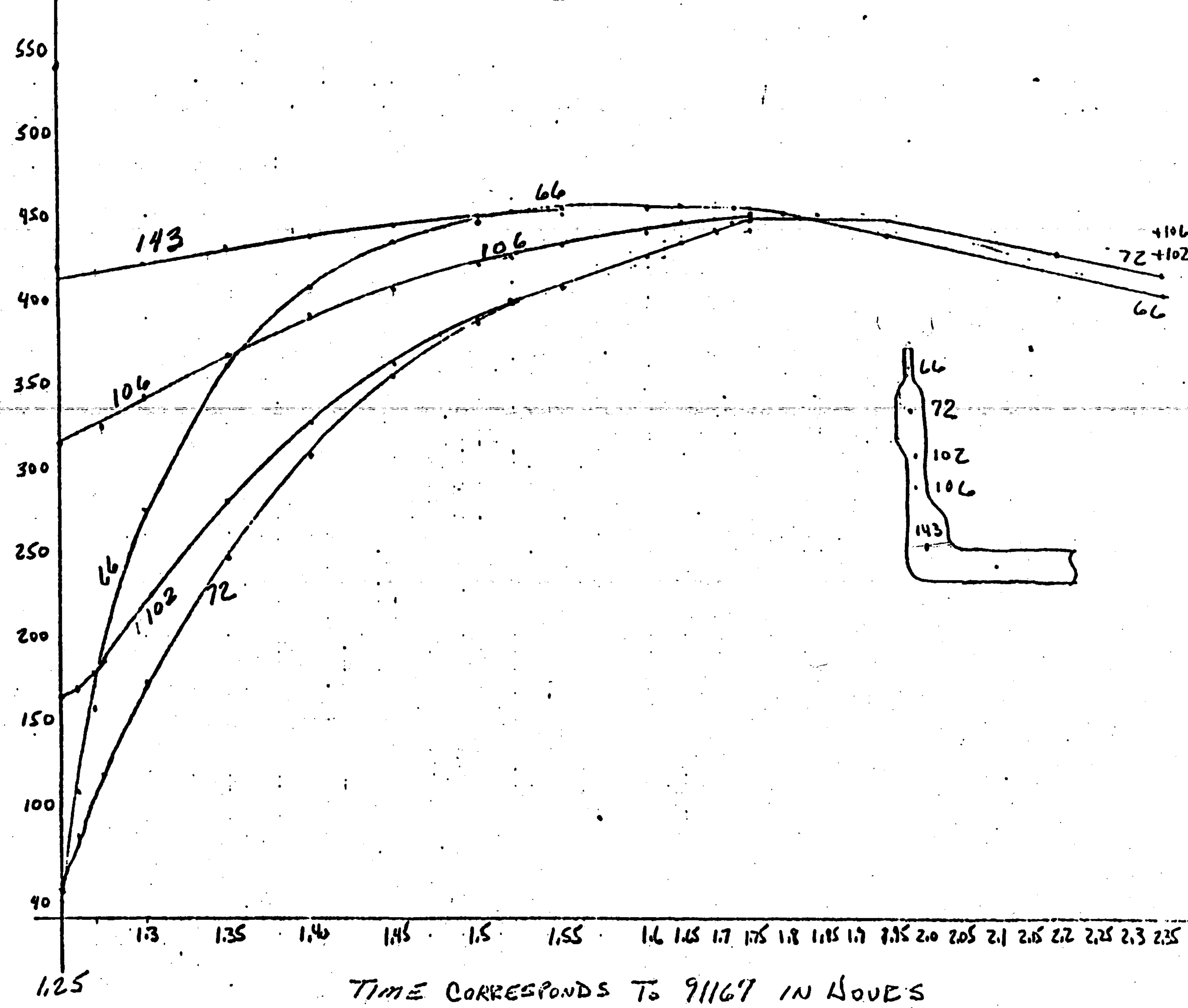
SUBJECT

AFTER HIGH PRESSURE INJECTION

JOB NO.

BY

DATE 4-Y



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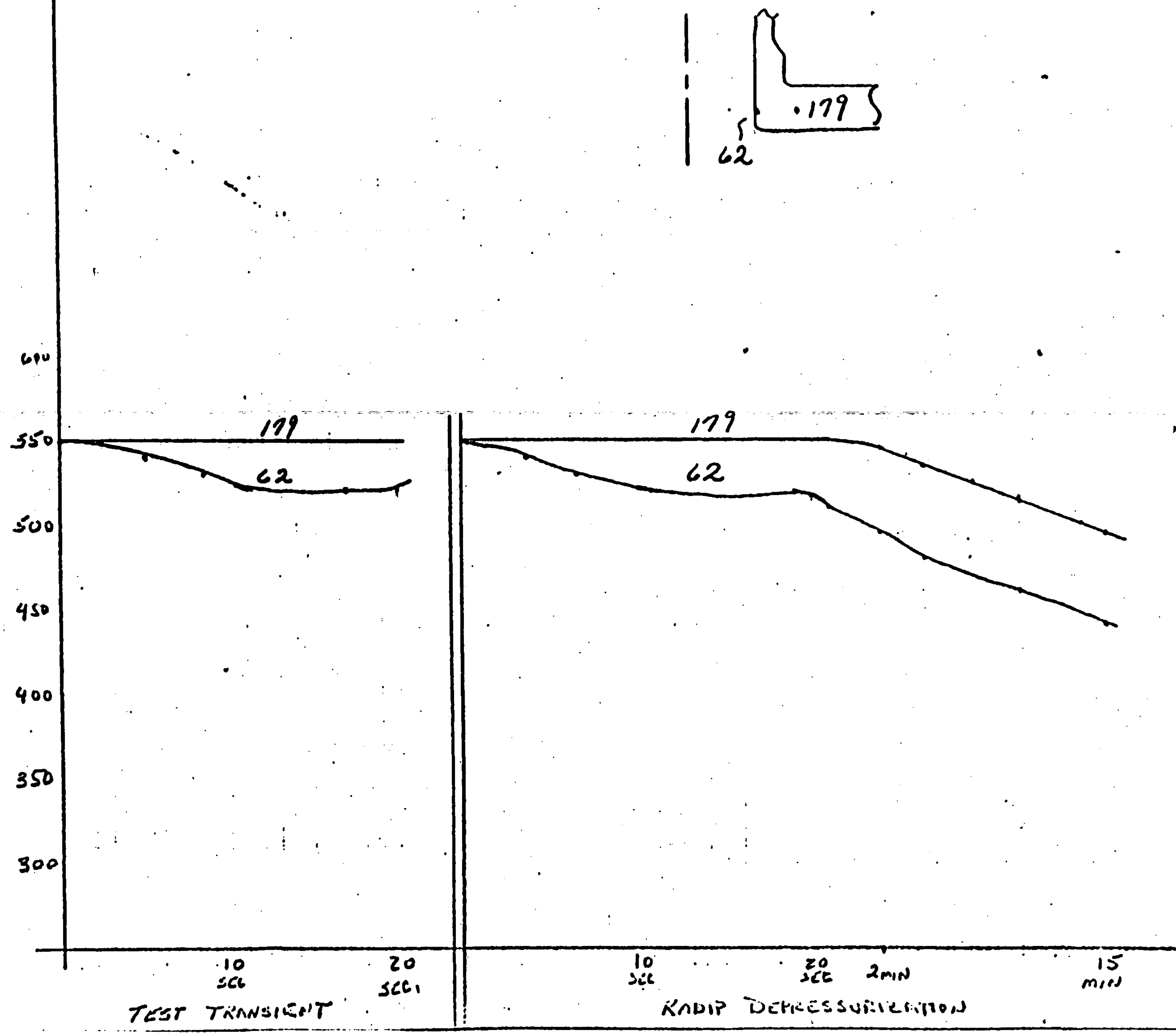

CUSTOMER

SUBJECT

JOB NO.

BY

DATE 4-7

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HPI STRESS CASES

ITERATION	TIME	EXPLANATION
27967	4.95 Hrs.	End of Heat-Up - No flow condition See Page 4-5
41491	7.5 Hrs.	Steady State Temperature at 575 Hottest temperature in vicinity of Bi-metal weld.
42021	7.6 Hrs.	Reversal in Axial gradient from 27967. See Page 4-5
3, 6, 8	0 - 10 Secs.	Maximum radial gradient stress during test transient. See Page 8-6
15	10.7 Sec. from start of test	Maximum axial gradient in upper part of nozzle
30	21.4 Sec. after test	Reversal of radial gradient
1211	14.8 min. after test	Reversal of axial gradient in upper part of nozzle
5060, 5063, 5072	0-10 Secs. after start of rapid depressurization	Maximum radial gradient stress in radid depressurization. See Page 4-7
5124	1.015 Hrs. .9 min. after start of rapid depressurization	One location of possible maximum axial gradient stress. See Page 4-7.
5237	1.0384 Hrs.	Possible maximum axial gradient stress
6059	1.2 hrs.	Possible maximum axial gradient stress.
6307	1.248 hrs.	End of 40°F water injection
6338	1.254 hrs.	Reversal of radial gradient and reversal of axial gradient. See Page 4-8
6850	1.35 hrs.	Reversal of axial gradient.

000619 0407

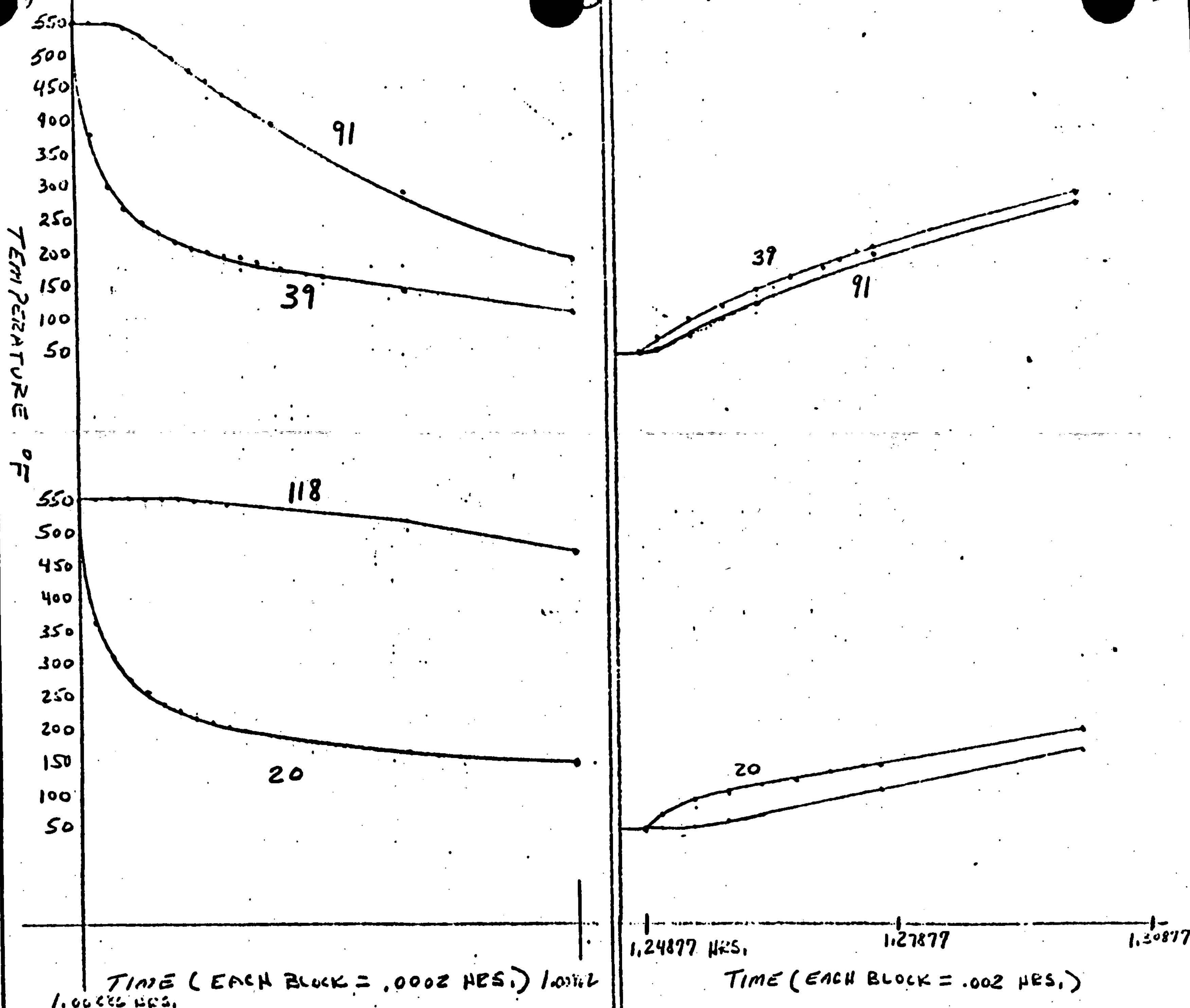
CUSTOMER

SUBJECT

JOB No.

BY

DATE 4-10



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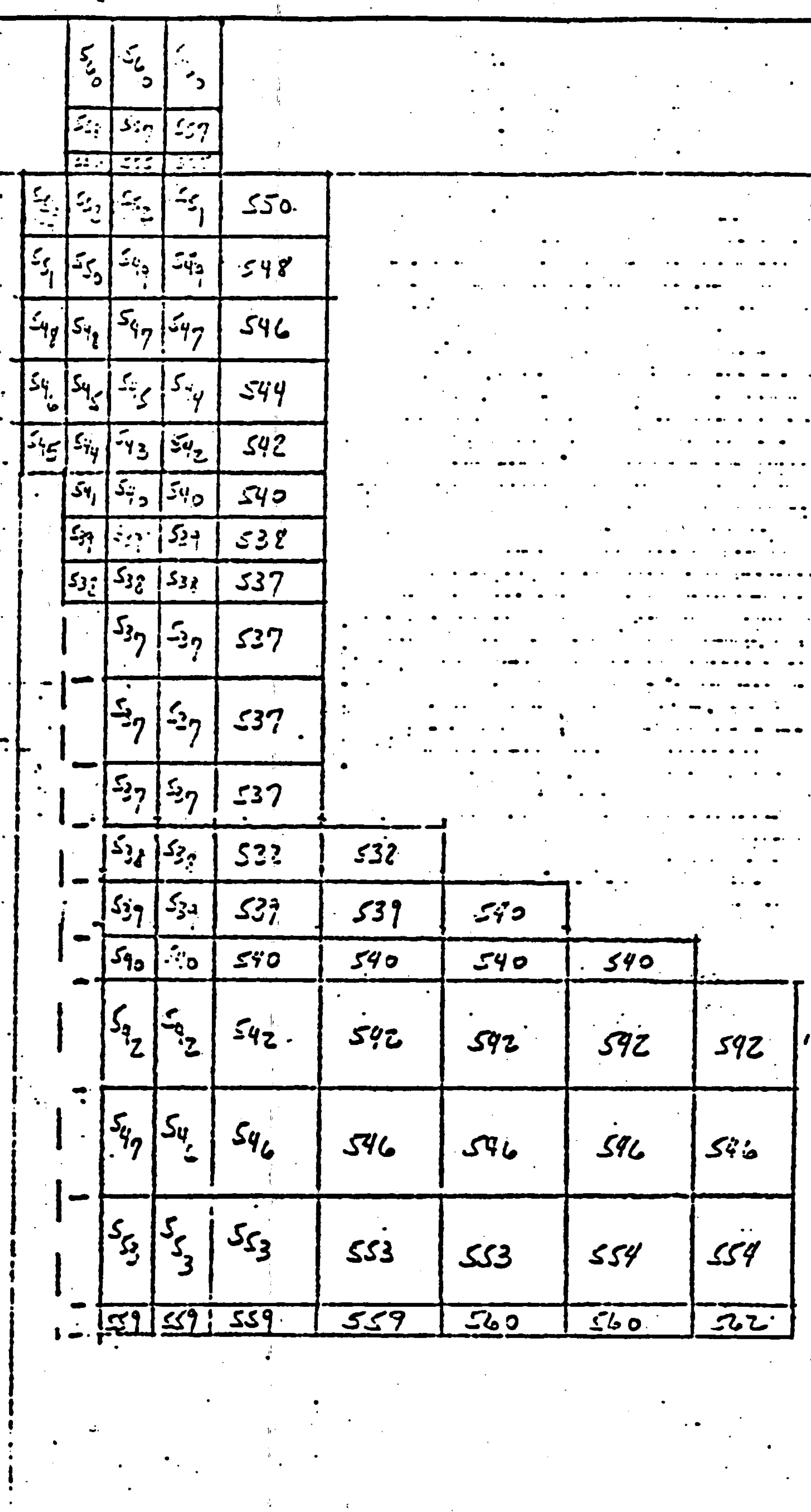
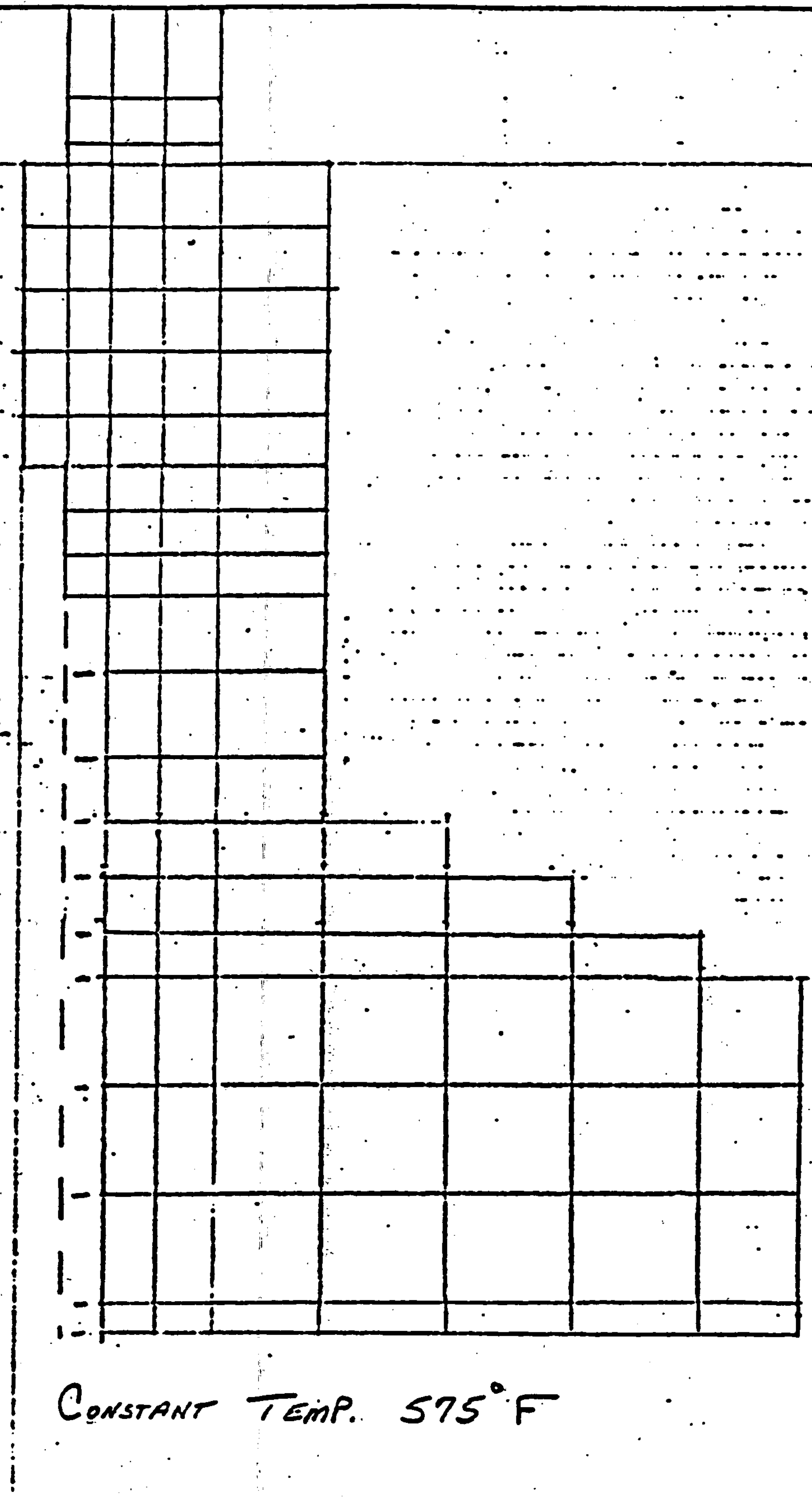


0005190403

TEMP. FOR ITER 27967

CUSTOMER	JOB NO.
SUBJECT 91167 GRID TO SCALE	
LONGITUDINAL SCALE 4 BLOCKS = 1"	BY
RADIAL SCALE 16 BLOCKS = 1"	DATE 4-12



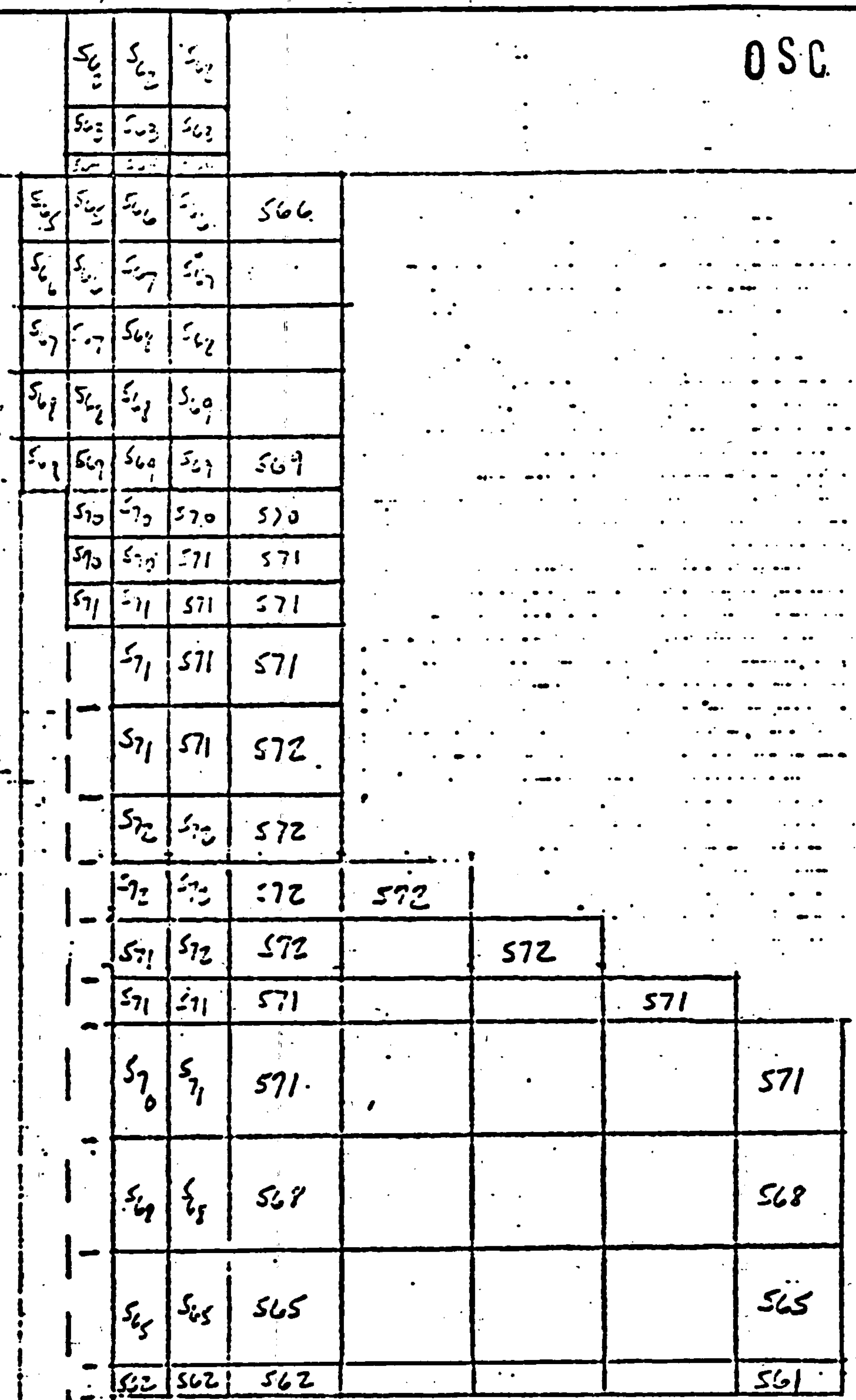
CONSTANT TEMP. 575°F

TEMP. FOR ITER 91491

CUSTOMER	JOB No.
SUBJECT 9167 GRID TO SCALE	
LONGITUDINAL SCALE 4" ... = 1"	BY
RADIAL SCALE " ... = 1"	DATE 4-13

000619 0409

OSC 1522



TEMP. FOR ITER 42021

CUSTOMER	JOB NO.
SUBJECT 9116T GRID T[illegible]	
[illegible] SCALE 4 [illegible] = 1"	BY
[illegible] SCALE 4 [illegible] = 1"	DATE 4-14

000619 411

TEMPERATURES PER SEGMENT USED IN PEAK PRINCIPLE ANALYSIS

Tree 3

SEGMENT	OUTSIDE T1	T2	T3	T4	INSIDE T5
1	468	458	420	330	169
2	468	458	420	330	169
3	468	458	420	330	169
4	468	458	420	330	169
5	475	468	437	350	168
6	475	468	437	350	168
7	475	468	437	350	168
8	475	468	437	350	168
9	477	474	456	394	178
10	480	480	476	438	188
11	480	480	476	438	188
12	480	480	477	470	305
13	480	480	477	470	307
14	480	480	477	470	308
15	480	480	477	470	310
16	480	480	480	480	480
17	480	480	480	480	480
18	480	480	480	480	480
19	480	480	480	480	480
20	480	480	480	480	480
21	480	480	480	480	480
22	480	480	480	480	480
23	480	480	480	480	480
24	480	480	480	480	480
25	480	480	480	480	480
26	480	480	480	480	480
27	480	480	480	480	480
28	480	480	480	480	480
29	480	480	480	480	480
30	480	480	480	480	480
31	480	480	480	480	480
32	480	480	480	480	480
33	480	480	480	480	480

THESE TEMP ARE T-70°

4-15

TEMPERATURES PER SEGMENT USED IN LEAK PRINCIPLE ANALYSIS

SEGMENT	OUTSIDE T1	T2	T3	T4	INSIDE T5
1	422	405	353	260	127
2	422	405	353	260	127
3	422	405	353	260	127
4	422	405	353	260	127
5	447	432	380	280	127
6	447	432	380	280	127
7	447	432	380	280	127
8	447	432	380	280	127
9	463	454	421	332	127
10	479	477	462	385	127
11	479	477	462	385	127
12	480	480	480	440	235
13	480	480	480	442	237
14	480	480	480	443	238
15	480	480	480	445	240
16	480	480	480	480	480
17	480	480	480	480	480
18	480	480	480	480	[illegible]
19	480	480	480	480	480
20	480	480	480	480	480
21	480	480	480	480	480
22	480	480	480	480	[illegible]
23	480	480	480	480	[illegible]
24	480	480	480	480	[illegible]
25	480	480	480	480	480
26	480	480	480	480	480
27	480	480	480	480	[illegible]
28	480	480	480	480	[illegible]
29	480	480	480	480	480
30	480	480	480	480	480
31	480	480	480	480	480
32	480	480	480	480	[illegible]
33	480	480	480	480	480

THERE TEMP. ARE T-70

9-4-

TEMPERATURES PER SEGMENT USED IN PEAK PRINCIPLE ANALYSIS *ITER 8*

	OUTSIDE				INSIDE
SEGMENT	T1	T2	T3	T4	T5
1	385	369	317	231	111
2	385	369	317	231	111
3	385	369	317	231	111
4	385	369	317	231	111
5	421	403	349	252	112
6	421	403	349	252	112
7	421	403	349	252	112
8	421	403	349	252	112
9	449	438	399	305	112
10	478	474	450	358	112
11	478	474	450	358	112
12	480	480	465	410	210
13	480	480	466	412	212
14	480	480	467	413	215
15	480	480	468	415	217
16	480	480	480	480	480

	OUTSIDE				INSIDE
SEGMENT	T1	T2	T3	T4	T5
17	480	480	480	480	480
18	480	480	480	480	480
19	480	480	480	480	480
20	480	480	480	480	480
21	480	480	480	480	480
22	480	480	480	480	480
23	480	480	480	480	480
24	480	480	480	480	480
25	480	480	480	480	480
26	480	480	480	480	480
27	480	480	480	480	480
28	480	480	480	480	480
29	480	480	480	480	480
30	480	480	480	480	480
31	480	480	480	480	480
32	480	480	480	480	480
33	480	480	480	480	480

THESE TEMP ARE T-70°

J-17

4-17

OSC 1522

$T_{FLUID} = 60°F$

$h = 130.0$

	274	337	393	
	266	340	400	
	314	377	418	
233	326	425	486	534
282	353	440	497	537
315	404	474	515	543
324	411	472	518	544
325	416	482	520	544
	537	542	545	549
	545	548	549	550
	546	548	549	550
		548	549	550

0006190414

TEMP. FOR ITER 15

CUSTOMER	JOB NO.
SUBJECT 9167 GRID T...	
LONGITUDINAL SCALE ... = 1"	BY
RADIAL SCALE ... = 1"	DATE 4-18

$T_{FLUID} = 550$

$h = 35$

	357	353	352					
	366	362	361					
	[illegible]	[illegible]	[illegible]					
412	417	432	451	492				
424	431	442	471	501				
413	430	452	480	511				
416	434	458	495	514				
420	441	467	492	519				
	519	526	544	541				
	534	540	546	547				
	537	542	545	548				
		544	543	547				
		544	546	547				
		544	546	547				
		544	548	548	549			
		544	546	548	549	550		
		544	546	548	549	550		
		544	546	549	549			550
		544	545	549	549			
		544	543	549	549			
		543	540	549	549	550		550

000619 415

TEMP. FOR ITER 30

CUSTOMER

JOB NO.

SUBJECT 7116? GRID T[illegible]

[illegible] = 1"

BY

[illegible] " [illegible] = 1"

DATE 4-19

$T_{FLUID} = 550$

$h = 35$

	540	539	533					
	538	538	537					
	535	535	535					
	[illegible]	[illegible]	[illegible]					
532	531	531	530	530				
530	530	529	529	529				
530	529	529	528	528				
530	529	529	527	528				
530	530	529	529	529				
	530	529	530	530				
	532	530	531	531				
	533	532	533	533				
		533	535	535				
		535	538	538				
		537	540	540				
		540	541	542	542			
		541	543	542	543	543		
		543	544	544	544	544	544	
		544	545	545	545	545	545	545
		545	546	546	546	546	546	546
		546	547	547	547	547	547	547
		547	548	548	548	548	548	549

TEMP. FOR ITER 1211

CUSTOMER

SUBJECT 91167 GRID T...

... SCALE ... = 1"

... SCALE ... = 1"

JOB No.

BY

DATE 4-20

000619415

0 0 0 6 1 9 [illegible] 4 1 7

ITERATION 5060

TEMPERATURES PER SEGMENT USED IN PEAK PRINCIPLE ANALYSIS

SEGMENT	OUTSIDE T1	T2	T3	T4	INSIDE T5
1	478	473	445	340	76
2	478	473	445	340	76
3	478	473	445	340	76
4	478	473	445	340	76
5	479	477	458	367	74
6	479	477	458	367	74
7	479	477	458	367	74
8	479	477	458	367	74
9	479	478	468	408	8[illegible]
10	479	479	478	450	93
11	479	479	478	450	93
12	480	480	480	480	370
13	480	480	480	480	372
14	480	480	480	480	373
15	480	480	480	480	375
16	480	480	480	480	480

SEGMENT	OUTSIDE T1	T2	T3	T4	INSIDE T5
17	480	480	480	480	480
18	480	480	480	480	480
19	480	480	480	480	480
20	480	480	480	480	480
21	480	480	480	480	480
22	480	480	480	480	480
23	480	480	480	480	480
24	480	480	480	[illegible]	480
25	480	480	480	[illegible]	480
26	480	480	480	480	480
27	480	480	480	480	480
28	480	480	480	480	480
29	480	480	480	[illegible]	480
30	480	480	480	480	480
31	480	480	480	480	480
32	480	480	480	[illegible]	480
33	480	480	480	[illegible]	480

THESE TEMP. ARE T-10

ITERATION 5063

TEMPERATURES PER SEGMENT USED IN PEAK PRINCIPLE ANALYSIS

SEGMENT	OUTSIDE T1	T2	T3	T4	INSIDE T5
1	407	386	317	200	38
2	407	386	317	200	38
3	407	386	317	200	38
4	407	386	317	200	38
5	439	419	352	225	38
6	439	419	352	225	38
7	439	419	352	225	38
8	439	419	352	225	38
9	458	448	407	298	37
10	478	477	462	372	37
11	478	477	462	372	37
12	480	480	478	440	255
13	480	480	479	442	271
14	480	480	479	443	286
15	480	480	480	445	302
16	480	480	480	480	480
17	480	480	480	480	480
18	480	480	480	480	480
19	480	480	480	480	480
20	480	480	480	480	480
21	480	480	480	480	480
22	480	480	480	480	480
23	480	480	480	480	480
24	480	480	480	480	480
25	480	480	480	480	480
26	480	480	480	480	480
27	480	480	480	480	480
28	480	480	480	480	480
29	480	480	480	480	480
30	480	480	480	480	480
31	480	480	480	480	480
32	480	480	480	480	480
33	480	480	480	480	480

THESE TEMP. ARE T-70

STRESS ANALYSIS OF HIGH PRESSURE INJECTION NOZ HEUNKE   ITERATION 5072

TEMPERATURES PER SEGMENT USED IN PEAK PRINCIPLE ANALYSIS

SEGMENT	T1 (OUTSIDE)	T2	T3	T4	T5 (INSIDE)
1	245	230	184	112	18
2	245	230	184	112	18
3	245	230	184	112	18
4	245	230	184	112	18
5	307	289	232	141	21
6	307	289	232	141	21
7	307	289	232	141	21
8	307	289	232	141	21
9	386	370	314	202	22
10	465	452	397	264	23
11	465	452	397	264	23
12	480	467	437	340	190
13	480	469	441	346	194
14	480	470	446	351	197
15	480	472	450	357	201
16	480	480	480	480	480
17	480	480	480	480	480
18	480	480	480	480	480
19	480	480	480	480	480
20	480	480	480	480	480
21	480	480	480	480	480
22	480	480	480	480	480
23	480	480	480	480	480
24	480	480	480	480	480
25	480	480	480	480	480
26	480	480	480	480	480
27	480	480	480	480	480
28	480	480	480	480	480
29	480	480	480	480	480
30	480	480	480	480	480
31	480	480	480	480	480
32	480	480	480	480	480
33	480	480	480	480	480

THESE TEMP. ARE T-70

FLUID 40°F
h = [illegible]

OSC 1522

	42	41	42					
	44	48	51					
	56	62	69					
57	76	95	111	131				
65	92	116	135	159				
96	123	147	166	185				
112	145	179	197	219				
138	185	223	250	275				
	334	349	354	364				
	399	403	411	418				
	428	438	446	453				
		463	466	470				
		473	477	420				
		483	487	491				
		494	499	505	511			
		502	507	513	519	524		
		506	511	518	524	527	532	
		510	515	522	529	533	536	538
		511	516	523	530	535	538	539
		518	516	523	530	535	538	540
		[illegible]	517	524	531	536	540	543

00051900429

TEMP. FOR ITER 5237

CUSTOMER
SUBJECT 9167 GRID [illegible]
[illegible] = 1"
[illegible] = 1"

JOB No.
BY
DATE 4-24

OSC 1522

	40	40	40					
	40	40	40					
	40	40	[illegible]					
40	41	[illegible]	42	42				
41	42	43	44	44				
44	46	47	49	50				
49	52	56	59	61				
58	67	74	80	84				
	114	116	119	112				
	146	149	151	154				
	178	182	185	188				
		219	220	222				
		258	260	262				
		299	302	304				
		336	340	345	355			
		362	366	372	380	387		
		381	386	391	398	404	410	
		403	407	413	419	424	428	431
		424	428	434	440	444	447	449
		443	448	454	460	465	469	470
		455	460	467	474	481	485	492

TEMP. FOR 6059

CUSTOMER

SUBJECT [illegible] GRID [illegible]

[illegible]

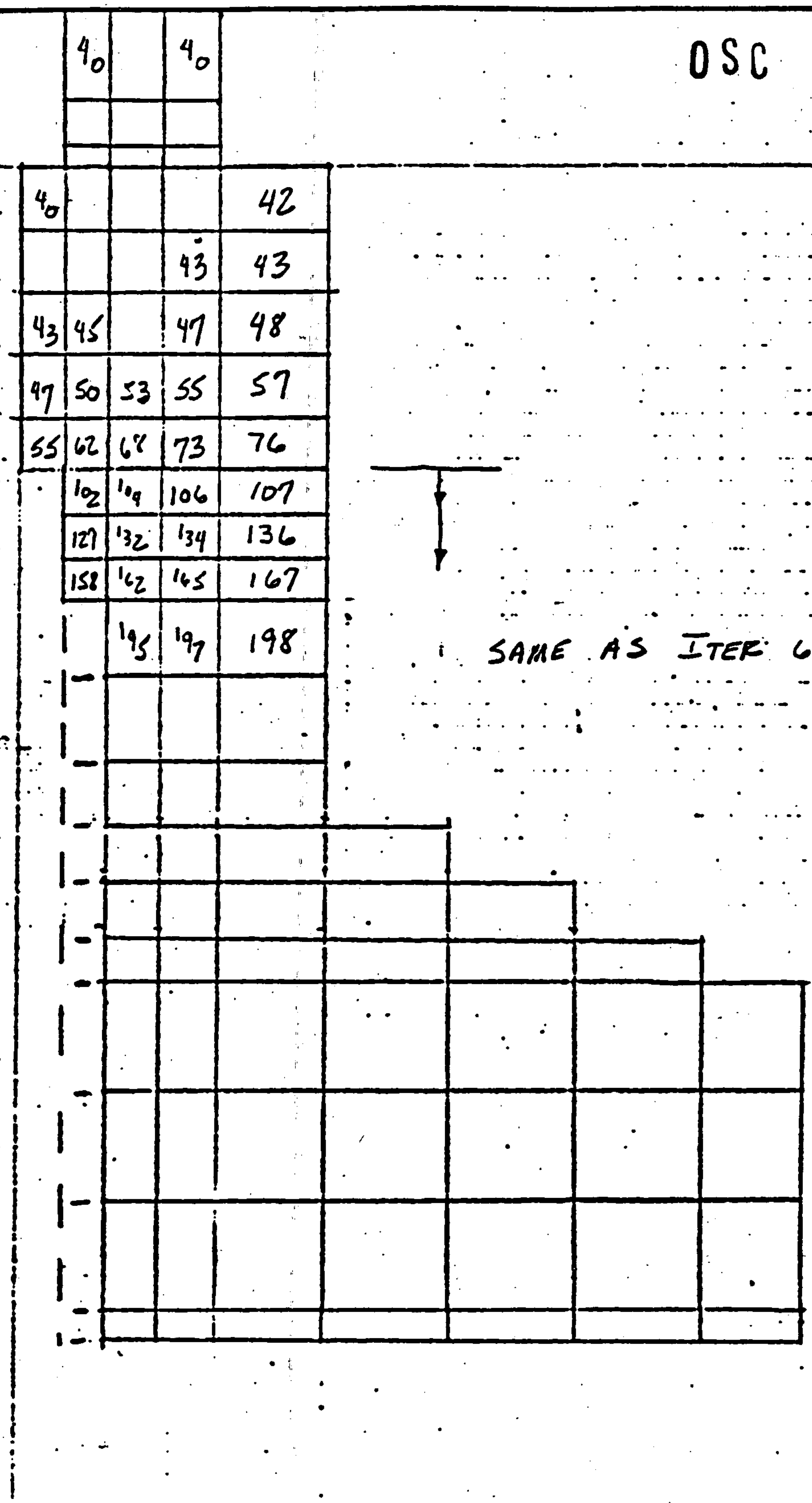
JOB NO.

BY

DATE 4-25

0006190421

OSC 1522



SAME AS ITER 6338

ITER 6307

CUSTOMER	JOB No.
SUBJECT 71167 GRID TO SCALE	
LONGITUDINAL SCALE 4 ROWS = 1"	BY
RADIAL SCALE 16 ROWS = 1"	DATE 4-26

	88	75	68					
	87	74	67					
	84	71	64					
70	76	63	55	47				
84	71	61	54	48				
79	69	60	55	51				
81	72	66	62	59				
94	87	82	79	78				
	105	105	106	107				
	130	132	133	135				
	160	163	165	167				
		196	197	198				
		233	234	236				
		274	275	277				
		310	313	318	327			
		337	340	395	352	359		
		357	360	365	371	377	382	
		380	383	388	393	398	402	405
		404	407	412	417	421	424	425
		427	431	436	442	446	450	451
		442	446	452	459	465	470	476

00051 [illegible]423

ITER 6338

CUSTOMER | JOB No.

SUBJECT 9/1/87 GRID TO SCALE

[illegible] SCALE [illegible] = 1"

BY

[illegible] SCALE 1/2 [illegible] = 1"

DATE 4-27

FLUID = 490
h = ?

	365	361	359					
	339	334	332					
	311	319	311					
297	291	279	272	270				
278	271	264	259	254				
269	258	252	247	243				
258	252	247	242	238				
262	255	249	245	241				
	252	251	249	297				
	265	263	261	259				
	282	281	280	279				
		301	301	301				
		325	324	329				
		348	348	347				
		367	368	368	372			
		382	382	323	384	387		
		394	394	394	395	397	399	
		410	410	410	410	411	412	413
		431	431	430	430	430	430	431
		453	452	452	453	453	453	459
		466	466	466	466	467	469	473

TEMP FOR ITER 6850

CUSTOMER
SUBJECT 91162 GRID T[illegible]
[illegible] SCALE 4 [illegible] = 1"
[illegible] SCALE [illegible] = 1"

JOB No.
BY
DATE 4-28

0006190421

SELECTION OF CRITICAL SEGMENTS

The following pages contain a sample temperature input and stress output for iterations 27976, 6, 5060, 6307. The reader can discern from this sample that the stainless segments 5 and 8 and carbon segment 23 (Bi-Metal Weld) are representative of the highest stress area in the nozzle.

Pages 5-16 to 5-20 contain a stress intensity summary of thermal stress iterations runs. Iteration I on this summary was run of pressure only on the nozzle at a pressure of 1000 psi. This summary is for Segments 5, 8, 21, 23, 33. It can be seen that segment 33 has stresses less than or in the vicinity of those shown for the make-up nozzle. Therefore, this point is not re-analyzed for the high pressure injection nozzle.

A complete analysis will be performed on Segments 5, 8, 23 therefore justifying the acceptability of this nozzle under the design criteria. This will be discussed further later.

JMS
8-72

00061[illegible]0423

STRESS ANALYSIS OF HIGH PRESSURE INJECTION NOZ HEHNKE ITERATION 27976

TEMPERATURES PER SEGMENT USED IN PRIMARY + SECONDARY ANALYSIS

	OUTSIDE				INSIDE		OUTSIDE				INSIDE
SEGMENT	T1	T2	T3	T4	T5	SEGMENT	T1	T2	T3	T4	T5
1	492	492	492	492	492	17	472	472	472	472	472
2	492	492	492	492	492	18	470	470	471	471	472
3	492	492	492	492	492	19	468	469	469	470	470
4	492	492	492	492	492	20	466	467	467	468	468
5	490	490	490	491	491	21	467	467	467	467	467
6	488	488	489	489	490	22	467	467	467	467	467
7	485	486	487	488	489	23	467	467	467	467	467
8	485	486	487	488	489	24	467	467	467	467	467
9	479	480	481	482	483	25	467	467	467	467	467
10	480	480	480	480	480	26	467	467	467	467	467
11	480	480	480	480	480	27	468	468	468	468	468
12	475	476	477	478	479	28	469	469	469	469	469
13	473	474	475	476	477	29	470	470	470	470	470
14	471	472	473	474	475	30	471	471	471	471	471
15	472	472	472	472	472	31	476	476	475	475	475
16	472	472	472	472	472	32	481	480	480	480	479
						33	485	485	484	484	483

STRESS ANALYSIS OF HIGH PRESSURE INJECTION NOZ BEHNKE   ITERATION 27976

PRIMARY + SECONDARY STRESSES

****

SEG. NO.	OUTSIDE LONG	OUTSIDE HOOP	OUTSIDE RAD.	MIDPLANE LONG	MIDPLANE HOOP	MIDPLANE RAD.	INSIDE LONG	INSIDE HOOP	INSIDE RAD.
1	.3	.1	-.0	-.0	-.0	-.0	-.3	-.1	-.0
2	-1.1	-1.1	-.0	.1	-.9	-.0	1.2	-.7	-.0
3	-8.9	4.2	.0	.5	9.2	.3	10.1	13.1	.0
4	118.9	28.7	-.2	-7.1	-7.4	-1.3	-134.9	-51.3	-.2
5	741.8	191.2	-4.1	-41.9	-195.3	-28.2	-833.4	-656.1	-4.1
	625.2	365.2	-10.8	-50.8	-117.8	-74.5	-711.0	-675.7	-10.8
	616.9	500.6	-14.4	-55.8	-118.1	-99.5	-705.0	-828.3	-14.4
8	559.7	273.3	-16.9	-58.0	-382.7	-117.1	-643.7	-1135.6	-16.9
9	-55.4	629.5	-15.6	-26.1	310.9	-105.3	54.1	-17.1	-15.6
10	73.7	129.6	-7.3	-23.7	60.7	-45.0	-98.0	-6.7	-7.3
11	122.3	10.7	-4.7	-15.9	-116.6	-30.3	-160.7	-316.6	-4.7
12	290.6	565.8	-17.2	-43.3	69.9	-111.0	-375.8	-608.9	-17.2
13	699.0	781.5	-25.8	-119.2	242.7	-161.4	-846.3	-430.6	-25.8
14	2248.5	1215.9	-32.2	-293.5	282.9	-196.2	-2848.5	-1021.5	-32.2
15	3072.7	1238.7	-36.8	-430.8	498.2	-236.3	-3864.2	-403.7	-38.8
17	4169.9	1597.3	-43.6	-472.5	494.7	-280.0	-5040.7	-823.4	-43.6
18	5170.5	1877.1	-57.9	-571.6	189.2	-376.2	-6262.2	-1963.5	-57.9
19	7563.5	556.9	-105.7	-835.5	-2626.8	-709.5	-9233.9	-7015.9	-105.7
20	6563.4	-4004.8	-192.3	-872.6	-8694.4	-1349.8	-8190.4	-15302.8	-192.3
21	1598.8	-9151.3	-247.4	-567.8	-13741.1	-1803.9	-2336.1	-20116.0	-247.4
23	3566.6	14126.9	100.6	-54.7	16799.1	811.3	-3862.1	20272.4	100.6
24	-8397.8	3083.2	117.7	779.0	7221.9	884.1	9719.8	12106.5	117.7
	-3337.8	-1831.8	62.3	361.3	-959.7	434.8	3776.6	-268.3	62.3
26	-793.5	-949.0	8.8	75.8	-895.3	53.5	898.2	-908.7	8.8
27	183.4	-246.7	-2.0	-23.3	-343.9	-18.5	-228.8	-469.8	-2.0
28	-153.6	-152.9	1.2	-9.7	-73.6	3.3	163.1	106.4	1.2
29	-229.5	-80.8	10.0	18.6	109.0	60.7	300.5	513.0	10.0
30	-152.6	36.0	22.3	47.6	315.6	137.9	280.2	934.8	22.3
31	28.7	34.5	13.4	21.8	143.8	87.7	-20.9	282.3	13.4
32	485.9	-7.6	3.2	-63.9	-64.8	22.3	-666.5	-259.8	3.2
33	802.4	-304.5	-19.8	-138.5	-645.6	-127.1	-1150.0	-1436.3	-19.8

(LONGITUDINAL DIRECTION IS A [illegible]

0006190428

5-3

STRESS ANALYSIS OF HIGH PRESSURE INJECTION NOZ [illegible]   ITERATION 27976

TEMPERATURES PER SEGMENT USED IN PEAK PRINCIPLE ANALYSIS

****

	OUTSIDE				INSIDE		OUTSIDE				INSIDE
SEGMENT	T1	T2	T3	T4	T5	SEGMENT	T1	T2	T3	T4	T5
1	492	492	492	492	492	17	472	472	472	472	472
2	492	492	492	492	492	18	470	470	471	471	472
3	492	492	492	492	492	19	468	468	469	469	470
4	492	492	492	492	492	20	467	467	467	468	469
5	490	490	490	491	491	21	467	467	467	467	467
6	488	488	489	489	490	22	467	467	467	467	467
7	486	486	487	488	489	23	467	467	467	467	467
8	486	486	487	488	489	24	467	467	467	467	467
9	480	480	481	482	483	25	467	467	467	467	467
10	480	480	480	480	481	26	467	467	467	467	467
11	480	480	480	480	481	27	468	468	468	468	469
12	475	476	477	478	479	28	469	469	469	469	469
13	473	474	475	476	477	29	470	470	470	470	470
14	472	472	473	474	475	30	471	471	471	471	471
15	472	472	472	472	472	31	476	476	475	475	475
16	472	472	472	472	472	32	480	480	480	480	479
						33	485	485	484	484	483

5-3

STRESS ANALYSIS OF HIGH PRESSURE INJECTION NOZ BEHNKE ITERATION 27976

PEAK PRINCIPAL STRESSES
****

SEG. NO.	OUTSIDE LONG	OUTSIDE HOOP	OUTSIDE RAD.	MIDPLANE LONG	MIDPLANE HOOP	MIDPLANE RAD.	INSIDE LONG	INSIDE HOOP	INSIDE RAD.
1	.3	.1	-.0	-.0	-.0	-.0	-.3	-.1	-.0
2	-1.1	-1.1	-.0	.1	-.9	-.0	1.2	-.7	-.0
3	-8.9	4.2	.0	.5	6.2	.3	10.1	13.1	.0
4	119.0	28.7	-.2	-7.1	-7.3	-1.3	-134.9	-51.3	-.2
5	810.0	63.2	-3.7	-33.0	-186.4	-29.6	-1020.6	-724.7	-3.7
[illegible]	465.1	203.7	-9.5	-33.8	-100.9	-79.3	-752.1	-718.5	-9.5
[illegible]	375.6	258.0	-12.3	-30.6	-93.1	-107.4	-765.0	-892.1	-12.3
8	467.2	-20.5	-14.3	-33.4	-358.7	-126.5	-829.1	-1233.1	-14.3
9	-298.4	386.3	-12.3	-2.0	334.8	-116.7	-3.4	-81.0	-12.3
10	21.9	76.7	-7.6	3.2	96.9	-40.4	-349.4	-236.3	-7.6
11	67.2	-45.1	-9.4	19.4	-74.1	-6.6	-411.9	-549.2	-9.4
12	281.5	560.9	-19.5	-37.1	72.3	-49.0	-366.3	-610.3	-19.5
13	580.3	660.5	-24.5	-106.5	255.9	-165.4	-929.0	-464.6	-24.5
14	2014.4	976.0	-28.4	-270.4	308.3	-208.7	-2916.9	-1088.2	-28.4
15	3068.3	1238.8	-36.2	-433.9	495.1	-244.3	-5151.2	-742.0	-36.2
17	4162.2	1585.3	-43.5	-471.5	495.2	-279.3	-5011.4	-820.0	-43.5
18	5037.7	1752.2	-57.7	-698.7	66.7	-377.6	-6381.3	-2079.2	-57.7
19	7415.2	408.3	-105.4	-808.3	-2597.2	-709.9	-9388.8	-7164.0	-105.4
20	6402.9	-4176.8	-192.4	-689.2	-8511.7	-1343.2	-6386.4	-15486.8	-192.4
21	1593.5	-9153.1	-247.6	-565.5	-13740.1	-1799.4	-2329.6	-20114.5	-247.6
23	3557.9	14124.0	100.7	-54.0	16796.6	811.8	-3852.2	20274.7	100.7
24	-9401.0	3000.5	117.8	779.3	7219.8	884.3	9723.5	12104.8	117.8
[illegible]	-3336.8	-1832.1	62.3	361.2	-966.4	434.8	3775.5	-289.5	62.3
26	-898.4	-913.4	8.8	75.8	-895.4	53.5	897.7	-908.9	8.8
27	206.7	-255.2	-2.0	-23.3	-343.7	-18.4	-228.9	-469.5	-2.0
28	-153.2	-152.7	1.2	-9.7	-73.3	3.3	162.7	106.7	1.2
29	-228.9	-80.5	10.0	18.6	109.3	60.7	299.9	513.2	10.0
30	-151.8	36.3	22.3	47.5	315.8	137.9	279.3	934.6	22.3
31	60.7	65.7	13.2	54.1	174.9	89.1	9.5	309.3	13.2
32	549.2	54.5	2.7	1.5	-2.1	26.6	-604.7	-206.1	2.7
33	1148.0	-319.9	-20.6	-39.9	-550.9	-119.8	-1056.1	-1355.0	-20.6

TEMPERATURES PER SEGMENT USED IN PRIMARY + SECONDARY ANALYSIS ITER 6
****

SEGMENT	OUTSIDE T1	T2	T3	T4	INSIDE T5
1	472	399	326	253	180
2	472	399	326	253	180
3	472	399	326	253	180
4	472	399	326	253	180
5	504	426	348	270	192
6	504	426	348	270	192
7	504	426	348	270	192
8	504	426	348	270	192
9	527	454	382	309	237
10	549	482	415	348	281
11	549	482	415	348	281
12	527	487	446	406	365
13	527	487	447	407	367
14	526	487	448	408	369
15	526	487	448	410	371
16	480	480	480	480	480
17	480	480	480	480	480
18	480	480	480	480	480
19	480	480	480	480	480
20	480	480	480	480	480
21	480	480	480	480	480
22	480	480	480	480	480
23	480	480	480	480	480
24	480	480	480	480	480
25	480	480	480	480	480
26	480	480	480	480	480
27	480	480	480	480	480
28	480	480	480	480	480
29	480	480	480	480	480
30	480	480	480	480	480
31	480	480	480	480	480
32	480	480	480	480	480
33	480	480	480	480	480

5-5

PRIMARY + SECONDARY STRESSES
****

ITER 6

SEG. NO.	OUTSIDE LONG	OUTSIDE HOOP	OUTSIDE RAD.	MIDPLANE LONG	MIDPLANE HOOP	MIDPLANE RAD.	INSIDE LONG	INSIDE HOOP	INSIDE RAD.
1	-49756.9	-49747.3	1105.1	4195.4	365.5	7609.1	55866.3	55881.4	1105.1
2	-49744.0	-49745.1	1105.1	4194.6	363.5	7608.9	55851.7	55874.5	1105.1
3	-49794.9	-49790.8	1105.0	4197.8	326.4	7608.3	55909.6	55847.6	1105.0
4	-50148.2	-49592.8	1106.9	4217.9	668.8	7622.0	56307.7	56413.1	1106.9
5	-59698.5	-57613.8	1143.7	4766.9	-2352.6	7863.2	67062.9	58116.0	1143.7
6	-52889.4	-54992.0	1322.8	5088.5	-2648.8	9028.9	60490.7	56520.9	1322.8
7	-62580.4	-56901.5	1394.7	5765.6	-1432.6	9526.8	71427.3	61353.0	1394.7
8	-60285.5	-57986.5	1466.6	6293.2	-248.5	10026.2	79003.4	65046.7	1466.6
9	-39747.3	-42979.9	1687.3	5752.1	3125.2	11392.4	48477.6	59394.2	1687.3
10	-27896.5	-35766.0	2014.4	6081.3	3649.0	13220.0	36850.2	54778.9	2014.4
11	-29596.2	-34858.2	2166.1	6607.5	5629.2	14007.5	39221.6	57834.2	2166.1
12	-27634.1	-26944.1	1807.0	6651.6	-122.5	11664.8	36297.2	30947.4	1807.0
13	-23677.6	-23629.1	1386.1	4846.0	1798.6	8922.6	30946.7	34223.0	1386.1
14	-13782.4	-19366.8	1356.8	3769.7	3647.4	8809.3	18524.5	32303.3	1356.8
15	-7909.5	-16795.2	1229.1	2839.9	4435.0	8010.7	11155.9	31116.8	1229.1
17	-10084.4	-6895.7	52.0	1074.4	-5514.4	266.9	12082.2	-4216.6	52.0
18	-4029.8	-5647.4	1.4	459.7	-6233.9	-68.8	4747.5	-7633.2	1.4
19	6200.4	-3416.3	-110.5	-672.1	-7318.9	-811.4	-7684.6	-13089.5	-110.5
20	7597.6	-5509.4	-225.8	-1032.9	-10963.3	-1610.3	-9495.8	-18627.7	-225.8
21	2586.7	-9810.7	-281.0	-721.6	-15110.3	-2049.3	-3568.9	-22409.9	-281.0
23	5272.0	14127.9	80.1	-203.4	16142.3	666.6	-5822.8	18849.4	80.1
24	-7331.9	3523.0	103.7	676.6	7360.2	787.0	8499.8	11946.1	103.7
25	-3356.7	-1646.6	59.9	359.1	-722.4	420.4	3810.3	40.9	59.9
26	-685.3	-845.0	9.1	70.1	-801.5	56.6	775.8	-828.4	9.1
27	391.9	-94.7	-3.5	-27.4	-258.1	-27.2	-451.5	-485.2	-3.5
28	130.1	-2.0	-3.5	-24.6	-51.2	-24.9	-166.9	-101.3	-3.5
29	54.2	13.6	-1.6	-14.3	-2.6	-10.8	-74.7	-9.9	-1.6
30	23.3	13.6	-.6	-6.8	7.3	-3.2	-32.3	11.1	-.6
31	10.8	13.5	-.3	-1.8	10.0	-.6	-11.8	14.8	-.3
32	2.7	8.9	-.1	.4	6.7	.8	-.7	10.3	-.1
33	.5	7.0	-.1	.9	4.5	1.0	2.1	6.6	-.1

(LONGITUDINAL DIRECTION IS ALONG SHELL MIDSURFACE. RADIAL DIRECTION IS NORMAL TO SHELL MIDSURFACE.)

TEMPERATURES PER SEGMENT UPTO [illegible] FOR PRINCIPLE ANALYSIS

SEGMENT	T1 (OUTSIDE)	T2	T3	T4	T5 (INSIDE)
1	422	405	353	260	127
2	422	405	353	260	127
3	422	405	353	260	127
4	422	405	353	260	127
5	447	432	380	280	127
6	447	432	380	280	127
7	447	432	380	280	127
8	447	432	380	280	127
9	463	454	421	332	127
10	479	477	462	385	127
11	479	477	462	385	127
12	480	480	480	440	235
13	480	480	480	442	237
14	480	480	480	443	238
15	480	480	480	445	240
16	480	480	480	480	480
17	480	480	480	480	480
18	480	480	480	480	480
19	480	480	480	480	480
20	480	480	480	480	480
21	480	480	480	480	480
22	480	480	480	480	480
23	480	480	480	480	480
24	480	480	480	480	480
25	480	480	480	480	480
26	480	480	480	480	480
27	480	480	480	480	480
28	480	480	480	480	480
29	480	480	480	480	480
30	480	480	480	480	480
31	480	480	480	480	480
32	480	480	480	480	480
33	480	480	480	480	480

5-6A

0 0 0 PEAK PRI[illegible]AL STRESSES

SEG. NO.	OUTSIDE LONG	OUTSIDE HOOP	OUTSIDE RAD.	MIDPLANE LONG	MIDPLANE HOOP	MIDPLANE RAD.	INSIDE LONG	INSIDE HOOP	INSIDE RAD.
1	-31531.0	-31516.3	1115.3	-5549.7	-9321.5	7388.8	74996.8	75020.7	1115.3
2	-31517.6	-31513.7	1115.3	-5550.5	-9325.0	7388.6	74981.6	75014.1	1115.3
3	-31563.9	-31561.6	1115.2	-5547.5	-9366.3	7387.8	75034.5	74980.5	1115.2
4	-31978.7	-31378.0	1117.2	-5523.8	-9999.6	7402.2	75502.3	75573.1	1117.2
5	-50961.3	-32896.2	1167.5	-6700.2	-13910.1	7588.2	104192.5	85987.6	1167.5
6	-32204.5	-33793.1	1368.1	-6422.1	-13476.2	8620.6	84198.5	80912.9	1368.1
7	-41056.7	-35254.2	1436.8	-5797.5	-12009.1	9098.1	94192.5	85767.7	1436.8
8	-65828.7	-29758.9	1503.5	-5324.4	-10692.6	9563.4	116512.6	93594.1	1503.5
	-16469.7	-19767.5	1871.9	-8730.6	-10722.4	10100.0	87873.7	99071.9	1871.9
1[illegible]	-4414.6	-11562.8	2593.8	-11598.5	-14031.0	9739.4	94786.3	109508.6	2593.8
11	-5496.6	-10340.7	2982.7	-11716.2	-12429.4	9165.1	96443.8	112611.9	2982.7
12	-9758.1	-9655.9	2601.0	-7000.7	-13015.7	6969.9	82689.2	76969.9	2601.0
13	-6431.4	-6633.6	2171.1	-8410.0	-10670.8	4429.8	77968.6	80662.6	2171.1
14	1698.6	-3022.5	2159.2	-9057.7	-8587.8	4359.0	67644.5	79498.9	2159.2
15	6587.7	-944.4	2058.5	-9592.1	-7630.7	3668.5	65144.2	79477.8	2058.5
17	-7596.0	-5550.8	31.9	798.4	-4672.0	146.0	9087.2	-3916.7	31.9
18	-2350.3	-4467.9	-11.5	266.7	-5280.6	-142.0	2732.9	-6856.8	-11.5
19	6572.7	-2759.2	-110.9	-717.1	-6554.3	-803.1	-8118.0	-12104.0	-110.9
20	7520.5	-5278.9	-220.3	-1016.4	-10601.2	-1567.8	-9392.8	-18083.7	-220.3
21	2481.9	-9710.3	-276.1	-702.0	-14419.7	-2013.6	-3436.4	-22105.8	-276.1
23	5088.5	14201.0	83.1	-186.0	16307.1	688.0	-5610.6	19123.0	83.1
24	-7503.0	3487.5	106.0	692.9	7382.5	803.2	8696.3	12030.1	106.0
25	-3365.9	-1672.4	60.5	360.8	-750.4	424.5	3819.2	4.9	60.5
26	-769.4	-821.3	9.0	69.5	-813.0	56.0	767.8	-845.8	9.0
27	449.6	-112.8	-3.6	-28.0	-260.4	-27.8	-457.6	-489.6	-3.6
[illegible]	131.7	-1.7	-3.6	-25.0	-51.3	-25.2	-169.0	-101.7	-3.6
29	54.8	13.8	-1.7	-14.5	-2.4	-10.9	-75.5	-9.6	-1.7
30	23.5	13.7	-.6	-6.8	7.5	-3.2	-32.6	11.3	-.6
31	10.9	13.6	-.3	-1.8	10.1	-.6	-11.9	15.0	-.3
32	2.6	9.0	-.1	.4	6.7	.8	-.7	10.4	-.1
33	1.0	7.1	-.1	.9	4.5	1.0	2.2	6.6	-.1

(LONGITUDINAL DIRECTION IS ALONG SHELL MIDSURFACE. RADIAL DIRECTION IS NORMAL TO SHELL MIDSURFACE.)

TEMPERATURES PER SEGMENT USED IN PRIMARY + SECONDARY ANALYSIS
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	OUTSIDE				INSIDE
SEGMENT	T1	T2	T3	T4	T5
1	558	475	391	308	224
2	558	475	391	308	224
3	558	475	391	308	224
4	558	475	391	308	224
5	560	482	404	326	247
6	560	482	404	326	247
7	560	482	404	326	247
8	560	482	404	326	247
9	554	487	421	354	288
10	547	492	437	383	328
11	547	492	437	383	328
12	498	485	471	457	443
13	498	485	471	457	444
14	498	484	471	458	444
15	497	484	471	458	445
16	480	480	480	480	480
17	480	480	480	480	480
18	480	480	480	480	480
19	480	480	480	480	480
20	480	480	480	480	480
21	480	480	480	480	480
22	480	480	480	480	480
23	480	480	480	480	480
24	480	480	480	480	480
25	480	480	480	480	480
26	480	480	480	480	480
27	480	480	480	480	480
28	480	480	480	480	480
29	480	480	480	480	480
30	480	480	480	480	480
31	480	480	480	480	480
32	480	480	480	480	480
33	480	480	480	480	480

PRIMARY + SECONDARY STRESSES

SEG. NO.	OUTSIDE LONG	OUTSIDE HOOP	OUTSIDE RAD.	MIDPLANE LONG	MIDPLANE HOOP	MIDPLANE RAD.	INSIDE LONG	INSIDE HOOP	INSIDE RAD.
1	-56571.9	-56563.4	1256.5	4770.1	415.0	8651.7	63518.0	63536.9	1256.5
2	-56572.3	-56572.2	1256.5	4770.2	404.6	8651.4	63518.6	63524.5	1256.5
3	-56700.0	-56566.2	1256.9	4717.7	456.8	8654.1	63663.0	63633.3	1256.9
4	-55798.1	-56129.0	1256.3	4722.8	665.0	8651.6	62638.3	63564.6	1256.3
5	-60614.9	-57521.0	1219.8	5058.8	-2350.8	8388.6	68193.0	58692.1	1219.8
[illegible]	-51951.5	-54244.5	1323.0	5043.4	-2163.6	9034.2	59439.5	56677.2	1323.0
[illegible]	-59818.5	-55870.2	1381.0	5592.9	-1269.8	9435.6	68316.7	60481.5	1381.0
8	-65323.1	-56880.6	1438.8	6023.6	-448.0	9836.2	74534.6	63327.5	1438.8
9	-35787.6	-38514.3	1595.1	5384.1	3745.0	10777.3	43760.2	55049.4	1595.1
10	-23077.5	-27950.0	1773.0	5343.9	5172.4	11667.2	30683.2	47809.5	1773.0
11	-22830.3	-26971.6	1818.7	5359.4	6419.9	11805.4	30431.8	49393.6	1818.7
12	-13865.9	-12966.9	1160.0	4522.3	-2689.1	7492.1	18381.0	5154.8	1160.0
13	-7378.9	-8930.3	449.0	1550.4	-1074.5	2851.0	9595.8	8639.1	449.0
14	-2749.4	-6064.7	434.6	1007.4	1123.7	2818.1	3843.1	10008.7	434.6
15	-430.2	-4949.9	387.8	653.9	1619.1	2534.1	945.4	9838.9	387.8
17	-369.1	-989.8	-10.6	24.3	-1245.3	-86.3	416.5	-1658.1	-10.6
18	2236.0	-627.4	-33.7	-238.2	-1791.4	-241.2	-2744.8	-3478.5	-33.7
19	7186.0	-838.8	-100.0	-777.1	-4107.2	-693.9	-8801.8	-8768.6	-100.0
20	7013.9	-4723.0	-198.6	-926.5	-9582.6	-1404.2	-8750.3	-16464.8	-198.6
21	1989.5	-9533.2	-259.7	-621.6	-14445.4	-1895.9	-2824.1	-21273.6	-259.7
23	4250.4	14269.0	93.8	-111.8	16718.1	764.4	-4645.9	19935.0	93.8
24	-8084.2	3284.5	113.6	748.4	7353.6	856.5	9362.0	12178.4	113.6
[illegible]	-3349.0	-1751.0	62.1	362.2	-853.2	434.5	3793.5	-143.5	62.1
26	-639.0	-866.9	8.6	66.2	-847.2	52.6	722.3	-903.4	8.6
27	411.5	-95.1	-3.9	-30.2	-265.5	-30.1	-475.4	-499.6	-3.9
28	136.0	-.4	-3.7	-26.1	-51.0	-26.1	-174.9	-101.8	-3.7
29	56.2	14.7	-1.7	-14.9	-1.7	-11.1	-77.6	-8.6	-1.7
30	23.9	14.1	-.6	-7.0	8.0	-3.2	-33.3	12.2	-.6
31	10.9	13.8	-.3	-1.8	10.4	-.6	-11.9	15.5	-.3
32	3.5	9.0	-.1	.4	6.8	.9	-.6	10.6	-.1
33	.3	6.9	-.0	1.0	4.5	1.0	2.3	6.7	-.0

(LONGITUDINAL DIRECTION IS ALONG SHELL MIDSURFACE. RADIAL DIRECTION IS NORMAL TO SHELL MIDSURFACE.)

TEMPERATURES PER SEGMENT USED IN PEAK PRINCIPLE ANALYSIS

	OUTSIDE				INSIDE
SEGMENT	T1	T2	T3	T4	T5
1	478	473	445	340	76
2	478	473	445	340	76
3	478	473	445	340	76
4	478	473	445	340	76
5	479	477	458	367	74
6	479	477	458	367	74
7	479	477	458	367	74
8	479	477	458	367	74
9	479	478	468	408	86
10	479	479	478	450	98
11	479	479	478	450	98
12	480	480	480	480	370
13	480	480	480	480	372
14	480	480	480	480	373
15	480	480	480	480	375
16	480	480	480	480	480
17	480	480	480	480	480
18	480	480	480	480	480
19	480	480	480	480	480
20	480	480	480	480	480
21	480	480	480	480	480
22	480	480	480	480	480
23	480	480	480	480	480
24	480	480	480	480	480
25	480	480	480	480	480
26	480	480	480	480	480
27	480	480	480	480	480
28	480	480	480	480	480
29	480	480	480	480	480
30	480	480	480	480	480
31	480	480	480	480	480
32	480	480	480	480	480
33	480	480	480	480	480

5-10

0 0 0 6 1 9 [illegible] 4 3 7

PEAK PRINCIPAL STRESSES

SEG. NO.	OUTSIDE LONG	OUTSIDE HOOP	OUTSIDE RAD.	MIDPLANE LONG	MIDPLANE HOOP	MIDPLANE RAD.	INSIDE LONG	INSIDE HOOP	INSIDE RAD.
1	-27543.0	-27531.5	1554.3	-15022.3	-18992.1	7070.8	116998.3	117022.5	1554.3
2	-27540.7	-27539.2	1554.3	-15022.4	-19002.2	7070.5	116995.8	117009.4	1554.3
3	-27670.4	-27543.5	1554.6	-15014.7	-18961.6	7072.8	117142.7	117104.9	1554.6
4	-26906.9	-27093.9	1554.5	-15061.5	-18689.8	7073.5	116274.4	117162.6	1554.5
5	-43079.7	-23849.0	1572.6	-14925.9	-21386.5	6593.0	144089.4	125578.1	1572.6
6	-22647.9	-24317.9	1801.7	-15130.5	-21049.4	6654.2	122157.7	120199.8	1801.7
	-29215.0	-25329.8	1853.6	-14664.7	-19869.6	7015.7	129573.0	123913.3	1853.6
8	-51361.5	-20006.5	1903.2	-14314.2	-18900.2	7361.7	149265.6	130543.4	1903.2
9	-8671.6	-11506.1	2300.6	-12467.8	-13271.0	7077.4	116882.6	127442.8	2300.6
10	-539.3	-4678.0	3021.6	-10500.4	-10790.6	5249.1	117164.4	128921.4	3021.6
11	93.7	-3446.9	3365.0	-11173.5	-10063.2	3885.7	116628.8	130656.9	3365.0
12	-5298.3	-5127.8	2185.7	-819.6	-6634.8	2194.1	43320.9	32004.4	2185.7
13	-528.6	-1967.7	964.8	-2403.5	-4147.0	286.3	35753.9	35082.0	964.8
14	3105.1	286.6	948.9	-2769.0	-2269.2	325.6	30707.9	35818.6	948.9
15	4972.5	1120.8	901.2	-3007.5	-1829.8	122.8	28163.4	35265.3	901.2
17	755.3	-309.2	-17.8	-97.4	-754.8	-127.5	-933.8	-1365.6	-17.8
18	2962.0	-47.5	-37.8	-319.1	-1279.1	-261.5	-3613.0	-3000.6	-37.8
19	7301.3	-540.5	-98.8	-789.5	-3736.0	-680.5	-8932.7	-8269.7	-98.8
20	6947.1	-4631.7	-195.5	-914.3	-9422.8	-1380.4	-8664.9	-16214.6	-195.5
21	1919.7	-9500.8	-257.3	-610.0	-14369.3	-1878.2	-2738.5	-21142.0	-257.3
23	4133.0	14285.7	95.4	-101.2	16784.9	775.7	-4510.6	20060.6	95.4
24	-8171.0	3257.1	114.8	756.7	7353.1	864.5	9461.6	12205.6	114.8
	-3348.2	-1763.1	62.3	362.5	-868.3	436.2	3791.7	-164.8	62.3
26	-718.6	-840.9	8.5	65.8	-852.5	52.1	716.1	-912.1	8.5
27	467.9	-113.8	-3.9	-30.6	-266.4	-30.5	-478.1	-501.3	-3.9
28	136.7	-.2	-3.7	-26.3	-51.0	-26.2	-175.8	-101.9	-3.7
29	56.4	14.8	-1.7	-15.0	-1.6	-11.2	-77.9	-8.4	-1.7
30	24.0	14.2	-.6	-7.0	8.1	-3.2	-33.4	12.3	-.6
31	11.0	13.8	-.3	-1.8	10.4	-.6	-11.9	15.6	-.3
32	2.5	9.0	-.1	.4	6.8	.9	-.5	10.6	-.1
33	.8	7.0	-.0	1.0	4.5	1.0	2.4	6.7	-.0

(LONGITUDINAL DIRECTION IS ALONG SHELL MIDSURFACE, RADIAL DIRECTION IS NORMAL TO SHELL MIDSURFACE.)

0 0 0 6 1 9 0,4 3

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S-12

TEMPERATURES PER SEGMENT USED IN PRIMARY + SECONDARY ANALYSIS

	OUTSIDE			INSIDE	
SEGMENT	T1	T2	T3	T4	T5
1	0	0	0	0	0
2	0	0	0	0	0
3	0	0	0	0	0
4	0	0	0	0	0
5	0	0	0	0	0
6	0	0	0	0	0
7	0	0	0	0	0
8	0	0	0	0	0
9	1	1	1	0	-0
10	3	2	1	0	-1
11	3	2	1	0	-1
12	16	13	10	7	4
13	29	24	19	13	8
14	42	35	27	20	12
15	69	68	66	65	64
16	69	68	66	65	64

	OUTSIDE				INSIDE
SEGMENT	T1	T2	T3	T4	T5
17	69	68	66	65	64
18	69	68	66	65	64
19	99	97	96	94	92
20	129	127	125	123	120
21	139	139	138	137	136
22	139	139	138	137	136
23	139	139	138	137	136
24	159	158	157	156	155
25	200	197	195	192	190
26	230	227	224	221	218
27	260	257	254	250	247
28	290	285	281	277	272
29	319	314	308	303	298
30	348	342	336	330	323
31	377	370	363	356	349
32	407	399	391	383	374
33	436	427	418	409	400

S-1

0 0 0 6 1 9 0 4 3 9

S-13

PRIMARY + SECONDARY STRESSES

SEG. NO.	OUTSIDE LONG	OUTSIDE HOOP	OUTSIDE RAD.	MIDPLANE LONG	MIDPLANE HOOP	MIDPLANE RAD.	INSIDE LONG	INSIDE HOOP	INSIDE RAD.
1	.0	.0	.0	-.0	.0	.0	-.0	.0	.0
2	.2	-.1	-.0	-.0	-.2	-.0	-.2	-.4	-.0
3	-3.3	-.7	.0	.2	.4	.0	3.8	1.6	.0
4	11.4	11.8	.0	-.7	16.2	.2	-13.0	8.3	.0
5	102.4	-45.0	-.5	-5.9	-90.2	-3.5	-115.5	-145.9	-.5
6	-6.4	-135.3	-1.1	-1.5	-166.9	-8.1	5.4	-205.9	-1.1
7	-183.9	-248.9	-.7	9.0	-243.6	-5.8	204.5	-239.8	-.7
8	-374.8	-341.4	.4	21.6	-288.4	1.0	419.2	-230.2	.4
9	-849.0	-669.1	6.5	67.2	-308.8	40.4	994.4	155.9	6.5
10	-1272.2	-775.4	24.9	153.1	-31.2	157.6	1599.4	1048.4	24.9
11	-1668.9	-732.2	44.0	251.9	212.3	282.8	2134.1	1506.3	44.0
12	-3323.5	-2404.5	81.6	455.2	-151.7	520.5	4234.4	2980.3	81.6
13	-5822.0	-3371.7	172.9	843.6	935.5	1111.6	7481.4	7027.0	172.9
14	-5632.3	-1880.4	312.3	1016.1	4625.1	2061.4	7439.1	13877.5	312.3
15	-3848.8	-3758.9	200.0	1075.6	-2766.8	1308.0	4879.8	-3292.4	200.0
17	-4455.4	-3552.8	39.6	487.2	-2449.5	223.6	5356.4	-1223.1	39.6
18	-2533.0	-1385.2	48.2	305.8	-194.5	301.4	3090.3	1321.3	48.2
19	1279.0	-1836.3	23.8	-36.1	-1962.0	147.3	-1559.6	-2535.6	23.8
20	2986.1	-3546.1	-38.8	-311.8	-4768.8	-299.0	-3699.4	-6811.5	-38.8
21	1485.2	-4658.9	-93.7	-275.3	-6747.5	-703.7	-1961.9	-9809.9	-93.7
23	2870.7	3934.4	15.0	-165.4	4287.7	133.8	-3223.0	4807.2	15.0
24	-1979.1	898.9	32.2	174.4	2397.7	242.3	2306.2	4244.4	32.2
25	-3265.7	-1383.8	47.6	280.9	581.0	328.9	3766.7	2905.8	47.6
26	-3019.4	-2938.8	48.5	279.4	-1277.4	325.0	3466.9	565.5	48.5
27	-2289.7	-2773.8	92.2	184.2	-154.0	603.7	2695.4	3613.2	92.2
28	-2145.0	-2633.2	163.6	338.0	684.5	1048.5	2881.4	5973.4	163.6
29	-1502.4	-2753.7	239.1	476.2	834.3	1487.7	2439.1	6867.2	239.1
30	-912.2	-3242.6	283.6	520.6	191.3	1693.8	1838.4	6063.5	283.6
31	-467.7	-1867.4	205.7	294.9	884.5	1237.4	909.2	5205.6	205.7
32	1123.3	-2133.8	219.8	144.3	259.2	1333.0	-1313.0	3284.4	219.8
33	2604.2	-4118.0	105.7	-155.8	-3345.3	584.1	-3643.2	-4040.5	105.7

(LONGITUDINAL DIRECTION IS ALONG SHELL MIDSURFACE. RADIAL DIRECTION IS NORMAL TO SHELL MIDSURFACE.)

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TEMPERATURES PER SEGMENT USED IN PEAK PRINCIPLE ANALYSIS

OSC 1522

SEGMENT	OUTSIDE T1	T2	T3	T4	INSIDE T5
1	0	0	0	0	0
2	0	0	0	0	0
3	0	0	0	0	0
4	0	0	0	0	0
5	0	0	0	0	0
6	0	0	0	0	0
7	0	0	0	0	0
8	0	0	0	0	0
9	2	1	1	0	0
10	3	2	1	0	0
11	3	2	1	0	0
12	15	13	11	7	3
13	28	24	20	13	7
14	40	35	30	20	10
15	68	68	66	65	65
16	68	68	66	65	65
17	68	68	66	65	65
18	68	68	66	65	65
19	99	98	95	94	93
20	130	127	125	123	120
21	145	137	136	138	137
22	145	137	136	138	137
23	145	137	136	138	137
24	160	158	157	156	155
25	200	197	195	192	190
26	230	227	225	221	218
27	260	257	255	250	247
28	289	285	282	276	272
29	319	314	309	303	298
30	348	342	336	329	323
31	377	370	364	356	349
32	407	399	391	382	374
33	436	427	418	409	400

PEAK PRINCIPAL STRESSES

SEG. NO.	OUTSIDE LONG	OUTSIDE HOOP	OUTSIDE RAD.	MIDPLANE LONG	MIDPLANE HOOP	MIDPLANE RAD.	INSIDE LONG	INSIDE HOOP	INSIDE RAD.
1	.0	.0	.0	-.0	.0	.0	-.0	.0	.0
2	.2	-.1	-.0	-.0	-.2	-.0	-.2	-.4	-.0
3	-3.4	-.7	.0	.2	.4	.0	3.8	1.7	.0
4	11.6	11.9	.0	-.7	10.3	.2	-13.2	8.3	.0
5	123.4	-52.4	-.5	-5.9	-91.4	-3.6	-139.1	-154.0	-.5
6	-7.6	-137.2	-1.1	-1.4	-168.8	-8.2	6.7	-207.9	-1.1
	-187.6	-251.9	-.7	9.2	-246.0	-5.8	208.7	-241.5	-.7
8	-483.5	-311.9	.4	22.0	-290.8	1.1	508.6	-208.6	.4
9	-879.4	-697.3	5.7	82.3	-292.1	44.7	873.0	40.5	5.7
10	-1316.8	-825.6	21.6	184.2	6.6	173.7	1336.2	817.1	21.6
11	-1709.6	-781.7	39.2	285.5	253.1	306.0	1864.6	1272.5	39.2
12	-3070.8	-2154.7	77.8	173.0	-437.6	528.1	4366.2	3109.9	77.8
13	-5276.4	-2821.5	170.9	238.2	318.3	1087.5	8016.0	7524.3	170.9
14	-4842.5	-1027.0	312.7	92.8	3700.3	2009.2	8439.9	14803.6	312.7
15	-3549.2	-3489.5	193.2	1220.9	-2613.2	1309.8	6149.8	-3155.8	193.2
17	-4155.9	-3287.6	26.4	656.5	-2278.4	275.8	4988.6	-1531.0	26.4
18	-2247.1	-1117.9	35.2	476.5	-14.9	355.0	2739.0	1031.1	35.2
19	1313.3	-1793.6	16.4	54.9	-1857.2	181.2	-1624.8	-2574.8	16.4
20	2790.7	-3722.4	-35.5	-312.1	-4751.1	-307.6	-3500.3	-6608.7	-35.5
21	-486.9	-6692.4	-69.4	358.5	-6092.9	-785.1	-2277.2	-10102.0	-69.4
23	1393.2	2425.8	36.1	297.1	4750.0	59.5	-3417.2	4604.3	36.1
24	-2151.2	728.3	43.9	177.7	2406.5	201.2	2262.7	4208.2	43.9
	-3360.4	-1475.6	48.7	184.0	487.5	324.4	3672.8	2816.4	48.7
26	-3402.1	-2784.6	48.1	56.7	-1495.5	324.1	3410.5	518.1	48.1
27	-2469.7	-2544.1	90.4	-164.7	-500.3	602.3	2690.3	3611.6	90.4
28	-2046.8	-2530.9	161.1	45.7	392.6	1043.1	2879.2	5972.6	161.1
29	-1424.7	-2672.6	236.8	240.6	598.7	1478.8	2440.2	6870.1	236.8
30	-854.6	-3182.2	281.8	342.4	13.9	1683.4	1841.4	6069.9	281.8
31	-426.8	-1825.6	204.4	174.4	766.2	1227.7	908.0	5212.2	204.4
32	1145.9	-2111.3	219.0	83.1	201.4	1327.3	-1316.6	3290.2	219.0
33	3438.5	-4462.2	105.4	-157.6	-3344.1	582.2	-3651.4	-4039.7	105.4

(LONGITUDINAL DIRECTION IS ALONG SHELL MIDSURFACE. RADIAL DIRECTION IS NORMAL TO SHELL MIDSURFACE.)

0 0 0 6 [illegible] A 45? . USC 1522

ITER	PRIMARY + SECONDARY STRESS INTENSITIES						PEAK STRESS INTENSITIES					
	L - P		R - H		H - L (5)		L - R		R - H		H - L	
	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSI[illegible]
3	58.1	-53.6	-50.2	50.9	-7.9	2.7	104.1	-42.6	-88.1	25.8	-16.0	16.8
6	65.9	-60.8	-57.0	58.8	-8.9	2.1	103.0	-52.1	-84.8	34.0	-18.2	18.2
8	64.1	-59.2	-55.2	57.8	-8.9	1.4	97.5	-51.9	-79.6	34.8	-18.0	17.6
15	49.7	-45.8	-40.0	44.1	-9.7	1.7	72.7	-50.7	-56.0	37.1	-16.7	13.7
30	1.4	-1.1	1.1	-.5	-2.4	1.7	1.1	-1.5	1.6	-.4	-2.6	1.9
1211	.1	-.1	-.2	-.1	.1	.2	.2	-.1	-.3	-.1	.1	.3
91	-.0	.0	.0	-.0	.0	-.0	-.0	.0	.0	.0	.0	-.0
1	1.7	1.4	-4.0	-2.3	2.3	.0	1.8	1.6	-4.0	-2.3	2.2	.7
27976	-.8	.7	.7	-.2	.2	-.5	-1.0	.8	.7	.0	.3	-.8
42021	.0	.0	.0	.0	.0	.0	-.1	.1	.1	.0	.0	-.1

STRESS OUTPUT ANALYSIS

5072	60.1	-55.4	-50.2	56.3	-9.9	-.8	87.9	-49.1	-69.5	35.3	-18.3	13.
5060	67.0	-61.8	-57.5	58.7	-9.5	3.1	142.5	-44.7	-124.0	25.4	-18.5	19.
5063	83.9	-77.5	-72.4	74.4	-11.5	3.1	129.2	-67.0	-105.9	43.5	-23.3	23.
5124	11.6	-10.6	-4.9	10.1	-6.7	.5	13.7	-12.2	-5.3	8.8	-8.4	3:
5237	2.2	-1.9	.3	1.9	-2.5	.0	2.8	-2.4	.0	1.8	-2.8	.
6059	-.1	.1	.2	.0	-.0	-.2	-.2	.1	.2	.1	-.0	-.
6307	-.1	.1	.1	.0	-.0	-.1	-.1	.1	.2	.1	-.0	-.
338	-5.7	5.3	4.5	-4.8	1.2	-.4	-7.2	6.3	5.1	-4.4	2.0	-1.
0850	-6.7	6.2	6.8	-4.0	-.1	-2.2	-8.4	6.3	7.5	-2.4	.9	-3.
1	1.7	1.4	-4.0	-2.3	2.3	1.0	1.8	1.6	-4.0	-2.3	2.2	.

STRESS OUTPUT ANALYSIS

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ITER	PRIMARY + SECONDARY STRESS INTENSITIES L - R INSIDE	OUTSIDE	R - H INSIDE	OUTSIDE	H - L INSIDE	OUTSIDE	(8) PEAK STRESS INTENSITIES L - R INSIDE	OUTSIDE	R - H INSIDE	OUTSIDE	H - L INSIDE	OUTS
3	63.7	-58.2	-54.7	50.2	-9.0	7.9	109.0	-58.7	-92.9	22.5	-16.0	28.
6	77.5	-70.8	-63.6	54.5	-14.0	11.3	115.0	-67.3	-92.1	31.3	-22.9	36.
8	70.8	-71.9	-62.9	59.2	-16.0	12.6	113.3	-70.6	-88.0	32.7	-25.3	37.
15	60.3	-63.0	-47.3	48.2	-22.0	14.9	95.0	-75.0	-64.2	38.0	-30.9	37.
30	7.7	-6.9	-1.2	1.1	-6.5	5.8	8.7	-9.4	-1.0	1.2	-7.7	8.
1211	-.4	.3	.1	-.1	.3	-.2	-.4	.4	.1	-.1	.4	-.
1491	.0	-.0	.0	.0	-.0	-.0	.0	-.0	.0	.0	-.0	-.
1	2.2	.6	-3.5	-1.6	1.3	1.0	2.5	.9	-3.5	-1.6	1.0	
42021	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	
[illegible]	-.7	.6	1.1	-.3	-.5	-.3	-.8	.5	1.2	.0	-.4	-.

STRESS OUTPUT ANALYSIS

5072	86.0	-78.3	-62.4	60.0	-23.6	18.3	117.3	-80.5	-83.1	34.7	-34.2	45
5060	73.1	-66.8	-61.9	58.3	-11.2	8.4	147.4	-53.3	-128.6	21.9	-18.7	31
5063	97.9	-89.3	-81.4	74.5	-16.4	14.8	143.3	-85.3	-115.7	39.3	-27.6	46
5124	33.0	-29.7	-13.1	15.1	-19.8	14.7	39.9	-36.7	-15.8	11.4	-24.1	25
5237	11.5	-10.4	-3.8	5.5	-7.7	4.9	14.2	-13.4	-5.1	4.8	-9.2	8
6059	.4	-.4	.3	.4	-.7	-.0	.5	-.5	.3	.3	-.8	
6307	.4	-.4	.2	.3	-.6	.0	.5	-.5	.2	.3	-.7	.2
6338	-7.7	7.0	5.6	-5.1	2.1	-1.9	-9.6	8.7	6.6	-4.3	3.1	-4.4
350	-3.5	3.1	-1.0	-.5	4.5	-2.6	-1.3	4.1	-3.4	-.4	4.7	-3.7
1	2.2	.6	-3.5	-1.6	1.3	1.0	2.5	.9	-3.5	-1.6	1.0	.7

STRESS OUTPUT ANALYSIS

5-17

(21)

ITER	PRIMARY + SECONDARY STRESS INTENSITIES						PEAK STRESS INTENSITIES					
	L - R		R - H		H - L		L - R		R - H		H - L	
	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSI[illegible]
3	-2.8	2.5	21.5	9.4	-18.7	-11.9	-2.7	2.4	21.3	9.3	-18.6	-11.[illegible]
6	-3.3	2.9	22.1	9.5	-18.8	-12.4	-3.2	2.8	21.8	9.4	-18.7	-12.[illegible]
8	-3.7	3.3	22.5	9.6	-18.8	-12.8	-3.6	3.2	22.3	9.5	-18.6	-12.[illegible]
15	-4.1	3.6	24.0	10.1	-19.9	-13.7	-4.1	3.5	23.8	10.0	-19.7	-13.[illegible]
30	-3.3	2.8	21.0	10.3	-17.7	-13.1	-4.1	2.5	21.7	10.6	-17.6	-13.[illegible]
1211	-2.1	1.8	19.9	9.1	-17.8	-10.9	-2.2	1.4	20.0	9.6	-17.8	-10.[illegible]
91	-2.4	2.1	21.3	9.5	-18.9	-11.6	-2.4	2.1	21.3	9.5	-18.9	-11.[illegible]
1	1.1	.6	-3.3	-1.2	2.2	.7	1.1	.6	-3.3	-1.2	2.2	[illegible]

STRESS OUTPUT ANALYSIS

5072	-4.7	4.0	23.0	9.4	-18.4	-13.5	-4.6	4.0	22.8	9.3	-18.2	-13
5060	-2.6	2.2	21.0	9.3	-18.4	-11.5	-2.5	2.2	20.9	9.2	-18.4	-11
5063	-3.2	2.8	21.8	9.4	-18.6	-12.2	-3.1	2.7	21.6	9.3	-18.5	-12
5124	-5.6	4.7	21.6	13.3	-16.0	-13.0	-2.7	5.6	18.7	12.3	-16.0	-17.
5237	-5.4	4.5	15.5	11.5	-10.2	-15.9	-4.0	4.7	14.2	11.2	-10.2	-15.
6059	-2.6	2.2	9.7	5.9	-7.1	-3.1	.1	1.8	7.1	6.3	-7.3	-8.
6307	-1.9	1.6	9.7	4.6	-7.8	-6.1	-2.2	-.4	10.0	6.6	-7.8	-6.
6338	-1.4	1.2	9.4	4.6	-8.0	-5.8	-1.8	-.8	9.7	6.6	-8.0	-5.
850	-1.2	1.1	12.2	5.5	-11.0	-6.6	-1.2	1.1	12.2	5.5	-11.0	-6.
1	1.1	.6	-3.3	-1.2	2.2	.7	1.1	.6	-3.3	-1.2	2.2	.

STRESS OUTPUT ANALYSIS

STRESS INSIDE OUTSIDE INSIDE OUTSIDE INSIDE OUTSIDE INSIDE OUTSIDE INSIDE OUTSIDE INSIDE OUTSI

ITER	PRIMARY + SECONDARY STRESS INTENSITIES						PEAK STRESS INTENSITIES					
	L - R		R - H		H - L		L - R		R - H		H - L	
	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSI
3	-5.2	4.6	-19.4	-14.1	24.6	9.5	-5.0	4.4	-19.6	-14.1	24.6	9.
6	-5.9	5.2	-18.8	-14.0	24.7	8.9	-5.7	5.0	-19.0	-14.1	24.7	9.
8	-6.6	5.8	-18.3	-14.1	24.9	8.3	-6.4	5.7	-18.6	-14.2	25.0	8.
15	-7.2	6.4	-17.1	-13.6	24.4	7.3	-7.2	6.3	-17.3	-13.7	24.4	7.
30	-5.8	5.1	-19.2	-13.3	25.0	8.2	-6.2	4.8	-18.9	-13.1	25.1	8.
1211	-3.9	3.4	-20.0	-13.8	23.9	10.8	-4.0	3.1	-19.9	-13.4	23.9	10.
191	-4.4	3.9	-21.0	-14.7	25.4	10.8	-4.4	3.9	-21.0	-14.7	25.4	10.
1	1.9	.4	-3.3	-1.4	1.4	.9	1.9	.4	-3.3	-1.4	1.4	.
27976	-4.0	3.5	-20.3	-14.0	24.1	10.6	-4.0	3.5	-20.1	-14.0	24.1	10.
42321	-4.5	3.9	-20.7	-14.6	25.2	10.7	-4.5	3.1	-20.7	-14.6	24.2	10.

STRESS OUTPUT ANALYSIS

5072	-8.1	7.1	-17.7	-14.4	25.8	7.3	-8.0	7.0	-17.9	-14.4	25.9	
5060	-4.7	4.2	-19.8	-14.2	24.6	10.0	-4.6	4.0	-20.0	-14.2	24.6	
5063	-5.8	5.1	-19.0	-14.1	24.8	9.1	-5.6	4.9	-19.2	-14.2	24.8	
5124	-9.5	8.4	-16.4	-12.3	25.9	3.9	-9.3	8.2	-16.8	-12.1	26.1	
5237	-8.9	7.8	-18.9	-10.6	27.8	2.7	-8.0	8.1	-19.9	-10.9	28.0	
6059	-4.5	3.9	-5.4	-4.4	9.8	.5	-5.0	3.3	-5.0	-3.7	10.0	
6307	-3.2	2.9	-4.8	-3.9	8.0	1.1	-3.5	1.4	-4.6	-2.4	8.0	
6338	-2.6	2.2	-5.2	-3.8	7.7	1.6	-2.8	.8	-4.9	-2.3	7.7	
6850	-2.4	2.1	-11.6	-8.1	14.0	6.0	-2.4	2.1	-11.5	-8.1	13.9	
1	1.9	.4	-3.3	-1.4	1.4	.9	1.9	.4	-3.3	-1.4	1.4	

STRESS OUTPUT ANALYSIS

JUNCTION NO. 433

ITER	PRIMARY + SECONDARY STRESS INTENSITIES L - R INSIDE	L - R OUTSIDE	R - H INSIDE	R - H OUTSIDE	H - L INSIDE	H - L OUTSIDE	PEAK STRESS INTENSITIES L - R INSIDE	L - R OUTSIDE	R - H INSIDE	R - H OUTSIDE	H - L INSIDE	H - L OUTSIDE
3	.0	.0	-.0	-.0	.0	.0	.0	.0	-.0	-.0	.0	.0
6	.0	.0	-.0	-.0	.0	.0	.0	.0	-.0	-.0	.0	.0
8	.0	.0	-.0	-.0	.0	.0	.0	.0	-.0	-.0	.0	.0
15	.0	.0	-.0	-.0	.0	.0	.0	.0	-.0	-.0	.0	.2
30	.6	-.5	-.6	.5	-.0	.0	1.5	-.3	-1.4	.1	-.0	-.4
1211	-.3	.3	.3	-.0	.0	-.2	-.3	.3	.3	.0	.0	.0
91	.0	.0	-.0	-.0	.0	.0	.0	.0	-.0	-.0	.0	.1
1	1.1	.1	-2.2	-.3	1.2	.2	1.1	.2	-2.2	-.3	1.2	
5072	.0	.0	-.0	-.0	.0	.0	.0	.0	-.0	-.0	.0	
5060	.0	.0	-.0	-.0	.0	.0	.0	.0	-.0	-.0	.0	
5063	.0	.0	-.0	-.0	.0	.0	.0	.0	-.0	-.0	.0	
5124	2.3	-1.8	-2.3	1.8	.1	.0	4.5	-1.4	-4.5	.6	-.1	
5237	1.8	-1.5	-2.0	3.2	.2	-1.7	3.2	-1.0	-3.3	2.0	.1	-1
6059	-1.7	1.1	2.1	3.3	-.3	-4.4	.1	2.6	.4	2.3	-.5	-.
6307	-3.7	2.5	4.1	4.2	-.4	-6.7	-3.8	3.3	4.1	4.6	-.4	-7.
6338	-3.7	2.5	4.1	4.2	-.4	-6.7	-3.8	3.3	4.1	4.6	-.4	-7.
6850	-5.6	4.1	6.4	.1	-.8	-1.2	-5.6	5.4	6.4	.6	-.8	-6.
1	1.1	.1	-2.2	-.3	1.2	.2	1.1	.2	-2.2	-.3	1.2	.

STRESS OUTPUT ANALYSIS

5-22

DETERMINATION OF MAXIMUM STRESS INTENSITIES RANGES AND FATIGUE ANALYSIS

Segment 5: Page 5-16 gives a summary of thermal stress intensities plus a stress intensity for a 1000 psi pressure. The worst stress intensity range for segment 5 would be full range of thermal stress from rapid depressurization plus pressure variation of 1500 psi (pressure at start of rapid depressurization) to 800 psi (pressure at time of reversal in thermal stress). The smaller pressure range is chosen since the pressure stresses are small and even the range of 2500 psi is less than the reversal in thermal stress. This will be assumed to occur 40 times.

The next maximum range comes from maximum thermal stress in the test transient plus range in pressure of 2200-0 psi (2200 psi is pressure at time of test).

The third range can be found using all the miscellaneous transients excluding the rapid depressurization and test transient. This last range will be shown to be acceptable for infinite number of cycles.

Segment 8 is analyzed for essentially same conditions as segment 5.

Segment 23, the carbon steel segment, is analyzed differently since it has less radial gradient thermal effects and its stress picture is more dependent on the temperature of the segment because of the bimetal weld.

Thus its highest stress intensity is derived from the range of its highest thermal stress to 0 stress plus the range of pressure from 2500 psi to 0. It is shown that all other ranges are essentially insignificant.

NOTE: This fatigue analysis includes thermal and mechanical discontinuity stresses only. For inclusion of stresses due to run and branch pipe motions, see Section "F".

D.MCK.
10/29/73
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CRITICAL STRESS JUNCTURE 5 (STAINLESS)

PRIMARY + SECONDARY STRESS

MAX. THERMAL STRESS RANGE = 83.9 - (-6.7) = 90.6 KSI
ITER. 5063 ITER. 6850

MAX. PRESSURE RANGE = 1500 - 800 = 0.7(1.7) = 1.2 KSI

$S_N = 90.6 + 1.2 = 91.8$ KSI $> 3S_m = 51.3$ KSI

ELASTIC - PLASTIC ANALYSIS WILL BE PERFORMED

1.) EQUATION 9 IS SATISFIED

2.) IT WILL BE SHOWN THAT PRIMARY PLUS SECONDARY STRESS RANGES DO NOT EXCEED $3S_m$ MORE THAN 250 CYCLES.

THE ABOVE RANGE WAS REPRESENTATIVE OF THE RAPID DEPRESSURIZATION CYCLE. THEREFORE IT OCCURRED 40 CYCLES.

- NEXT MAXIMUM RANGE WILL BE FROM THE TEST TRANSIENT -

RANGE IN THERMAL STRESS = 65.9 KSI
ITER. 6

RANGE IN PRESSURE 2200 PSI - 0 = 2.2(1.7) = 3.74 KSI

$S_N = 65.9 + 3.74 = 69.64$ KSI $> 3S_m = 51.3$ KSI

ACTUAL CYCLES = 40

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CRITICAL STRESS JUNCTURE 5

NEXT MAX. RANGE OF PRIMARY + SECONDARY STRESSES

RANGE OF THERMAL STRESS DISREGARDING RAPID DEPRESSURIZATION AND TEST TRANSIENT = LESS THAN 5 KSI.

RANGE OF PRESSURE = 2.5(4) = 10 KSI

$S_N = 5 + 10 = 15 \text{ KSI} < 3S_m = 51.3 \text{ KSI}$

THEREFORE, PRIMARY + SECONDARY STRESSES EXCEED $3S_m$ ONLY 80 CYCLES.

0 0 0 6 1 [illegible] 0 4 4 9

5-2472

FATIGUE ANALYSIS OF JUNCTURE 5

CASE 1 RAPID DEPRESSURIZATION CYCLES = 40

PEAK THERMAL STRESS RANGE (PG. 5-16) = 142.5 + 8.4 = 151 KSI
PEAK PRESSURE STRESS RANGE (PG. 5-16) = .7(1.8) = 1.3 KSI

$S_p = 151 + 1.3 = 152.3$ KSI $K_e = 1/.3 = 1/n$ $S_n > 1.7(3S_m)$

$S_{ALT} = .5(1/.3)(152.3) = 254$ KSI

ALLOWABLE CYCLES = 55 $U_1 = \frac{40}{55} = 0.727$

CASE 2 TEST TRANSIENT TO ZERO STRESS STATE CYCLES = 40

PEAK THERMAL STRESS ITER. 3 = 104.1 KSI
PEAK PRESSURE STRESS AT 2200 PSI = 2.2(1.8) = 3.96 KSI

$S_p = 104.1 + 3.96 = 108$ KSI

$$K_e = 1 + \frac{(1+n)}{n(m-1)}\left[\frac{S_n}{3S_m} - 1\right] = 1 + \frac{.7}{3(.7)}\left[\frac{79.74}{51.3} - 1\right] = 2.523$$

$S_{ALT} = 0.5(2.523)(108) = 136$ KSI

ALLOWABLE CYCLES = 360 $U_2 = \frac{40}{360} = 0.111$

NOTE: THIS FATIGUE ANALYSIS INCLUDES THERMAL AND MECHANICAL DISCONTINUITY STRESSES ONLY. FOR INCLUSION OF STRESSES DUE TO RUN AND BRANCH PIPE STRESSES, SEE SECTION "F"

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CASE 3 ALL OTHER CONDITIONS

THERMAL STRESS RANGE LESS THAN 10 KSI
PEAK PRESSURE STRESSES = 2.5(4) = 10 KSI

$S_P = 10 + 10 = 20$ KSI

$S_{ALT} = 10$ KSI ALLOWABLE CYCLES = ∞

THEREFORE,

$U_{TOTAL} = U_1 + U_2 = 0.727 + .111 = 0.838 < 1.0$

NOTE: THIS FATIGUE ANALYSIS INCLUDES THERMAL AND MECHANICAL DISCONTINUITY STRESSES ONLY. FOR INCLUSION OF STRESSES DUE TO RUN AND BRANCH PIPE MOTIONS, SEE SECTION "F".

1-2421

CRITICAL STRESS JUNCTURE 8

PRIMARY + SECONDARY RANGE

THERMAL STRESS RANGE = 97.9 − (−7.7) = 105.6 KSI
ITER. 5063 ITER. 6338

PRESSURE STRESS RANGE
PRESSURE AT ITER. 5063 = 1500 PSI S = 3.3 KSI
PRESSURE AT ITER. 6338 = 800 PSI S = 1.76 KSI

TOTAL S = 105.6 + 3.3 − 1.76 = 107 KSI > $3S_m$ = 51.7 KSI

AN ELASTIC-PLASTIC ANALYSIS PER THE USAS B31.7 CODE, PARA. I-705.4 WILL BE PERFORMED.

DETERMINE NUMBER OF CYCLES $3S_m$ CAN BE EXCEEDED.

1.) THE ABOVE CASE COMES FROM TIMES WITHIN THE RAPID DEPRESSURIZATION TRANSIENT. THEREFORE, THE NUMBER OF CYCLES = 40

2.) DETERMINE NEXT THE MAXIMUM RANGE OF STRESSES

0 0 0 6 1 0 0 4 5 2

OSC 1522

STRESS JUNCTURE 8

NEXT MAXIMUM RANGE COMES FROM THE TEST TRANSIENT AND A NO FLOW CONDITON. CYCLES = 40

THERMAL RANGE = 78.8 − (−.7) = 79.5 KSI
ITER. 8 ITER. 27976

PRESSURE RANGE = 2500 − 2200 = 300 PSI
MAX. TEST

A WORST CASE IS DISREGARDING THERMAL STRESS REVERSAL AND USING P_{RANGE} OF 2200

$S_{MAX} = 78.8 + 2.2(2.2)_{(L-R)} = 83.6$ KSI > $3S_m = 51.3$ KSI

3.) NEXT MAXIMUM RANGE EXCLUDING RAPID DEPRES. / TEST TRANSIENT

THERMAL RANGE = 1.1 KSI ITER. 27976
PRESSURE RANGE = 2500 PSI; $S = 2.5(3.5)_{(R-H)} = 8.75$ KSI

$S_{MAX} = 1.1 + 8.75 = 9.85$ KSI < $3S_m = 51.3$ KSI

NUMBER OF CYCLES OVER $3S_m$ = 40 + 40 = 80 < 250

THEREFORE $3S_m$ IS NOT EXCEEDED MORE THAN 250 CYCLES AND ALL ELASTIC-PLASTIC REQUIREMENTS ARE MET.

0005100453

FATIGUE ANALYSIS OF JUNCTURE 8

CASE-1 RAPID DEPRESSURIZATION TRANSIENT 90 CYCLES

PEAK THERMAL RANGE (PG. 5-17) = 147.4 - (-9.6) = 157 KSI
PEAK PRESSURE RANGE (PG. 5-17) = 0.7(2.5) = 1.75 KSI

$S_{PEAK} = 157 + 1.75 = 158.7$ KSI

CALCULATE K_e FACTOR FOR ELASTIC-PLASTIC FACTOR. THE 1971 SECTION III EQUATION WILL BE USED SINCE IT IS MORE CONSERVATIVE THAN THE B31.7 1968 DRAFT VERSION.

$K_e = 1/n = 1/.3 = 3.33$ SINCE S_N EXCEEDS $1.7(3S_m) = 87.2$ KSI

$\therefore S_{ALT} = \frac{1}{2}(3.33)(158.7) = 264$ KSI $\therefore$ ALLOWABLE CYCLES = 60

$U_1 = \frac{90}{60} = 0.667$

CASE-2 TEST TRANSIENT COMBINED WITH A NO FLOW CONDITION - 90 CYCLES

PEAK THERMAL RANGE (PG. 5-17) = 115 KSI
PEAK PRESSURE RANGE (PG. 5-17) = 2.2(2.5) = 5.5 KSI

$S_P = 115 + 5.5 = 120.5$ KSI

NOTE: THIS FATIGUE ANALYSIS INCLUDES THERMAL AND MECHANICAL DISCONTINUITY STRESSES ONLY. FOR INCLUSION OF STRESSES DUE TO RUN AND BRANCH PIPE MOTIONS, SEE SECTION "F".

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OSC 1522

JUNCTURE 8 (CONTINUED)

$K_e = 1/n = 3.33$ $S_{ALT} = 1/2(3.33)(120.5) = 201.0$ KSI

ALLOWABLE CYCLES = 140

$U_2 = \frac{40}{140} = 0.286$

CASE - 3 MAXIMUM RANGE EXCLUDING RAPID DEPR. + TEST

PEAK THERMAL RANGE (PAGE 5-17) = 1.2 KSI
PEAK PRESSURE RANGE (PAGE 5-17) = 2.5(3.5) = 8.75 KSI

$S_p = 1.2 + 8.75 = 9.95$ KSI $S_{ALT} = 5$ KSI

ALLOWABLE CYCLES = ∞ $U_3 = 0.0$

$\therefore U_{TOTAL} = U_1 + U_2 = 0.667 + 0.286 = 0.953 < 1.0$

NOTE: THIS FATIGUE ANALYSIS INCLUDES THERMAL AND MECHANICAL DISCONTINUITY STRESSES ONLY. FOR INCLUSION OF STRESSES DUE TO RUN AND BRANCH PIPE MOTIONS, SEE SECTION "F".

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CRITICAL STRESS JUNCTURE 23 CARBON STEEL
PRIMARY + SECONDARY STRESS

MAX. RANGE OF THERMAL STRESS = 27.8 KSI [H-L INSIDE]
(PG 5-17)

MAX. RANGE OF PRESSURE = 2500 PSI
$S_{PRESS} = 2.5(3.3) = 8.25$ KSI

$S_N = 27.8 + 8.25 = 36.05$ KSI $< 3S_m = 53.4$ KSI

THEREFORE, THIS JUNCTURE DOES NOT EXCEED THE $3S_m$ LIMIT.

FATIGUE ANALYSIS OF JUNCTURE 23

CASE-1 MAXIMUM STRESS IN CONJUNCTION WITH ZERO STRESS STATE CYCLES = 290

MAX. PEAK THERMAL STRESS = 28 KSI ITER. 5237 (H-L INSIDE)
MAX. PEAK PRESSURE STRESS = 3.3(2.5) = 8.25 (R-H INSIDE)

$S_p = 28 + 8.25 = 36.25$ KSI $S_{ALT} = 18$ KSI

ALLOWABLE CYCLES = 35000

$U_1 = \frac{290}{35000} = 0.007$

NOTE: THIS FATIGUE ANALYSIS INCLUDES THERMAL AND MECHANICAL DISCONTINUITY STRESSES ONLY. FOR INCLUSION OF STRESSES DUE TO RUN AND BRANCH PIPE MOTIONS, SEE SECTION "F".

0 0 0 5 1 0 0 4 5 5

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CASE - 2 MAXIMUM STRESS RANGE DISREGARDING HEAT-UP & COOL-DOWN

PEAK THERMAL STRESS RANGE = 26.1 - 10 = 16.1 KSI
ITER. 5724 ITER. 6059

PEAK PRESSURE RANGE = (2.5 - 1.7) 3.3 = 2.64 KSI
THIS MAX. PRESSURE - MIN. PRESSURE (REACTOR TRIP + B) DISREGARDING ZERO STRESS STATE.

$S_P = 16.1 + 2.64 = 18.74$ KSI

$S_{ACT} = 9.4$ KSI ALLOWABLE CYCLES = ∞

$U_{TOTAL} = U_1 = 0.007 < 1.0$

(O.K.)

NOTE: THIS FATIGUE ANALYSIS INCLUDES MECHANICAL AND THERMAL DISCONTINUITY STRESSES ONLY. FOR INCLUSION OF STRESSES DUE TO RUN AND BRANCH PIPE MOTIONS, SEE SECTION "F"